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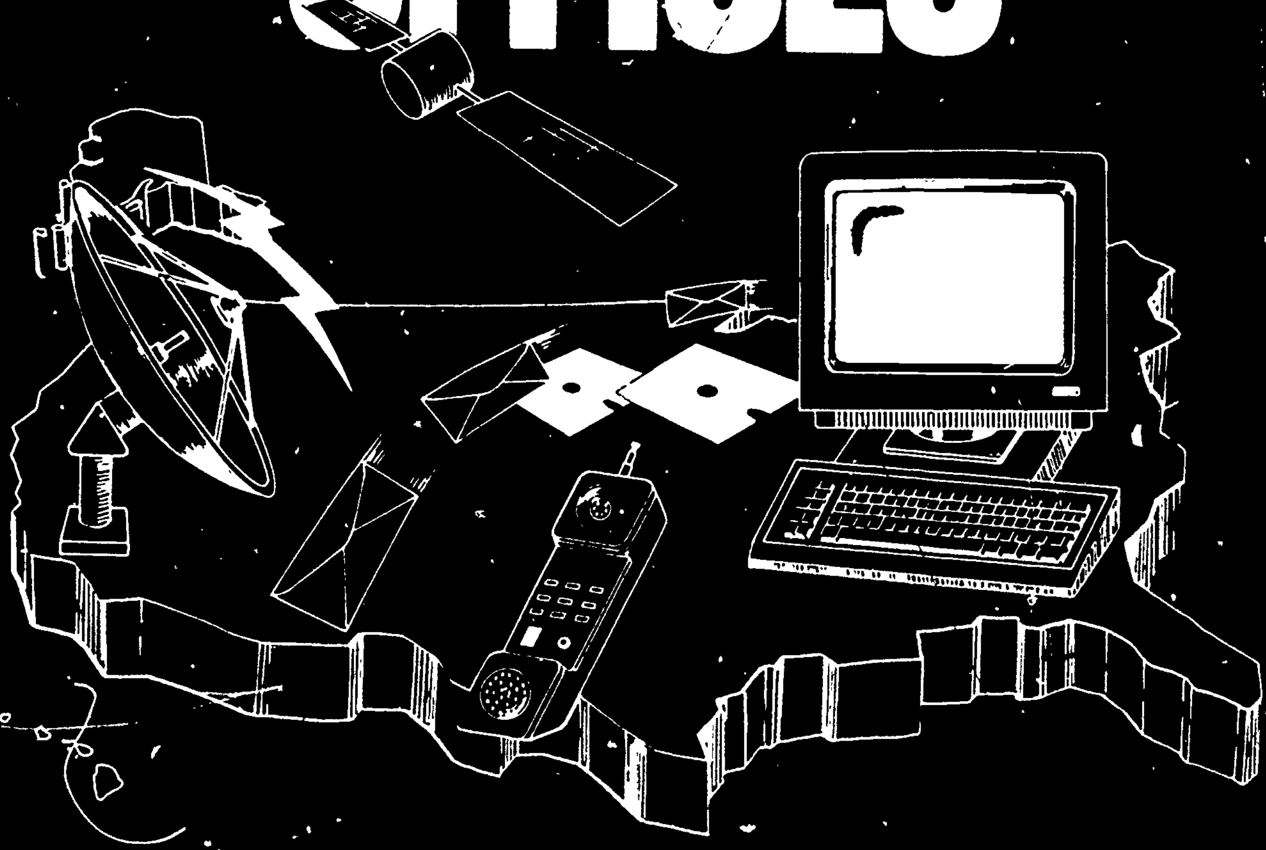
ABSTRACT

This study assesses the consequences of the continuing and rapid introduction of information and telecommunications technologies in offices. The report of the study contains 12 chapters. After a brief look at the context of office automation from the perspective of history, the first chapter highlights some expectations about the technologies and their development over the next 15 years. It also introduces a framework that guides the assessment, summarizes the findings, and identifies policy issues for the next decade. 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 by office automation: home-based work and performance of data-entry operations in countries with lower paid workers. Chapter 9 and 10 look at office automation in the public sector, while Chapter 11 deals with office automation and small businesses. The final chapter considers the implications of office automation for two groups: working women and minorities. Appendix A describes office automation technology as it is now and as it is likely to develop between 1985 and 2000, while Appendix B summarizes case studies of the automation of several offices. (KC)

AUTOMATION OF AMERICA'S OFFICES



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Foreword

Automation of America's Offices, 1985-2000, assesses the consequences of the continuing and rapid introduction of information and telecommunications technologies in offices: the workplace of about 45 million Americans. The use of computers and new communication systems in offices is bringing about fundamental changes in employment patterns, the skills needed for white-collar occupations, and the quality of worklife and the office environment. These changes will affect all industry sectors, since office work is a growing component of every industry as well as all public sector organizations.

The study, requested by the Senate Committee on Labor and Human Resources and the House Committee on Education and Labor, will also be of interest to many other congressional committees because it addresses a wide range of subjects of concern to industry, government, and educational institutions, and to employers, employees, and their organizations.

OTA wishes to thank the many people and organizations that contributed to this assessment through advisory panels, workshops, interviews, and other means of sharing their information and experience with us. The final responsibility for the study, however, rests with OTA.

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Contents

Chapter	Page
1. The Outlook for Office Automation: 1985-2000	3
2. Productivity and Employment	33
3. Training and Education for Office Automation	75
4. The Changing Nature of Office Work	95
5. Office Automation and the Quality of Worklife	125
6. Confidentiality and Security Issues With Office Automation	171
7. Home-Based Automated Office Work	189
8. Off-Shore Office Work	211
9. The Automation of Federal Government Offices	233
10. Office Automation in State and Local Governments	265
11. Office Automation in Small Business	283
12. Office Automation and Differentially Affected Groups: Women and Minorities	297
Appendix A—The Technology of Office Automation	307
Appendix B—OTA Case Studies	330

Chapter 1

The Outlook for Office Automation Technology, 1985-2000

Contents

Page

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 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

Figure No. *Page*

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

Chapter 1

The Outlook for Office Automation Technology, 1985-2000

INTRODUCTION

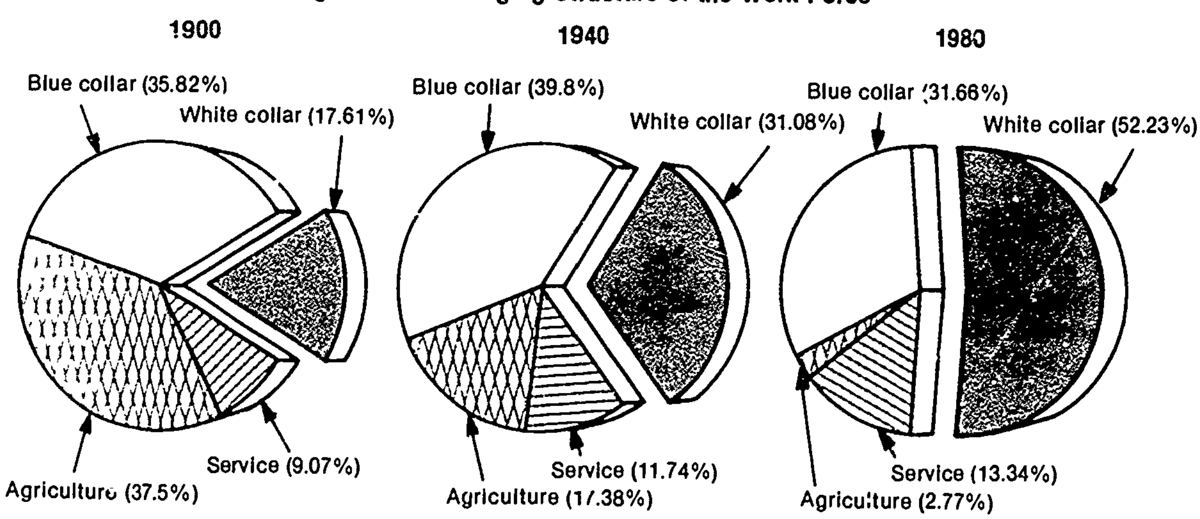
America has become an information society. Our economy is driven as surely by the incessant demand for information as it is by the continuing necessity of converting raw materials into finished products.

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 employment"[1] 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 employment will depend in large part on the interactions between them.

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

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 conceptual 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 offshore 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-

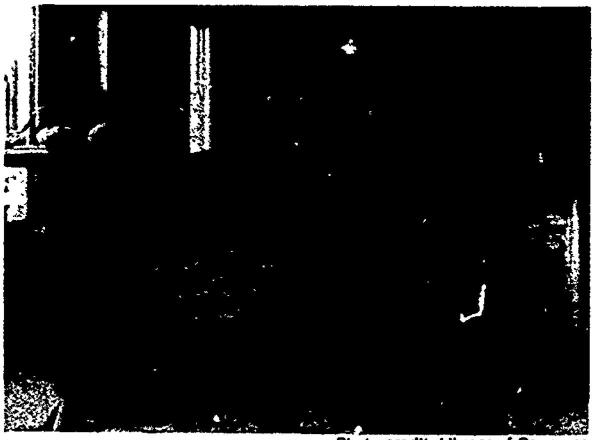


Photo credit: Library of Congress

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 tracking, monitoring, recording, directing, and supporting complex human activities.[2] 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 communication devices and systems that can link them together.

[2]By 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.

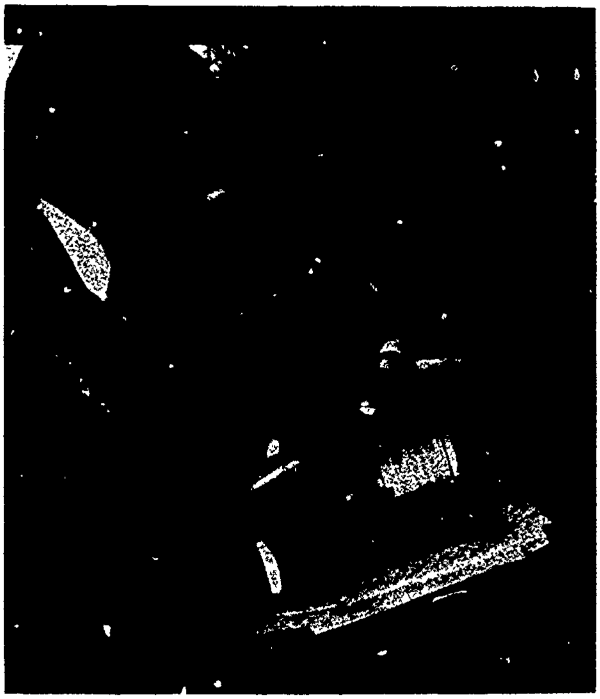


Photo credit: Motorola Inc.

Cellular mobile telephones are one example of how telecommunication technologies can affect where office work is done

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

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

[4]One 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. 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.

[5]Note 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.

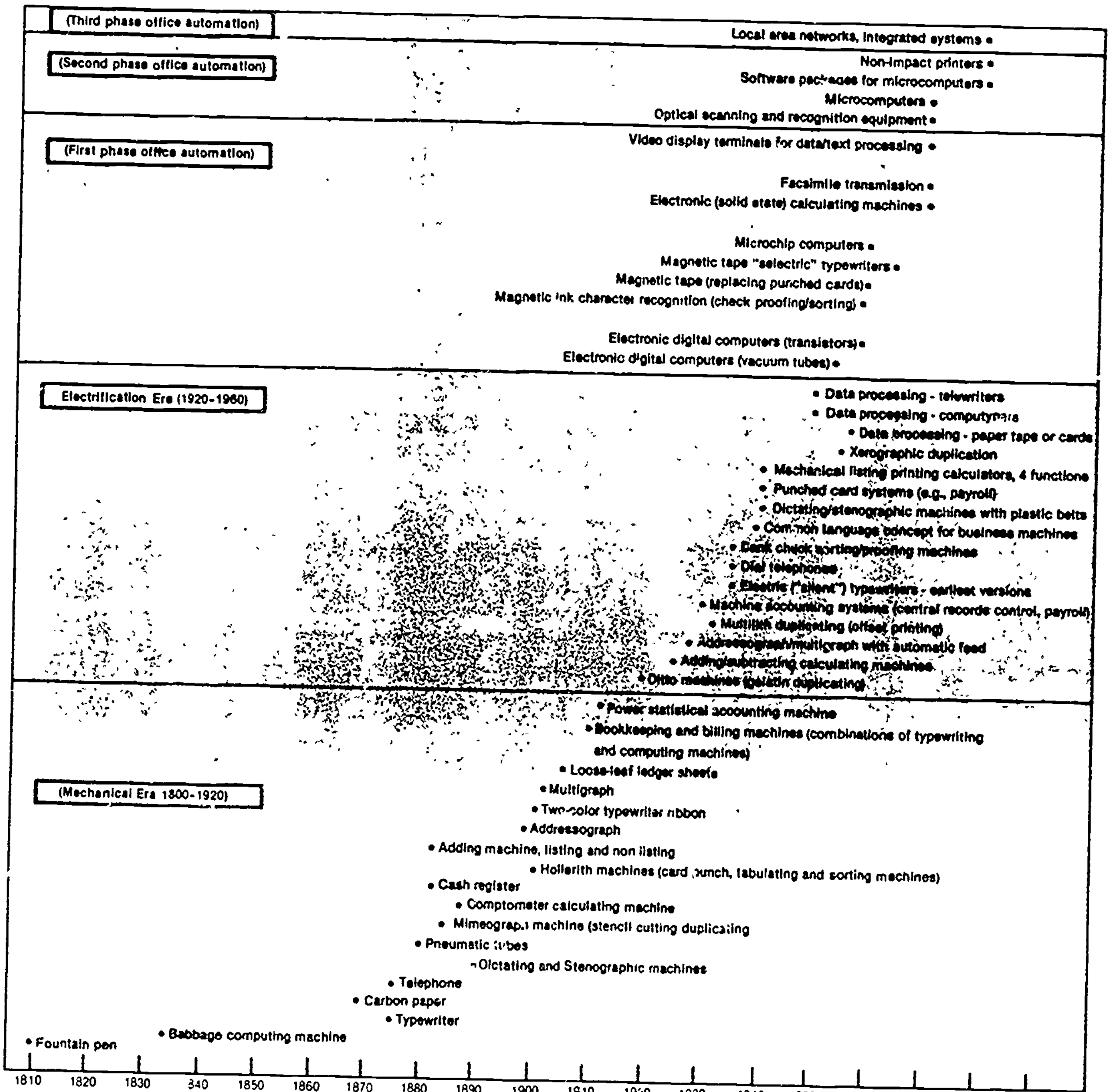
UNDERSTANDING THE IMPACTS OF OFFICE AUTOMATION

In carrying out this assessment, OTA used a simple conceptual model as an aid in looking for the possible effects.[6] (See figure 1-3.) It suggests that when organizations adopt new technology, there are likely to be three kinds 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

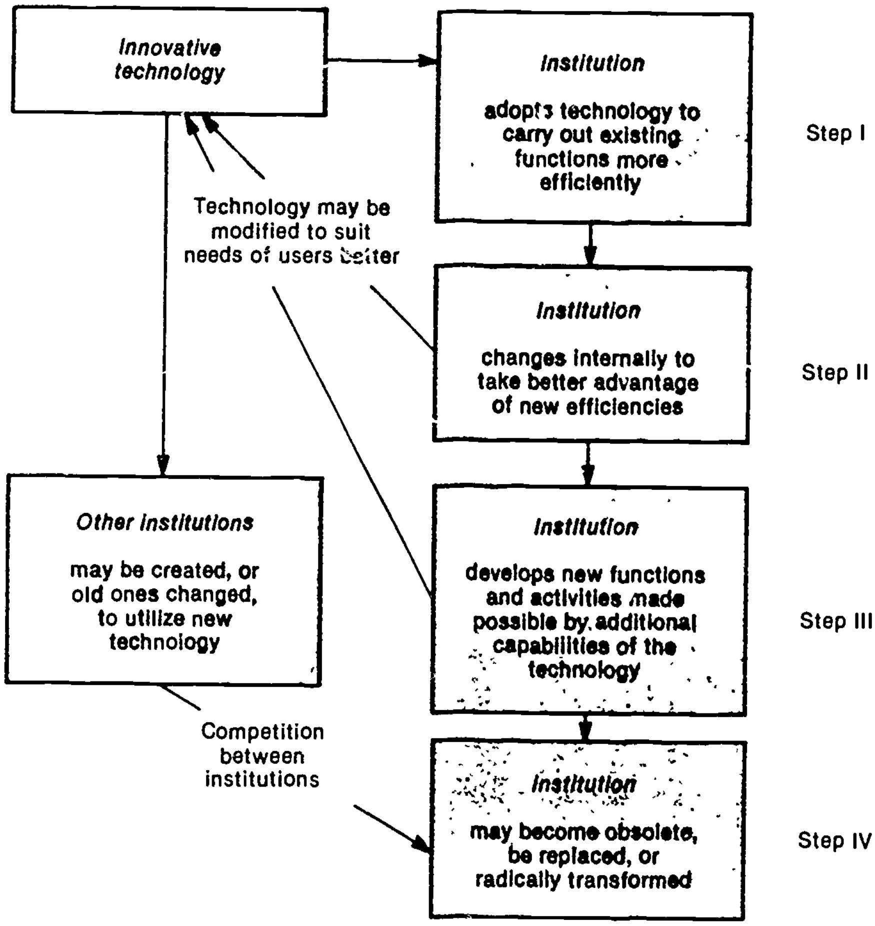
[6]This model was developed by J.F. Coates and V.T. Coates; for an example of other assessments in which it has been used, see V.T. Coates, et al., *A Retrospective Technology Assessment: Submarine Telegraphy* (San Francisco: San Francisco Press, 1980); and V.T. Coates, "The Potential Impacts of Robotics,"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

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.

[7]See 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 superceding 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.

[8]The 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 uncontrolled 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.[9] 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 rekeyboarded 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

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

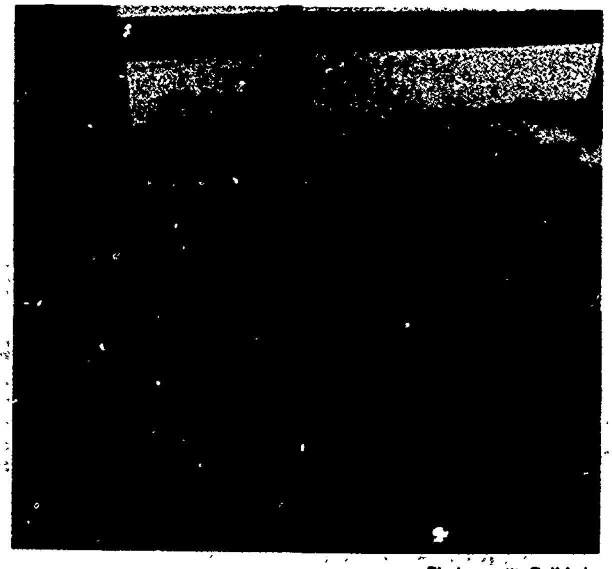


Photo credit: Bell Labs

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 technology; 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.

[10]The 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.[11]

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 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.[12]

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

[11] 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.

[12] 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 crossover 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 a new 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 a way 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. Information 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 organizations 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 competition, 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 home-based 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 entrepreneurs 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 hampering 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-co[llar] employment, working conditions, and care[er] 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 overgrading. 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 Congress 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 automation 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 office 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 may be 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 white-collar 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 colleges 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 additional 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.

Chapter 2

Productivity and Employment

Contents

	Page
The Uncertain Outlook	33
The Framework for Analysis	34
What Follows	36
Recent Labor Force Projections	37
Productivity and the Nature of White-Collar Work	45
How Office Automation Affects Employment	47
Emerging Occupational Shifts	50
Technology and Recent Trends in White-Collar Employment	56
Part-Time and Temporary Employment	59
Analogies From Past Waves of Automation	64
The Future White-Collar Labor Supply	67
Conclusions	68
Policy Considerations: Labor Market Adjustment Options	68
The Need for Monitoring of Structural Economic Change Related to Information Technologies	68
Longer Range Policy Options	69
What Action Is Needed Now?	71

Tables

Table No.	Page
2-1. Growth in Selected Occupations as Projected by the Bureau of Labor Statistics, 1982-95	38
2-2. Percent of Total Work Force in Occupational Groups by Selected Industry Sectors, 1982	51
2-3. The Growth in the Number of Clerical Jobs, 1950-84	57
2-4. Changes in the Percent of Total Employment for Involuntary and Voluntary Part-Time Workers as Percent of Total Employment, 1968-84	59
2-5. Shifts in Employment by Industry Sectors, 1900-80	65
2-6. National Unemployment Rates During Recession Troughs and Recovery Peaks, 1961-84	66

Figures

Figure No.	Page
2-1. Framework Describing the Relationship of Office Automation to Changes in the Number of Office Jobs	35
2-2. Framework for Analyzing Long-Range Effects of Office Automation on White-Collar Employment	50
2-3. Changing Percentage of Work Force From 1900-80 White-Collar Compared to Blue-Collar	56
2-4. Capital Investment Per Production Worker, 1970-80	57
2-5. Changes in the Percent of Total Employment for Involuntary and Voluntary Part-Time Workers, 1968-84	59

Chapter 2

Productivity and Employment

Office automation promises an increase in productivity in all sectors of the U.S. economy, because all industry sectors increasingly depend on information as a major component of products and service. Office automation will significantly reduce the number of jobs required for a given volume of information-handling work. It will also fuel a growing demand for information and information processing.

Thus, it is possible that there will be continuing strong demand for additional office workers. **The most likely outcome is, however, slowing growth in the number of office jobs, and eventually, an absolute reduction in the number of jobs in offices from some peak in the 1990s.** While the latter outcome is by no means certain, there is sufficient evidence pointing in this direction to justify 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.

THE UNCERTAIN OUTLOOK

The first two conclusions—that work required for handling a given volume of information will decrease, and that demand for information will grow—can be made with considerable certainty. Between these two conclusions and the third, that the number of office jobs may ultimately decline, lie several large questions. The most important is, "how much will the total volume of information-handling increase?" Second, what are "information-handling" jobs, and which ones will be affected? Third, if there is a stable or lower demand for white-collar work, are there ways of adjusting without creating structural unemployment?

This assessment indicates that, with the amazing capability inherent in computer and communications technologies, even the needs of a thoroughly information-driven economy do not, in the long term, assure rising levels of white-collar employment equal to growth of the labor force. That labor force by the year 2015 will be about 142 million people or 35 percent larger than it is now. But the number of people entering the work force each year is declining. If the transition to stable or declining office employment is slow enough then the negative effects would be muted. If there is strong economic growth, then office employment could continue to grow, although more slowly than in the past. Strong continuing economic growth like that of the 1950s and 1960s is not, however, certain in the future.

The overall employment effects of the first phase of office automation, the large computers installed in the 1960s and 1970s, have been hard to detect amid other changes in the economy. But the second phase of office automation, decentralized computing and advanced communication capability, is spreading rapidly. The third phase, the evolution of integrated office systems or networking, will bring about much restructuring of the flow of work in and between offices.

Delayed effects of the first phase and the emerging effects of the second and third phases are overlapping. From this perspective, it is possible to see the latent productivity enhancing effects of office automation as water building up behind a dam. The dam is made of institutional inertia and the unavoidable transition problems. When that is removed, there could be a flood of work force reductions, unless workers are channeled into productive new jobs and industries.

Organizations often resist laying off workers when they adopt labor-saving technology, preferring, when possible, to let attrition solve the adjustment problem. This is one example of institutional inertia. But every year some firms go out of business and some new businesses are started. New organizations are likely to use new technology from the beginning, creating fewer jobs than new starts would otherwise create. This is probably already happening; for example, Dun and Bradstreet reported that in 1984 more new firms were started than in 1983, but they employed nearly 5 percent fewer people. In the financial, insurance, and real estate industries, which are the leaders in office automation, the number of workers hired by new organizations declined by over 9 percent.[1] If new organizations tend to create fewer jobs because they make effective use of new technology, then employment effects would tend to accelerate over time.

Which white-collar jobs will be affected? Most directly and strongly, they will be clerical jobs. The number of professional and managerial jobs is apt to be less strongly affected and professional work may continue to expand indefinitely in an information society. However, even managerial and professional jobs are not immune from the labor-saving effects of office automation.

Businesses are now engaged in strong efforts to reduce labor costs and to increase productivity. *Forbes Magazine* reported that the nation's 500 largest publicly owned companies (which account for about a fifth of all civilian employment) expanded their total sales in 1984 by 4 percent and at the same time shrank the number of people on their payrolls by 4 percent, or 840,000.[2] Sales per employee rose by 10 percent, and assets per employee rose by 11 percent; these are two rough measures of increasing productivity. There are other signals of pressure on employment growth despite continuing job creation. During recent business cycles, unemployment rates in "business recovery years" have remained higher than they were in recession years before the mid-1960s, in spite of the creation of thousands of new jobs. The number of involuntary part-time workers is continuing to grow. These indicators are not tied directly to office automation, yet there is a strong possibility that some of the effects on employment of two decades of office automation are now becoming apparent.

The Framework for Analysis

The long range effects of office automation on office employment are pictured, in figure 2-1, as a dynamic interaction between:

- growth in demand for information, and
- the labor-saving characteristics of office automation technology.

Information handling and communication play a larger and larger role in all economic activities. This is what is meant by an "information society." Computers whet the appetite for information. More kinds of information can be collected. It can be analyzed in more ways, thereby producing still more information. All of this data can be used in new ways and easily communicated to more people.

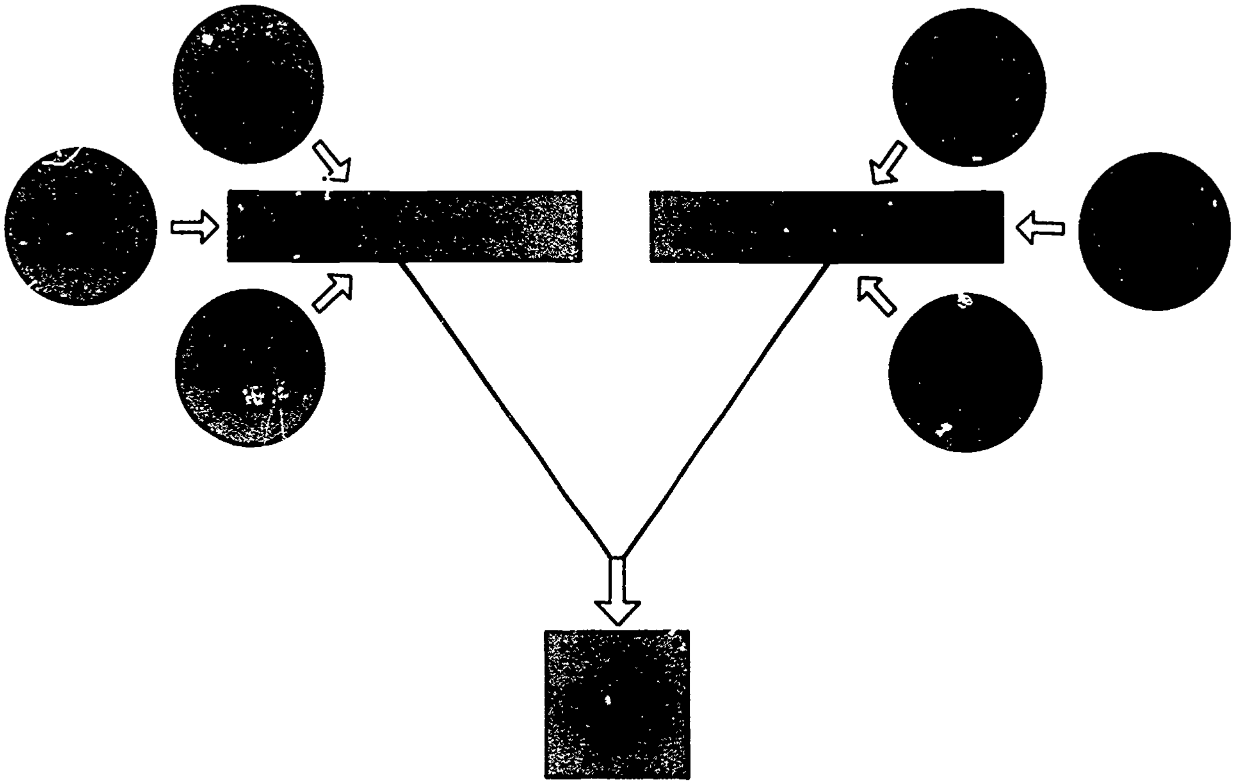
Organizations are likely to find more internal or intermediate uses for information, and to produce new information-intensive services or products as office automation technology makes it possible to combine, package, and distribute information in innovative ways. Consumer expenditures appear to be shifting from hard goods to soft goods and services, as evidenced by the growth in service industries and in particular by the proliferation of new financial services in recent years.

Because information-handling costs have always been primarily labor costs, and because office automation technology is labor-saving, it is assumed that the cost of information-handling will decrease. This should, accord-

[1] The 102,329 new starts in 1984 hired 578,838 workers compared to 607,416 new hires for the 100,868 new starts in 1983. See "Dun and Bradstreet Looks at Business," a Dun and Bradstreet subscriber newsletter, vol. 3, No. 3, May-June 1985.

[2] *Forbes Magazine*, Apr. 29, 1985, p. 231.

Figure 2-1.—Framework Describing the Relationship of Office Automation to Changes in the Number of Office Jobs



SOURCE Office of Technology Assessment

ing to standard economic theory, tend to further increase the market for information.

Office automation is adopted for many reasons, and often reduction of the work force is not one of the objectives. But it is, by nature, labor saving, even when that is not a primary motivation for its adoption. This argues for a significant reduction in the labor necessary for handling a given volume of information.

The statements made above are hypotheses or arguments often heard in discussions about whether office automation will lead to an increase or a decrease in office jobs. The purpose of this chapter is to examine these propositions in more detail. They provide a basic framework for discussing the long-range effects of office automation on future office employment. But there are several levels of complexity that must be considered. Many of these propositions involve, or conceal, definitional or logical difficulties. The interactions between them are not well understood. There are other factors and forces acting on white-collar employment—and intermediate steps in these relationships—that are ignored in the simple diagram shown in figure 2-1.

Estimates of the relative magnitude of these competing forces are judgment calls. Those who see an increasing demand for information producing an expanding need for information-handlers, and those who anticipate new industries or new occupations to create jobs for displaced office workers can not, in the nature of things, offer a valid description of what those future products, industries, and jobs might be. They are therefore often accused of optimism based on ungrounded faith. Those who see disturbing signals of future job loss can point only to fragmentary and widely dispersed evidence that is difficult to compare or aggregate, and are equally subject to charges of ungrounded pessimism.

Employment data is notoriously difficult to work with because job categories and occupational titles are not standardized and change over time. Projection of trend lines is not very helpful in discussions of significant technological change, and arguments from analogy to automation in the past are not convincing because the surrounding social and economic environment has radically changed.

These caveats do not mean that analysis is useless; they only warn of the degree of uncertainty necessarily involved. It is the task of policy analysts to advance conclusions in spite of incomplete evidence, as it is the task of policymakers to make decisions under conditions of uncertainty.

What Follows

Since OTA's conclusions about the possible employment effects of office automation are less optimistic than some recent long-range employment projections, these will be reviewed to point out forces and factors that are usually not adequately accommodated by econometric models and that strongly affected the conclusions of this assessment. These considerations have to do with the way in which technological change erodes the validity of conventional assumptions, disrupts long-term trend lines, and changes the meaning of established categories of occupations and industry boundaries.

The conclusion that the number of office jobs may, between 1985 and 2000, tend to stabilize and possibly begin to decline, rests on the following points:

- Computers represent a fundamental technological change rather than a marginal improvement; their adoption will resemble that of the telephone and the typewriter rather than that of the industrial robot. Office automation will be pervasive.
- Recent technology/employment forecasts are flawed and probably understate the employment effects of office automation. (See "Recent Labor Force Projections.")
- The potential productivity benefits of office automation are larger than are generally recognized; they have been and will be masked during a transition period because of technical and managerial problems, and institutional inertia in adapting to technological change. (See "Productivity and the Nature of White Collar Work.")
- Office automation will reduce the need for labor by sharply reducing the need for both primary and secondary data entry; time saving in analytical, computational, and communication-related tasks; direct substitution for labor in many tasks; eliminating intermediate and preparatory steps or tasks; and transferring tasks from highly paid to lower paid employees (see "How Office Automation Affects Work").
- Specialized occupations with narrowly defined tasks will be most directly and immediately affected (see "Emerging Occupational Shift"). Automation will eliminate or reduce the need for tasks characteristic of some "generic" clerical occupations (i.e., those common to most or all industry sectors). Growth of some categories of management occupations may be sharply constrained or even reversed because of time savings in information collection, analysis, and formatting; time savings in communications; increases in scope of supervisory attention and monitoring capability; and reduction in the number of workers to be supervised.
- There are already possible indicators of constrained employment growth from office automation, including declining unit labor costs in the heavily automated financial, insurance, and real estate (FIRE) industries (see "Technology and Recent Trends in White Collar Employment").
- Office automation could also encourage conversion of employees to part-time, temporary, or independent contractor status, with a reduction in the number of full-time, permanent jobs (see "Part-Time and Temporary Employment").
- Off-shore sourcing of clerical work, now small in volume, could increase significantly in the next decade (see chapter 8).
- Office automation may have more significant or more highly visible impacts than

earlier waves of mechanization and automation in the United States because the economy will not be growing as rapidly, it will affect more occupations, and it will cut across industry sectors (see "Analogies From Past Waves of Automation"). There are, in many cases, some signs that technology has contributed to rising unemployment rates since the end of World War II.

The remainder of this chapter discusses these points in more detail, beginning with a review of recent employment forecasts. It ends with a brief discussion of labor force growth, possible adjustment mechanisms, and some policy implications.

RECENT LABOR FORCE PROJECTIONS

The Bureau of Labor Statistics (BLS) expects employment in managerial, technical and professional, and clerical occupations to increase by about 28 percent by 1995.[3] Most job growth is projected to be in the service producing industries (transportation, communications utilities, trade, finance, insurance, real estate, government, and "other services"), which BLS expects to account for 75 percent of all new jobs, or 18.7 million by 1995. Since these industries are the ones in which office automation could have major effects, the BLS reasoning should be examined closely.

BLS expects that a quarter of all employment growth, 31 million jobs, through 1995 will be in the category of "other services." Within this category the largest industry is business services, which includes a variety of things from business consultants to janitorial services, and is projected to grow by 5.3 percent per year, with employment growth of 3.9 percent per year. Professional services (legal, engineering, accounting, etc.) are expected to add another 850,000 jobs. Financial and banking services are projected to have strong growth but "modest" gains of employment of 1.9 percent per year or 21 percent increase in 10 years.

The BLS projection assumes: 1) full recovery from the 1982 recession and stable economic growth through 1995, 2) continuing decline in the average weekly work hours per worker, 3) productivity growth at the rates of the late 1960s and early 1970s, and 4) some shifts in employment, namely that "new labor-saving technologies will cause shifts to occur among industries, with many of the old-line factory jobs giving way to new industries and occupations."[4] Factory automation and office automation will displace some workers but they will have an opportunity to move into other jobs; what new industries and occupations will be created is not specified.

BLS expects that jobs requiring college or specialized technical training will increase significantly, as will some less skilled jobs; for example, nursing aides and orderlies. The BLS analysts recognize that "employment growth in many occupations will be affected by technological change . . . " and that among these are typists. Nevertheless, they expect many office occupations to grow, as shown in table 2-1.

BLS projections show three alternative growth rates, which are based on alternative assumptions about the overall rate of economic growth. The BLS employment projection process links a labor force model, an aggregate macroeconomic model, an industry activity model, a labor demand model, and an occupational demand model. Under different assumptions

[3]George T. Silvestri, John M. Lukasiewicz, and Marcus E. Einstein, "Occupational Employment Projections Through 1995," *Employment Projections for 1995*, U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 2197, March 1984, p. 44.

[4]Manufacturing employment, which has declined from 25 percent of all jobs in 1959 to under 19 percent, is projected to hold this share through 1995. This means that manufacturing would have to create about 4.3 million additional jobs, or one-sixth of all new jobs.

Table 2-1.—Growth in Selected Occupations as Projected by the Bureau of Labor Statistics, 1982-95

Occupations	Projected growth[a] Low	Moderate	High	Range of jobs added[b] (thousands)
Total: all occupations	23%	25%	28%	23,336-28,392
Total: professional, technical, managerial, and clerical	26	28	31	11,921-14,165
All professional, technical, and related occupations	30	31	35	4,96[illegible],741
Accountants, auditors	38	40	44	325-373
Computer specialists	79	81	84	414-439
Economists	29	27	30	9-9
Managers, officials, and proprietors	26	28	31	2,476-2,935
All clerical workers	24	26	29	4,484-5,489
File clerks	0	2	5	21-34
General clerks	7	9	12	642-765
Office machine operators	26	28	30	243-284
Computer operator personnel	25	27	30	147-172
Data entry operators	−12	−11	−9	−38-−28
Secretaries, stenographers	24	26	29	644-787
Typists	15	16	19	146-185
Telephone operators	6	8	10	19-31

[a]Projections were made for low, moderate, and high occupational growth scenarios with associated variation by industry.
[b]The range represents the low to high estimates.

SOURCE: George T. Silvestri, John M. Lukasiewicz, and Marcus E. Einstein, "Occupational Employment Projections Through 1995," *Employment Projections for 1995*, U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 2197, March 1984, p. 44.

about economic growth, industry sectors grow at different rates. If an industry is expected to grow, occupations concentrated in that industry are projected to grow proportionately, with marginal adjustments made to accommodate anticipated technological changes. The tying of occupational growth to growth in specific industries accounts for some curious outcomes to be noted in table 2-1, which is abstracted from much larger tables in the BLS projection. For example, demand for economists increases less under the moderate growth scenario than under either the low or high growth scenarios, presumably because economists are concentrated in industries that would expand least in a period of moderate economic growth.

Some occupations that declined from 1979 to 1982 are nevertheless projected to grow in the future, because the decline is attributed to the business recession and it is assumed that with recovery, past trends in occupational growth will be resumed. The model does not separate change due to business cycles from technological change. For example, drafters decreased by 1.6 percent from 1979 to 1982, but are projected to increase from 2 to 8 percent. Cost estimators declined 2 percent but growth of 41 to 48 percent is projected. Bookkeepers (hand) declined by 3.9 percent but 13 to 18 percent growth is projected. General clerks declined by 1.2 percent but 27 to 33 percent growth is projected.

This mechanical linking of occupational growth to industry growth suggests that BLS may underestimate the effect of technological change (and office automation in particular) even though the text accompanying its projection acknowledges that:

> Most office clerical occupations are expected to grow more slowly during 1982-95 than in the 1970s because of office automation . . . Secretaries will increasingly use advanced office equipment in the future, thereby becoming more productive. This in turn will dampen demand for the occupation. Nevertheless, secretaries are projected to grow at a rate that is about average because of the growth of industries in which they are concentrated.[5]

Anticipated growth in demand for goods and services, generated through the BLS macroeconomic model, is translated into a projection of industry activity (e.g., growth rates) through the use of input/output analysis. As a commentary on the BLS methodology[6] notes:

> (Input/output modeling) . . . assumes, for example, fixed coefficient production; that is,

[5]Silvestri, Lukasiewicz, and Einstein, op. cit., p. 44.
[6]John A. Hansen, *Bureau of Labor Statistics Methodology for Occupational Forecasts*, a contractor report for the Office of Technology Assessment, April 1984, p. 13.

that there is a single production process that must be used in the production of each good. No substitutions are permitted between the various inputs to the production process . . . (U)nless a new input/output table is constructed for each time period, technological change cannot be incorporated into analyses based on input/output tables. The use of input/output tables therefore naturally makes it difficult to incorporate technological change into occupational forecasting.

BLS analysts are acutely aware of this problem. Adjustments to take into account technological change are made at several points in the BLS process. Technological change will effect the forecast output of the economy as a whole, and the allocation of final demand into the 156 categories used in the model. A technological development that affected the distribution of demand for transport of freight between the trucking and air transport industries would require changing coefficients at many points in the model, for example, those governing the relationships between demand for transportation, energy, and perhaps steel and rubber.

Industry outputs must then be translated into demand for labor—and number of jobs. The econometric model that does this is based on a constant elasticity of substitution production function, that is, a basic formula that interprets the substitutability of one input for another, for example, capital for labor. It includes a technology variable that governs the total output-to-capital ratio for the economy as a whole. This variable is given a different weight for each industry. When the output-to-capital ratio is changing significantly (as it has been in office-oriented industries) this weight must obviously be adjusted. Some adjustments are also made in translating labor demand into number of jobs, to accommodate trends in length of workweek and work year.

Such adjustments are made, in the BLS procedures, by the analysts using their own knowledge of and assumptions about current and anticipated technological developments. They are, in other words, made on the basis of judgment and can only be evaluated in that light. However, the rationale for making these adjustments, and the precise changes that are made, are difficult for outsiders to track and examine.[7] BLS is, however, notably conservative in making such adjustments, relying heavily on past trends.

In a recent General Accounting Office (GAO) publication,[8] BLS stated its assumptions for some "growth occupations." They were very simple, brief, and generalized. For example, for accountants and auditors, the only technological assumption was:

> It was assumed that there will be no technological changes or developments that will affect employment in this occupation.

For bookkeepers (hand), the relevant assumptions were as follows:

> Computerization has had a significant effect on employment in this occupation by slowing down the rate of growth. This trend will continue, causing the employment of bookkeepers to grow more slowly than average.
>
> Computerization will continue to develop, but its adverse effect will be offset by the rapid increase in the volume of business.
>
> Computerization will continue to spread between 1982 and 1995. There will be further evolution of labor-saving technologies and continued diffusion throughout the economy, resulting in higher productivity and a slower-

[7]Ibid., See also Timothy L. Hunt and H. Allen Hunt, of the W.E. Upjohn Institute for Employment Research, "An Assessment of Data Sources to Study the Employment Effects of Technological Change," a paper submitted to the National Academy of Sciences' Committee on Women's Employment and Related Social Issues, October 1984. They comment:

> Technological change actually enters into the (BLS) system in at least three places . . . (T)echnological change will have specific effects on some occupations, it will have an overall impact on the productivity of workers, and it will affect the demand for goods and services generally.
>
> It is worthy of note that this system involves a considerable amount of judgment, especially in anticipating the effects of technological change. There are no simple equations that predict changes in staffing patterns within an industry. In fact, the BLS staff has found that trends in industry employment levels can be predicted more accurately than the changes in occupational employment . . . This is due in large part to the difficulty of projecting specific occupational impacts of technological change.

[8]U.S. General Accounting Office, *Specific Technological Assumptions Affecting the Bureau of Labor Statistics' 1995 Employment Projections*, Report to the Hon. Berkley Bedell, U.S. House of Representatives, GAO/OCE-85-2, May 20, 1985.

than-average rate of growth for this occupation.

The occupational forecast is made by disaggregating the labor demand further; that is, the 156 industry sectors used in the other models is spread apart into 360 industries and the total number of jobs is allocated between them. For each of the 360 industries, BLS considers the historical staffing pattern—obtained from the Occupational Employment Survey and carried out by State Departments of Employment Security.[9] The jobs that it is assumed the industry will provide are distributed among the occupations according to the ratios that have been obtained in the past, with some qualitative adjustment. In preparing the occupational projections for 1995, the BLS procedure assumes that all workers will be in occupations that not only exist now, but have existed long enough that employers begin listing them as separate categories.[10]

BLS uses several kinds of sensitivity analyses in preparing its forecasts; the analysts lay out three different scenarios or trend lines for economic growth, and also make varying assumptions about labor productivity. These, however, would not capture fundamental changes in production processes and capital-to-output ratios. No sensitivity analyses are performed to test the effect on staffing patterns of technological change.

In summary, the strong link in BLS forecast methodology between industry growth and projected occupational growth, together with reliance on traditional industry staffing patterns and occupational distributions, tends to greatly underestimate the effects of fundamental technological change. This forecast cannot be assumed to capture reliably the potential effects of office automation.

The Leontief-Duchin Forecast, "The Impacts of Automation on Employment, 1963-2000,"[11] also used input-output analysis. To deal with the problem of incorporating the effects of technological change into the model, however, Leontief and Duchin allowed the coefficients in the matrix to change over time, adjusting these coefficients on the basis of qualitative judgments.

Four scenarios were developed. Scenario 1 assumed no further automation or any other technological change after 1980; it is clearly a highly unlikely scenario and is used as a reference or benchmark for the others. Scenarios 2 and 3 project an increasing use of computers in all sectors for specific information processing and machine control tasks and their integration. Of these two, Scenario 3 assumes faster technological progress and more rapid adoption of available technologies, including more powerful software. Scenario 4 is identical to Scenario 3 except that it uses different final demand assumptions. The study concluded that the intensive use of automation:

> . . . will make it possible to achieve over the next 20 years significant economies in labor relative to the production of the same bills of goods with the mix of technologies currently in use. *Over 11 million fewer workers are required in 1990 and over 20 million fewer in 2000, under Scenario 3 as compared to Scenario 1*: this represents a saving of 8.5 percent and 11.7 percent respectively of the reference scenario labor requirements.[12] (Emphasis added.)

The differences by 1990 between Scenario 1 (no further automation) and Scenario 3 for major categories of workers are:[13]

- 5.5 percent more professionals,
- 13.9 percent fewer managers,
- 32.4 percent fewer clerical workers, and
- 8.4 percent fewer jobs in all categories in the national economy.

[9]The survey covers 500,000 businesses, one-third of which are covered each year, and 1,500 occupations found within those businesses.

[10]Hansen, op. cit., p. 18.

[11]Prepared by the Institute for Economic Analysis, New York University, for the National Science Foundation, April 1984, Wassily Leontief and Faye Duchin, Principal Investigators.

[12]Leontief and Duchin, op. cit., p. 1.15. There is a slight discrepancy between the percentages given in the authors text quoted here and those given below and computed from their tables (p. 1.16 of the report cited); the difference is minor and perhaps was caused by rounding errors.

[13]This includes all private sector employment plus public education and health, but does not include public administration, the armed forces, or household employees.

By 2000, the changes are greater:

- 21.5 percent more professionals,
- 41 percent fewer managers,
- 45 percent fewer clerical workers, and
- 11.4 percent fewer jobs in all categories in the national economy.

Note, however, that "fewer" here means only fewer than there would be without any further automation—not fewer workers than there are now. As compared to the real figures in 1978 (the base year), total employment will grow by 49 percent under Scenario 3 as compared to 53 percent growth under Scenario 1—no further automation. By 2000, it will increase 76 percent over 1978 employment in Scenario 3, as compared to 98 percent increase in Scenario 1.

Under Scenario 3, the proportion of professional jobs to all jobs rises from 15.6 percent in 1978 to 19.8 percent in 2000; managers' jobs decline from 9.5 to 7.2 percent, and clerical jobs from 17.8 to 11.4 percent. Sales workers decline slightly relative to total employment, while the proportion of craftsmen, operatives, service workers, laborers, and farmers each increases. The increases in professional jobs, under Scenario 3, are mainly in demand for computer specialists and engineers.

The good news in the Leontief-Duchin forecast is that if their projections were correct, the labor requirements for Scenario 3, in 2000, would exceed the projected available labor force of 157.4 million (after allowance is made for public administration, household workers, and some multiple job holders). This means, however, that the rate of growth in final demand that they assumed could not be achieved without still greater technological change.

This problem reveals a serious weakness in the model; it ignores the importing of both capital goods and services. Since imports are a major, and growing factor in the economy, the Leontief-Duchin model does not reflect economic reality.

Leontief and Duchin developed a fourth scenario to assess the growth in demand that could actually be attained under their technological assumptions. Growth in demand was progressively reduced until the labor force needed fell within the range of the projected labor force available for the years 1990 and 2000. This scenario does not correct the defect of ignoring imports; all demand is again assumed to be supplied by domestic labor.

This required a reduction of their projected output demand of 4.4 percent for 1990 and 17.8 percent in 2000. Because overall economic activity is lower in Scenario 4, capital investment is also lower, and the number of jobs related to production of capital goods falls, especially craftsmen's jobs. The occupational composition of the work force otherwise remains much the same. The percentage reduction in demand for labor is, however, greater than the reduction in final demand.

Scenario 4 therefore represents an estimate of the extent to which real per capita consumption can increase *if* the entire projected labor force is employed, using computer-based technologies, and demand is met by domestic production. It is important to note that the Leontief-Duchin team did not generate its own projection of consumption (final demand, or delivery of goods and services), but used that generated by BLS for its moderate growth scenario, discussed above.

Leontief and Duchin, as noted, incorporated the potential effects of technology into their forecast by changing the input-output coefficients over time. These changes are exogenous to the model; the direction and magnitude of the changes were arrived at by the team of analysts on the basis of extensive review of research results and scholarly and trade literature, and their assumptions are set out within their project report. The factors explicitly taken into consideration were estimates of the rate and extent of capital investment, the amount of time in 1977 that a worker spends performing particular tasks, the amount of automatic equipment that will be applied to those tasks, the amount of time that can be saved per task by using automated equipment, the percent of workers in particular occupations and industry sectors that will use the new technology in a given year, and the possible increase in demand for certain office occupations (i.e., the effects of increased demand for information-handling). Coefficients were modified accordingly; for example, in Scenario 3, the labor coefficient for "stenographers, typists, and secretaries" for 1990 was set at 0.65 of the 1977 coefficient, and for 2000 it was set at 0.45 of the 1977 coefficient, meaning that for a given unit of work done by these workers in 1977, only 65 percent as much labor will be needed in 1990 and only 45 percent as much by the year 2000. To look more closely at the narrower category "secretaries," the team assumed that by the year 2000 in comparison to 1977:

- 30 percent of secretaries will *not* be affected by word processing,
- 20 percent of a secretary's time is spent in tasks not affected by word processing,
- word processing saves 80 percent of the time required for conventional typing,
- 35 percent of secretaries are also affected by other office technologies,
- 45 percent of their time is affected by other office technologies, and
- 75 percent of secretaries' time is saved by new technology relative to old technology.

While other analysts may quarrel with one or all of these estimates or assumptions, and may question whether they have foreseen likely technological breakthroughs, their assumptions in general do not appear to be overly conservative. There is no obviously better way available as yet to arrive at such estimates than the one the project used—expert judgment. The far larger problem has to do with the assumptions about future economic growth.

This brings one back to a broader version of the question proposed at the beginning of this chapter: will the demand for information (which is to a large extent a function of the level of economic activity in this country) really grow to an extent that it will more than balance the labor-saving effects of information technology? Both the BLS and Leontief-Duchin forecasts of employment growth depend on an assumption that it will do so. The model formulated by Leontief and Duchin is dynamic in that investment is a function of changes in output in industry sectors. They project significant gains in employment in most sectors because the model projects nearly unlimited increases in the production of capital goods (output). But the model ignores the strong trend toward import of capital goods (and of services); in reality, the income generated by production of capital goods outside of this country does not directly translate into increased consumer demand within this country and can translate instead into a loss of employment.

Leontief and Duchin, recognizing this uncertainty, conclude that "it is not yet possible to pass a final verdict on the question of technological unemployment by the year 2000." Another reason is, as they acknowledge, that to do so they would have to incorporate into their forecast other kinds of technological change, which will change the nature and level of final demand for goods and services.

Leontief and Duchin also postulate on the basis of their model that "labor requirements to satisfy a continually but moderately increasing standard of living will number 124 million jobs in 1990 with the required occupational composition reflecting the technologies that will be in place . . . but because of very slow change in the orientation of education, training, guidance, and so on, these individuals' skills and occupational expectations will reflect the mix of jobs that corresponded to the technologies that were in place in 1978 . . . " Under those conditions, they point out, 744,000 managers and over 5 million clerical workers could be potentially unemployed while there would be about the same number of unfilled jobs in other occupational categories, for which they lacked the necessary skills. The problem for public policy, in other words, could be very serious even if demand for labor is equal to or greater than the supply.

A major difficulty with this forecast is doubt about the assumption of great and increasing demand for information-handling, which is ultimately derived from the assumption of steadily increasing production of capital goods.

A Georgia Institute of Technology Forecast prepared for the U.S. Department of Labor[14] dealt with clerical employment in the banking and insurance industries only. It concluded that by the year 2000 there would be an absolute reduction in clerical employment of 22 percent (over 1980 levels) in the insurance industry and 10 percent in the banking industry, which together employed in 1980 more than 20 percent of all clerical workers (the clerical employees in these two industries alone constitute nearly 4 percent of the entire U.S. work force).

The Georgia Tech research began from the premise that there are "weaknesses in techniques used to incorporate technological change in employment forecasts,"[15] including the unsystematic and qualitative consideration of emerging technological capabilities, the use of existing occupational descriptions based on fixed technologies, the inability to generate estimates of how particular technologies change the amount of time spent on basic tasks, and the use of an overly short time horizon (usually 10 years).

The study began with a technological forecast of office automation hardware and software, organized in terms of information processing functions (descriptions of the content of tasks related to information processing in the two industries). The forecast was designed to identify breakthrough technologies that would have major consequences for clerical employment. Industry officials participated in a Delphi (a forecasting technique that generates by consensus opinion quantified estimates of specific variables). This produced assumptions about different paths that penetration of office automation technology might take in each industry and the different employment/occupational mixes that might result. The analysts then used the technological assumptions to estimate the reduction in clerical time needed to perform specific functions in 1985, 1990, 1995, and 2000. Tying these estimates to 1980 clerical employment, an analytical model calculated the changes in the task/function work distribution over the period 1985-2000 for specific clusters of clerical jobs in each industry. For sensitivity analysis and validation, the results generated by the model were compared with those generated by the industry Delphi to determine the sensitivity of results to different estimates of the extent to which and rapidity with which specific technological changes will affect particular clerical functions.

The Georgia Tech team concluded that breakthrough technologies have the potential to displace or otherwise reshape clerical employment in at least two functional areas—data input and data processing. These include technologies such as optical scan, speech recognition, software languages and programs, and artificial intelligence, most of which the OTA Assessment also identifies as critical elements in the employment outlook.

There were several strengths in the Georgia Tech approach which lent credibility to the results. First, it went beyond conventional occupational categories to consider what it is that clerical workers actually do, in these two industries, in their daily and hourly work. Secondly, it attempted to estimate the relative amounts of time spent in these tasks, and to relate this to the time-saving potential of existing and emerging office technologies. Thirdly, it considered a number of potential organizational adjustments to the changing nature of the tasks in terms of organizational structural patterns. Finally, this approach permitted examination of future clerical work at several disaggregated levels, e.g., functions, tasks, and job clusters, rather than in terms of formal occupational categories.

There are also a number of weaknesses in the approach. The analytical model lacked feedback loops—for example, it did not account for the way in which the level of clerical employment affects the number of clerical supervisors needed, and did not account for rela-

[14] Georgia Institute of Technology, *Impact of Office Automation on Office Workers,* final report, April 1984, prepared for the Employment and Training Administration, U.S. Department of Labor; J. David Roessner, Project Director.

[15] Georgia Institute of Technology, op. cit., vol. II, Technical Report, p. 2.

tionships between clerical and nonclerical work. It did not consider creation of entirely new jobs and had little to say about the conversion of professional work to clerical tasks. It did not consider the possibility of significant restructuring of the industries themselves, and their products and services. More importantly, the forecast does not explicitly deal with growth in workload, except through very broadly stated, arbitrary macroeconomic assumptions, i.e., growth within the two industries of about 3 percent annually.[16] There was not explicit consideration of expansion of the role of information within the two industries, which are of course already highly information intensive.

Finally, the methodology used depends on judgmental data—estimates by industry experts and team analysts—even though it is treated quantitatively. In this of course, all employment forecasts are alike insofar as they go beyond mechanical extrapolation of time-series data. To do otherwise would defeat the purpose of anticipating change brought about by technological or economic trends.

All of the above forecasts thus are highly dependent on the assumptions made about the increasing volume of information handling (independently of the credibility of the models used) and the continuation of long established trends in the growth of occupations and their association with specific industries. The BLS projection anticipates increases in office employment in the neighborhood of 25 percent over the next decade but is probably much too conservative in its attention to technological change. The Leontief-Duchin forecast points to continued growth, although highly constrained by the effects of automation, but bases this forecast on flawed economic assumptions. The Georgia Tech forecast, which points to a decline at least in clerical employment, gives more attention to likely technological breakthroughs (in this field more credible than an expectation of smooth technological evolution) but is narrowly limited to two industries.

Agreement or disagreement with these forecasts does not turn primarily on the models and methodology used, but on the complex assumptions, estimates, and judgment that generated the numbers fed into those models. All such models address the question of "what will happen if . . ."; if for example, technology changes in certain ways, is adopted at certain expected rates, produces in practice the productivity benefits that in theory should result, and leads to the changes in organizational behavior that can be rationally anticipated.

In spite of the fact that vendors and advertisers are often accused of overstating the benefits to be gained by automation, forecasts such as these may underestimate them. Technology and employment forecasts often misfire in this way, for two reasons. First, forecasters have no reliable way of estimating how pervasive a technological change will be—the ultimate rate of penetration. Some technologies are likely to be widely adopted only in a few industry sectors or in certain parts of a given industry, or only by organizations in a certain size range. Other technologies affect a broad range of economic and social sectors or become so pervasive that they fundamentally change social and economic activities—for example, the internal combustion engine and electric communications (the telephone and telegraph). Office automation, in particular, computers, are in the latter and more fundamental category of technology; and likely to become as pervasive in office activities as the telephone and the typewriter have become in the last few decades.

Secondly, technology forecasts often go wrong either because they assume technological or scientific breakthroughs that fail to come about, or because they assume a smooth evolutionary development of technology rather than breakthroughs that suddenly occur. In computer technology, the latter mistake is more common. Recent employment forecasts appear to assume that computer-based technologies of the next 5 to 15 years will not be signifi-

[16] The most important of these were (op. cit., p. 18). 1) periods of growth and recession, but no major depression; 2) modest overall economic growth averaging 3 percent annually; and 3) growth in insurance and banking industries paralleling growth in the general economy.

cantly better than or different from today's. On the contrary, there is no reason to believe that their rapid development has come to an end. For example, input technologies, specifically optical character recognition and speech recognition, are likely to have a significant impact within 15 to 20 years. The rapid development and spread of end-use computing was not anticipated in many technology forecasts of the 1960s and early 1970s. In the field of microelectronics, it appears safer to anticipate quantum leaps in capability than to ignore the probability of their occurring.

The chief value in these and other such forecasts is that they force attention to the many and complex *uncertainties* that will affect future levels of white-collar employment. OTA's analysis differs from those above primarily in suggesting that there are impending technological developments that will have a particularly significant effect on some large categories of office employment; that adoption of office automation will proceed at an increasing rate and be much more widespread than most other kinds of technological change have been; that productivity gains have been and will be for a few years masked by transition problems but will soon become apparent; that economic growth rates could be lower than they have been for most of our history; and that competitive pressures will lead organizations to take full advantage of the labor-saving characteristics of the technology. These conclusions, like those of the forecasts described above, are certainly arguable but merit prudent consideration.

PRODUCTIVITY AND THE NATURE OF WHITE-COLLAR WORK

Productivity is defined in economic terms as a ratio between quantity of output and quantity of input; increased productivity is achieved by producing the same amount of product or service with fewer resources (technological change), or producing more product or service with the same resources (resource reallocation). Sometimes organizations automate their office work in order to do the same amount of work with less labor cost (which could mean either fewer workers, or the same number of workers doing less skilled work for lower pay). Sometimes organizations foresee or seek an expanding workload and hope to accomplish it without increasing their work force (or their total expenditure for labor).

Applied to white-collar work, however, the concept of productivity becomes complicated and troublesome. It is least complicated in the context of routine processing of large amounts of standardized, easily quantified data—number of units sold, dollars paid or received, ticket stubs returned, keystrokes made. It is most complicated when applied to work where quality is more important than quantity—analysis, decisions, staff support, and policy formulation.

If the final output of the organization's activity is an information product or service (an advertisement, a document or research report, a legal brief, an advisory memorandum or set of guidelines), then the number of units processed per hour is often less important than the quality, the timeliness, the fit to a client's needs, or the degree of customer satisfaction. Effectiveness is more important than efficiency. But effectiveness is much more difficult to measure, since it refers to the characteristics of the output rather than to a ratio between countable units of input and output.

If the organization's final product is a material good such as automobiles, the contribution of office work to overall productivity is difficult to determine because much of it is concerned with the coordination of intermediate steps in the conversion of resources into products. Both effectiveness and efficiency are important and impossible to separate.

There are other general problems in discussing the productivity of service industries. Service outputs are different from material products. They can usually not be stockpiled. Customer behavior intrinsically affects the delivery mechanism. For example, a study of increased productivity in British accounting firms found that most of the productivity gains came not so much from anything the accountants did but rather from the clients' computerization of their own accounts, which allowed the accountant to save vast numbers of person-hours in auditing.[17]

In fact, the concepts of "input" and "output" both become blurred in many kinds of white-collar work. "Hours logged in" or "hours paid for" are often not the same as "hours worked." This is true in both blue-collar and white-collar work, but perhaps most obvious for professional and managerial workers who may be "processing information" or "formulating decisions" while they read the newspaper or fall asleep at night. The quality of work is often more important than the quantity of work for both blue- and white-collar workers, but for white-collar workers quality is more difficult to measure in terms of error rates. The skill that a receptionist uses in soothing irate clients, or that a secretary uses in locating an elusive file, shows up in the company's records only indirectly as an addition to a salesperson's accounts or a lawyer's clients. Contributions to corporate reputation or employee morale are difficult to measure.

In terms of outputs, a good decision or the elimination of erroneous information from a data bank may not be counted, or even be possible to identify as a discrete output. There is a tendency to use worker activity, an input, as surrogate for an output in measuring productivity, with the unwarranted assumption that more is better. Thus, computers and word processors sometimes lead to a proliferation of reports that may or may not be useful and may or may not represent increased productivity.

[17]Irving H. Siegal, *Productivity Measurement. An Evolving Art*, Work in America Institute Studies in Productivity, No. 16 (New York: 1980).

It is therefore difficult to measure, to define, and even to discuss the amount of increased productivity that could be gained by office automation even if it is widely adopted by organizations of all kinds and all sizes. Some organizations have been slow to adopt office automation for this reason.

However, an organization will usually not decide to automate a specific task or set of tasks if it expects that over the long run the task will therefore require *more* labor, or will take *longer* to perform per unit of workload than without automation. Automation usually implies some transference of work from humans to machines, and thus a substitution of capital for labor.

If office automation only allowed those organizations that automate (assumed for the present to be more efficient) to take over markets previously served by nonautomating organizations, the result would be a reduction in the total amount of labor used. On the other hand, if office automation only stimulated the creation and sale of products and services that could not previously be offered—that is, created new markets—the total amount of output and labor used would increase. But office automation will both create new information markets *and* reduce the amount of labor required for existing and new products and services. The difference—net labor demand—could be either positive or negative.

The factor of time is crucially important. For some period of transition, longer for some organizations than for others, there is little or no gain in productivity and often some loss. On the other hand, the new technologies are so powerful that some organizations settle for the short-run labor savings and limited cost reductions that are possible from limited use of automated devices, rather than run the risk of temporarily disruptive restructuring of the work to systematically capture all the potential benefits. Across the economy as a whole, with sectors and industries and organizations at all stages of this transition, it is difficult to anticipate how long this transition will take. Over time—measured in decades—more efficient organizations should tend to replace less efficient ones, and newly created organizations should tend to be automated, and more efficient, from the beginning.

This is the dynamic shift which needs evaluation in terms of the net labor demand. How thoroughly will office work, throughout the economy, be automated in the next 15 years? Will the demand for information processing create more than enough new jobs to compensate for the labor reduction effects of office automation?

HOW OFFICE AUTOMATION AFFECTS EMPLOYMENT

Office automation can substitute for labor, supplement labor, or reorganize work and thereby make labor more efficient. It can allow highly technical, knowledge-intensive work to be done by relatively untrained and unskilled, lower paid workers. (Skill enhancing and job enhancing features of the technology are also important, but are discussed elsewhere.) It can change the characteristics and skills associated with occupations and alter their role and relative importance to an industry. It can allow office work to be done away from the office and outside of conventional office hours, even outside of the country.

Credit: Communications Workers of America

"We ve decided to call it the neutron chip. It eliminates jobs but leaves the work-place intact".

The most dramatic potential substitution of technology for labor, in the future, could be the elimination of a large proportion of today's data-entry work (either numeric or text) by:

- interorganizational transfer of data, directly from computer to computer;
- direct input of data by optical scanning technologies, and possibly by speech recognition technology; and
- capture of data at the point of origin, in a variety of ways ranging from bar code readers to consumer use of terminals, e.g., bank automated teller machines (ATMs).

In short, second-time keyboarding of the same data may eventually disappear almost completely (i.e., once data exists in machine readable form it will be endlessly changeable and exchangeable). First-time keyboarding may also be sharply reduced. This may not happen within the next decade, and yet optical scanning technology and computer exchange of data is already reducing data entry in some areas, and all of these trends could develop very quickly.

Direct substitution for labor is only one possibility. Automation reduces the time required for many tasks. The measured time-saving for specific tasks, in numerous pilot projects and implementation case studies, varies from minutes to days. There is no way to validate, compare, and aggregate such figures across organizations. The estimate of "15 percent time saving" for complex procedures and task clusters recurs with great frequency in both private and public sector office automation plans, cost justifications, and cost-benefit studies surveyed by OTA, but again it is difficult to document or generalize this measure. The most that can be concluded is that time-saving is real but its magnitude and overall effect on productivity cannot yet be stated.[18]

[18] App B summarizes several case studies done for this OTA assessment; others from scholarly and trade literature are referenced throughout the report.

Automation also can reduce the time that people have unavoidably spent between productive tasks, or in sequencing tasks. One example is the way voice mail and electronic mail can reduce the time spent in communicating by eliminating "telephone tag" or frequent callbacks, searching for telephone numbers, and getting wrong numbers or busy signals. Electronic filing can eliminate walking to a file cabinet and searching for a particular file; word processing eliminates cutting and pasting or retyping documents to eliminate errors.

In some applications a long series of tasks that required several workers is combined into one task. For example, in mail processing, a many-step function that involved several clerks (mail openers, sorters, typists) can be redesigned to require only a mail opening machine and a clerk entering information into a computer terminal.[19] Professional case workers in a New York City Municipal agency formerly sorted mail from clients and selected and typed one of four form letters in response. Now lower paid clerical workers call up the client's file and push one computer key to send the appropriate form.[20]

These are examples of process change, or reorganization of work and workflow to take advantage of office automation. Some insurance companies have been phasing out jobs that involve responding by individual letters to mail inquiries about claims, policy changes, or policy applications. Policy holders or applicants have a toll free number to call. The employees who answer such calls use terminals to retrieve the information required to answer most queries. By telephone the employee can elicit all the necessary information, some of which is often absent from mail communication, thus requiring more than one exchange of letters. The cost per inquiry is reported to be one-third the cost per mail inquiry.[21]

As the conceptual model described in chapter 1 suggests, even if an organization adopts office automation to reduce unit labor costs in standard tasks, managers will subsequently recognize that it also has other capabilities, and will adapt the workflow or production process to take better advantage of those possibilities. This may take considerable time, since problems arising from the initial substitution and from the interface of new technology with old procedures usually get first attention. Initial transaction costs of adapting the production process to new technology are high. Training and system support costs in particular often outweigh hardware and software expenditures. The risks associated with trying new ways to get the work done appear very large and potentially disruptive to many firms. For this reason the full effects on employment are likely to appear only after considerable time and experience.

Office automation can also complement and augment labor, making new tasks possible. Computers made it feasible for insurance companies to move from annual billings to quarterly or monthly billings (thus encouraging lower wage earners to buy insurance), and the increased availability of information also led States to impose increased reporting require ments on the industry. In other financial service industries, automation allowed the creation of new consumer services that would not have been cost-effective otherwise. In large law firms, some evidence suggests that the introduction of word processing resulted in support staff employment growing several times faster than legal staff.[22] Some people suggest that once word processing is substituted for typing, a great deal of "hidden work" appears—work that there was no time to get done before. This is one aspect that leads to an increase in the demand for information processing, and often therefore to a net increase in demand for labor.

[19]Matthew P. Drennan, "Implications of Computer and Communications Technology for Less Skilled Service Employment Opportunities," Final Report to the U.S. Department of Labor, grant No USDL 21-36-31, Jan. 21, 1983, p. 2.
[20]See ch. 10.
[21]Matthew P. Drennan, op. cit., p. 64.

[22]Mary C. Murphree, "Brave New Offices: The Changing World of the Legal Secretary," *Women's Toils and Triumphs at the Workplace*, Karen Sacks and Dorothy Remy (eds.) (New Brunswick, NJ: Rutgers University Press, 1984).

The net effect of other, equally important, effects of office automation on work and workflow is even more difficult to assess. Chapter 4 considers these changes in considerable detail. Automation clearly leads to reallocation of tasks, for example, professionals and managers drafting their own letters and documents on the word processor. Analytical work that formerly required specialists with long training can be incorporated in software that can be used by people without extensive professional training. Reason suggests that in the interest of cost-saving organizations will tend to professionalize clerical work—i.e., push tasks downward in the hierarchy—and reduce the number of middle-level professionals and managers rather than the number of clerical workers, since the former are paid more. This is the argument for the so-called "disappearing middle management" or "flattened hierarchy" phenomenon that some experts anticipate.[23]

The "clericalization of professional work" appeals to many professionals, because it gives them more autonomy and more control over the quality and pacing of their work; they can alter and revise as they go, they need not queue up or compete with others for the typists' time. There is some evidence from case studies and general observation that the ratio of support staff to professional staff is tending to decrease in many offices—that is, the pattern of one secretary to one boss has already commonly changed to one secretary serving three to five professionals, or a cluster of support staff working for a large group of professionals and managers.

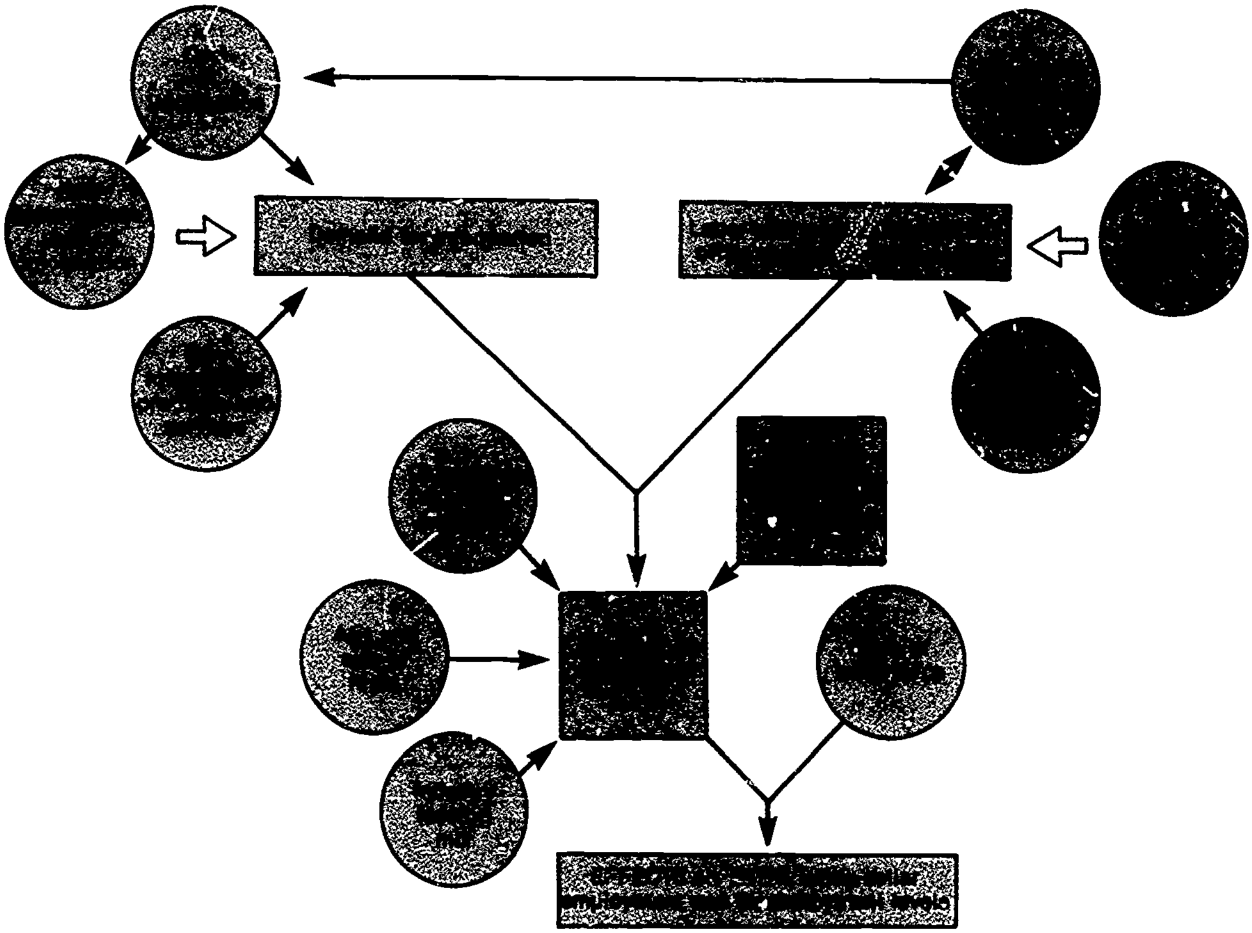
Office automation may result in a more varied occupational structure, because of the diverse choices among applications and because automation allows production process and staffing to vary widely with the type of product. For example, three staffing patterns have been observed among insurance carriers.[24] In highly automated personal lines underwriting departments of large property/casualty carriers, rating and risk assessment may be computerized and the functions formerly divided among many clerks, raters, and underwriting assistants, may be consolidated and delegated to highly skilled clericals. Unskilled clerical work is then largely eliminated. Underwriters become "exceptions handlers," doing more complex work, and their work may shift to planning and marketing. Skilled clericals become the bulk of the work force. In other insurance firms, where products are standardized and high volume, almost all of the semiskilled tasks are computerized and a bipolar work force is created, with a large number of routine-data entry clerks and a few highly skilled, professional exceptions handlers. In still other cases where product lines are low in volume, specialized or complex, there is likely to be less extensive, more discrete automation. Data entry will be done by operators using dumb terminals, and underwriters review all policy.

Thus, a view of office automation's effects on employment must take into account not only substitution of capital equipment for labor in specific tasks, and the expansion of workload, but many additional and intervening variables including (see figure 2-2) recombinations of tasks, reassignment of tasks across jobs and occupations, changing skills

[23]Many office automation experts and industry planners expect that various computer applications will allow managers to extend their scope of supervision and planning, and will thereby allow organizations to reduce the number of supervisory managers required, and flatten the management hierarchy. This thesis has sometimes been addressed, in popular literature, in terms of a related issue, that of the "disappearing middle (income class)." Saskia Sassen-Koob and others have put forward an argument that there is, or will be, a growth in employment in both high- and low-income categories in the fastest growing industries (advanced services), with a decline in middle-income categories, and thus income polarization. See Saskia Sassen-Koob, "The New Labor Demand in Local Cities," *Cities in Transformation*, Michael Smith (ed.) (Beverly Hills, CA: Sage Publications, 1984), pp. 137-171. The income statistics put forward by Sassen-Koob as evidence that the "disappearing middle" is occurring are effectively challenged by Neal H. Rosenthal, "The Shrinking Middle Class. Myth or Reality?" *Monthly Labor Review*, March 1985, pp. 3-10. However, the possibility of a reduced management hierarchy need not stand or [illegible] on the terms of this controversy at the macroeconomic level.

[24]Barbara Baran, "Technology Innovation and Deregulation. The Transformation of the Labor Process in the Insurance Industry," Berkeley Roundtable on International Economy, contract No. 433-3610.0, prepared for Technology and Economic Transition Project, Office of Technology Assessment, January 1985.

Figure 2-2.—Framework for Analyzing Long-Range Effects of Office Automation on White-Collar Employment



SOURCE Office of Technology Assessment

requirements and corresponding job definitions, changes in the definition of occupations, and shifts in the number of jobs per occupation. The way in which these changes occur is further discussed in chapter 4.

Emerging Occupational Shifts

Other things being equal, the introduction of labor-saving technology is most likely to cause displacement where the task that is automated has constituted all, or nearly all, of the responsibilities of a given job. In other words, the more narrow and specialized the job, the more likely the job-holder is to be displaced by automation. This applies, at least potentially, to professional specialists as well as to clerical workers. Highly specialized knowledge is potentially most appropriate for incorporation into an expert system (a special software for decisionmaking) while broad, general knowledge is difficult to incorporate.[25]

When word processing is introduced, assuming that the workload does not increase, fewer dedicated typists (keyboarders) will be needed. A general secretary who spends only a part of her time typing, is not likely to be displaced by a word processor; more likely she will have more time for other responsibilities and may take on new ones. Secretarial positions have been increasing throughout the two decades of office automation, while "typist" jobs are decreasing.

[25] *Science,* "Artificial Experts," Mar. 23, 1984, p. 1281.

At the most general level, table 2-2 shows the relative shares of major occupational categories in the economy. Clerical workers are the largest employment category, followed closely by professional and technical.[26]

In the first stage of automation (large computers), the tendency was to make affected jobs more narrowly defined—in other words, to rationalize work. Batch data processors did not learn or do other work. Word processors were set apart in word processing centers. New specialties were created, ranging from computer operators to programmers, and the holders of those jobs typically did nothing else. If data-entry work is completely automated (e.g., by optical scanning technology) those who do only data entry are most likely to be displaced and secretaries are unlikely to be displaced by that development.

As discussed in chapter 4, second phase automation—end-user computing—appears less likely to rationalize tasks or to narrow jobs. Personal computers can be used to integrate tasks and broaden jobs. Moreover, organizations that rationalized work during their early office automation are in some cases using further automation to reverse that process. Many firms have decided that computer and communication technologies are often most effective in reducing costs when control, communication, and decisionmaking are decentralized and when hierarchic organization and functional specialization of tasks are reduced. They are experimenting with the elimination of both low-skill clerical jobs and routine technical/professional jobs, and with the creation of new multiactivity, skilled clerical positions.[27] In some insurance firms, the result of task reintegration has been a significant reduction in unit labor requirements and an increase in the average skill levels of the remaining clerical, sales, and professional work force.[28]

It is important to note that reduction of unit labor requirements has been achieved in both work rationalization and work integration, with office automation being used for both.

The networking of computers is likely to eliminate some jobs that have until now provided the link between automated tasks—for example, those concerned with reorganizing

[26]A major problem in assessing occupational change is a set of difficulties and deficiencies encountered in working with occupational data as it is now collected and aggregated. Occupational data are derived from surveys, and the more specific and narrow the occupational category used, the smaller the survey sample is, and therefore the less reliable the estimate of the total. A more important problem is the lack of consistent time-series data because of frequent changes in occupational classifications, especially between the 1970 and 1980 censuses. Much of the data used in this chapter is drawn from the occupational industry employment matrix prepared by the Bureau of Labor Statistics from Occupational Employment Survey data, modified by BLS use of a statistical model. Both the survey and the model have some methodological problems; for example, there are variations over time in the way that survey data was collected, and matrix data for 1980 and 1982 are not fully comparable. For more information on employment statistics consult the *BLS Handbook of Methods,* vol. 1, Bulletin 2134 1, December 1982.

[27]In the insurance industry, management first tended to follow the logic of scientific factory management, rationalizing and fragmenting tasks. Some insurance firms are now using integrated systems to reintegrate tasks, allowing one person to handle multiple service transactions so that the individual master record for each policy is a complete database.

[28]Eileen Appelbaum, "Technology and the Redesign of Work in the Insurance Industry," Stanford University, Institute for Research on Educational Finance and Governance, Project Report No. 84-A22, November 1984, p. 10.

Table 2-2.—Percent of Total Work Force in Occupational Groups by Selected Industry Sectors, 1982

	Industry Sector						
Occupations	All industry	All manufacturing	Fire[a]	Services	TCU[b]	Health services	Trade
Professional, technical, and related occupations	16.39%	10.27%	9.46%	33.65%	7.36%	34.47%	3.78
Managers, officials, and proprietors	8.37	6.69	17.06	6.82	8.99	4.38	9.34
Clerical	20.36	11.75	63.40	19.11	33.29	17.02	20.68
Total	45.12	28.71	89.92	59.58	50.14	55.87	33.80

[a]FIRE – Financial, insurance, real estate
[b]TCU – Transportation, communications, utilities

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings,* vol. 30, No. 1, January 1983 or resorting data generated by computers in one department for entering into another system, or the rekeyboarding that has been necessary when one organization's data was passed on to another.

Office occupations must be considered in the context of industries and industrial sectors, all of which have some component of office work. In office-oriented industries such as finance, insurance, and real estate (FIRE industries), a very high proportion of the work force in clerical and professional occupations is likely to be directly affected by office automation. In other industries, such as machine tools production, a much smaller proportion of the work force is in office occupations, and these tend to be in less specialized jobs (i.e., general secretary).

Some occupations are more or less standard across industries. Typists and payroll clerks do much the same work with only minor variations in whatever industry they find themselves. The same is true of many professional categories—tax lawyers, auditors, or certain types of engineers work for many industries that require the same general skills. Other occupations are characteristically found in one industry or a cluster of highly related industries.

Both generic and industry-specific occupations may perform narrowly defined tasks and thus be potentially subject to displacement. If office automation is broadly adopted across industries for tasks performed by generic occupational groups, then the people who are displaced will find it difficult to find similar jobs in a different industry. On the other hand, if industry-specific occupations find their work being automated, they may move to smaller firms or less rapidly automated firms within the same industry—unless those applications are insensitive to the size of the firm.

Labor force adjustment to office automation may require major shifts in employment levels across occupations. Industry sectors differ in the proportion of workers in major occupational categories (see table 2-2).

Professional Occupations

Professionals here are defined as workers doing cognitive tasks that require specialized knowledge gained through lengthy education, often with a graduate degree, or special certification or licensing.[29] They make up more than 16 percent of the work force and are found in all industry sectors, but there are relatively few in some sectors such as agriculture and trade, whereas in some service industries (health services, business services) they make up more than a third of the work force. Some professional categories are generic; lawyers, accountants, and computer scientists for example are found in every industry. Others are industry-specific, such as insurance investigators, title examiners, and broker's floor representatives; or are heavily concentrated—more than 82 percent of financial analysts, for example, are in the FIRE industries.[30]

In an information-driven economy, in which services—with high concentrations of professionals—is the most rapidly growing sector, it is likely that the demand for professional workers will increase. This category has indeed been increasing much more rapidly than any other occupational category. Its growth is not, however, unaffected by office automation.

Many professionals are not primarily office workers; for example, teachers, medical doctors and laboratory scientists may have or use offices, but the core of their activity is not office work and is not directly susceptible to office automation. However, it usually requires supporting clerical and administrative work that will be affected. Professionals may themselves use office automation in peripheral tasks, and their professional tasks may be

[29] The term "professional" has undergone a subtle change in meaning in this century; historically, most professionals practiced their calling on an independent or free-lance basis and in common parlance professionals tended to be distinguished from salaried workers. Now most professionals are probably employees of organizations.

[30] To some extent, however, this distinction is an artifact of the way jobs are titled in various industries. People with different job designations in different industries may still do much the same work, or have much the same training and basic skills.

automated by other kinds of computer applications (e.g., diagnostic technology) beyond the scope of this assessment.

About half of all professionals are in office-oriented occupations; for example, lawyers, accountants, analysts, and consultants. As already noted, some highly specialized professional tasks are potentially subject to computerization through expert systems. More commonly, information systems and data banks allow part of the professional's responsibilities to be taken over by paraprofessionals with less extensive graduate education and less stringent credentialization and certification requirements. For example, paralegals, engineering technicians, and library assistants do some of the work formerly done by professionals, and are paid less than professionals. Thus, there is strong economic motivation to constrain the increase in professional jobs by combining automation and paraprofessional workers, and the number of paraprofessionals is growing rapidly.

Office automation also typically decreases the amount of time that a professional spends in accomplishing a given amount of work, for example, in telephone communications, locating and aggregating information from scattered libraries, or reformatting tables and drawing graphics. Some tasks incidental to, and preparatory to, generating or analyzing information can be eliminated or shortened.

From this perspective, it can be argued that the amount of information-handling might increase a great deal before requiring a significant increase in the number of professionals. Once organizations have gained experience in successfully automating basic clerical tasks, office automation for professionals and managers will look increasingly attractive, since their higher wages will increase the cost-saving possible from automation.

Office automation stimulates the growth of some professional categories. Between 1970 and 1978, the number of computer specialist jobs grew by 58 percent (compared to 20 percent growth in all jobs). BLS expects growth in computer specialists employment throughout this decade, and the National Science Foundation has forecast a shortage between 1982 and 1987.[31] This is however growth from a small base; there were just over half a million computer specialists in 1982, 0.56 percent of total employment. Moreover, computer technology itself may dampen the expected demand; as computers and their software become more usable by nonspecialists, the need for programmers is shifting from user organizations to producers of computer goods and services, and should grow at a slower rate. Software engineering systems will automate some of the work of both programmers and systems analysts. Thus, there is likely to be some leveling off of the need for computer specialists in spite of the growth in number of computers in use.

Demand for information scientists may continue to grow, especially with the spread of the relatively new industry of information service, which provides and manages databases, on-line search services, and customized searching and abstracting.[32] It is not clear from occupational statistics how many information scientists there are or how rapidly their number is increasing, since many different job titles are used in this new professional area.

There are other specialized professional occupations that are growing because of computers. For example, personal financial advisors and tax advisors were once used only by the very rich, but small computers made it possible for them to offer their services more cheaply to middle-income people who have money to invest but are confused by complicated choices among financial services and investment and tax-sheltering schemes.

The ultimate effect of office automation on professional employment is hotly debated. Some argue that there will be a peaking and eventual decline in information-handling jobs,

[31] National Science Foundation, *Projected Response of the Science, Engineering, and Technical Labor Market to Defense and Nondefense Needs. 1982-1987* (Special report NSF 84-304), January 1984.

[32] U.S. Department of Commerce, International Trade Administration, *Competitive Assessment of the U.S. Information Services Industry*, May 1984

including professional jobs.[33] Others argue that the role of professionals within organizations will change, as the information component of products and services increases, and they will become "generalists who include many traditional managerial functions in their everyday work."[34] Possibly the meaning of the term "professional" will become progressively blurred as specialized knowledge becomes more widely accessible through information technology.

Clerical Occupations

The great growth in clerical occupations mirrors the broad shift from a manufacturing-based economy to a service-based economy. In manufacturing, clerical jobs are only a small proportion of employment, although that proportion has been increasing. In those service industries that collect and use large volumes of standardized data, such as legal firms, insurance, banking, and credit, more than half of all employees are clerical workers.

A large number of clerical occupations are generic, and the work is similar across industries. For example, bookkeepers, accounting clerks, file clerks, general clerks, office machine operators, payroll and timekeeping clerks, personnel clerks, receptionists, telephone operators, order clerks, and shipping and receiving clerks can be found in nearly all industries. There are more than 100,000 workers in each of those categories. Official occupational statistics treat other occupations as industry-specific; thus, according to BLS, all insurance clerks (medical) are employed in health services, all train ticket clerks and freight rate clerks are in transportation, communications, and utilities industries, and all credit authorizers are in wholesale and retail trade. However, the basic office skills used in those industry-specific occupations are in large part transferable to other clerical occupations.[35]

To the extent that office automation reduced employment in one or a few industries, clerical workers should be able to move to similar jobs in other industries. Their mobility might be greater than that of professionals in industry-specific occupations. This rationale sometimes appeared in the 1970s, for example, in explaining why more attention was paid to the displacement of aerospace engineers than to displacement of clerical workers from the same firms. But office automation appears likely to be adopted across industry boundaries in a relatively short time. Thus, if computers sharply reduced the demand for bookkeepers, bookkeeping jobs would be increasingly difficult to find in most industries or locations.

Potentially the most dramatic and widespread impacts of office automation or clerical employment are related to data y, as already discussed. The strong trend toward capture of data at the point of origin, and further development of optical character recognition (OCR) technology and speech recognition technology are likely to greatly reduce the need for primary keyboarding. OCR is already being used to this end. More and more information will be in machine-readable form from the beginning, and computers and telecommunication technologies will increasingly exchange information between organizations without the necessity of rekeyboarding. This trend alone will have a strong impact on clerical employment.

Advanced communications strongly affect clerical jobs that provide the interface between people, organizations, and activities, for example, messengers, mail clerks, and telephone and switchboard operators. Such displacement has been going on for a long time. It also affects clerical workers not usually considered communications workers. A chain of hotels may have a centralized, computerized worldwide reservation system with local-area networks and microcomputers. When a reservation is made through a toll-free phone number, all appropriate information, including credit references, will be automatically loaded into the central mainframe database. Information about next-day guests will be transferred to the hotels' microcomputers in the middle of the night and a reservation clerk will have only

[33] For example, Charles Jonscher, "Information Resources and Economic Productivity," *Information Economics and Policy 1* (North Holland: Elsevier Science Publishers, 1983).

[34] Paul A. Strassman, *Information Payoff. The Transformation of Work in the Electronic Age* (New York. The Free Press, 1985).

[35] There are of course exceptions to this general rule; general secretaries could probably not become legal secretaries without additional training, although legal secretaries might become general (or executive) secretaries in another industry.

to key in information on last minute walk-in guests.[36]

Not all clerical jobs are equally vulnerable. Of the ten fastest growth clerical occupations between 1970 and 1978, all but one (computer operator) were occupations that require direct contact with people outside an office—e.g., cashiers and receptionists. These jobs are sometimes considered relatively impervious to office automation. However, when the personal transactions can be standardized the job can be automated; again the bank's automated teller machine is one example. Supermarket cashier stations are another.

Some clerical jobs include both information-processing and manual tasks. Shipping and weighing clerks, packing clerks, etc., may be only indirectly affected by office automation, but are also vulnerable to the effects of automated materials handling and storage systems. Many organizations are also beginning to electronically print forms as needed, eliminating the need to buy, handle, and warehouse preprinted forms. In this case, the cost-saving sought is primarily in the costs of space and materials, but labor-reduction is an added benefit.

Ten occupations with declining employment from 1970 to 1978 were tabulating, bookkeeping, calculating, keypunching, stenography, postal clerk, telephone operators, mail carriers, and meter readers. Most of these are occupations directly affected by the early phase of office automation and the effects are now showing up in statistics. They are also occupations that are relatively narrowly defined in terms of tasks, again illustrating that the most narrowly defined jobs are those likely to be first eliminated.

In a later section of this chapter, the use of part-time and temporary office workers is discussed, and other chapters examine in detail the phenomena of home-based work and off-shore work. Part-time and temporary work distribute employment among more workers, but they tend to depress the number of full-time-equivalent jobs. They allow employers to hire the minimum number of people necessary for their base workload, relying on part-timers and temporaries to handle short-duration increases or peak loads. Home-based work programs have the same benefit of load-leveling since most of the home-based workers are used on the basis of "when work is available." Off-shore data entry, on the other hand, simply eliminates jobs in the United States.

In short, while office automation will likely lead to a great deal of shifting between clerical occupations, it is also highly likely to result in an absolute reduction, across the board.

Managers and Supervisors

Table 2-2 showed that managers comprise a relatively small proportion of total employment; the proportion varies considerably across industries. BLS data identify a principal group of managers, officials, and proprietors, and also identify supervisory occupations within the clerical and other personnel categories. Within most industries, firms vary considerably in the proportion of managers to other employees, with small firms tending to have proportionately fewer managers—i.e., a flatter structure.

Organizations are generally using more data, in more systematic ways, in coordinating their operations. As management becomes more information-intensive, it is possible that more managers may be needed. There is some relationship between the information intensiveness of an industry and the industry proportion of employees who are managers. Manufacturing firms have relatively low levels of managerial staffing, while insurance carriers, securities, computer and data processing services, and mailing and reproduction services have relatively high levels. Managerial employment is also above average in accounting and auditing services; engineering, architectural, and surveying services; wholesale and retail trade; transportation, communications, and utilities; and printing and publishing. It is relatively low in health services and legal services, but

[36]*Communications Week*, "Holiday Inns to Use SNA Gateway to Link 1,600 PCs With Mainframe," Nov. 5, 1984, p. 49.

these industries have large numbers of professionals who also act as managers.

There are large numbers of managers whose work is only partly and secondarily office work; for example, bar and cafe managers or automobile repair shop managers. Office automation technology, if adopted, may help them to focus on supervisory responsibilities by reducing the time spent on "office" chores.

In offices, some managers are primarily concerned with the direction and supervision of clerical or production operations and personnel. If fewer clerical personnel are needed with office automation, proportionately fewer supervisory managers should also be needed. In addition, as discussed in chapter 4, office automation can be used to increase the scope of supervision; that is, one manager or supervisor can monitor the performance of more workers or an increased volume of production.

The tasks of many lower and middle-level managers largely center on: 1) information collection, processing, and reporting, tasks that office automation either facilitates and enhances, reduces the necessary expenditure of time, or takes over completely; and 2) communication and coordination, where office automation can be very time-saving. Higher level managers concentrate more on decisionmaking. Here computers can be used in many ways. Some decisionmaking can be, and is being, built into computer programs, reducing the need for lower level managers. Management information systems and other kinds of computer programs are designed to help managers make decisions, by integrating and displaying the information they need. In some situations this saves a great amount of time for the manager; in other situations, it takes more time to make a decision because more information is available to be considered.

In some organizations, information that was once collected, integrated, and laid out by lower level managers for review by higher level executives, is now aggregated and formatted by computers and accessed directly by the decisionmaker. This points toward a reduced number of lower level managers, and some corporations are reported to have adopted office automation with the explicit objective of flattening the management hierarchy. Heightened competition and pressure to cut labor costs can lead firms to try to keep a lean management staff, since their salaries are high compared to other workers. At present, the job market for managers is strong because of overcutting of managerial ranks during recent recession years.[37]

Thus, there are conflicting trends to be considered in the outlook for managerial jobs, but they are not immune to the effects of office automation.

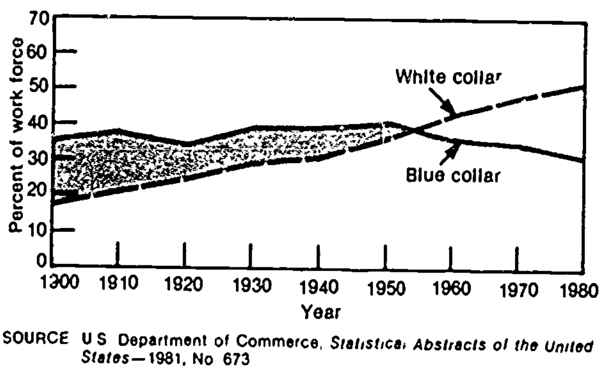
Technology and Recent Trends in White-Collar Employment

White-collar employment has grown rapidly in recent decades. (See figure 2-3.) The narrower category of clerical jobs, about 16 percent of all employment, has also grown rapidly even through the first phases of office automation. Table 2-3 appears to indicate, however, that this growth may already have slowed or stopped.[38]

[37] *Dun's Business Month,* "Executive Job Market: Filling the Talent Gap," November 1984.

[38] Does not include cashiers (of whom there were about 230,000 in 1950 and 2.2 million in 1984). Beginning in January 1983 BLS reclassified some occupations; cashiers and real estate appraisers were removed from the clerical occupations category These reclassifications are one of the continuing pitfalls of working with occupational data time-series.

Figure 2-3.—Changing Percentage of Work Force From 1900-80 White-Collar Compared to Blue-Collar



SOURCE U S Department of Commerce, *Statistical Abstracts of the United States*—1981, No 673

Table 2-3.—The Growth in the Number of Clerical Jobs, 1950-84

Year	Number of clerical jobs[a] (million)	Growth in the number of jobs	Total employment (percent)
1950	6.6	—	11 3%
1960	8.8	33%	13.4
1970	12.9	46	16.4
1980	16.9	31	16.9
1982	16.8	−0 6	16.8
1984	16.7	−0.6	15.9

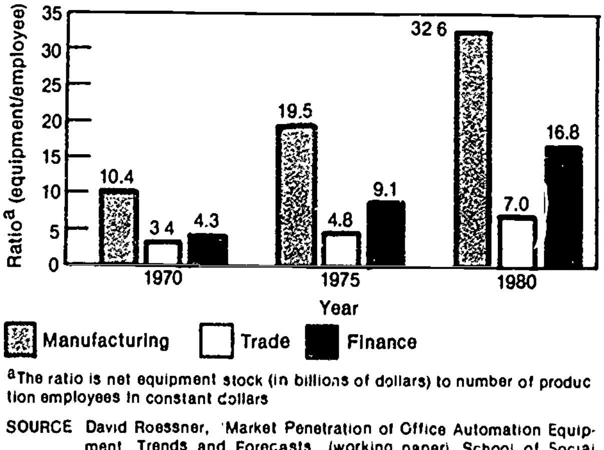
[a]The difference between the 1982 figure for clerical jobs on tables 2-2 and 2-3 illustrates the difficulty of analyzing detailed employment trends because of ambiguities in data sets.

SOURCES U.S. Department of Commerce, Bureau of the Census, *Census of Population 1950, 1960, 1970, 1980*, and U S. Department of Labor, Bureau of Labor Statistics, *Current Population Survey Annual Averages, 1982 and 1984.*

If the automation of office work is labor-saving, why did clerical employment increase so rapidly during the 1960s and 1970s? The capital-output ratio, which has traditionally been very low in white-collar work,[39] increased steadily (see figure 2-4), but from these figures would seem to have had little effect on labor demand. A closer look at the financial service industries, which have been at the forefront of office automation, tends to counter this impression. They were expanding rapidly during this period in part because of the new products and services made possible by their office automation. Life insurance carriers, for example saw sales increase over 49 percent from 1970 to 1980. Yet their labor force increased only 9.8 percent. During the 1970s the average annual real value added per full-time employee equivalent (a measure of productivity) for all industries was 1.1 percent; in the insurance industry it was 2.7 percent. From 1975 to 1979 it was 1.3 percent for all industries but 6.7 percent for insurance carriers.[40]

[39]Leontief and Duchin, citing many sources, accept that white-collar workers at the beginning of the 1980s worked with an average of $2,000 in equipment compared to the factory workers $25,000 in equipment; op. cit., p. 5.7.

Figure 2-4.—Capital Investment Per Production Worker, 1970-80



[a]The ratio is net equipment stock (in billions of dollars) to number of production employees in constant dollars

SOURCE David Roessner, 'Market Penetration of Office Automation Equipment Trends and Forecasts (working paper), School of Social Sciences, Georgia Institute of Technology, 1985

Social, economic, and political conditions favored the expansion of the FIRE industries during this period. High levels of employment growth during the 1960s and 1970s and the rapid increase in the number of two-income small families drove the proliferation of checking accounts. The rising level of disposable personal income during much of that period, and the fact that more women were earning income and insuring themselves for the first time, increased insurance expenditures. Fringe benefits also expanded, and workers compensation coverage was extended. A flood insurance program was established. New insurance and financial service products responded to, as well as contributed to, the growth in the market.[41]

Because these industries were growing rapidly, office automation in the 1970s constrained growth of their work force but did not reverse it. The labor-saving effects are nevertheless apparent; between 1970 and 1978, insurance industry professional and technical workers increased by 24 percent and managers by over 21 percent, but clerical workers increased by only 8 percent. During this first phase of automation, technology most directly affected clerical work. In the occupations where automation directly substituted for labor the effect was greater. Key operators declined by 22 percent, bookkeepers by 7 percent, file clerks by 20 percent, mail clerks by 11 percent, and typists by 12 percent (but secretaries increased

[40]Baran, op. cit., pp. 100 ff.

[41]Inflation and higher interest rates had a mixed effect; insurance carriers, for example, derive more income from investments than from policies but were sometimes locked into older low-interest investments and needed new investments to balance these. Inflation left life insurers more vulnerable to disintermediation and made forecasting of future cash flows for investment difficult. Liability settlements were also growing.

by 8 percent and computer operators by 119 percent).[42]

In some parts of the insurance industry, there were also dramatic labor reductions in some areas of professional work; for example, among underwriters in the life and health insurance fields, there was a dramatic decrease in numbers during the 1970s.

As a result of the interaction between market growth and office automation, labor displacement in FIRE industries as a whole clearly occurred but resulted in depressed growth, rather than decline, in employment.[43] In financial services, employment increased by about 20 percent, but growth was lowest in sales and clerical jobs, and highest for managers and professionals.[44]

The labor-saving effects of office automation are likely to become more apparent in the near future. The first phase of automation was a more direct substitution of machine for labor than is later office automation, but in the first decade of use, organizational goals placed higher priority on better data collection and reporting and news services. The mass data handling industries were automating pre-existing functions, such as payroll, inventory control, and other basic procedures. But they were dealing with a new technology, with no experience and precedents to guide them; reorganization of the organizations' workflow and labor force took time. In the FIRE industries there are strong indicators that the emphasis has more recently shifted to cost-reduction, and much reorganization and labor force reduction is now occurring. Unit labor costs have in fact been dropping since 1969 and the drop began accelerating about 1975.[45]

Market conditions can either offset or reinforce employment effects. In the case of the insurance industry, one group of analysts concludes that:

> ... some of the present job losses occurring in the industry are directly attributable to computer technology, though more often than not these are the delayed effects of an earlier stage of innovation rather than the latest developments: some of the losses are best regarded as the indirect consequences of technology, which for example might allow reorganization and rationalizations to be made; and some losses are attributable to separate factors such as declining market conditions or out-moded management structures. On the whole one might sum up by saying that computer technology has provided the vehicle which makes it possible to respond efficiently to market conditions, whether this be by expansion of business or by contraction of operating costs.[46]

This analysis agrees with other evidence that white-collar employment is becoming more sensitive to cyclical economic conditions.

In both future and past shifts in employment, it is difficult to separate the role of technology from the effects of market change and other broad economic factors. But analysts at Bell Canada have studied the effects of technological change on their work force from 1952 to 1972, and concluded that "technological change resulted in substitution of capital for low-skill labor, overwhelming any price complementarity with capital."[47]

In 1952, Bell Canada was using an average of 48 to 52 million person hours yearly, 23,000 to 25,000 jobs. Over the next two decades output steadily increased by 7 to nearly 10 percent per year, or over 500 percent, but labor demand at the end of the 20 years was less than 15 percent higher than in 1952.

The econometric model used in the Bell Canada study was designed to separate technological effects (i.e., automation) from price and

[42] Baran, op. cit.

[43] Valerie Personick, "The Job Outlook Through 1995. Industry Output and Employment," *Monthly Labor Review*, November 1983, p. 34, U S. Department of Labor, Bureau of Labor Statistics, *Technology and Labor in Five Industries*, Bulletin 2033, 1979.

[44] Baran, op. cit., p. 105.

[45] Baran, op cit ; also Eileen Appelbaum, op cit

[46] Richard Barras and Julia Swann, *The Adoption and Impact of Information Technology in the UK Insurance Industry* (London. The Technical Change Centre, November 1983), p. 21.

[47] Michael Denny and Melvyn Fuss, "The Effects of Factor Prices and Technological Change on the Occupational Demand for Labor: Evidence From Canadian Telecommunications," *The Journal of Human Resources*, XVII, 2, spring 1983, pp. 161-176.

market effects. The study concluded that technological change outweighed wage/capital and wage/material ratios in affecting overall employment levels, and in the case of demand for telephone operators, whose jobs were the primary focus of technological change, far outweighed the effect of output growth.

Small computers and word processors allow the standard office functions to be automated in small organizations, and incrementally, with relatively low capital investment at one time. Office automation need not involve construction of new facilities or extensive alteration of facilities. Where it replaces existing equipment—typewriters, calculators, bookkeeping machines, and old telephone systems—that stock does not represent large amounts of embedded capital. Most such equipment is more than 5 years old and has already been amortized. Office computers and equipment also enjoy a rapid tax write off. For all of these reasons, office automation may proceed more evenly, more widely, and more rapidly than other kinds of automation did in the past.

The speed with which a technological change occurs, and its breadth, are both important in assessing the impact. A slower pace allows both individuals and the labor market to make whatever adjustments are possible. In this regard the potential office automation of small businesses is particularly important. Small firms, in many parts of the country, account for the preponderance of office jobs. A reduction in the number of office jobs available relative to the total work force would therefore be felt in all areas of the country as well as in all industrial sectors, although not with the same force in all sections and sectors.

Part-Time and Temporary Employment

The proportion of part-time and temporary workers has been increasing since the early 1950s. The number of voluntary part-time workers has remained between 13 and 14 percent since 1970 but the proportion of involuntary part-time workers has continued to increase (see table 2-4 and figure 2-5), indicating that the strongest factor in the growth

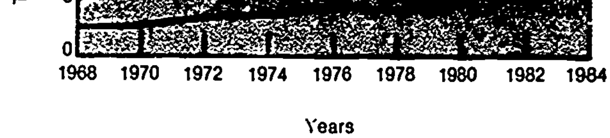
Table 2-4.—Changes in the Percent of Total Employment[a] for Involuntary and Voluntary Part-Time Workers as Percent of Total Employment, 1968-84

	Part-time work force		
Year	Total	Involuntary workers	Voluntary workers
1968	14.9%	2.5%	12.4%
1969	15.5	2.6	12.9
1970	16.4	3.1	13.3
1971	16.8	3.4	13.4
1972	16.8	3.3	13.5
1973	16.6	3.1	13.5
1974	17.1	3.5	13.6
1975	18.4	4.6	13.8
1976	18.0	4.2	13.8
1977	18.0	4.0	14.0
1978	17.7	3.8	13.9
1979	17.6	3.8	13.8
1980	18.4	4.5	13.9
1981	18.6	4.9	13.7
1982	20.2	6.4	13.8
1983	20.0	6.5	13.5
1984	18.9	5.7	13.9

[a]These calculations are for nonagricultural workers aged 16 and over.

SOURCES. 1968-81—Labor force statistics derived from the *Current Population Survey. A Data Book, Volume 1* (Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, September 1982, Bulletin 2096), p 682 1982—*Employment and Earnings*, vol. 30, No. 1 (Washington, DC: U S Department of Labor, Bureau of Labor Statistics, January 1983), p 169. 1983—Employment and Earnings. vol. 31, No. 1 (Washington, DC· U S Department of Labor, Bureau of Labor Statistics, January 1984), p. 194. 1984—*Employment and Earnings*, vol. 32, No. 1 (Washington DC: U.S. Department of Labor, Bureau of Labor Statistics, January 1985), p. 192.

Figure 2-5.—Changes in the Percent of Total Employment[a] for Involuntary and Voluntary Part-Time Workers, 1968-84



[a]These calculations are for nonagricultural workers aged 16 and over

SOURCES 1968-81—Labor force statistics derived from the *Current Population Survey A Data Book, Volume 1* (Washington, DC· U S Department of Labor, Bureau of Labor Statistics, September 1982, Bulletin 2096), p 682 1982—*Employment and Earnings*, vol 30, No 1 (Washington, DC U S Department of Labor, Bureau of Labor Statistics, January 1983), p 169 1983—Employment and Earnings, vol 31, No 1 (Washington, DC U S Department of Labor, Bureau of Labor Statistics, January 1984), p 194. 1984—*Employment and Earnings*. vol 32, No. 1 (Washington, DC U S Department of Labor, Bureau of Labor Statistics, January 1985), p 192 is not workers' choice of a more flexible lifestyle, but employers' response to economic pressures. In some industries and some organizations, slack workloads lead employers to convert workers to part-time in preference to a layoff. Other employers, however, are adopting a policy of keeping a minimum-size work force, which can be temporarily augmented when necessary.[48]

There are reports that in other industrialized countries automation has greatly increased part-time work; for example in Japan, "introduction of part-time workers and subcontraction has grown massively."[49] Office automation and creation of a part-time work force are in some situations alternative or competing strategies for cost-cutting but they may also be complementary. Part-time workers (considered by BLS as an employee working less than 35 hours a week) are cheaper than a proportionately smaller number of full-time employees because they often are paid lower wages and do not qualify for benefits packages, regular yearly wage increases, or job security agreements based on seniority. There have been many anecdotal and press reports of companies reducing work hours to one or two hours fewer per week than would qualify workers as full-time employees, but few companies are willing to admit formally to this practice. The biggest advantage of part-time workers for employers however is that of load-leveling; that is, they can be used during parts of the day or week when the workload is heaviest.[50] To the extent that office automation allows the work force to be reduced and workflow made more efficient, it may obviate some interest in moving toward a part-time work force.

But in other situations, office automation encourages the creation of a part-time work force. Where it is used to standardize and deskill work many employers have found it profitable to use part-time, low-paid workers. Some have reportedly moved to suburban locations to take advantage of the availability of housewives willing and eager to work part-time at low wages because there is another primary wage-earner, with a full benefits package, in the family. As discussed in chapter 7, office automation also makes it feasible to use home-based workers, on a part-time and piece-rate basis. In the long run, office automation may stimulate a stronger trend toward use of part-time or temporary workers by allowing employees to maintain a minimum work force that will need supplementing during hours or seasons of work overload; and by standardizing the basic skills needed by clerical workers and some kinds of professional and technical workers.

In 1955, only 8 percent of American workers were part-time;[51] this rose fairly steadily to about 15 percent in the late 1960s and continued to rise to 20 percent by the 1980s. (See table 2-4.) Thus. about one-fifth of American workers are working part-time. Women are much more likely to work part time, often in order to combine paid employment with child care. About 29 percent of working women work part time, compared to 12 percent of working men. About 21 percent of teenagers aged 16-19 and employed, are working part time.

In 1983, in the FIRE industries—leaders in office automation—only 11 percent of employees were part-time. This sector ranked fourth among major industry sectors, after the wholesale and retail trade (32 percent), service industries (27 percent), and construction (14 percent). In the service industries, a large proportion of the part-timers were probably also office workers.

In the office-oriented sectors of banking and insurance of other industrialized countries, however, part-time work is expected to increase.

[48]See, for example, a recent article in *Business Week*, "Part-Time Workers: Rising Numbers, Rising Discord," Apr. 1, 1985, p. 62, reporting explicit statements by several company spokespersons about reluctance to staff to full capacity.

[49]Katsus Nishiyama, "Introduction and Spread of VDT Work and Their Occupational Health Problem in Japan," to be presented at the 5th UOEH International Symposium in Japan, Sept. 19, 1985.

[50]*Business Week*, op. cit. Another strong factor has been the growth in demand for part-time employees by fast-food restaurants, shopping centers and shopping malls, and neighborhood banking locations, many of which are open long hours, at night, or on Sundays.

[51]*New Work Schedules for a Changing Society* (Elmsford NY: Pergamon Press, 1981), p. 45.

According to the International Labor Organization, part-time employment in the banking and insurance industries is rising in its member countries, and in Sweden over 26 percent of banking and insurance employees are part-time.[52]

ATMs have probably reduced the need for part-time tellers and clerks in the United States. But other forces are now at work. Four of the biggest eight accounting firms, and many financial service firms including Citibank, Traveler's Insurance Company, and other major employers of clerical workers such as Control Data Corporation (CDC) are now emphasizing part-time employment.[53] Travelers Insurance Company has developed a job bank of retired professionals for temporary market research and product development, and plans to train them for use as programmers, part-time. CDC has a formal program of using part-timers, which has been in effect for 2 years. The goal is to have 15 percent of their work force (chiefly clerical and production workers) on part-time or temporary status and another 15 percent as independent contractors. This goal has been partly realized; by 1984 CDC was reported to have 4,500 part-time workers, or 10 percent of their work force.

Closely related to part-time work is temporary work, which for employers is another strategy for workload leveling. Many clerical workers are temporaries, but there is a growing trend toward using temporary programmers, systems analysts, computer engineers, and data communications specialists.[54] Temporary workers can be called in on short notice when work is briefly or seasonally heavy, and can be dismissed almost instantly and without penalty. From the employer's viewpoint temporaries are part-time workers for whom the organization has no responsibility for long-range job security. The worker who is individually hired on a temporary basis generally suffers the disadvantages of a part-time worker—i.e., not qualifying for benefits and relatively little chance of promotion, and by definition has no job security. Many temporary office workers, however, are employed by firms within the new temporary employment service industry; that firm provides them with assignments to client firms. The worker may be available to the employment service firm full-time or nearly full-time, or may wish to work only occasionally or sporadically. Some employment service firms are now providing their regular workers with prorated benefits similar to those that they might receive as permanent employees of a large firm. More generally, however, temporary workers do not have such benefits.

Photo credit: Kelly Services, Inc.

This simulator exactly duplicates several major word processing systems and is used for testing in an employment services firm.

The temporary service industry is growing rapidly, nearly twice as fast as GNP over the last 14 years, and faster than the computer equipment industry, to a payroll of $5.5 billion in 1984.[55] At first, it appeared that auto-

[52] International Labor Organization, Advisory Committee on Salaried Employees and Professional Workers, *The Effects of Technological and Structural Changes on the Employment and Working Conditions of Non-Manual Workers*, Eighth Session, Geneva, 1981, pp. 50-51.

[53] Joann Lublin, "Shorter Hours. More Managers Are Working Part Time, Some Like It But Others Have No Choice," *Wall Street Journal*, June 2, 1982, p. 50.

[54] John J Davis, President of Worldwide Computer Services, Inc , "Is There a High-Tech Pro in Your Future?" *Management Information Systems Week*, May 22, 1985, p 64.

[55] The National Association of Temporary Services reported a payroll of $431 million in 1971 and $5.50 billion in 1984, an average of nearly 20 percent growth per year. (Figures sup- *(continued)*

mation would be a barrier, since temporary workers would be unfamiliar with equipment, which varies widely between offices, but the larger temporary agencies provide training in a broad spectrum of office automation equipment and applications, particularly word processing. Also, automation has standardized and de-skilled some tasks for which temporary workers can be used. Clerical occupations accounted for over 60 percent of temporary assignments made by the industry in 1980, although it accounted for only 49 percent of the revenue since clerical wages are generally lower than those in technical, medical, and industrial assignments made by the temporaries industry.

Temporary computer and data communication specialists, and other professionals, are in growing demand. They can offer up-to-date knowledge of current systems, languages, and protocols, because of recent schooling and varied experience, and may choose to work as temporaries for fear of becoming trapped in a narrow specialty or job where their knowledge will gradually become obsolete.[56] A computer services official attributes the trend toward use of temporary professionals in computer-related work to "the triangle brought about by mounting costs in corporate and government-mandated fringe benefits, the inability of many companies to meet peak workloads with their permanent staff, and finally the growing number of professionals who desire to change their work patterns."[57]

Closely related to temporary employment are employee leasing and use of independent contractors. Employee leasing may be used by employers as a still longer term strategy for workload leveling (by month, year, or project-duration), but it is more generally used by very small firms or professional offices (doctors, lawyers, dentists) to shift the administrative costs and benefits costs associated with employees to a contracting firm, which can benefit by economies of scale.[58] The leased worker usually enjoys a full benefits package, although he or she is not guaranteed permanent employment (in practice, the job security may be about the same as in conventional forms of employment).

Office automation appears to have given a large boost to the growth of independent contractors offering business services such as word processing, data entry, and computer programming. Independent contractors are self-employed, with all the risks and benefits this entails; he or she assumes the costs associated with slack work periods and loss of worker's benefits in return for autonomy. The work may be done in the employer's facility, with the contractor/worker effectively indistinguishable to observers or coworkers from employees. The work may however be done in the contractor/worker's home, using the communication capabilities of office automation.

Some clerical and professional independent contractors are entrepreneurs, or small business men and women, seeking multiple clients either at one time or in sequence. They may or may not plan to expand their activities and take on employees of their own. Many contractors on the other hand work for only one firm and are in effect employees without the benefits otherwise associated with employment. The unresolved tax and legal issues associated with independent contractor status are discussed at greater length in chapter 7 in connection with home-based clerical workers, many of whom are former employees converted to the status of independent contractor.

Part-time and temporary employment and independent contracting are likely to increase as automated offices move toward a lean work force with need for occasional supplementary business services, and as more workers are familiar with the equipment. There are strong

(continued from p. 61)
plied by the National Association of Temporary Services and also based on the Census Bureau's *County Business Patterns*, "Vital Statistics of the Temporary Help Industry," *Contemporary Times*, vol. 2, issue 6, fall 1983.)

[56] Davis, op. cit., says "In practical terms, they do not want to spend the next 5 years of their careers learning how to apply Unix or C into an insurance company microcomputer system."

[57] Davis, op. cit.

[58] Some service contracting companies make their profits from the interest on advance deposit of the monthly fees paid by the client to cover wages plus associated costs.

benefits in it for workers as well as for employers. Many people prefer and actively seek part-time work. Students, mothers, and retired people often want to work less than a standard workweek; others want more time for families, education, or recreation. They choose to trade income for leisure time, and are willing to pay the additional costs in terms of loss of benefits such as health insurance, lack of job security, and diminished likelihood of promotion and advancement. The standard 40 hour workweek has not changed since the 1930s, and part-time work is the way some people create their own shorter workweek.

Many "temporaries" choose this form of employment because they want or need the flexibility it gives them. Some use it as a form of job-hunting, or trying out potential employers. However, some temporaries are unable to get assignments as regularly as they wish, and find the unpredictability of their income a severe disadvantage, but have been unable to find permanent employment.

At a minimum, part-time work is preferable to unemployment. Employers sometimes convert full-time employees to part-time status during a recession, in preference to laying them off and losing a valuable worker.[59]

If part-time work is beneficial to many employers and is sought by many employees, under what conditions is it a public policy concern? First, if enough full-time jobs are eliminated—i.e., converted to part-time jobs, opportunities will be diminished for those who must have full-time work to make enough money to support themselves and their dependents. Second, in the United States, many social services and income protection mechanisms are provided not directly by tax payers but through employee benefits packages—e.g., health insurance, life insurance, income during illness or childbirth, pension plans, and to some extent training and higher education. These protections are much more costly, if they are available at all, on an individual basis. If conversion to part-time work means that a sizable proportion of the population no longer has these protections through employment, then the taxpayer is in the long run likely to bear more of the burden of the illness, old age, and death for these people, and the average level of health and well-being of the population is likely to decline.

Society may be willing to bear this risk, if that is the price of allowing people to choose part-time work. If part-time work is not a choice, but the only alternative available to them, and especially if this limitation on choice is the result of employers' decisions, then the public policy issue becomes one of whether this shifting of responsibility for basic protections from employer to employee is acceptable to the society at large. Historically, the choice of full-time or part-time work has been regarded as the individual's prerogative. We must then ask: is this still a free choice, and will it be so in the future? To what extent is *involuntary* part-time work increasing?

The official part-time employment figures based on annual averages do not tell the whole story. The number of people who work part time at some time during a year is often double the annual average. For example, in 1978, a recession year, the annual average was 21.4 million part-time workers, but a retrospective survey indicated that 40.9 million people, at some time during 1978, had only part-time work.[60] While the annual average showed 3.4 million of the part-timers as working part-time involuntarily (that is, because they could not find full-time work)[61] the retrospective survey counted 10.1 million. The number of involuntary part-timers has been increasing, as shown in table 2-4, to more than a quarter of all part-timers (and about 5 percent of all employed)

[59]Robert Bednarzik, "Short Workweeks During Economic Downturns," *Monthly Labor Review*, June 1982, pp. 3-11.

[60]Sylvia Terry, "Involuntary Part-Time Work: New Information From the CPS," *Monthly Labor Review*, Febrary 1981, pp. 7-74. See also U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings*, January 1984, table 31, footnote 17.

[61]The Bureau of Labor Statistics counts as involuntary part-time workers those who are working less than 35 hours per week because of slack workloads, material shortages, or repairs to plant and equipment (in other words, the employer has insufficient work for them to do), those whose job ended or whose new job began in the middle of a workweek, and those who cannot find full-time work.

at present. Recent increases in involuntary part-time employment and multiple-job holding for women suggest that there may not be enough full-time jobs for those that seek them.[62] Thus the number of people who "want" to work part-time may be smaller than assumed, and the change in attitudes and lifestyles cited above as a factor in the trend may not play as strong a role as is often assumed.

Public interest in part-time and temporary work is therefore twofold:

1. that the number of involuntary part-time workers not increase to undesirable levels, causing a deterioration in income levels, because full-time jobs have been converted to part-time jobs; and
2. that the costs of worker protection not be shifted from employer to worker to a degree that ultimately causes them to be borne by the taxpayer.

These unanswered questions again point to the need for more careful and systematic monitoring of trends in employment, since a significant increase in the number of long term involuntary part-time workers would challenge the adequacy of existing mechanisms for income security and other employee protection mechanisms.

Analogies From Past Waves of Automation

Throughout modern history, mechanization and automation of work have brought dire warnings of unemployment.[63] But employment has continued to expand. Mechanization and automation have contributed to, or driven, this expansion by reducing the costs of food and material goods, stimulating the market for them, providing paychecks for workers to buy those goods, and creating capital to be invested in production of more and still cheaper goods, further stimulating the market.

In general, workers displaced by mechanization have taken other jobs in the same industry as it expanded, or moved into new or expanding economic sectors.

The argument from history is powerful; in general, technology creates rather than destroys jobs. That is why developing nations, with exploding populations, struggle to industrialize. There are however several important considerations to be noted. The great waves of mechanization and automation in the past were still part of the continuing industrial revolution. The United States was, in the 19th century, a developing nation—an agricultural nation becoming an industrial nation, with an expanding national market based on plentiful resources, in which the consumers who bought goods were also the workers that produced them. From World War II through the 1950s, at least, U.S. technology enjoyed worldwide preeminence across the board. But this is now a mature economy, strong but with increasing competition for both domestic and world markets. Imports are a major factor in the economy. It is therefore not clear that the American economy will grow, in the future, at the vigorous rate of the past. In an economy that is growing more slowly, new jobs are created at a slower rate, and workers do not enjoy the mobility they have in a rapidly growing economy.

Secondly, past waves of automation have been concentrated in one or a few industries, for example, at one time agriculture, at another period commodity manufacturing or industries that could use assembly line techniques. Automation proceeded unevenly across economic sectors, crafts and occupations, industries, organizations according to size, and geographical regions. Jobs were increasing in some industries and occupations, when jobs at approximately the same skill level were decreasing in other industries. Large companies automated well before small companies. Many

[62] According to Professor Eileen Appelbaum in a talk prepared for presentation to the Panel on Technology and Women's Employment of the National Academy of Sciences, Washington, DC, Feb. 17, 1985.

[63] Mechanization is the use of machinery as a substitute for human or animal labor. Automation is a narrower term, meaning the use of machinery that "makes decisions" about the work without human intervention, that is, machinery with control systems that incorporate the principle of feedback to fine-tune or correct the machinery's operations. Computerization carries this internal decisionmaking a great deal further, with the use of information stored in memory and by the sensing of external conditions.

kinds of manufacturing automation, for example, have never been adapted to batch manufacturing or for small machine shops. This contrasts with office automation, which can be used in basic office functions across all industries, and especially with small computers and stand-alone word processors, which allow even small offices to automate.

Although total employment has grown through and after historical waves of automation, each has left behind some structural unemployment. In many cases, older workers failed to make the adjustment and new jobs went to new workers with more recent training, new skills, or more flexibility. In other cases, new jobs and new industries more than compensated for lost jobs in number, but were located in other regions, leaving displaced workers behind. (The coal miners of Appalachia are a pertinent example.)

Agricultural employment declined steadily from 27 percent of all employment in 1920 to 2.7 percent in 1980 (an absolute loss of 8.7 million jobs) as agriculture was mechanized. See table 2-5. However, employment was created in food processing (1.6 million jobs in 1982), in agricultural research, and in transport and sales of food. As population and the economy grew, blue-collar employment stabilized. There were only 3 percent more blue-collar jobs in 1980 than there were in 1950, while the work force grew by 69 percent in those decades. The 30.5 million blue-collar jobs in 1950 were over half of total U.S. employment, while the 31.5 million blue-collar jobs in 1980 were less than 32 percent of total employment. Now the number is decreasing. BLS reports that 2 million manufacturing jobs have been lost since 1979.[64] Had white-collar employment not been expanding rapidly, new workers could not have been absorbed into the economy.

At the beginning of the 20th century, there were only 5.1 million white-collar jobs, accounting for under 18 percent of all employment. By 1950 these jobs had quadrupled to nearly 22 million, but still accounted for less than 37 percent of employment. In 30 years—less than the working lifetime of an office worker—the number of white-collar jobs has more than doubled to nearly 52 million jobs, accounting for at least 55 percent of all American workers.

Structural change in the economy has created jobs in some sectors while it displaced jobs in others. The result is a net increase in employment, and there is also a more equitable distribution of employment opportunities (e.g., better status jobs for more people, and more jobs open to women). Creation of jobs has by and large kept up with both population growth and growing participation in the labor force. In 1950, 57 percent of the population was in the labor force, but by 1980 this had grown to nearly 64 percent.

[64]BLS originally reported to the Joint Economic Committee that 8 million jobs had been lost, but issued a correction after this was reported in the press. See "BLS Corrects Figures on Factory Job Losses," *Washington Post*, June 18, 1985.

Table 2-5.—Shifts in Employment by Industry Sectors, 1900-80

	1900	1910	1920	1930	1940	1950	1960	1970	1980
Total labor force (000)	29,030	37,291	42,206	48,686	51,742	58,992	67,990	79,802	104,058
White collar:									
Growth		56%	32%	36%	12%	34%	26%	39%	42%
Labor force	18%	21%	25%	29%	31%	37%	40%	47%	51%
Blue collar[a]:									
Growth		37%	14%	19%	11%	14%	9%	19%	21%
Labor force	45%	48%	48%	49%	52%	52%	49%	49%	45%
Farm:									
Growth		6%	−1%	−9%	−13%	−23%	−41%	−40%	−6%
Labor force	38%	31%	27%	21%	17%	12%	6%	3%	3%

[a]This includes manual and service workers

SOURCES U S Department of Labor, Bureau of Labor Statistics, *Historical Abstracts, Colonial Times to 1970*, Series D, Nos 182-232, p 139, and U S Department of Commerce, *Statistical Abstracts of the United States—1985*, p 400

But it is not clear that the creation of new jobs has completely compensated for the long range labor-saving effects of mechanization and automation. High unemployment rates (7.5 to 7.1 percent) have persisted in spite of the highest employment ever achieved in this country. In 1984, after recovery from a recession, 3.5 million new jobs were created (the second highest growth rate in our history) but unemployment did not significantly decrease and stood at 7.2 percent at year end.[65] If those workers are counted who have dropped out of the labor market because of discouragement, or have accepted part-time work because they can not find full-time work, the unemployment rate would be several points higher than it officially is; for example, in early 1985, about 10.8 percent rather than 7.3 percent. The number of jobs in manufacturing declined by 1.6 million from 1979 to 1984, and in the goods-producing sector very few industries employ more workers now than before the recession began.[66] During a recession, some markets may be lost to international competitors, and some organizations do not recover. Also, organizations tend to adjust slowly to labor-saving technology, preferring normal attrition to layoffs; but when layoffs are forced for other reasons, they are likely to take advantage of this to eliminate redundant jobs permanently.

The "normal" level of unemployment has in fact been rising for at least half a century. Several kinds of unemployment are usually distinguished. One kind is "frictional" unemployment—that which is normally attributed to the demise of individual firms and the mobility of workers moving between schools, jobs, and occupations. Another kind results from relatively discontinuous or sudden expansions of labor supply, for example, disbanding of a military force, a wave of immigration, or—less precipitous but still unprecedented—the increased participation of women in the labor force in recent years. Third, there is cyclic unemployment resulting from fluctuations in aggregate demand, which can be an acute and serious problem during recessions but declines when the economy recovers. The fourth kind of unemployment and the most serious in long-term considerations is structural unemployment, often defined as a mismatch between the supply of jobs and the supply of workers with the skills needed for those jobs, but in theory also possible when there are not enough jobs, at any skill level, to engage all would be workers.

Until about 1970 it was generally assumed in this country that an "acceptable" level of total unemployment was about 3 to 4 percent.[67] But the rate has not been that low, even in periods of expansion, since 1969. As shown in table 2-6, unemployment rates have been rising for about two decades, not falling back even in "boom" years to previous lows.

This long-term rise in unemployment has been attributed to many causes. One is demographic—the flow of young people and women into the labor market during the 1970s. Others are shifting industry patterns (e.g., involuntary job loss in the automobile industry as a result of foreign competition), changing life styles (willingness of people to take temporary or part-time jobs for the sake of leisure time, or greater mobility), and slackening of aggregate demand. But as shown in table 2-6, the increase can be seen through both the troughs

[65] U.S. Department of Labor, Bureau of Labor Statistics, *The Employment Situation* (monthly) and *Employment and Earnings*, January 1984; Linda LeGrande, "Employment Status of the Nation: Data and Trends," Congressional Research Service, Issue Brief IB82097, updated May 6, 1985.

[66] LeGrande, op. cit., p. 3.

[67] In fact, unemployment rates frequently exceeded this figure in recession years throughout the century and from 1931 to 1940 was higher than 14 percent, with more than 20 percent of the labor force unemployed in 1932, 1933, 1934, and 1935. During the war years unemployment was under 2 percent, and has been on an upward slope since then.

Table 2-6.—National Unemployment Rates During Recession Troughs and Recovery Peaks, 1961-84

Recession troughs		Recovery peaks	
		1961-69	3.6%
1969-70	5.8%	1973	4.8
1973-75	8.3	1979	6.0
1980	7.5	1981	7.4
1981-82	10.6	1984	7.1

SOURCE: Bureau of Labor Statistics data, compiled by Michael Podgursky, "Sources of Secular Increases in the Unemployment Rate, 1969-1982," *Monthly Labor Review*, July 1984, p. 20.

and high points of business cycles. Economist Michael Podgursky notes that there has been a long-term rise in involuntary job loss and argues that:

> ... rising structural unemployment in traditional segments of the labor force may also have played a significant role ... the secular rise in the unemployment rate since 1969 seems to have been generated by more than just labor market adjustment problems associated with a rapidly growing labor force.[68]

It is worth noting at this point that Podgursky's analysis suggests that structural unemployment so far may have affected primarily blue-collar jobs. This would argue that both automation and rising imports of capital goods have played a role. Both will also increasingly affect white-collar work in the future (see chapter 8 for a discussion of off-shore sourcing of data-entry work).

In summary, the number of jobs has continued to increase through waves of mechanization and automation in the past; the U.S. economy was growing strongly, and an assumed major driver in this growth was technological advancement. But there are disturbing signals that structural unemployment has also grown.

The Future White-Collar Labor Supply

The number of office jobs is likely to grow more slowly at best, and at worst to decline, with a possible precipitous decline in lower level clerical jobs such as data entry if certain technological developments proceed as anticipated. The effect on employment levels must be considered in terms of the supply of labor—or the demand for jobs.

During the coming decade, from 1985 to 1995, the population will grow by about 10 percent. But the work force will grow about 16 percent, from 113.5 million to well over 131 million; nearly 18 million more jobs will be needed.[69] There will be fewer young workers entering the work force each year; the number of people in the work force who are under 24 will in fact decline as will the number of workers 55 and over, while the number of "prime age" workers, age 25-54 is growing. These changes of course reflect wide variations in the birth rate in past decades; the average age of workers will increase.

About 65 percent of the workers added to the work force will be women (by 1995, they will make up at least 47 percent of the work force). The number of working women between the ages of 35 and 44 is expected to more than double, and the number between 45 and 55 should increase by nearly 60 percent. Women in these age groups who are already working are heavily concentrated in clerical occupations. This is a demographic group that will be strongly affected by the outlook for office jobs over the next 15 years. The proportion of nonwhite workers will also be growing; now 12.5 percent, they will be 14.5 percent of the work force by 1995. The number of black women in the work force, for example, will increase by over 50 percent. Since minority women are disproportionately represented in lower level clerical jobs, this is another group that will be differentially affected by office automation. A further discussion of the effects on these groups is in chapter 12.

[68]Michael Podgursky, "Sources of Secular Increases in the Unemployment Rate, 1969-1982," *Monthly Labor Review*, July 1984, p. 24.

[69]This is the middle growth scenario used by BLS, see *Employment Projections for 1995*, Bulletin 2197, March 1984.

CONCLUSIONS

The most likely outlook appears to be slowing growth in office employment over the next decade; some decline in office employment could begin by 2000. Slowing employment growth, or even decline, is most likely to occur in clerical occupations but may also affect lower and middle management positions.

This outcome is not certain or inevitable. Strong growth in the U.S. economy and continuing growth in demand for information, and information-based products and services may outweigh the labor-saving achieved through office automation. Nor would slow growth in office employment necessarily result in lower overall employment levels. Growth in other occupations could more than compensate for a decrease in office jobs, especially if higher office productivity contributes significantly to the productivity of U.S. industry and its competitiveness in world markets.

The possibility of slow growth or decline in office employment, which now occupies about 45 percent of all employed Americans, is nevertheless something which Congress should watch closely, in order to take preventative or corrective actions in a timely fashion. The further possibility of a significant increase in part-time and temporary work, at the expense of full-time employment, should also be watched carefully, lest it leave a growing proportion of American workers without essential benefits, income security, and other social protections.

As has been noted throughout this chapter, however, **the ability of Federal policy makers to monitor technological change and its effects on employment and the structure of the economy is weak.** It is limited both by inadequate data and by lack of capability in technological and economic forecasting. The latter limitation in turn, reflects in part the state of development of these disciplines themselves; however, in the civilian agencies little resources are being allocated to improving these capabilities and recent budget cuts, may have further eroded government capability for foresight and planning, at least in the important area of information and communication technology development.

POLICY CONSIDERATIONS: LABOR MARKET ADJUSTMENT OPTIONS

The Need for Monitoring of Structural Economic Change Related to Information Technologies

While the possible long-range effects of office automation can be foreseen, they are subject to many and complex uncertainties related to broader changes in the national economy and the global economy, as well as to natural social adjustments and accommodations and to specific policy interventions. Nevertheless, the potentiality is troublesome enough to merit both careful monitoring and systematic contingency planning by responsible agencies of the Government.

That kind of serious monitoring and planning is not being adequately done. Executive agencies have few incentives to warn of possible long-range problems when such warnings, or the preparatory actions they imply, may call into question immediate administration policies or the assumptions around which they are framed.

Congress may, therefore, wish to consider now how such monitoring and long-range planning may be set in motion.

There are serious institutional barriers to such analysis within the executive branch of Government. The first necessity for analysis of emerging and potential employment problems related to structural change in the economy is the availability of time-series data organized in appropriate categories. There are at present troublesome deficiencies in the way in which labor data is collected and organized for use by government analysts. A second necessity is the continuing development of capability for monitoring and forecasting technological change. To analyze the employment implications of technological change, there must be a close link between technical, economic, and social science knowledge and analytical expertise. There is no institutional locus in the executive branch of the Government developing excellence in the technical monitoring and forecasting of information and communication technology and studying the economic, social, and political implications, despite the central role that information and communication technology now plays in the economy and in the Government itself. On the contrary, some of the relevant but partial and fragmented functions and capabilities that have been developed along those lines have recently been curtailed or weakened by budget cuts (e.g., the planning and forecasting elements within the Institute for Computer Science and Technology in the National Bureau of Standards).

Congress should therefore consider means of mandating and implementing a mechanism or governmental unit within the executive branch with the capability for systematic monitoring, analysis, and reporting of changes in the structure of the economy related to fundamental changes in the technologies of communications, computers, and information management.

Longer Range Policy Options

If, as it appears possible, office automation will over the long run lead to inadequate growth in demand for office work or outright decline in the number of office jobs, or in the narrower but still large category of clerical jobs, what could be done about it? The policy options discussed below are long-range options, interventions to be considered if and when it appears that white-collar unemployment is becoming a serious problem.

Discouraging the spread of office automation in the United States is clearly undesirable, because of the benefits it promises in terms of productivity and in terms of the quality of work life; and discouraging it is also virtually impossible under the U.S. economic and constitutional framework.

Some of the marginal effects of office automation on employment could be controlled directly. For example, Congress may wish to consider options to discourage the off-shore sourcing of office work, or of the narrower category of data entry, should this increase to the point of significantly affecting clerical jobs in the United States.

Conventional kinds of policy intervention would aim at improving labor market adjustment—that is, helping displaced workers get new jobs. These mechanisms might include a broadening of the applicability of labor market adjustment support to white-collar workers, and an increase in the level of that support.

In the matrix of 1982 dollars, the money spent by the Federal Government on general employment and training programs and for the Federal Employment Service per labor force participant has fallen from $46.35 in 1970 to $30.30 in 1982, a 35 percent decrease. This is about one-quarter of the expenditures in some other industrial nations, for example, Sweden. As pointed out by an expert in labor adjustment policy:[70]

> Current policy takes a passive orientation toward the labor market and serves only the most disadvantaged workers. What is required is a more activist policy in which *structural change is anticipated* and a broad segment of the labor force is assisted in adjustment. With-

[70] Michael Podgursky, University of Massachusetts, "Labor Market Policy and Structural Adjustment," a paper prepared for the Conference on U.S. Industrial Policy and International Development, held by the Overseas Development Council, Washington, DC, Mar. 4, 1983. Podgursky made this argument in the context of displacement of manufacturing workers and overall structural changes in the economy and was not specifically referring to white-collar displacement.

> out such a change existing employment and training programs will continue to play only a marginal role in assisting workers in the mainstream of the industrial labor force who face economic hardship as a result of ongoing structural changes in the economy. (Emphasis added.)

An alternative or complementary strategy is to focus Federal programs on those office workers apt to be most directly and strongly affected, and also relatively disadvantaged in terms of current employment status. This group includes: 1) those in specific clerical occupations generally at lower levels of the wage scale, most of whom are women; 2) minority workers; and/or 3) all women office workers, since even in managerial and professional occupations women as a group have less seniority than men and are concentrated at the lower levels of the occupational hierarchy most likely to be affected by automation.

Existing job training programs and labor exchange or employment service systems that provide labor market information are primarily framed around blue-collar employment.[71] Programs available to displaced workers in the automobile and steel industries, for example, have given relatively little attention to office workers in those industries. There may be ways to improve the quality and availability of labor market information and counseling services for office workers, with an emphasis on forecasting changes in occupational demand.

Development of serious white-collar unemployment could result in demands for actions in the broad category of "share the work" mechanisms; for example, a shortening of the standard workweek. Industry has generally resisted all such suggestions for three decades, and will surely continue to do so on the grounds that it would subvert the productivity increase sought in adopting office automation. From the standpoint of labor, such a strategy would be undesirable unless wages were raised proportionately. If wages did not rise, then many workers would seek to compensate for shorter working hours by taking second (part-time) jobs, which would tend to make the strategy ineffective.

In effect, the standard workweek may be shortened without policy intervention if the use of part-time workers increases. This has disadvantages from a public interest viewpoint, because as discussed above it would result in a deterioration of income security, and very likely a long-range increase in the costs of necessary social services and/or an increase in the share of that burden borne directly by taxpayers.

To some extent that problem might be alleviated by laws requiring the prorating of all workers' benefits packages, stronger controls over conversion of employees to independent contractor status (or more stringent definition and clarification of that status), and nationwide eligibility of involuntary part-time workers for prorated unemployment benefits. This would lead to a more rational allocation of labor resources by eliminating the advantages that accrue to employers who substitute part-time workers for full-time workers not to level the workload but to save the cost of fringe benefits. Rigorous cost-benefit studies would be necessary, however, to assess the desirability of such policy actions; they should include cost-effectiveness studies to determine the relative advantages of employer-sponsored fringe benefits and publicly provided social services.

One possible strategy is shared work compensation, also known as voluntary reduced work time (VRWT). This concept calls for State legislation to allow payment of partial unemployment compensation to workers when companies, facing the necessity of laying off workers, choose instead to reduce the work time of employees (e.g., putting at least 10 percent of the workers on a 4-day week).[72] A VRWT

[71]See the forthcoming OTA report, *Technology and Structural Unemployment: Reemploying Displaced Adults*, early 1986.

[72]This strategy has been widely used in Europe, in Germany, payment of partial unemployment benefits to more than 770,000 involuntary part-time workers during the recession year 1975 was credited with keeping the unemployment rate about 1 percent lower than it would otherwise have been. In 1929 the Hoover Administration urged employers to reduce workweeks in order to spread work, but without unemployment pay-

program spreads available work (or more exactly, shares the burden of unemployment) thereby maintaining purchasing power and curtailing need for public welfare expenditures. It also has the advantage of preserving the employment gains of women and minorities, who constitute a disproportionate share of "last hired-first fired" workers. The full costs of such a program are uncertain, but in theory the benefits paid out should not be much greater than they would be under regular unemployment compensation programs since they would merely be partial payments to more workers rather than full payments to fewer workers. California passed Work Sharing Unemployment Insurance legislation in 1978 and at least six other States followed.

States determine eligibility and terms for unemployment compensation, which is basically financed by taxes levied against employers by the Federal and State Governments. The Federal Government could provide incentives to States to provide such programs, and in fact has already provided some encouragement. A section of the Federal Tax Equity and Fiscal Responsibility Act of 1982 requires the Secretary of Labor to conduct cost/benefit studies of VRWT and to develop model uniform legislative provisions for use by the States.

ments the result was further decline in wage levels. James W. Singer, "Sharing Layoffs and Jobless Benefits—A New Approach Is Attracting Interest," *National Journal*, Feb. 9, 1980, p. 232.

What Action Is Needed Now?

Office automation will restructure employment patterns for a large portion of the American work force. This will challenge much existing Federal labor policy. That policy may have to be altered:

- to maintain Federal policy objectives in this new environment;
- to prevent unintended barriers to social and labor market adjustments that are appropriate and desirable; or
- to mitigate undesirable side effects of such adjustments or to prevent undesirable adjustments.

The labor force adjustment mechanisms mentioned above are conventional proposals for dealing with structural employment problems. OTA does not suggest that white-collar unemployment resulting from office automation will call for such actions, or more extreme actions, in the immediate future. Such responses are, however, most effective at the early stages of a developing problem. Without the capability to detect structural changes before they become seriously disruptive, those early stages cannot be credibly identified so that actions can be taken. OTA concludes, therefore, that better monitoring mechanisms would improve Congressional capability for effective action.

Chapter 3

Training and Education for Office Automation

Contents

	Page
Technology and Training	76
The Stakeholders	76
Basic Skills Required for Office Automation	78
Determining Training Requirements	79
Methods for Delivery of Training	79
How Is Training Obtained?	81
The Adequacy of Office Automation Training	83
Education for Office Automation Technologies	85
Teachers and Computers	87
Curriculum Development	87
Access to Education	88
Policy Considerations	89
Policies in Foreign Countries	89
Existing Legislation	89
State and Local Practices	91
Policy Options	92

Tables

Table No.	*Page*
3-1. Average Costs for Training Among Selected Office-Related Occupations	77
3-2. Sources of Training Needed for Obtaining Current Job Among Representative Selected Office-Related Occupations	84
3-3. Sources of Training for Skills Improvement Among Representative Office-Related Occupations	85

Figure

Figure No.	*Page*
3-1. The Use of Computers in Elementary and Secondary School Education	86

Chapter 3

Training and Education for Office Automation

Automated office technologies are promoting change in skills, jobs, and organizational structures. These changes are creating a continual need for new kinds of training and education for office workers. The demands on the resources of companies, governments, and individuals to keep up with these relatively rapid changes will be enormous. Those who are getting the largest share of work-related training are those already employed, in higher level jobs, white, young to middle age, with discretionary income and time.

The training costs associated with introducing new technologies were not fully anticipated by early users and are just beginning to be fully recognized as a necessary element in achieving increased productivity. Frequently, organizations have designed and implemented new systems without recognizing the evolution that might occur and the need for continuing training that would accompany this evolution. The result was often decreased productivity. More attention paid to training can provide significant benefits, including greater job satisfaction, reduced turnover of employees, improved efficiency, and more effective service to customers. Experience with office automation has led to greater recognition of the importance of training. Training is itself now a fast growing industry.

This chapter looks at ways in which workers obtain training and the implications of this to individuals and employers.

There are good data on educational levels attained by citizens before leaving school. It is more difficult to determine how much adult training and education occurs and how much of it is job related. In 1981, nearly 21 million adults participated in adult education and vocational education provided by universities, community colleges, governments, secondary schools, private schools, commercial schools, and employers. Much of this training is recreational, such as crafts, photography, and travel classes. However, much of it is also job related; for example, computer courses.

There are signs that a large part of the population does not have access to training, which creates inequities in opportunities for available jobs. The lack of coordination on a national level of information on training and education for work and on job opportunities hampers the ability of individuals to plan careers and to adjust to changing job markets. The benefits for the individual in achieving new skills are not only higher income or greater income security but also an increase in self-esteem and confidence, which promotes the ability to learn additional new skills.

Training and continuous education opportunities for acquiring office automation skills are critical for at least three reasons:

1. At least 75 percent of the adult workers for the year 2000 are already in the labor market. The majority of those that must be trained and educated to use office technologies are adults past the stage of secondary education.
2. Office automation (OA) technologies have the potential to affect the lives of more people than any other type of computerized technology, since office workers now outnumber manufacturing workers.
3. Employment trends show a continual change in skill requirements. This means that adults must be frequently retrained to use the new technologies and adapt to changes in occupations and the work environment. Changes in the work environment and work performed may necessitate adaptation to unforeseen work situations.

TECHNOLOGY AND TRAINING

New technologies and the accompanying training needs seem to operate in cycles. The training cycle for a technology has been described as follows:[1]

- new technology introduced—employers provide extensive training and upgrading of employees because of lack of available expertise in the work force;
- technology becomes widely adopted and equipment is standardized—specific skills become general skills; employers lose employees to other firms;
- employers cease to provide general training; training is shifted out of the workplace and into the schools, and firms focus on firm-specific skills;
- increased demand makes it feasible for public and private schools to standardize and formalize training; and
- the industry using the technology, or the technology itself, declines; demand for skills contracts—training focused on replacement needs of the firm and on retraining of displaced workers.

Office technologies are in the early stages of this cycle. Some employers are continuing and even increasing their expenditures on training, but with the largest proportion spent on management skills training. Some are beginning to require skills in using automated equipment as a condition for employment, as they find a more plentiful supply of already trained workers.

Public and private educational systems are now offering training in office automation as well as providing the general education needed by office workers. U.S. companies spend $40 billion per year on further education and training of workers.[2] Over 21 million people participated in adult education (part-time, nondegree studies) in 1981.[3] Fifty-seven percent of these courses were in formal educational institutions such as universities, vocational and trade schools, community colleges, or elementary and high schools. Twenty-seven percent of the courses were provided by business, labor, and professional organizations or government agencies. Sixty-one percent of the courses taken were job related, that is, were taken to improve skills for a current job or to get a new job.[4]

The Stakeholders

According to the Bureau of Labor Statistics (BLS) the work force is expected to grow by 23 percent by 1995. BLS projected growth of 1.6 percent per year between 1982 and 1990. This would slow to 1.0 percent per year between 1990 and 1995.[5] This is based on a projected population increase of 12.5 percent by 1995.[6]

About 75 percent of the U.S. labor force for 2000 is already in the labor market, creating a great need for adult learning opportunities. As the "baby boom" generation ages, the need for teaching new skills to an adult work force has been termed an "adult learning crisis."[7] The term "crisis" refers to the wide gap in future skill requirements for work in automated offices and the current capacity to train adults, and was identified for example in the Leontief-Duchin employment forecast described in chapter 2. Changes in elementary and secondary education will have little immediate impact on these adult learning needs in the next two decades, since the formal educational system may reach only 25 percent of that work force that are new entrants.

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1. Patricia Flynn, *The Impact of Technological Change on Jobs and Workers* (Waltham, MA: Bentley College, March 1985).
2. *Manpower Comments* (Washington, DC: Scientific Manpower Commission, July-August 1985), p. 7.
3. *Digest of Education Statistics, 1983-84* (Washington, DC. U S Department of Education, National Center for Education Statistics, December 1983), p. 157.
4. *Training*, October 1983, pp. 54-68.
5. Randolph Brown, "Demographics of the Current and Future American Work Force," *Profit Sharing*, vol. 32, November 1985, pp. 5-17.
6. The BLS projected population for 1985 was 237.5 million. The population, according to the Bureau of the Census, actually reached 238 million in May of 1985 that indicates that the total for 1985 will be somewhat higher than was projected.
7. Lewis J. Perelman, *The Learning Enterprise: Adult Learning, Human Capital and Economic Development*, The Council of State Planning Agencies, 1984, p. xv.

Because of continuing technological change, office workers will have to train and retrain over a lifetime. This will have a heavy impact on the resources of both providers of training and of those who are trained. In 1981, when the average annual earnings in private industry were just over $13,000, 42 percent of the participants in adult education had incomes of over $25,000, 42 percent had incomes of $10,000 to $25,000, and 12 percent had incomes of under $10,000 (the remainder were unreported).[8]

Average costs for training in some office-related occupations are illustrated in table 3-1. Additional costs to the trainees are reduced leisure, family, and personal time. These costs can be a substantial barrier, especially for those with child care and other family responsibilities.

Women, who are heavily employed in clerical work and increasingly striving to move up in organizational hierarchies, have a large stake in the changes in jobs and training. Women have constituted a large proportion of the increase in the labor force in the past 15 years.

Blacks have also been moving into office jobs in the past three decades, increasing their participation rate in clerical jobs from 2.7 percent in 1950 to 10.2 percent in 1984. They, too, have a strong interest in the changes occurring. Black and other groups will enter the work force at a faster rate than whites, and will account for about one-fourth of the projected increase in the labor force to the year 1995.[9] Hispanics will also make up a larger part of the office work force because of a higher birthrate than whites and because of high immigration rates.

The group most effected in the past by discrepancies between skills required for available jobs and their own education and skills, are young workers, and especially those from inner-city minorities. More than 40 percent of the unemployed in January 1983 were under 25 years old.[10] The rate was 50 percent for black teenagers. This situation may be somewhat alleviated by the decrease in number of young workers, but the problem of lack of needed skills will continue to limit the opportunities in office work for many young minority workers.

The 35 to 50 year olds who will constitute the largest group in the work force until after 2000 have completed their basic formal education. Their additional training and education will be achieved through on-the-job training or through their own efforts outside the workplace.

Older workers also have a stake in changing skill requirements. There is no evidence to prove that age is directly and linearly related to performance,[11] or to learning, but there is less incentive for organizations to offer continuing education and training to older workers as they approach early retirement age. Attitudes on the part of managers that reflect their own perceptions of a worker's capabilities play a large part in determining what training is offered. While there is no evidence that intelligence, learning ability, memory, or motivation decline with age until very late in life,[12] this perception can seriously affect the kind and amount of training and retraining that is offered to older workers.

[8]*Digest of Education Statistics, 1983-84*, op. cit., p. 157.
[9]*Monthly Labor Review* (Washington, DC. U.S. Department of Labor, Bureau of Labor Statistics, November 1983), p. 3.

Table 3-1.—Average Costs for Training Among Selected Office-Related Occupations

	Costs (dollars)		Hours	
Occupation	Public	Private	Public	Private
Accounting	$488	$2,893	1,238	1,019
Business administration	395	3,913	1,148	1,198
Secretary	541	2,903	998	1,043
Computer programmer	551	3,473	1,276	704
Clerk	507	1,870	924	785

SOURCE: U.S. Department of Education, National Center for Education Statistics, *Digest of Education Statistics, 1983 198-*, Washington, DC, table 139

[10]*The Employment Situation. December 1982* (Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, Jan. 7, 1983).
[11]U.S. Senate, Special Committee on Aging, *The Costs of Employing Older Workers* (Washington, DC: U.S. Government Printing Office, September 1984), p. 4.
[12]Ibid., p. 59.

Basic Skills Required for Office Automation

Whether skills required to work in automated offices are at a "higher" or "lower" level than those they are replacing, and whether more or less training and education will be needed by future employees, has been the subject of much debate.

The basic skill requirements for all office work can be obtained through the traditional educational system. These include reading, writing, spelling, and some math proficiency. Problem solving, abstract thinking, communications, and interpersonal skills are increasingly important. But studies have concluded that one-fifth of the Nation's adults do not have adequate reading and writing skills to function competently in the labor force.[13]

Some office automation equipment will foster jobs that require less skill than do manual operations, but many jobs found in an automated office require a higher degree of discretion, initiative, understanding, and creativity. A few specific skills become redundant, but many workers must cover a wider span of work activity than before, often in a shorter time span.

The degree of automation achieved may determine the skill levels required. In the factory, levels of automation vary from a power tool that is hand controlled to a robot that identifies and selects appropriate actions and corrects its own performance while operating. The skills required can increase as tasks are automated but only to a certain level.[14] When the automation reaches higher levels the required skill levels can decrease, as the worker is required only to monitor the machine and respond when the machine warns that something is wrong.

Most offices are now at the lower to middle levels of automation; it is likely that the skills required are more complex at this time because of the many sets of rules that need to be learned to operate the new equipment, and because of the changes in the work process and in relationships between work groups.

Among clerical workers surveyed by Kelly Services, Inc., 88 percent of the 613 respondents believed that their skills were increased by automation and that this would help them obtain salary increases, even though only 30 percent of them had achieved such increases since acquiring new skills.

Some experts[15] challenge the popular belief that computer training should be basic in schools in order to prepare students for the workplace, on the grounds that the "higher" the technology, the lower the skill level required. A BLS analysis indicates that only a small percentage of new jobs in the future will require computer literacy beyond what can be learned on the job in a few hours or days.[16] Others challenge the assumption that jobs requiring use of a computer are automatically transformed into "knowledge work."

Researchers seem to be in agreement that the number of jobs available in the future requiring in-depth knowledge of computers are not a large proportion of projected new jobs. However there is also general agreement that skills will change for many jobs (particularly office jobs) and that training and retraining, probably throughout the lifetime, will be required for many workers. As lower level clerical jobs are automated and eliminated, the remaining jobs will require higher level skills. To what extent employers are willing to provide this training on the job will depend on the availability of workers who have obtained the required skills elsewhere. From the workers' point of view, achieving these skills will be critically important in obtaining employ-

[13] See Norvell Northcutt, *Adult Functional Competency*, Adult Performance Levels Project, Industrial and Business Training Bureau, University of Texas, Austin, 1975.

[14] James Bright, "The Relationship of Increasing Automation and Skill Requirements," *Employment Impact of Technological Change, Appendix Volume II: Technology and the American Economy*, National Commission on Technology, Automation, and Economic Progress (ed.). Washington, DC. 1966, pp. II-209.

[15] For example, Douglas Noble, "Computer Literacy and Ideology." *Teachers College Record*, vol. 85, No. 4, summer 1984, pp. 602-614.

[16] Henry Levin, "Jobs: A Changing Workforce, A Changing Education?" *Change*, vol. 16, October 1984, pp. 32-37.

ment and in making job changes throughout their lives; 81 percent of adult Americans feel that additional training will be required of them because of changes in the workplace.[17]

Determining Training Requirements

The major factors to consider in determining training requirements are the needs of the users (their current skill level and learning needs level), the nature of the technological applications and products in a specific office, and the characteristics of the job.

Users of automated office technologies include: 1) those currently unfamiliar with computers; 2) those who currently use computers as tools to perform specific tasks but are unaware of "how the computer works"; and 3) those who program, perform systems analyses, and do other work that requires understanding of how computer systems work.[18] OTA case studies indicate that an increasing number of computer users fall between divisions 2 and 3; they are not computer professionals and they usually employ software packages developed by others; but they may occasionally write small programs to improve the computer's effectiveness as a tool.

The tasks to which office automation can be applied include: 1) tasks that require only a well-defined, step-by-step procedure; 2) tasks that require a limited amount of problem solving; and 3) tasks that involve analyzing and manipulating data to achieve some goal.[19]

For some tasks in the first category, training may be brief—as little as a few hours. Even for tasks in the third category, learning to use a computer as an effective tool may take relatively little time when the worker already has other expertise. For example, an economist learning to use a statistical package may require only a few days' training and practice, to be reasonably competent. However, there are many jobs in insurance, banking, and elsewhere, in which the automated system is an integral part of the work process. Weeks or even months of training and practice may be needed before an employee is fully competent.

The organizational structure and environment also has a bearing on training requirements and success. Skill needs change as an employee moves up in the hierarchy of the organization. Training managers to supervise workers in an automated office environment is a different process from training workers to use the equipment. The immediate working environment depends largely on the philosophy of the organization's management. Management may or may not, for example, consult employees about the implementation of office automation, the redesign of the workflow, and training methods.

Methods for Delivery of Training

Research has demonstrated the importance of hands-on experience in learning office automation skills; how well people learn a new skill depends heavily on how much "engaged time" they spend on the learning,[20] although experts differ as to whether this applies to less motivated trainees to the same degree as it does to the highly motivated. Hands-on and on-the-job training assure that the trainee is "engaged" during the learning session.

Self-teaching (and mutual learning) appears to be the most common mode of training, followed by home study. But there are some problems with self-teaching. The lack of formal, guided instruction for all employees creates an unequal knowledge base, leaving some employees at a disadvantage. For example, many workers are not allowed training time on the job, and have responsibilities that take up their time off the job, and so are prevented from learning even when they want to do so.

[17] "America at Work: The Evolving Role of Proprietary Vocational Education," ITT Educational Services, Inc., Indianapolis, IN, 1982. Summary of a survey of a representative national cross-section of more than 1,000 adults.

[18] Paul Harmon, "Training: Psychology Meets Technology," *Computer World,* May 2, 1983, p. 9.

[19] Ibid., p. 12.

[20] Raymond Nickerson, "Information Technology and Psychology," *Third Annual Houston Symposium* (New York: Praeger Publishers, 1982), p. 203.

Generally, when office automation equipment is purchased, the vendor provides a limited amount of orientation training, often in a classroom setting or through computer-based training. The users must then experiment independently to determine what applications are best for their own specific tasks. Coworkers supply additional knowledge.

Key workers are often used to train others in an office and assist them in acquiring office automation skills. These "internal trainers" may receive formal training from the vendor or may develop expertise on their own. Then they must "interpret" the skills and tutor other staff members. Other office workers benefit by learning from someone who knows both the business operations and the system.

Beneficial as this short cut to formal training may seem, it may not be as productive as it first appears. The internal trainers are often volunteers whose formal job descriptions do not take this role into account and no allowance is made for it in their official work schedules.[21] They must balance the importance of their training activities against the possible loss of productivity in their own assigned duties. While the key workers often enjoy their teaching role, they may or may not be good teachers and may or may not treat coworkers fairly in sharing their time and attention among them.

User groups are formed by users of a technology to share information and to assist each other. Such groups are usually formed by employees and are most often managed and maintained by the users themselves. User groups are also encouraged by equipment vendors. Outside help or intervention is rare. During meetings, users take on the role of teacher, translator, trainer, problem solver, and student.

Centers for learning, testing, and exchanging information (often called user or technical information centers) have been established in many organizations, as a place that employees may go to learn about automated technologies. These "user information centers" may offer a variety of services including—instructional classes, computer-based training, hardware and software testing, rating guidelines for applications and prepurchases, and educational and informational publications. The training is most often self-initiated by the worker seeking basic skills or further applications knowledge. These forms of in-house, group learning are beneficial because people feel rewarded when they meet new challenges on their own.

Computer-based training (CBT) for learning office automation skills is increasingly available. There are multiple choices of off-the-shelf equipment and systems, standard sets of equipment and software programs that can quickly and easily be adjusted to a variety of requirements. Some include optical disk and video text. As more manufacturers and vendors have entered the field, the cost of CBT hardware has decreased; it is no longer a prohibitive factor in most cases. In its 1984 industry survey, *Training* magazine reports that 46.4 percent of all responding organizations use computers for training.[22]

Computer-based training is popular because it reduces the two most commonly cited problems of training—cost and time. One expert reports that the use of CBT reduced course length and that students trained on such techniques achieved the same or a better level of performance than was achieved by those trained in the longer conventional instruction courses. A review of the literature found no evidence that the use of computer-managed instruction (CMI) or computer-assisted instruction (CAI) caused students to do less well than control groups receiving other forms of instruction within the classroom.[23] Two matters cause concern when CBT is used—the fidelity of the training system in simulating the work envi-

[21] Tora Bikson, Don Mankin, and Cathleen Stasz, "Individual and Organizational Impact of Computer-Mediated Work. A Case Study," The Rand Corp., OTA contract report, March 1985, p. 42.

[22] *Training*, October 1984, p. 56.

[23] See Mildred D. Jarvis, "Computer Based Training: Lessons Learned," *Proceedings of the Human Factors Society—28th Annual Meeting*, 1984, pp. 515-519, also her reference to Orlansky and String's report on the cost-effectiveness of CBT in military training, 1979.

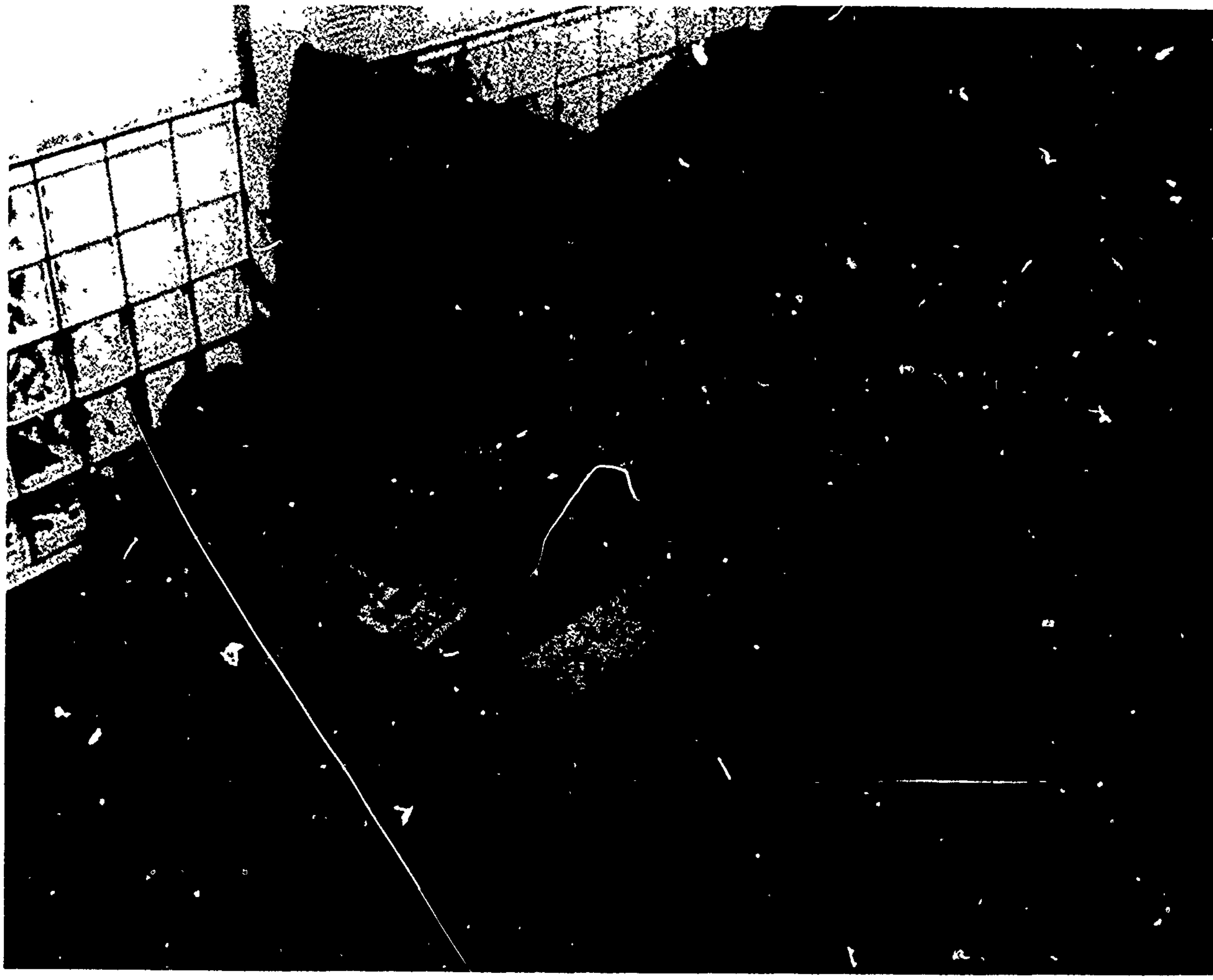


Photo credit: Digital Equipment Corp

Computer-based training

ronment, and the quality of the written documentation used in the training. The closer the learning situation follows the work setting, as opposed to merely presenting drill and practice exercises, the greater the applied learning that is acquired. Poorly written documentation prevents trainees from advancing through the stages of learning or achieving the highest level of learning possible.

Home study is a growing alternative to formal classroom-based training. CAI and CMI packages are offered, for example, by the National Radio Institute (NRI), which provides technical correspondence courses. Cost is the restricting factor for home study because it is expensive to convert courses to technology-oriented modes of delivery and because the students must often purchase their own hardware and software to study at home. However, for basic education, TV-presented courses are very cost effective. While sending employees to a training seminar or conference can cost approximately $40 per hour, and a university course can cost $7.50 per hour, a TV course costs only pennies per hour.

How Is Training Obtained?

A survey of Fortune 1500 firms[24] indicated that companies, when automating offices, are

[24] "America at Work: The Management Perspective on Training for Business," ITT Educational Services, Indianapolis, IN, 1983, p. 44.

most likely to hire new employees with the required skills (44 percent), switch employees into positions requiring no additional skills (40 percent), or reduce the number of employees (40 percent). Thirty-six percent switched employees into positions that required additional training.

In addition to formal education institutions, many public and private sector organizations, including unions, are involved in providing training and/or education, but demand so far outstrips supply. Some experts have questioned whether the capacity exists to respond to all training and retraining needs. Many business organizations are increasing their budgets for training. A 1983 survey of 1,821 private and government employers[25] showed that 1984 training budget increases were predicted by 47.4 percent of the companies surveyed, but 53.5 percent actually did increase those expenditures in 1984.

Although it varies considerably by industry, the dollars spent on nontechnical training such as sales and supervisory skills, outweigh the dollars spent on technical training such as word processing, programming, and electronic testing. Also, according to this survey[26] managers were much more likely to receive training than lower level employees. Midlevel managers and first line supervisors received an average of 32.5 hours of training, executives received 28.3 hours, and professionals, 27.2 hours, while administrative and secretarial employees received approximately 11 hours. Most of the companies surveyed offered both in-house and outside training with executives most likely to receive outside training and lower level employees most likely to receive in-house training. Only 31 percent of these companies engage in retraining of employees, usually lower level employees.

In a survey of selected clients in Chicago, Price Waterhouse[27] found that 42 percent of these firms provide on-the-job training, most often with vendor prepared documentation. The figure went up to 64 percent for the smaller firms surveyed. This agrees with the BLS survey showing that 50 to 60 percent of workers gained qualifying skills on the job.

Temporary agencies anxious to increase their supply of trained workers are offering word processing training to potential employees, often by means of computer-aided instruction and simulation. A standard for basic, intermediate, and advanced skills has been developed by one agency.[28] This standard requires that an operator with basic skills be able to—set up the system, keyboard, create documents, make minor corrections and proof, store and file text, recall/retrieve text, and print text. Advanced operators should also be able to execute special software packages, develop graphics, write special programs, and supervise other operators.

The Kelly surveys[29] found in 1982 that 52 percent of the companies surveyed developed their own training programs and 51 percent

[25]"Training Budgets '84: In the Pink—and the Green," *Training*, October 1984, pp. 16-31.

[26]"Training Magazine's Industry Report," *Training*, October 1984.

[27]"Price Waterhouse Office Automation Survey," Chicago, IL, 1984.

[28]"Manpower—The Temp Agency—Launches New Approach to WP Training & Placement," *Inside Word Processing*, vol. 4, No. 6, June 1983.

[29]*The Kelly Report on People in the Electronic Office* (Troy, MI: Kelly Services, Inc, 1982); *The Kelly Report on People in the Electronic Office II: How Office Workers View Automation* (Troy, MI: Kelly Services, Inc., 1983); and *The Kelly Report on People in the Electronic Office III* (Troy, MI: Kelly Services, Inc., 1984).

Photo credit: Manpower Inc

trained their own personnel. Fifty-one percent used a manufacturer-developed training program and 32 percent used the manufacturer's trainers. A 1983 survey showed that 34 percent of the nonmanagerial employees surveyed received their training from a vendor representative, 28 percent from a supervisor, 26 percent from a manual (self-trained), and 11 percent from an outside consultant or a class off the premises.

Professionals and managers in offices are not neglected in the market for office automation training. Courses focusing on the upper level employees' need for training are becoming common. Many professionals and managers learn such skills on the job, through their own efforts, by means of a manual or by "just fooling around" with the machine. The availability of simplified software in specific professional fields is making it easier for the professional to be self-taught, and new ways to get work done are finding their way into management training curricula.

Data on the sources of training for current jobs were developed by Carey and Eck at the Bureau of Labor Statistics.[30] Table 3-2 shows that in 1983, 70 percent of computer systems analysts and scientists received training for their current jobs in a school, mostly 4-year colleges. Fifty-seven percent of secretaries, stenographers, and typists and 22 percent of records clerks received school training. Seventeen percent of all workers received qualifying training in 4-year (or more) college programs. Professionals working in offices, such as economists, statisticians, engineers, etc., usually obtain their qualifying training in a 4-year college. Business administrators and managers are also increasingly qualifying for their jobs through college education. Employers seem to be requiring higher qualifications for many jobs as a more highly educated work force becomes available. This reduces opportunities for less educated employees to be promoted to higher level positions.

Formal company training programs reached 27 percent of computer systems analysts and scientists, 30 percent of operations and systems researchers and analysts, 17 percent of general office supervisors, 25 percent of insurance adjusters, examiners, and investigators, but only 4 percent of secretaries. Informal on-the-job training was received by considerably larger proportions of the occupations shown in table 3-1.

About 55 percent of a sample of all workers employed in January 1983 indicated that, according to their own perceptions, they needed specific training to qualify for their current jobs. One-third of all workers had undertaken skill improvement (see table 3-3 for some typical office-related occupations) since obtaining their current jobs.

Although only about 5 percent of all workers obtain training from high school vocational programs, a large proportion of these are office workers. Thirty-five percent of secretaries have received vocational training as have a large proportion of computer systems programmers and computer systems operators. Thirty-five percent of the 5.9 million enrolled in public vocational education in 1981-82[31] studied office trades, and 23 percent of adult education participants studied business-related courses.[32] Business/office school enrollment increased 38.1 percent between 1975 and 1981, while vocational and technical schools and institutes suffered decreasing enrollments during that time.

The Adequacy of Office Automation Training

A recent study[33] found that in the last 20 years, the post-secondary education field was able to accommodate quite well to changes in demand for its services. However, secondary

[30] Max Carey and Alan Eck, "How Workers Get Their Training," *Occupational Outlook Quarterly*, vol 28, winter 1984, pp. 3-21.

[31] *Occupational Projections and Training Data* (Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, 1984), table C-1.

[32] *Digest of Education Statistics, 1983-84*, op. cit.

[33] Sue Berryman, *The Adjustment of Youth and Educational Institutions to Technologically Generated Changes in Skill Requirements* (Washington, DC. National Commission for Employment Policy, May 1985), p. 66.

Table 3-2.—Sources of Training Needed for Obtaining Current Job Among Representative Office-Related Occupations

Occupation	Number in occupation (thousands)	Sources of training (percent of occupational employment)										
		Any school	High school vocational	Post high school private vocational	Post high school public vocational	Junior college or technical institute	College, 4 years+	Formal company	Informal on-the-job	Armed forces	Correspondence	Friends
Computer systems analysts and scientists	243	70	4	2	1	9	52	27	45	5	1	2
Operations and systems researchers and analysts	117	57	3	5	1	9	44	30	34	7	1	—
Public relations specialist	82	28	5	2	1	1	41	6	48	4	—	6
Legal assistants	85	42	8	—	2	8	30	3	59	—	—	2
Supervisor, general office	228	26	5	2	—	7	12	17	41	3	1	2
Supervisor, financial records processor	61	37	2	1	3	3	29	8	43	3	1	2
Computer equipment operators	410	34	11	4	2	14	7	15	43	2	—	1
Secretary, stenographer, typists	3,426	57	35	6	4	13	7	4	31	—	1	1
Records clerks	105	22	8	2	1	4	10	11	29	—	1	—
Financial records processor	1,488	33	16	4	2	8	6	5	35	—	1	2
Insurance adjusters, examiners and investigators	132	27	7	—	2	4	14	25	35	—	1	—
Eligibility clerks, social welfare	40	38	10	—	3	16	9	6	35	—	—	1
Statistical clerks	54	30	9	5	3	6	10	11	36	3	—	3

SOURCE: Max Carey and Alan Eck, "How Workers Get Their Training," *Occupational Outlook Quarterly*, winter 1984

Table 3-3.—Sources of Training for Skills Improvement Among Representative Office-Related Occupations

Occupation	Number in occupation (thousands)	Sources of training (percent of occupational employment) School	Formal company	Informal on-the-job	Other
Computer systems analysts and scientists	165	16	37	25	8
Operations and systems researchers and analysts	94	31	38	22	7
Public relations specialist	52	15	16	16	8
Legal assistants	38	19	9	12	2
Supervisor, general office	180	14	26	16	7
Supervisor, financial records processor	47	24	26	11	1
Computer equipment operators	247	13	16	25	2
Secretary, stenographer, typists	1,309	11	7	11	3
Records clerks	80	7	13	19	3
Financial records processor	692	11	6	12	2
Insurance adjusters, examiners and investigators	112	10	25	23	6
Eligibility clerks, social welfare	29	11	13	23	5
Statistical clerks	36	8	15	26	4

SOURCE: Max Carey and Alan Eck, "How Workers Get Their Training," *Occupational Outlook Quarterly*, winter 1984

vocational education in comprehensive schools was relatively unresponsive to changes in skill requirements. This problem may be exacerbated by declining enrollments and the need to delegate scarce resources to the academic studies, for that there is greater demand in these comprehensive schools. By contrast, private and public schools that focused on vocational education are more adaptable to changes in skill requirements in the labor market.

Although the adequacy of any training or retraining depends on the office, the job, and the individual's needs, commitment, and capability, it is possible to discuss in general terms other factors influencing the quality of training. The quality is dependent on the quality of the instructional materials and design, the quality and availability of instructors, and the range of courses that are offered.

There is currently no legislation to regulate, assess, or accredit the content or the quality of the courses offered in the private and commercial sectors. Those who invest in such training are at the mercy of the market. This lack of quality control can be expensive and can drain the resources of individuals and organizations.

EDUCATION FOR OFFICE AUTOMATION TECHNOLOGIES

Computers have assumed such an important function in the contemporary practice of business, industry, science, and scholarship that almost no student can expect to remain isolated from these tools. This imposes on education the additional task of preparing students for jobs in which they will use the computer as a partner.[34] Schools and colleges find themselves pressed for expanding the curriculum:

- by students—many of whom expect schools to provide them with access to computing and instruction in computer-related subjects, and
- by the job market—because employers expect applicants to have some basic computer literacy before they arrive on the job.

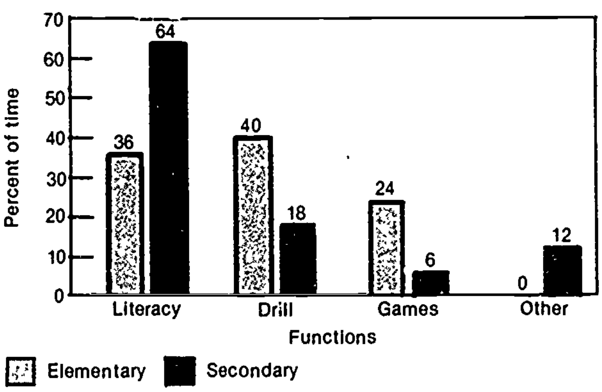
[34]Charles Mossman, Associate Vice President, Academic Resource Planning, California State University, Fullerton, in joint hearings before the U.S. Congress, House, Information Technology in Education, Apr. 2-3, 1980, p. 145.

According to a recent national study, computers in high schools are used two-thirds of the time to teach children how to use a computer ("computer literacy"), and 18 percent of the time for drills and practice in various subject matter. Results of a survey of 1,082 elementary and secondary schools, conducted by the Center for the Social Organization of Schools, the Johns Hopkins University, are shown in figure 3-1. It appears that relatively little is being done to exploit the computer's potential for teaching traditional subject matter in a more efficient, interesting, or effective manner. Also, time is not spent on the computer to teach and develop office automation skills for future jobs.

Computer-assisted instruction (CAI)—the computer as teacher—has been introduced to improve the delivery and productivity of general education. CAI has been found to reduce by 10 to 30 percent the amount of time students need to master a subject.[35] CAI supplements the teachers' efforts in the traditional classroom setting and provides specialized individual instruction.

[35]Education Turnkey Systems, Inc., "Uses of Computers in Education," prepared for the National Commission for Employment Policy, April 1985, p. 42.

Figure 3-1.—The Use of Computers in Elementary and Secondary School Education



SOURCE Figure derived from, School Uses of MicroComputers, Reports From a National Survey, (working paper), Center for Social Organization of Schools, The Johns Hopkins University, No 2, June 1983

The effectiveness of CAI is hindered by the lack of high-quality software. The Educational Products Information Exchange Institute, in cooperation with the Consumer Union, evaluated 600 pieces of educational software in 1984 and rated only 5 percent of what was examined, or 30 programs, as "first-rate."[36]

It takes about 200 person-hours to create 1 hour of conventional CAI. Work is being done at the Advanced Computer Tutoring Project, Carnegie-Mellon University, Pittsburgh, Pennsylvania, to reduce the time required to develop CAI.[37] Attempts are also being made to develop intelligent CAI, or ICAI, which allows for conceptual modeling and interactive instruction.

Computer-managed instruction (CMI) is an automated technology used for the management of the school system and for managing the instructional flow in the classroom. It aids both the teacher and student by providing pre- and post-tests to evaluate advances in learning levels, offering diagnostics, helping students with assignments, and keeping student records. The teacher need not be present for all testing, assigning, and recordkeeping. Cognitive diagnostics for learners can also be provided by computer programs.

The hardware available for educational uses and teaching office automation skills has focused on using microcomputers. Video disks in the future may play an important role because they allow for greater interaction in instruction by simulating actual situations. Although information on educational software, evaluations, and availability is published, the price of these analyses limits access to this information for many educators. Most school districts lack the means to identify better software, and in most schools only a handful of teachers have the training to make effective use of computers.[38]

[36]Edward B. Fiske, "Computers, In Most Schools, Have Brought No Revolution," *New York Times*, Dec. 9, 1984, p. 80.
[37]John R. Anderson, C Franklin Boyle, and Brian J. Reiser, "Intelligent Tutoring Systems," *Science*, Apr. 26, 1985, p. 228.
[38]Fiske, op. cit., p. 1.

Teachers and Computers

The proportion of college freshmen choosing education as a major has declined from 22 percent in 1966 to 4.7 percent in 1982,[39] because of the job disincentives common to the teaching profession (low status, low pay, low-advancement opportunity, and diminished psychic income). Teachers are being pursued by industry to fill training positions and they are finding these jobs more rewarding than teaching.

The difficulties of competing for manpower and other resources in a rapidly growing high-technology market are acutely felt by educators at the university level. Over the decade from 1970-71 to 1981-82, B.A. degrees in the computer sciences increased from 2,388 to 20,267, nearly 750 percent. Yet a large portion of faculty positions are unfilled and the number of Ph.D.s graduating each year has dropped substantially. The shortage of faculty in the field of engineering and computer science has been attributed to the fact that industry, by offering higher salaries and other incentives, has been able to draw academics and students away from universities.[40] The percentage of computer science faculty leaving for industry is twice that of any other field of engineering.

Curriculum Development

Efforts have begun to update curricula and include more courses in the use of computers, but office automation and other technology-related subjects are caught in the lag between need, development, and implementation of new curricula. This is especially obvious at the secondary and post-secondary levels of education, where these skills are most often learned.

The rapid pace of technological change has complicated the delivery of appropriate courses. In a report on office automation productivity,[41] Russell Aldrich of Apple Computer, who teaches at Golden Gate University in San Francisco, says that:

> Many times, a particular course was a good course, and a required course 5 to 10 years ago. But because technology is progressing rapidly, we are seeing so large a revolution in certain areas of office productivity, communications process, and management roles, that what was on the frontier 2 years ago is no longer relevant today. *What is lacking is a mechanism for higher education institutions to quickly and accurately evaluate the information industry's pulse* so that it can design and plan curriculum that anticipates educational needs and fills them.[42] (Emphasis added.)

The Office Systems Research Association (OSRA), in a cooperative effort between educators and business sector representatives, is working to develop a model curriculum in office systems for universities and colleges. "Office systems" is defined as the business function related to the coordination and management of the information resources of an organization. Generally, this includes responsibilities for automated and manual office equipment, human factors, and office procedures. According to OSRA, managers in the office systems area are responsible for a business unit too complex to rely strictly on a computer background or management techniques applicable to the traditional office environment. The Office Systems Model Curriculum Project was begun in 1984 and is aimed at providing a framework, and possible standardization, of office systems curricula for all schools. OSRA plans to have a draft of their model ready in mid-1985.[43]

[39]Center for Strategic and International Studies, *Technical Excellence in America: Incentives for Investment in Human Capital*, Debra van Opstal (ed.) (Washington, DC. Georgetown University, October 1984), p. 1.

[40]U.S. Department of Education, National Center for Educational Statistics, *Condition of Education*, 1984, table 2-12.

[41]Frank Freudberg, *Office Automation Productivity: Lost En Route to the Promised Land* (Willow Grove, PA: Association of Information Systems Professionals, 1984), p. 14.

[42]Freudberg, op. cit., p. 15.

[43]This information is based on correspondence and conversations with Bridget O'Connor, OSRA Vice President, Professional Studies, Business Education Program, New York University, March 1985.

Access to Education

To the extent that computer literacy and computer expertise are needed for success in getting and keeping jobs, inequities in receiving computer experiences in school are especially serious for low-income, female, and rural students. They translate into social and economic inequities by giving some people more effective tools for working and living in an age of information technologies than others.

Each year the National Assessment of Educational Progress (NAEP) surveys[44] a stratified random sample of students aged 9, 13, and 17 in approximately 700 schools in the United States. Data from the 1982 survey show inequities in access to computer literacy associated with wealth of the school, community size, region, gender, and race.

Student enrollment in computer programming is much lower in schools that qualify for Title I assistance (by having a large percentage of the parents with income below the poverty line) than in schools that do not qualify. After a survey of schools in 1983, Quality Education Data, Inc., reports that the 12,000 wealthiest schools are four times as likely to have microcomputers as are the 12,000 poorest schools. Rural and disadvantaged urban communities provide computer learning opportunities at a much lower rate than other communities.[45] Among students at age 13, less than 17 percent of the rural/ghetto students, but 32 percent of those living in "urban/rich" areas, reported use of computers in schools. Eighteen percent of junior high school students in small towns report school computer use, compared with 26 percent in large cities.

Students living in the South are much less likely to have used computers in schools than students living in other parts of the country. Those in the Western States are twice as likely as southern students to receive such experience.

Young women in secondary schools are less likely than young men to spend time with computers and to enroll in computer classes.[46] Females are less likely to take computer programming classes than males; one study in 1983 showed that 8 percent of the females and 14 percent of the males have enrolled in programming courses for at least one semester. The Women's Action Alliance of New York City has devised several school-based strategies to overcome this problem, working with parents and teachers to increase girls' use of computers. The results after a year of trial at a

Photo credit: Manpower, Inc

[44]Education Commission of the States, National Assessment of Educational Progress, Denver, CO, July 1983.

[45]These and the following figures are based on the work of Ronald E. Anderson, Wayne W. Welch, and Linda J. Harris, *Computer Inequities in Opportunities for Computer Literacy*, University of Minnesota, based on work supported by the National Science Foundation under grant SED 8022125A01, 1983, p. 4.

[46]As shown in studies by Anderson, Welch, and Harris, op. cit., 1983.

middle school in Wisconsin, showed a 42-percent increase in computer usage by girls.[47]

While the NAEP data showed some racial inequity in computer exposure in 1978, more recent results reveal no significant difference between black and white students when income differences are equated. Apparent inequity between black and white students in use of computers in schools and for enrollment in computer programming courses is derivative of income and rural/urban differences.

Inequities in computer access identified here point to the need for attention at all levels of the educational system: National, State, community, district, school, and the classroom.

[47]Margie Snider, "Education Equity Projects That Work," *Women's Political Times*, January/February 1985, p. 2.

POLICY CONSIDERATIONS

Policies in Foreign Countries

In some countries, training and retraining programs are used as a basic instrument to deal with specific labor market problems. The successes and failures of foreign experiences are rich in lessons for shaping U.S. policy.

The European and Japanese emphasis is on strong vocational education as a basis for work life and on periodic training to keep skills up to date. Their philosophy is that these programs serve not only low-wage workers, but a broad segment of the primary labor force.[48] However, the degree of government involvement differs among these countries.

In France, the Law for Continuous Training, implemented in 1971, committed the government to provide training opportunities to adults and youth. In Sweden, where workers are considered to have a right to training, the government plays a strong role in adult training and retraining. A close coordination among government, employers, and unions helps ensure that government programs mesh well with national needs. The flexibility of the system in identifying new jobs and in retraining workers has reportedly added to the success in Sweden.

Union involvement and training vouchers encourage wide participation in West Germany; the government and private industry both play major roles. In Japan almost all efforts are by private companies. Japan continually retrains selected workers in the "lifetime employment" system. Increasing "labor-market transparency" or skill transferability, providing job referral, counseling, testing, training, and relocation assistance to workers, are regarded as a matter of high public interest and the public employment service plays a major role in labor-market adjustment policy in Europe and Japan.[49]

[48]Michael Podgursky, *Labor Market Policy and Structural Adjustment*, paper prepared for the conference on U.S. Industrial Policy and International Development, Overseas Development Council, Washington, DC, Mar. 4, 1983, p. 17.

Existing Legislation

This section will present a summary of legislation and regulations related to education and training for automated office work and some options for congressional consideration.

The potential for successful delivery of education for office automation skills and knowledge already exists in the traditional education system, most often addressed at the secondary and post-secondary level, where much of the Federal legislation is focused. Educational policies and legislation set the framework for addressing new and changing education needs. The higher education delivery system in the United States is a complex matrix of private and public institutions that function with varying degrees of independence and dependence on State agencies. The Federal Government's direct role in institutional control has been limited to setting criteria for an institution to participate in Federal programs or receive

[49]Ibid, p. 26.

Federal contracts. Various congressional actions have been taken to draw attention to selected national problems, to provide the fiscal resources needed to address these problems, to support research activities that have national and international implications, and to complement and supplement the role of parents and State and local governments in supporting individuals and institutions.

Although there is no existing Federal legislation specifically addressing office automation education, there are related laws that could provide a vehicle for delivery of office automation education.

Direct Federal involvement in training and employment programs is considered to have begun with the Area Redevelopment Act (ARA) of 1961, although indirect Federal involvement in training through vocational education programs began with the Smith-Hughes Act of 1917. The Manpower Development and Training Act (MDTA), enacted in 1962, focused training efforts on workers displaced due to automation. The Johnson Administration's war on poverty brought about a wide range of work experience and training programs targeted on the poor, minorities, and youth. The Comprehensive Employment and Training Act (CETA), passed in 1973, absorbed many existing work and training programs and was designed to operate primarily at the local level.[50] CETA underwent amendments during its history that expanded its purpose and reach. The Trade Adjustment Assistance (TAA) program reauthorized in 1981, also authorized funds for training. *The Job Training Partnership Act (JTPA)* replaced all portions of CETA on September 30, 1982. This new program shifted the focus away from direct Federal involvement in training programs and established a business-government partnership in the provision of training for job skills. Training programs are operated by the States in combination with local-area governments and Private Industry Councils (PICs) and provide for the training of unemployed displaced workers in skills relevant to real employment opportunities in the area. These programs were not primarily aimed at office workers or at office automation training.

Target groups for legislated training programs have traditionally included about 8 percent of the population. These groups include—low-skilled adults (especially women and minorities), disadvantaged youth, and residents of economically depressed areas. The gaps in public policy left by JTPA and similar programs relate to: 1) the retraining needs of the large-middle tier of employed but at-risk workers; and 2) the basic skill needs of the 20 million or so functionally illiterate adults in the work force who will not be touched by reforms in elementary/secondary education, and whose learning handicaps prevent them from benefiting from job-specific training.[51]

The Vocational Education Act (Perkins Act), as revised in 1984, provides focus on educational needs at the secondary and post-secondary school level. The Perkins Act grants funds to States to make vocational education programs accessible to all persons, but follows the current trend of placing greater control and responsibility at the State and local levels. Targeted groups include:

- handicapped and disadvantaged persons,
- single parents and homemakers,
- adults in need of training and retraining,
- persons in programs designed to eliminate sex bias and stereotyping in vocational education, and
- persons incarcerated.

The act is designed to improve the quality of vocational education programs in order to give the Nation's work force the marketable skills needed to improve productivity and promote economic growth. Under this act, the acquisition of office automation skills may be included in State programs for general vocational opportunities. Part E of Title III, "Industry-Education Partnership for Training in High-Technology Occupations," allows for

[50]U.S. Congress, Library of Congress, Congressional Research Service, *Job Training Programs: Reauthorization and Funding Issues,* by Karen Spar, Issue Brief No. IB82005, Feb. 8, 1982.

[51]Perelman, op cit., p. 27.

grants to States to provide incentives for business and industry and the vocational education community to develop training programs for high-technology equipment, systems, and processes. These programs are intended to be closely tied to the local labor market and skill needs.

The act states that to the maximum extent practicable, funds will be utilized in coordination with JTPA to avoid duplication of effort and to ensure maximum effective utilization of funds under both acts. While the goals of the two acts are similar, the manner of achievement is different. The focus of the Perkins Act is public vocational training and education, while the focus of JTPA is on industry-sponsored training. The two acts overlap where there is the greatest need for assistance.

Funding for these programs is the key to their success. However, the level of Federal funding for employment and training decreased by 49.7 percent between 1981 and 1984. Funding for elementary, secondary, and vocational education decreased by 8.9 percent during that period. There were some increases for fiscal year 1985—17.5 percent for elementary, secondary, and vocational education; and 14 percent for training and employment; but decreases are again projected for fiscal years 1986 through 1990 in training and employment functions.[52]

Federal aid to State and local governments for vocational and adult education decreased by less than one-half percent between 1981 and 1984, but is projected to increase by 23.7 percent in 1986. Federal aid to State and local governments for employment and training services was decreased by nearly 57 percent between 1981 and 1984, and is projected to increase by only about 13 percent by 1990, with some fluctuations. If this trend continues, State implementation of this act will not be effective.[53]

The Employee Education Act amends the Internal Revenue Code to extend for 2 years the income tax exclusion for amounts received by an employee under a qualified employer provided assistance program. Unless extended by Congress, this act will expire at the end of 1985. The act limits the exclusion to $5,000 of educational assistance furnished to an individual during a calendar year.

State and Local Practices

Typically, State funding and support of education has been related to economic development. Several private sector industries and research and development firms have recently moved toward more direct involvement with higher education institutions by starting joint education ventures. While joint ventures are encouraged by some Federal laws, many businesses have traditionally contracted locally for training and education programs for their employees.

States have assumed a greater role during the past few years, as they enact student assistance programs to supplement declining Federal support and shoulder the responsibility of Federal programs. As State policymakers have been confronted simultaneously with revenue declines and requests for additional funds for higher education as well as for other human resource investments, some have taken the unpopular course of raising taxes to provide additional support. Others have reduced real levels of support for higher education in general and for research universities in particular. The funding pattern has been unique to each State.

Some States are making strong efforts to keep up with the new teacher and curriculum needs. For example, the State of Minnesota has made new office automation skills and computer knowledge a high priority for vocational education programs. Efforts are being made first to increase the competency of teachers through conferences and workshops on high-technology equipment, office systems, telecommunications, and curricula design. An integrated office system has been installed for teachers' hands-on experience. The system provides administrative assistance for teachers.

[52]Executive Office of the President, Office of Management and Budget, *Historical Tables, Budget of the U.S. Government, Fiscal Year 1986*, table 3-3 (19) and (20), 1985.
[53]Ibid., table 12-3 (43) and (52).

The State's vocational program will also include more opportunities for the adult and part-time student communities.

Another example of State activity is in Texas, where "House Bill 246" will be implemented in all school districts in the 1985-86 school year. This law mandates computer literacy courses for middle school (seventh and eighth grade) students and computer science classes for all high school students, as requirements for graduation. The computer literacy course includes history, terminology, basic programming skills, and issues of computer use in the society. Computer-related course credits are not required at the elementary school level, but many school districts are providing some type of computer awareness at that level.

Policy Options

Federal actions that could encourage education and training opportunities related to office automation might include:

- designate funds specifically for office automation education programs through new legislation or existing vocational education legislation that provides aid to schools;
- increase funds for programs through existing legislation (e.g., the Perkins Act);
- promote access for students in low-income families and in rural areas, and for women, through direct funding and establishment of service programs;
- increase Federal attention to maintaining the capacity and quality of research in the Nation's universities and the flow of new talent into academia;
- provide career counseling, job guidance programs, job search assistance and training programs that do not penalize those receiving unemployment insurance;
- encourage ties with the private sector through cooperative educational efforts, curriculum development, and industry-based activities for office automation skills;
- establish support programs or tax credits for small businesses to ensure that the education of employees is adequate to maintain current levels of employment and productivity;
- provide training grants and tax credits to businesses that incur expenses for office automation training. Also provide incentives to establish training programs in office automation skills, including employment tax credits for employers who train and educate workers. Employers could be given the same kind of tax write-offs for training that they get for plant modernization;
- establish a program of Individual Training Accounts (ITAs), similar to the Individual Retirement Accounts. The ITA may require employers and employees to make equal contributions to a bank account; this money would not be taxed until withdrawn. The account could be drawn by employees to pay for retraining when needed. This would direct resources toward retraining needs of mainstream workers now being neglected. A key objection to this proposal is that workers may not be able to choose and direct their own retraining in the best way, or appropriate programs may not be available;
- expand the tax deductibility of training for current and new occupations related to office automation;
- change unemployment regulations to permit receiving unemployment benefits during training. Encourage States to consider those in training programs as still available for work, and to reserve parts of their State funds to establish permanent funds for retraining; and
- encourage union involvement in negotiations for skill training opportunities. Include requirements that firms give notice of plant closings in advance and aid in the retraining of displaced workers.

Congress may determine to take none of the above actions, making the conscious choice to preserve the status quo. Since there is no existing regulation of office automation training, the training available commercially is likely to grow, but with existing inequities in access and quality unchecked.

Chapter 4

The Changing Nature of Office Work

Contents

	Page
Case Studies	95
The Individual and the Work Process	96
The Nature of Office Work	96
The Work Process	97
The Information Age Office	101
Task Change and Computer-Mediated Work	103
Job Changes With Automation	104
Management and Professional Jobs	105
Clerical Jobs	107
Job Ladders and Mobility	109
Organizational Structure and Relationships	111
Power and Access to Information	111
End-User Computing Power	114
Communication	114
Dispersion of Work Activity	116
Implementation	117
Reason for Adoption	118
Key Actors	118
Adaptive Planning	119
Users in the Implementation Process	119

Figures

Figure No.	*Page*
4-1. Possible Variations of Work Process for Word Processing	98
4-2. Model of an Integrated Customer Service System	102

Chapter 4

The Changing Nature of Office Work

Translating the capabilities of office automation technology into tangible operating benefits for an organization illustrates effects at many levels—individual tasks, the work process, organizational structure and culture, and quality of working life. These effects are at the core of the most interesting and pressing issues related to office automation. Yet, they are difficult to address because it is not possible to give a simple or universal description of the effects of automation on workers, jobs, or organizations.

This chapter looks primarily at the effects of office automation on the nature of office work, on job content, and on organizations. It examines the effects of office automation on the work process; on specific tasks, skills, and jobs; and on promotional opportunities. Next it discusses the possibility of structural or cultural change in organizations that adopt office automation. Finally, it reviews some of the major factors that contribute to successful implementation of office automation.

One point to be emphasized throughout this chapter is that the technology itself is not the only factor—and may not be the most important factor—in bringing about these changes. Managerial strategies—decisions about the organization's goals and the role of people and technology in achieving them—are of major importance in determining how the technology is used. In many cases, it can be seen that outcomes are more dependent on how the technology is used rather than on what specific equipment is employed.

CASE STUDIES

Many of the examples used in this chapter were taken from case studies of offices using automated equipment. In addition to the case studies in the literature, OTA commissioned a number of small case studies, discussed in more detail in appendix B.

Case studies provide a rich source of detailed information about the process of implementing office automation and the possible changes in tasks, jobs, work processes, and organizations. They allow one to view the intended and unintended consequences at many levels, and in a variety of contexts. In this chapter, case studies are used to provide illustrative details about the effects of technology in a wide variety of organizations. These observations form the basis of some cautious generalizations about the effects of office automation on organizations.

Caution is needed in making use of case material for a number of reasons. First, the methodology and level of detail of published case studies vary widely. Some are highly quantitative, others depend largely on qualitative, participant-observer, or anecdotal information.

Second, the organizations studied are all unique. Authority structure, corporate culture, management philosophy, internal dynamics, financial health, and operating environment are different. To the extent that these factors of themselves cause certain outcomes, or moderate the effects of technological change, it is difficult to state authoritatively that the result observed at one study site can be expected at other locations.

Third, the technology itself is defined differently from one organization to another and from one study to another. Office automation in one organization may be word processing capability used almost as a direct substitution for typewriters; in another it may be an extensive multiuser, multifunction operational system governing the production of the organization's primary product. Many possible systems and combinations of functions, including text processing, messaging and communication, decision-support software, graphics, and numerous special purpose applications may have a separate effect on the individual, the job, or the organization. The choice of features, the way the work process is organized to use them, and the order and timing of system introduction, often make each case of office automation unique.

Finally, the time factor must be considered. User reactions and use of technology in a "honeymoon" phase shortly after the equipment is up and running may be different from what happens at a later date when new capabilities or limitations are fully understood. Some changes in the work process may take place immediately after implementation, while others may not become evident for some time. Thus, the findings of a case study may depend on where the organization was in the system life cycle when the study was carried out. There are few longitudinal studies that follow the same set of organizations over time. Even within one study it can be difficult to compare "before" with "after" in an environment where new technology is introduced gradually over a period of months or years, and where systems are continually being upgraded or expanded.

Despite these difficulties, case studies are often the only information available, and they capture the detail necessary for understanding dynamic change within the organizations.

THE INDIVIDUAL AND THE WORK PROCESS

The Nature of Office Work

Office automation has transformed office work. Many offices are now semiautomated environments where people and computers interact. An "office," in the sense of a working unit of people doing information processing work, is seldom a totally automated environment. A fully automated procedure is one that does not require human intervention in order to produce its final output. Automatic data processing falls into this category; all transformation of information is internal to the computer. But such fully automated procedures usually make up only part of the work. Office work usually involves a series of steps, some are fully automated, some are manual, and some require interaction between people and computers.

For the purpose of this chapter, a *task* will be considered any clearly definable activity that forms a step in producing the final product of the office. Tasks may be performed by people or by machines. The *work process* is the social and technical organization of work. It is the way people and machines are organized to produce a result—the way information or materials flow from one to another until the final product is completed. *Jobs* are organizationally defined positions that are usually associated with a bundle of tasks and a particular role with a defined set of responsibilities in the work process. The *work unit* or *office* is a group of people of any size, with responsibility for producing some identifiable final product. The work unit has a skill and task mix, that is, its members are at different levels, have different roles, and perform a range of functions to produce their product. *Skills* are the attributes and knowledge that workers need to perform useful activities.

The impact of office automation on office work goes beyond changes in tasks. It can introduce new tasks, change the nature of the skills required, modify the work process, and ultimately can cause or be associated with changes in jobs and in organizational culture and structure. This is at least in part because computer-based technology bundles tasks in a way that is different from the way they would be done manually. When part of a process becomes automated, the tasks that remain to be done by people may be different kinds of tasks. A new process is necessary for integrating the work done by people and the work done by machines to accommodate those differences. When the work process changes, the organizational structure, which defines the roles and responsibilities of the members, can also change.

Take, for example, an office where a professional researcher writes reports and a secretary types them. Introducing a word processor can change the work process in a number of ways. First, the nature of some tasks will change, and the new tasks will require different skills. If the professional decides to use the word processor, then composing on a keyboard will require skills quite different from those of writing by hand. Some skills needed for old tasks—like the secretary's ability to neatly paste up final copies—may seldom be used.

Further, a change may take place in the process that governs the interactions of author, secretary, and other people needed to produce the report. Partially completed drafts may no longer pass between the author and the secretary. The secretary may be left out of the revision procedure entirely, or at least the secretary's responsibilities may no longer include the task of typing the author's reports.

There are also some points where the technology does not dictate a change, but allows an opportunity for choice. The word processor could be given to the secretary instead of to the author. The author might still hand write drafts, with the secretary keying in the document and making corrections on the word processor. In this case, the word processor is more like a simple substitute for the secretary's typewriter. The relationship of author and secretary, and the flow of work between them, might have been altered only a little, although the secretary will have to learn new skills. In another scenario, that relationship might be severed completely. The secretary might be reclassified as a word processing operator and moved to a newly created pool to key and correct drafts for many authors, as part of a change in the structure of the organization.

The use of new technology also introduces new steps and new tasks. For example, use of an automated system introduces the need to make backup copies, design and use an electronic filing system, and manage disk space or diskette storage. Decisions about whether these tasks will be handled by all users, by secretaries, by a system administrator, or by some combination will affect the work process.

There is also the possibility that the availability of the technology will catalyze its own use. In the experience of many authors, the ease of editing a document on a word processor sometimes leads to additional rewriting, so that this step can sometimes seem to be repeated almost indefinitely.

Thus, even with this simple example it is possible to see how changes at the level of the task, job, work process, and organization could take place as a result of office automation.

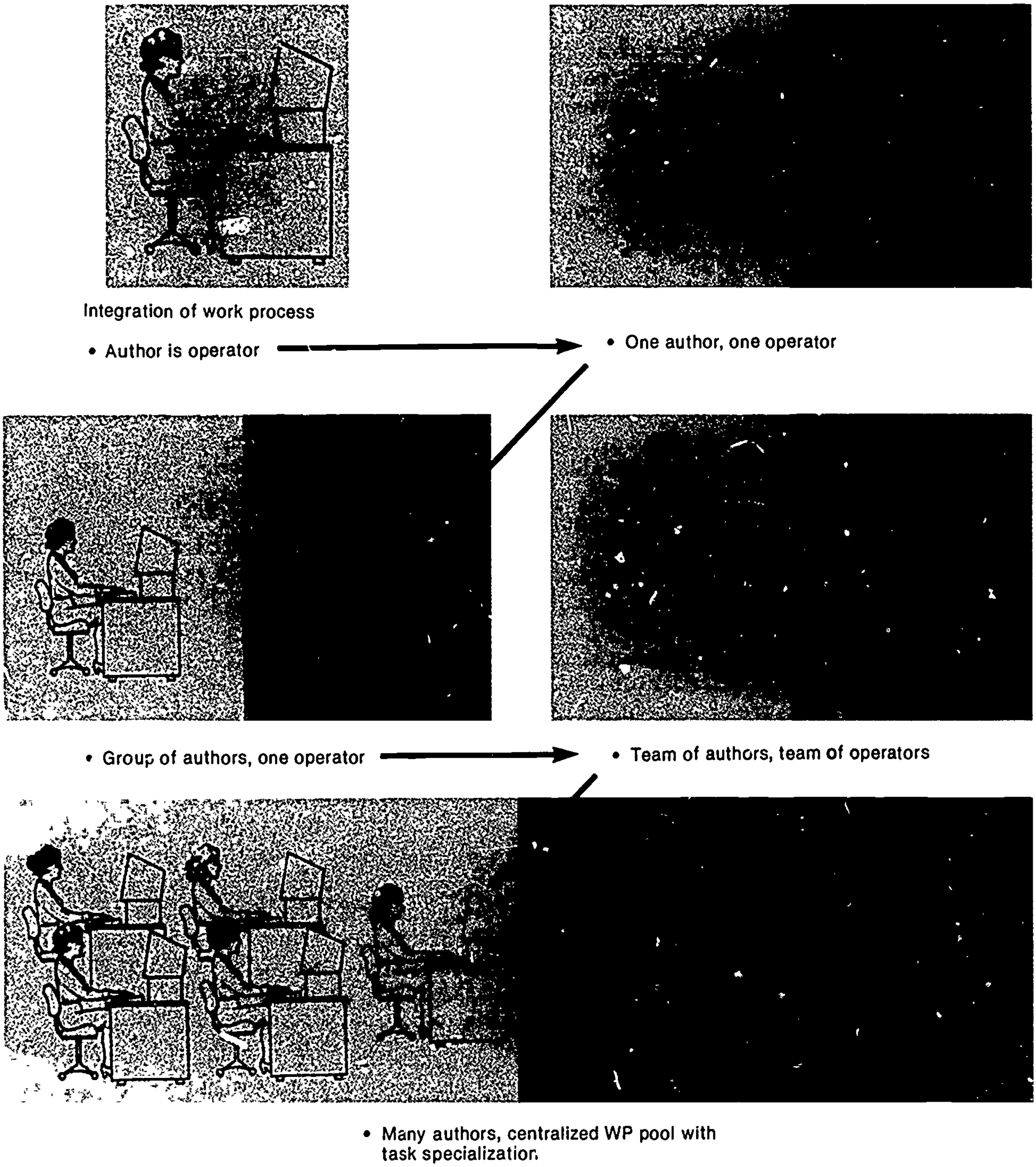
The Work Process

The bundle of tasks an individual performs describes the job, but the job is more than merely the set of tasks. The job is an organizationally defined position. In many organizations it is characterized by a job description that legitimizes the position. People identify with their jobs. The job defines a role within the work process and within the social structure; it is the point of articulation between the individual, the technology, and the organization. Thus it is not sufficient to talk about how office automation affects individual tasks. Jobs also change—the bundle of tasks, the role in the work process, the position in the organization, and the self perception.

Division of labor is necessary when there is too much work for one person to handle. Once a division of labor is made, the work process governs the relationship of the various workers to the partially completed product.

One way of looking at work process is as a continuum that runs from the most integrated to the most differentiated. Figure 4-1 shows five possible steps along this continuum for a word processing office. The most integrated is the one where authors do their own word processing and have complete responsibility for all steps in the process and control

Figure 4-1.—Possible Variations of Work Process for Word Processing



SOURCE: Adapted from S. M. Pomfret, C. W. Olphert, and K. D. Eason, "Work Organization Implications of Word Processing," *Proceedings of the 1st IFIP Conference on Human Computer Interaction (INTERACT '84)*, vol 2, 1984, pp 357-363 over the end product. The most differentiated is one where authors send work to a centralized word processing pool where operators have specialized tasks—some key in text, some proofread, some do corrections, etc. Between these extremes might be one-on-one relationships between author and operator, or situations where one operator or a team of operators focus on all stages of work for a particular group of authors.

The basic concept of work integration or differentiation can apply to a large extent regardless of the level of technology employed. The example above works equally well if the technology used is typewriters or quill pens. There is a popular perception that advancing technology is associated with increasing differentiation and fragmentation of work. The manufacturing assembly line, with workers performing repetitive tasks, is a product of the industrial revolution, not of earlier craft manufacturing. Many people's only image of office automation is a picture of the centralized word processing or data-entry pool. Although there has been a connection between computerization and fragmentation of work in the past, other forces are also at work. Office automation technology offers the possibility of reintegrating the work process in some cases.

Another way of looking at the work process and the way it changes with automation is in terms of the three generic types of work processes in offices identified by Giuliano—preindustrial, industrial, and information age.[1]

The preindustrial form of organization is used by many small and medium sized offices, for example, a real estate brokerage or professional office. These work units may have a number of workers with different jobs, or roles, in the work process. However, each worker is to some extent a craftsman. Each works with some independence and performs a variety of tasks. There has been little effort to completely standardize or systemize the work process. A variety of individual work styles is tolerated. There may be some fuzziness or overlap in responsibilities and workers may be sufficiently familiar with the work of others to switch tasks occasionally, or take over in an emergency.

While the preindustrial style of organization works well in many contexts, it is often inefficient in handling large numbers of transactions. Thus, in the insurance industry, banking, or the billing departments of large firms, where high transaction volume is handled, industrial-style offices evolved. They are designed to organize people to serve the needs of a large, rigid production system. The industrial office is a production line. Workers are differentiated into functional groups, for example—typists, log-in clerks, validation clerks, and signature control clerks. Each group has its own supervisor, and is responsible for some step in the processing of a transaction. Documents related to customer transactions flow from one functional area to the next, from one "out" box to the next "in" box, receiving some incremental processing at each stop.

The flow of work in an industrial office is consciously designed according to principles of "scientific management" first articulated for manufacturing by Fredrick W. Taylor in the early 1900s. With Taylorization, a complex production process is analyzed and divided into a series of simple tasks that can each be performed quickly and efficiently. Workers are assigned to perform a single task, or a narrow range of tasks, in a routine and repetitive way. The industrial form of work organization is a deliberate attempt to increase efficiency by rationalizing the work process, and by reducing individual discretion and variation.

Because industrial-style offices were ones in which the work process had been consciously analyzed and the individual tasks identified, isolated, and standardized, they were ideal candidates for the early introduction of computers. Certain tasks could be automated completely, making use of the computer's ability to do large batches of calculations quickly. However, many manual tasks remained in preparing data for the computer or making use of computer output.

[1]Vincent E. Giuliano, "The Mechanization of Office Work," *Scientific American*, September 1982, pp. 149-164.

Some have argued that computerization allows managers to speed the process of Taylorizing and routinizing office work in order to reduce costs and increase management control.[2] Certainly, as automation began to be used in offices, it appeared that Taylorization and computerization were mutually complementary and interdependent processes, as computers were first introduced in those areas where manual processes had already been "industrialized."[3]

Indeed, computerization seems to have intensified the factory-like nature of industrial-style offices. "Pools" of functionally similar workers existed before, but the trend toward specialization increased with computerization, especially in routine data-entry tasks:

> Routine keyboarding was separated more sharply from other clerical functions and was often spatially isolated . . . As a result of the heightened fragmentation of work, processing personnel (both data processing and word processing) typically worked at machines all day. . . both the technical and social relations of work in these centralized word processing and data processing centers were factory-like. The work process was machine paced and often machine supervised; autonomy of the operator was minimal; competence measured by manual dexterity and speed.[4]

Taylorization is not limited to clerical processing functions. It isolates predictable tasks. Professional or managerial jobs can be analyzed and the more routine functions stripped away. Baran and Teegarden note that underwriting, the main professional occupation in the insurance industry, has been increasingly rationalized. At one firm, this was done by splitting off the lower level functions and creating a new clerical position called underwriting technical assistant to perform them. Remaining professional positions were divided into specialty categories.[5]

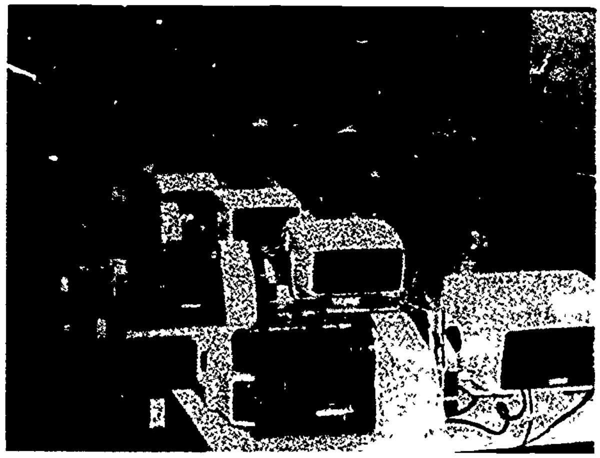


Photo credit: Michael Smith

Some offices are in factories. Note that some of these clerical workers are protecting their ears from excess noise.

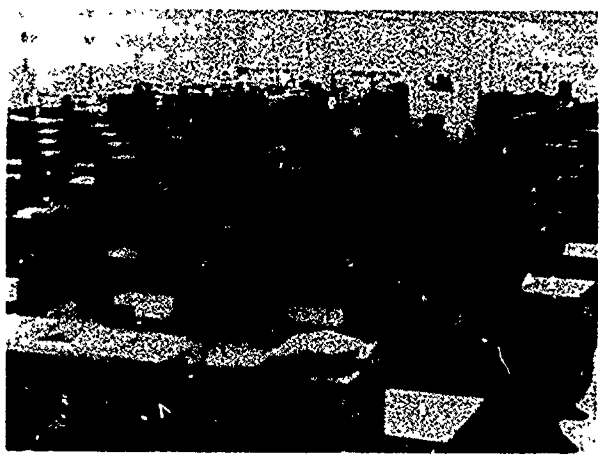


Photo credit: Michael Smith

Some offices where large numbers of transactions are handled resemble factories.

The industrial style of office organization works well for highly routine processes. It has some disadvantages, in dealing with "exceptions" or nonroutine situations, and is usually not efficient for customized services. Some experts also note that it is susceptible to possible long-term growth of overhead costs. For example, in order to deal with error detection and correction it may be necessary to add more steps, thus making the process longer and more unwieldy. Generally, no one employee has all the information needed to correct an error, so mistakes may persist or build on one another; papers might cycle through the system several times before they are corrected.

[2]For example, see Harry Braverman, *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1974), pp. 293-358.

[3]Barbara Baran and Suzanne Teegarden, "Women's Labor in the Office of the Future: Changes in the Occupational Structure of the Insurance Industry," Department of City and Regional Planning, University of California, Berkeley, 1983, p. 11.

[4]Ibid.

[5]Ibid.

It can become difficult to provide quick, accurate customer service when work is processed in a production line fashion. The process of issuing an international letter of credit at one bank required 23 steps performed by 14 workers over a 3-day period, and generated stubs and carbon copies to be stored in a number of locations.[6] A customer with a question had a difficult time finding the one worker with the right bit of information to answer it, and if a customer wanted a transaction to be modified, the whole process had to start over again.

Finally, for many workers, the endless repetition of a limited range of tasks is boring. Yet information-handling tasks, even boring ones, usually require a high degree of focused attention. The result can often be a high error rate in the work, and a high turnover rate among the employees. These problems will be discussed at greater length in the next chapter.

The Information Age Office

For some businesses, office automation offers the possibility of restructuring the work process in a way that reduces some of the problems of the industrial style of work organization. This new approach has been called "post industrial" or "information age" and is characterized by an electronic reintegration of the steps involved in producing a product.

Electronic reintegration of work represents a new approach to rationalization of work. Instead of attempting to make the work process efficient by rationalizing each task and function separately, this approach seeks to rationalize a whole procedure, perhaps along product or market lines. This is possible because the technology allows: 1) the integration of information from many sources, and 2) the distribution of information to many locations.

A general example can be seen in the case of the bank mentioned above. Under the old system, each worker performed one or two steps in the processing of all letters of credit. Under the revised work process, each worker, with the aid of a computer workstation and a client database, performs all the necessary steps in processing letters of credit for a particular set of clients. The database contains all information related to the customer's account. The customer service worker is the single point of contact between the customer and the bank for corrections or inquiries.

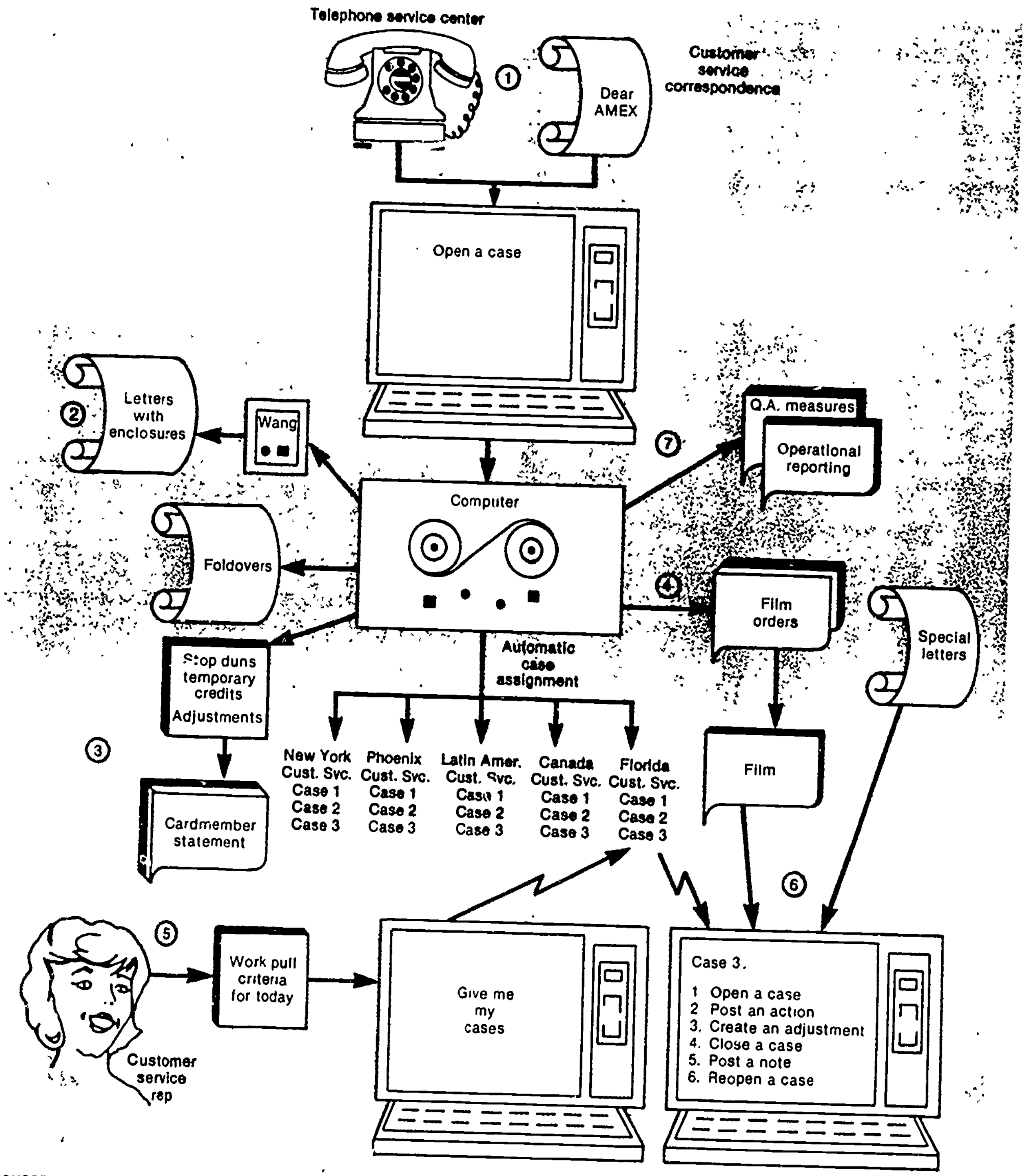
An illustration of the capabilities of an integrated customer service system at American Express is shown in figure 4-2. Customer service representatives have the ability to deal with a wide variety of activities related to their cases. Working from the on-line database they can answer telephone inquires, send written replies to mail inquires, make credit adjustments, stop automatic duns, or issue a special statement. In addition to the on-line database, the customer service workers have access to historical records stored on computer output microfilm.

Electronic reintegration allows a worker a view of the whole operation and gives a variety of tasks to perform. Both factors are indicative of a "de-Taylorization" of work, and probably contribute to greater job satisfaction, and in many cases, greater autonomy and responsibility. However, electronic reintegration does not necessarily lead to greater autonomy, responsibility, or discretion. Because the work is dependent on the use of the computer, it can be subject to machine monitoring and pacing.

When a whole process cannot be handled by one kind of worker, electronic integration can still be used to accommodate a decentralized team approach to the division of labor. Some insurance firms have created small teams of raters, underwriters, and clerical support workers to work on specific product lines. Workers that were formerly separated by function are now integrated into a team that serves a specific market. Organizing the workers in teams rather than isolating them in functional groups allows them greater understanding of the whole production process and facilitates communication.

[6]Richard Matteis, "The New Back Office Focuses on Customer Service," *Harvard Business Review*, March-April 1979, pp. 146-159.

Figure 4-2.—Model of an Integrated Customer Service System



SOURCE Jay W Spechler Director Performance Engineering American Express Co personal communication 1985

Baran and Teegarden suggest that in the insurance business, firms will tend to continue to use the industrial-style work process to produce and distribute standardized products. Much of the work will be highly routine, and the work force will consist of a shrinking number of low-skilled clericals and a few highly skilled professionals. With these products the goal is to reduce unit costs as far as possible and to minimize labor costs. For more specialized products, those that require customizing or responsiveness to individual client needs, there may be more use of the team approach along with integrated office automation systems.[7]

[7]Baran and Teegarden, op. cit., p. 21.

TASK CHANGE AND COMPUTER-MEDIATED WORK

One commonly noted characteristic of work with computers is that they make work more abstract and alter the worker's relationship to the task. This is sometimes called a "computer mediated" relationship, in that the individual must now do the task through the medium of the computer system rather than through direct contact with the objects of the task.[8] Using any sort of tool can, of course, distance a worker from direct tactile contact with an object. But most manual or power tools still allow the worker to remain close enough to the object to get direct feedback about the condition of the object, the status of the process, or the need for adjustments. When a computer is used, feedback is indirect, in the form of symbols generated by the information system.

Office work is already abstract. What is actually being processed is information. Yet from the point of view of the worker, this information becomes concrete because it is carried on physical objects—signature cards, account ledgers, invoices, letters, reports, and checks. Most manual or mechanically aided office tasks involve transforming the information by manipulating the object—copying, typing, updating, or signing it. When computers are introduced, many of these objects disappear completely. The worker is left to deal with intangible information, which is transformed in invisible ways inside the computer.

The rules by which information is prepared or transformed also change with computer mediation. Quantitative comparisons are easy for computers to handle, qualitative judgments are not. Thus, in the process of restructuring work to be done by computers, qualitative aspects of information are either quantified or lost. Correctness of data or procedures must be redefined to fit the formal logic of the computer, and formal correctness can become more important than the relevance of information content.[9] Human judgments are often replaced with computer-based decisions and human error detection or correction become difficult.

The language of the human-computer interface is different from human language, as well. Although computers are becoming easier to use, they still require human operators to learn specific codes and procedural commands. Further, even when these commands are similar to plain English, the formalized process by which the computer works may be quite different from human thought patterns. The human operator must learn to think and to perform actions in a precise order that reflects the logical sequence built into the software.

The ability to think in a way that parallels computer logic is not a trivial intellectual discipline, and represents a new way of working for many people. For example, retrieving information from a computerized database re-

[8]See, for example, Shoshanah Zuboff, "New Worlds of Computer-Mediated Work," *Harvard Business Review*, September-October 1982, pp. 142-152.

[9]Further discussion is in Gunnar Aronsson, "Changed Work Qualification Structure in Computer-Mediated Work," National Board of Occupational Safety and Health, Solna, Sweden, 1984.

quires different modes of thought than finding a folder in a filing cabinet. Physical search is aided by physical aids to memory—thickness of the file, color, a coffee stain on the corner. These do not exist in a computer-based file. There is only a name, constructed according to rules inherent in the computer logic. A search through a database requires use of the right key words, in the proper relationship; otherwise the search may yield faulty results.

An example of how tasks change when computers take over part of the process may be seen in banks. With computerization, the process of fabricating accounts, the principal activity of a bank, was made internal to the computer. These procedures had previously been done manually, or with the assistance of mechanical accounting machines. The role of human operators then changed from one of doing banking to one of surveillance of the computer as it does banking. Adler points out that:

> . . . a series of tasks formerly considered the very essence of bank work have been eliminated, including accounting imputation and adjustment, classification of documents, multiple entries of data, manual data search, and supervision by signature.[10]

He also notes that new tasks were introduced. For example, "Accountants now diagnose and rectify residues and anomalies listed by the computer system. New types of errors—and fraud—appear."[11]

Some observers note that the increased abstraction can affect people's understanding of the work. Some managers in banking have noted, for example, that new employees—those who have only worked on the automated systems—understand the system, but don't necessarily understand banking. They think like computer programmers instead of like bankers. As one manager said:

> Now you make an input and it's gone. People become more technical and sophisticated, but they have an inferior understanding of the banking business. New people have no idea of the manual procedures so they never see or understand the process. People start creating programs that don't necessarily reflect the spirit of the operation.[12]

Clearly employees acquire new skills, they learn to interact with the computer, they may never learn certain old skills. To the extent that processes are automated and these skills are not needed any more, this may not be a problem. But, if the skills are still needed, either at that job level or at another, there may be costs to individuals or the organization for allowing them to be lost. To continue the example above, an understanding of basic banking practice probably is necessary for promotion above the lowest operational levels. To the extent that employees do not gain it by doing bank work, it may be necessary to acquire it through formal training.

[10] Paul Adler, "Rethinking the Skill Requirements of New Technologies," Working Paper 9-784-027, Graduate School of Business Administration, Harvard University, Boston, October 1983, p. 17.

[11] Ibid.

[12] Shoshanah Zuboff, "Problems of Symbolic Toil: How People Fare With Computer-Mediated Work," *Dissent*, winter 1982, pp. 51-61.

JOB CHANGES WITH AUTOMATION

Office automation can change jobs in many ways. The automated system may completely take over certain tasks. To the extent that certain processes become completely automated, jobs that consist solely of those tasks or processes might be eliminated. This does not necessarily mean that the people are eliminated from the organization—they may be retrained and transferred—but particular positions no longer exist.

On the other hand, office automation creates new tasks, either supporting the system or related to new products made possible by the system. These tasks may be incorporated into existing jobs or new jobs may be created, as in cases where a trainer or systems specialist position is created after introduction of office automation.

Finally, very commonly, a change in the work process modifies jobs through the addition or deletion of tasks. This can also result in a change in the boundaries between jobs, transferring a task from one job to another. Any of these changes may or may not be accompanied by a formal change in job titles, descriptions, or compensation.

The boundaries between clerical and professional and between clerical and managerial are showing interesting changes with office automation. Some researchers have referred to this redistribution of labor as the "clericalization of professional work" and the "professionalization of clerical work."[13] Most clear is the shift of keyboarding tasks when professionals and managers acquire terminals or personal computers. Individuals who would never have typed their own memos and reports now routinely draft them on their personal computers. Clerical workers have not stopped doing keyboard work completely, however. Secretaries may work on documents at a later stage to revise, format, or print them, or they may still key documents that professionals and managers choose not to key themselves. Nevertheless, many organizations have seen a decrease in the amount of time secretaries and other clerical workers spend in keyboarding or revising original material when professionals and managers begin using the system.

By the same token, secretaries and some other clerical workers have taken over tasks formerly defined as professional. In case studies of two different banking organizations, for example, secretaries began using on-line databases and statistical software available on their terminals to collect data and do analyses formerly done by economists.[14] Clearly, new technology is not the only factor in clerical workers' being able to take on new and interesting tasks; there must be management support for these job changes.

The question of whether changes related to automation lead to an increase or a decrease in skill is a hotly debated one. Often the terms job "de-skilling" and "enrichment" are used to describe the changes. Enrichment usually implies an increase in task variety, autonomy, skills acquisition, and other factors that are considered to contribute to job satisfaction. De-skilling usually means the removal of these features, usually through simplifying the work and narrowing the number of tasks performed, and is usually associated with rationalizing or Taylorizing the work. Both de-skilling and enrichment could be accompanied by job "enlargement," that is, an increase in workload.

It is clear that the impacts of office automation will vary from one job to another. The following is a brief summary of some generic changes that have been seen to affect different categories of workers.

Management and Professional Jobs

Increasingly, computers are helping professionals get more work done by providing more and better information, by providing tools to aid in formulating professional opinions, and by taking over some routine decisions. Traditionally, professionals and managers have high levels of autonomy in their work.[15] Use of new technology can give managers and professionals better control over their time and even greater autonomy in their jobs. For example, electronic messaging may reduce telephone

[13]See, for example, Joan Greenbaum, Cydney Pullman, and Sharon Szymanski, "Effects of Office Automation on the Public Sector Workforce: A Case Study," OTA contract No. 433-7990.0, April 1985.

[14]B.C. Amick and J. Damron, "Considerations in Defining Office Automation: A Case Study in the Eastern Africa Region of the World Bank," *Human Computer Interaction: Proceedings of the First USA-Japan Conference on Human Computer Interaction*, Gavriel Salvendy (ed.) (Amsterdam: Elsevier Science Publishers, 1984), pp. 439-445. See also app. B, "Computer Mediated Work in Commercial Banking."

[15]B. Kaplan, et al., *Job Demands and Workers Health* (Washington, DC: U.S. Government Printing Office, 1975).

Photo credit: Board of Realty Information Service

Technology can help change the way people work. Here a computerized database combining both text and photographs offers realtors and home buyers an alternative to the laborious process of showing properties.

call-backs, or in some cases, the number of meetings. Managers can get up-to-date information on factory operations or business activity by accessing on-line databases within their companies. They may be able to manipulate these data, to do "what if" studies to determine the probable outcomes of their decisions before actually making them. Managers and professionals can avoid the need for outside data processing or other expert help by using spread-sheet software or information databases at their own terminals. They can produce polished reports on their own printers without a secretary or a graphics artist.[16]

Along with these advantages, there can be some drawbacks as well.

Greater autonomy, for example, can have its disadvantages. When managers and professionals demonstrate less need for a secretary to do their typing, they may lose the secretary entirely, even if they still want one for other duties—or for a status symbol.

In another example, a manager who is pleased to get up-to-date information about factory operations through the office automation system, may be dismayed to find that the same information is available to a senior executive, who is therefore capable of more closely monitoring or second-guessing decisions. In this case, the use of the technology might lead to a reduction in autonomy for the lower level manager.

"Knowledge engineers" have been attempting to identify the skills, information, and expertise that go into managerial and professional judgments and to incorporate these into software. The results are a variety of computer-based models, expert systems, and decision-support systems.

Some analysts have expressed fears that computer-based models are making professional and managerial work more routine. There are also fears that some people are going too far in allowing them to replace human judgment. Human judgment is not perfect, but its imperfection is generally recognized and expected. Many people have higher expectations of computers, and sometimes a misplaced faith in their accuracy. A computer-based model, no matter how good, is only a partial representation of complex relationships, and its internal assumptions, theoretical biases, and mathematical quirks can produce results that are not consistent with the real world. Overconfidence in the effectiveness of computer-based models, some believe, can lead to neglect of other forms of research that were, before computerization, the basis of expertise. Skill in these areas is still important as long as the model is incomplete.[17]

The ability of computers to give the wrong answer to six significant figures is sometimes called "the tyranny of illusory precision." Its danger to professionals and managers has probably been exacerbated by the growing use of computer graphics. Advertisements by computer companies rightly tout the greater per-

[16]Alexia, Martin, *Office Automation. Catalyst for Change*, SRI, International, 1983, p. 9.

[17]Linda Sandler, "Securities Risk: Wall Street Is Finding Its Trusty Computers Have Their Dark Side," *Wall Street Journal*, Dec. 4, 1984, p. 1.

suasiveness of good graphics (the CEO adopts the proposal illustrated by manager A's colorful pie charts, but he throws manager B's laboriously typed tables into the trash). However, slickness of presentation and effectiveness of results are not necessarily related.

Some professionals have expressed fears that too much use of computer-based information or decision-support software is limiting creative problem solving. Much of the value of a professional judgment is that it weighs many factors, many of which are unquantifiable, or even ambiguous or fuzzy. Someone who formulates a professional opinion gives weight to the nonquantifiable information in a "gut feeling" based on experience. Information available through a computer database may be more complete than information accumulated through other means, but it is also "perfect"—ambiguity has been removed. Some writers have suggested that ambiguous situations provide a "free space" for creative thinking that is fundamental to professional work.[18]

The problem may be short term. Continued research and development along with practical use will further demonstrate both the potential and the limitations of computer-based tools in aiding decisionmaking. If professionals and managers who put too much reliance on computer systems make more mistakes than those who rely more on traditional skills, they will presumably prove less effective over time.

Clerical Jobs

It is in the area of clerical jobs that most studies of the effects of office automation have focused, and it is here that many of the impacts seem apparent.[19] Nevertheless, it is hard to generalize, because so many impacts depend on how the technology is implemented in a particular organization, rather than on the technology itself.

For many clerical workers, both quantitative and qualitative data show that workload has changed following the introduction of office automation. The work pressure scale from the NIOSH study shows that the introduction of a computer terminal has led workers to report greater work pressure. In most cases this is because management choice has been to redesign work according to the "industrial" or production-line model. The most common scenarios are those of the secretarial worker, the data-entry clerk,[20] or the directory assistance operator.[21] In each case, rationalization of the job fragments it into its component parts. A secretary, for example, who previously did filing, typing, answering phones, and a number of nonroutine tasks may end up only doing word processing.

Work pressure may also increase when the work is less paced by the person and more by the computer terminal. In the extreme case, the directory assistance operator may be expected to take a call every 30 seconds, with calls continually forwarded to the operator by the computer. It is this combination of pacing and specialization that leads to increased workload.[22]

Whether the worker's autonomy and control are increased or decreased on the job can depend on how the automated system is designed. This can be seen, for example, in some of the automated collection systems being used

[18]Zuboff, op. cit.

[19]Examples include: Mary C. Murphree, "Rationalization and Satisfaction in Clerical Work: A Case Study of Wall Street Legal Secretaries," Ph.D. dissertation, Department of Sociology, Columbia University, 1981, Evelyn N. Glenn and Rosalyn L Feldberg, "Proletarianizing Clerical Work: Technology and Organizational Control in the Office," *Case Studies in the Labor Process,* Andrew Zimbalist (ed.) (New York: Monthly Review Press, 1978), pp. 51-72, and Robert A. Arndt, and Larry Chapman, "Potential Office Hazards and Controls," OTA Case Study, 1984.

[20]Michael J. Smith, B.G.F. Cohen, and L.W. Stammerjohn, "An Investigation of Health Complaints and Job Stress in Video Display Operations," *Human Factors* 24:4, 1981, pp. 387-400; Gunn Johansson and Gunnar Aronsson, "Stress Reactions in Computerized Administrative Work" Reports for the Department of Psychology, University of Stockholm, Supplement 50, 1980.

[21]Note the example cited in B.C. Amick and D.D. Celentano, "Human Factors Epidemiology: An Integrated Approach to the Study of Health Issues in the Office," *Human Aspects in Office Automation,* B.G.F. Cohen (ed.) (Amsterdam. Elsevier Science Publishers, 1984), pp. 153-166.

[22]R. Feldberg and E. Glenn, "Technology and Work Degradation. Effects of Office Automation on Women Clerical Workers," *Machina Ex Dea. Feminist Perspectives on Technology* (New York: Pergamon Press, 1984).

both by private firms and government agencies. Often these are implemented in a way that reduces autonomy. Under a manual system, the individual worker had some descretion about which account to pursue, when to start a new file, or how often to call. Many automated systems make all those decisions. The system makes other decisions as the worker keys new information into the files during telephone calls with the delinquent accounts. The worker's individual assessment of priorities or intuitive judgments of which people are most likely to respond to extra cajoling become less important. The automated system determines when, how often, and how long each call should be. Sometimes the worker has no understanding of the whole case, except through the notes provided by the system. Under a manual system, a worker ends each day with a big pile of completed work and a sense of accomplishment; a machine-paced system may continue to send new work at the same rate, no matter how much is accomplished.

On the other hand, if designed differently, the same sort of system can maintain worker autonomy and control while providing the advantages of a computer-based information system. For example, work can be bundled so that one worker, or a team of workers, follows a certain set of accounts from beginning to end, and has the satisfaction of seeing the big picture in each case. If the system is modifiable by the user, so as to give some discretion about timing and duration of tasks or to allow use of individual expertise, it can offer the best features of both the manual and automated systems. Autonomy is not directly tied to the technology and is related to characteristics of the organization and the work process prior to automation.

Changes in the work process can lead to a redistribution of tasks, which may either reduce or increase workload for clerical workers. Where professionals and managers have begun to do most of their own keyboard work, or where keyboarding is sent to a word processing pool, secretaries may find their typing load considerably reduced. How this change is handled depends on managerial and individual decisions. In one OTA case study site, a New York City office, secretaries organized themselves to solicit overflow typing from other departments.

In the case of one Wall Street law firm, legal secretaries found they were losing their keyboard work to the word processing pool and their "lawyering" tasks to paralegals. As a result, their work is generally now limited to performing "primarily those nonroutine tasks that involve social skills, time emergencies, and multiple contingencies," such as fielding phone calls, gatekeeping, coaxing rush jobs through the bureaucracy, etc. The firm has made a deliberate effort to reduce the number of secretaries and to eliminate the one-secretary-one-attorney relationship. Increasingly, secretaries work for more than one attorney or as members of small clusters in teams with other secretaries.[23]

The allocation of tasks is a management decision. In the case of the law firm, business and economic factors moved management to allocate tasks in a new way. A centralized word processing pool appeared to minimize capital costs and ensure maximum use of equipment. Technology helped make the reallocation of tasks possible, but did not guarantee it. The other change in the legal secretaries' work had more to do with accounting procedures than with technology; "lawyering" work done by paraprofessionals is billable to clients, but the same work done by legal secretaries is considered an overhead expense. Economic factors motivate both the acquisition of new technology and the assignment of work.

For secretaries at one major bank the increase in workload relates not to fragmentation, but to the addition of new and interesting tasks. When personal computers were introduced into their work unit their keyboarding duties did not decline; the unit withdrew from the typing pool it had used previously, making secretaries responsible for more key-

[23]Mary C. Murphree, "Brave New Office: The Changing World of the Legal Secretary," *My Troubles Are Going To Have Trouble With Me: Everyday Trials and Triumphs of Women Workers*, K. Sacks and D. Remy, (eds.) (New Brunswick, NJ: Rutgers University Press, Douglas Series, 1984).

boarding. At the same time, the secretaries discovered that the statistical packages and databases available on their terminals allowed them to do some types of work previously done by professionals. They found this work an enjoyable challenge and do not wish to give it up, even though it increases their workload.[24]

Job Ladders and Mobility

Changes in job content may affect career mobility within organizations (internal labor markets) as well as mobility within the economy at large (external labor markets). In many firms employees have the possibility of moving up job ladders within the organization—acquiring new skills, assuming greater responsibility, and receiving higher compensation. The development of these opportunities and the cultivation of this internal labor market has been very important to some firms. Some indeed consider the experience of working up through the ranks, with its concomitant understanding of internal operations and demonstrated loyalty to the firm, to be more important than any amount of outside training. These firms may have a policy of filling certain positions only through promotions rather than from outside.

Both company policy and the shape of the job ladders may change over time due to any number of factors, including technological change. What will be the impact of those changes directly related to office automation, or to the changes in work process or job definition permitted by technological change?

On the one hand, the fragmentation of work into a multiplicity of narrowly defined jobs has traditionally aroused concern about the availability of "good" jobs. On the other hand, the prospect that office automation may lead to more standardized jobs raises concern about potential polarization of job opportunities into low skill, low wage and high skill, high wage jobs with breaks in the job ladder between them.

The import of diminished mobility must be judged relative to the context, which includes both internal and external labor market conditions. In many industries, internal job ladders have been significant factors in the past. Capable and ambitious workers could learn the industry from the ground up, coming in as clerical workers and working their way up through lower level supervisory (or paraprofessional) jobs into management levels. In the insurance industry, for example, clerical workers might become raters and later underwriters.[25]

> Some technologies provided a natural learning sequence so that workers learned on the job how to carry out more complex tasks and operations. Firms that anticipated future growth wisely saw to it that there were pools of workers at the various intermediate skill levels available for promotion so that expansion could be smooth and free of external labor market constraints.[26]

The insurance industry traditionally selected and trained managers from within the industry, usually from within the firm. In other industries too, such as retail trade, the internal job market was the most significant and employers provided much formal and informal training for lower level employees. Although the messenger-to-manager or clerk-to-CEO paths were trod to the end by very few, the possibility that a combination of diligence, striving, and luck could take one to the top was a powerful motivating factor.

Some researchers have suggested a growing trend in recent decades to externalize both training and recruitment. In other words, employers are depending more on lateral recruitment of managers and skilled workers trained in colleges and business schools.[27] This also

[24]B.C. Amick and J. Damron, op. cit., pp. 439-445.

[25]It has been pointed out by several researchers that this job ladder worked well only for male clerical workers before the early 1970s, women clerical workers seldom made the climb. Under pressure of equal opportunity initiatives this became a significant job ladder for women in the 1970s, but is now said to be truncated by the automation of rating and routine underwriting.

[26]Eileen Appelbaum, School of Business Administration, Department of Economics, Temple University, personal communication, Feb. 5, 1985.

[27]See for example, Thierry J. Noyelle, "Employment and Career Opportunities for Women Minorities in a Changing Economy. The Experience of Large and Medium Sized Firms," Conservation of Human Resources, Columbia University, January 1983.

applies to lower level workers, because of the longer years of schooling for the general population and the growing availability of vocational schools and community colleges, employers can rely on the public sector for training once provided within the firm. For those who cannot or do not get that training and education—for reasons related to socioeconomic conditions, culture, talents, or the driving necessity of earning a living early in life—a critical alternative path to better jobs is being eroded.

Office automation could further weaken and truncate internal job ladders by completely automating some of the jobs that provided the intermediate rungs, and by encouraging employers to rationalize, simplify, and narrow tasks so that workers learn about only smaller and smaller fragments of the total work of the organization. This also makes the individual worker less and less valuable to the employer since he or she can be readily replaced by others who require only the briefest training, or have already learned the same simple procedures in other firms or other industries. Their skills are, in other words, fully standardized.

This tendency from one perspective increases the mobility of workers, who can move relatively easily from one firm to another or from one industry to another with fully transferable skills. But it does not increase their upward mobility at the same time. If the supply of lower level jobs shrinks and the supply of higher level jobs increases, such workers may not benefit because the higher level jobs are likely to be filled laterally, with people who have had the benefit of higher education- or more recent education.

Some researchers believe these trends are leading to a polarization of the labor force into low skill, low paid jobs and high skilled, high paid jobs, with few opportunities in between. Empirical evidence regarding any economy-wide trend toward job polarization within organizations gives conflicting signals. Polarization of jobs has occurred in such office-oriented industries as banking and insurance; examples are provided in previously cited research by Baran and Appelbaum. Conditions in those industries are not necessarily generalizable to general office circumstances, where initial staffing patterns are different and motivations regarding job design are also different. In many general office environments with lower levels of clerical employment (the extreme being the one-secretary office) office automation is not driven as strongly by the objective of immediate reductions in force. In many such offices, there is perhaps a stronger need for quality improvement, greater timeliness, and workload leveling. The result could be a greater tendency for job enhancement and possibly improved internal job ladders.

Many people advance their careers by moving from one organization to another. Thus, the external labor market is also a source of opportunity. In professional, technical, and managerial occupations, advancement by moving between organizations, as well as by moving within them is relatively common. A study of occupational mobility noted that most job changes during the study period occurred within the same major occupational group, especially for both male and female professionals.[28] Indeed, mobility of these personnel seems to be the foundation for the employment agency and placement business.

Although some people can advance readily via the external labor market, some groups find that more difficult. In many cases, a change in jobs does not reflect advancement. It was noted in the previously cited occupational mobility study that a relatively high percentage of women who had recently moved into manager or sales positions had previously been clerical workers. However, the largest group of women changing jobs were those who moved from one clerical occupation to another.[29] For lower level clerical workers, advancement through job changes is likely to require formal, external training, if on-the-job acquisition of skills needed for higher level positions is diminished. A reduction in intraorganiza-

[28] Ellen Sehgal, "Occupational Mobility and Job Tenure in 1983," *Monthly Labor Review*, October 1984, pp. 18-23.
[29] Ibid.

tional career ladders is a shift in training burden from employer to employee. That burden is aggravated inasmuch as access to good education and training is uneven; job opportunities may be increasingly tied to social class or economic means.

ORGANIZATIONAL STRUCTURE AND RELATIONSHIPS

Changes in the structure of organizations related to introduction of office automation can be influenced by economic, environmental, or cultural considerations, in addition to technology. Managerial strategies—upper level decisions about the organization's goals and the role of technology and of people in achieving them—are probably the major considerations.

Formal structural changes (i.e., something that would be noticed on the organization chart) might take place during implementation of office automation or shortly afterwards, perhaps reflecting a change in the work process. For instance, in some firms, the creation of administrative centers and the aggregation of all support personnel in word processing pools accompanied the decision to adopt office automation technology. On the other hand, change may not be reflected formally at all, but may only be seen as changes in communication patterns or in power relationships between groups or departments.

Organizational effects often take place over a period of time, as part of an evolutionary process. As familiarity with technology and its capability grows, structural changes may be introduced that allow the organization to take better advantage of those capabilities. New product lines made possible by the technology may emerge, which in turn give rise to new work groups or departments.

Power and Access to Information

Early research on the computerization of organizations suggested that introduction of computing appeared to change power relationships, and a central preoccupation of research in the 1970s, was whether computers led to growing centralization of power among upper level managers. The sources of organizational power include such things as control over resources, information, critical technical skills, or coping capability.[30] As control over the computer offered senior management many of these things, some researchers predicted that computerization would increase the centralization of decisionmaking power.

These studies were done for the most part in the era of mainframe computers. However, even in the age of personal computing and distributed processing, there may be reason to believe that integrated information systems can aid in the centralization of organizational power. Possible routinization of middle management work, through dependence on computer-based information systems and decision-support models, was discussed earlier. Some researchers have pointed out that any worker whose job becomes more routine becomes less powerful, less able to offer a unique contribution to the organization. While middle managers may retain responsibility for making certain decisions, their range of choices could become more rigidly circumscribed by the assumptions inherent in their decision-support system. Their authority could be accompanied by increased supervision and control, as higher level management will have access to the same information and decision aids.[31] Another expert has suggested that "paradoxically, [centralization] may be manifested by locating decisions at lower levels but controlling decision outcomes through the provision of performance records."[32] It has been suggested that the widespread use of integrated office auto-

[30] Jeffrey Pfeffer, *Power in Organizations* (Marshfield, MA: Pitman Publishing Inc., 1981), p. 274.

[31] M. Lynne Markus, *Systems in Organizations. Bugs and Features* (Boston, MA. Pitman Publishing Inc., 1984), pp. 52-53.

[32] Daniel Robey, "Computer Information Systems and Organizational Structure," *Communications of the ACM*, October 1981, pp. 619-687.

mation systems reduces the need for middle management and could ultimately lead to a flattening of some organizational pyramids.[33]

The concept of centralization is too simple to describe all the possible changes in power relationships that might result from the introduction of office automation. Organizations are not monolithic; different departments, work groups, or factions may be affected differentially.

A set of case studies found that introduction of automated production scheduling systems into Danish plants altered the power relationships among management groups because of differential access to information. The plants had a matrix organization, with major decisions being made by interdepartmental teams of production planners, production managers, and plant managers.[34] The new computer-based production planning system was "owned" and mainly used by production planners. It seems to have concentrated up-to-date knowledge in their hands, thus giving them greater power over production decisions and higher status as compared to production managers and plant mangers. These shifts of influence were evidently unintended by the designers of the system. One expert[35] in interpreting the same study, points out that this concentration of power caused the matrix arrangement to lose some of its anticipated effectiveness, although it was still retained, largely for symbolic or ideological reasons.

In one of the OTA case studies, Aircraft Instruments Plant, the introduction of the MRP II planning and scheduling system seems to have given greater power to production-support office workers while taking some discretion away from the supervisors on the factory floor. (See appendix B.) While access to up-to-date information is partly responsible for this shift, even more important is the ability to act on information. Under the new system, only production-support staff have the authority to override the system when the automatic response would be inappropriate. Because of the complexity of the work and also because of some conceptual problems in the system's design, such conditions arise frequently. Previously, factory supervisors might have dealt with exception conditions on their own authority, but now they must request permission from production support.

On the other hand, where shifts in relative power are inappropriate to the "corporate culture" of any organization, management has the option of reinforcing existing lines of authority and modifying the automated system to ensure that change does not take place.

One example is that of a military organization that replaced its manual logistics system with a computerized one. Under the old system, senior officers received requests for equipment transfers and had junior officers to compile a detailed report on which to base a decision. The junior officers gathered information for these reports through written documents and through telephone contacts with a network of supply officers at other installations. With the new system, the junior officers worked at computer terminals with on-line access to information about the location and status of equipment, a decision-support system to calculate least-cost routing, and the means to implement transfers. Because the junior officers had timely and complete information, people began making requests for equipment directly to them rather than going through proper channels, and the junior officers sometimes could not resist the temptation to respond, even though they did not have authority to do so. Senior officers attempted to have the new system removed. In the end it was retained, but it was redesigned so that junior officers were unable to take action based on their decisions.[36]

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[33] Rolf T. Wigand, "Integrated Communications and Work Efficiency: Impacts on Organizational Structure and Power," paper presented at the International Communication Association Annual Convention, Honolulu, Hawaii, May 22-27, 1985, p. 16.

[34] N. Bjorn-Anderson and P. Pederson, "Computer Systems as a Vehicle for Changes in the Management Structure," Information Systems Research Group, University of Copenhagen, Working Paper 77-3, 1977. Cited in Rob Kling, "Social Analyses of Computing: Theoretical Perspectives in Recent Empirical Research," *Computing Survey* 12 (March 1980), pp. 61-110.

[35] Robey, op. cit.

[36] Markus, op. cit., p. 74.

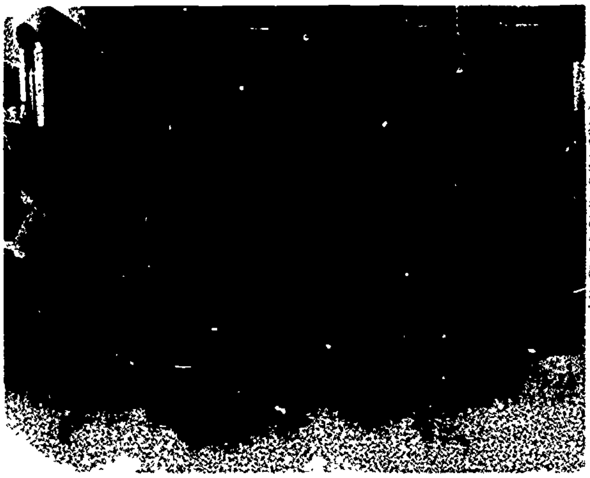


Photo credit: Smithsonian Institution

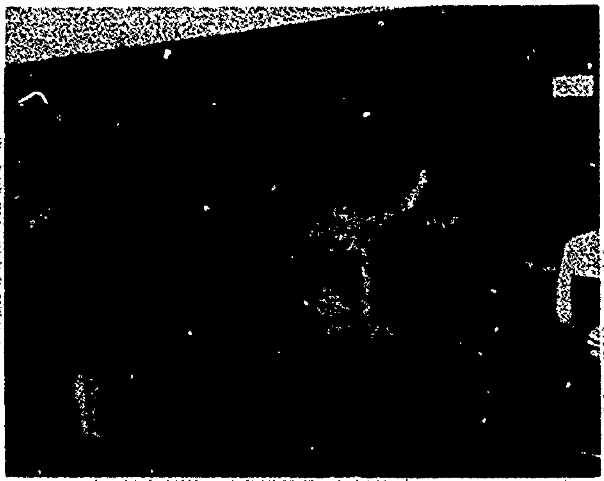


Photo credit: Smithsonian Institution

Photo credit: Bill Kelley, Communication Workers of America

Advances in microelectronic technology have made telephone operators more productive.

Many firms are using integrated databases, and employees at various levels need access to it in order to do their jobs. However, access to different parts of the database can be stratified so that existing organizational lines of authority are not threatened.

End-User Computing Power

Since one source of power is control over resources and since the computer itself (or what it can do) is a resource, there has been some dispersal or shifting of power in many organizations. Only a few years ago computers were a *scarce* resource; data processing professionals usually acted as gatekeepers between all other departments and the computer, and thus were in a position of power. Over the past 5 to 10 years, with the declining cost of electronic hardware, computer power has become much more widely dispersed throughout many organizations.

High costs of computer equipment used to make centralization more attractive. Lower prices, increased capabilities, and the ability to link workstations in networks now make it possible for firms to disperse data processing and word processing capabilities. This does not necessarily mean that the word processing pools have disappeared (although they have in many firms) but that word processing capability is now available to private secretaries, receptionists, professionals, and others. Nor are centralized data processing departments likely to disappear, as many organizations continue to need the power of mainframe computers and the expertise of computer professionals. However, the ability to do a growing variety of data processing activities can now be brought directly to every professional and manager.

In some organizations there may be an overall strategy to keep centralized control over computer resources, to maintain compatibility between systems, to make sure that personal computer users can access databases, etc. This function may be performed by the data processing department or by some other office automation group. Where some other group is designated, turf difficulties with the data processing department have often arisen with the continuing convergence of word processing, data processing and communication. In one Fortune 500 company, conflict between the data processing department and ad hoc office automation group was finally resolved when the office automation group was assigned responsibility for managing all resources for data and word processing within the firm. The data processing department was limited to providing data processing services for external clients.[37]

In many cases, organizations have acquired office automation, especially personal computers, without a grand plan, in response to grass roots decisions at the individual or departmental level. Later attempts to standardize or to centralize control of the organization's information resources inevitably result in battles when different kinds of equipment or different philosophies of operation have already become entrenched. No system is perfect for everyone's needs, and many groups may want to influence the development of office automation systems to make them most suitable to their own needs or most acceptable from their own bias.

Communication

Additional organizational implications of office automation are related to their effects on communication within organizations. An interesting sidelight on the case involving the military logistics office is the way in which the new system changed communication patterns. The senior officers were "left out of the loop," when supply officers began contacting junior officers directly for equipment transfers. In addition, however, the flow of information reversed along the junior officers' network of telephone contacts. The junior officers had created these networks to call out for information. However, once the on-line system came into place, the junior officers became a source of systemwide information. Their form-

[37]Ginger Levin, "Excellence in Information Resource Management," GHL Inc., Washington, DC, 1984.

er informants made use of the same telephone network, with its established informal working relationships, past favors, friendships, etc., to call in for information or for emergency equipment transfers.

Changes in communication patterns may be at the base of many of the organizational changes associated with office automation, simply because communication is such a major part of white-collar workers' jobs. Managers, especially, spend a large portion of their time communicating. It is estimated that from 46 to 77 percent of their day is spent in oral communication, including both telephone conversations and face-to-face meetings.[38]

The introduction of new pathways of communication may bypass traditional gatekeepers and make profound changes in "who talks to whom." Although some researchers have predicted that full access by many workers to a linked electronic system could lead to a complete reshuffling of power relationships, giving most power to those with access to the system,[39] there is little evidence that formal hierarchies are greatly affected by innovations like electronic mail and messaging. In fact, these systems are often constructed in such a way as to reinforce the existing hierarchy, e.g., automatically sending information copies to managers of all their subordinate's messages, but not the other way around. There are some anecdotes of superiors using the system to intensify pressure on subordinates ("I requested that information an hour ago! Don't you check your messages?"). In addition, even in a completely wide open system, where everyone theoretically has access to everyone else, it is doubtful that everyone has something useful to say to everyone else.

However, there are cases where use of an electronic mail system has lead to the undermining of an organization's traditional hierarchy and authority structure. In one example, members of a disbanded project team used their firm's electronic mail system to continue work on an abandoned project, eventually convincing management to revive it. At the same firm, the electronic mail system became a means of exchanging complaints and criticisms about management.[40] More recently there have been other reports of electronic messaging systems being used for "flaming," or emotional outbursts related to organizational or other problems.[41] Such "subversive" use of electronic mail probably depends a good deal both on corporate culture and on the configuration and capabilities of the system. Anecdotes from other firms suggest that their electronic mail is never used for complaints or any communication with implications for internal politics because electronic messages are more easily traced than paper ones.

It is not yet clear how effectively electronic messaging will replace face-to-face or telephone communication. Early evaluations have not shown consistent patterns of replacement of telephone, face-to-face, or written messages with electronic messages across organizations. At some organizations, as at OTA case study site Company XYZ, electronic mail has been consciously rejected because personal communication is considered important to the corporate culture. In another OTA case study, Office of the Special Trade Representative, internal electronic mail is used extensively for circulation of documents for comment and it would be used externally if other agencies were equipped.

Many managers do not use electronic mail extensively to replace face-to-face meetings or telephone calls. This may be attributable to two factors. First, use of the technology may interfere with the personal management style. Second, there may be dissonance between the electronic system and the type of information being transferred. In one study, over one-third of the messages exchanged in face-to-face or

[38]Margarethe H. Olson, "New Information Technology and Organizational Culture," *MIS Quarterly Special Issue 1982*, pp. 71-92.

[39]See for example, Carol T. Gaffney, "The Impact of Office Automation on Power in Organizations," Proceedings of AFIPS Office Automation Conference, Philadelphia, February 1983, pp. 216-217.

[40]Markus, p. 60, citing Ralph Emmett, "VNET or Gripenet?" *Datamation*, November 1981, pp. 48-58.

[41]"Conversations by Computer," *Electronic Services Unlimited*, October 1984.

telephone meetings contained "soft" information, that is, they conveyed opinion or conjecture. It is possible that messages of this sort cannot be effectively communicated through electronic mail.[42] Another researcher has noted that teleconferencing also is more successfully used for giving or receiving factual information, and less so for complex tasks like bargaining and persuasion.[43] These factors make it likely that these technologies are more likely to reinforce existing trends in the organization rather than to bring about radical changes.

Major changes in the way people communicate at work may come, not from electronic mail, but from common access to databases and to computer operations that control the work process. If office automation offers employees new access to information, it can also change their informal patterns of communication. For example, where coordination between work groups is taken care of in informal "hallway conferences" among work group members, there is opportunity for social interaction as well as the exchange of work-related information. The introduction of an office automation system with a shared database may allow these groups to accomplish coordination through the system, and the people may no longer need to see one another for that purpose.

At Aircraft Instruments Plant, an OTA case study site, coordination through the system, and the elimination of informal conferences and negotiations, were clearly goals of the new MRP II system. Although these goals have not yet been achieved, the new system has clearly changed patterns of communication within the plant and its offices. Informal conferences continue, but now a major purpose of negotiation is to get permission to override the system. (See appendix B for further information.)

This integrative quality of computer systems, which when successful allows coordination without physical proximity, leads directly to the subject of the next section.

[42]Olson, op. cit.

[43]Thomas Mandeville, "The Spatial Effects of Information Technology, Some Literature," *Futures*, February 1983, p. 67.

Dispersion of Work Activity

Perhaps the most powerful effect of the communication features of office systems is the ability to change the location and geographic distribution of work activity. Once words, data, or pictures have been converted to electronic form they can be sent to a device across the room, across town, or halfway around the world with almost equal ease. As a result, people do not have to be aggregated in one place in order to work in the same "office."

Traditionally, information-intensive services have located in large cities where they have the advantage of proximity to other organizations and people. To the extent that telecommunication can substitute for proximity, organizations will have many more choices in where to locate. Many see this as leading to a more geographically dispersed style of functioning because:

> . . . the increasing spread (and cheapness) of telecommunication reduces the former external economies of physical proximity, we see the dispersal of corporate headquarters and major white-collar operators like the insurance industry from the decaying central cities to the suburbs.[44]

Firms might minimize use of expensive big city office space not only by locating in the suburbs, but by moving to or establishing branches in small cities or towns, or even in foreign countries so long as a suitable work force and an adequate telecommunications system are available. The departments most likely to be located in remote locations are those that need little outside contact or that primarily engage in routine communications.[45] So long as coordination and integration of work can take place electronically, there is no longer much need for spatial proximity.

In a study of automation in the insurance industry, it was pointed out that the centralizing and dispersing tendencies of automation are complementary.[46] Procedures for insurance

[44]Ibid.

[45]Ibid.

[46]Barbara Baran, "Technological Innovation and Regulation: The Transformation of the Labor Process in the Insurance Industry," prepared for Technology and Economic Transition Project, Office of Technology Assessment, OTA contract No. 3433-3610.0 Washington, DC, January 1985, p. 95.

rating, underwriting, and claims handling are increasingly being standardized and automated. A recent trend has been to centralize physically the databases on which these activities depend. Many insurance companies are now consolidating their regional offices into two or three highly automated regional centers. At the same time, these firms are disbanding some of their large centralized data-entry pools. Data-entry work is being dispersed to functional departments located in agencies or field offices, connected by on-line terminals to computers at the regional centers. Functional units within the company can be integrated electronically through the computer even if they are geographically distant. At the same time, "because in all cases information is being increasingly consolidated in central master files, although access to it is proliferating and decentralizing spatially, decentralized production is fully compatible with centralized direction and control."[47]

Spatial dispersion of office work could have major effects on the labor force of the future and could have differential impacts based on race and class. Large data processing pools often employ high proportions of minority women in low-skilled clerical jobs. These are the jobs that are increasingly being automated away. The more highly skilled clerical jobs that remain will increasingly be located outside of cities as organizations search for lower cost, nonunionized or more highly educated labor. In one insurance company relocation, labor force characteristics were explicitly important in the location decision—the company sought to place its offices in communities where women were "well educated, of German descent, with unemployed husbands"—as these were considered the most likely to put in a good days' work.[48]

There is probably a limit to how far spatial dispersion can go. Most organizations are unlikely to scatter branch offices across the country simply because office automation makes it possible. Certain activities may not lend themselves easily to dispersion. Because of the unsuitability of telecommunications for activities like negotiating, persuading, or exchanging "soft" information,[49] it is likely that some critical mass of employees would have to remain near each other for face-to-face meetings. In addition, other cultural, logistical, and cost factors unrelated to the features of office automation may limit the number of separate installations.

[47]Ibid.

[48]Baran and Teegarden, op. cit., pp. 30-31.

[49]Olson notes that this may be one reason why many managers have not started using electronic mail to replace face-to-face meetings. See Olson, op. cit.

IMPLEMENTATION

While advertisements are full of the promised benefits of office automation, there are a vast number of horror stories about unsuccessful attempts. The technological and organizational barriers to be overcome, the internal political battles that often must be fought, the planning and redesign of work to be done, are daunting. After hearing and seeing some of the things that can go wrong, those responsible for bringing office automation to their own organizations may consider an implementation to be successful if it is not completely botched—if productivity does not plummet or employee turnover does not rise to the ceiling.

Paul Strassman, formerly Vice President of Xerox, noted that many organizations greatly underestimate the organizational costs (as opposed to technological costs) of automation. Organizational costs, for example, inefficiency while learning new procedures, time lost for training, time spent negotiating with peers about new work processes, can add up to several thousand dollars per employee in the first year if properly noted and accounted for.[50] Where organizational issues like job redesign and workflow restructuring have not been

[50]Paul A. Strassman, "The Real Cost of OA," *Datamation*, Feb. 1, 1985, pp. 82-94.

properly managed, organizational costs can more than offset productivity gains expected from new technology. A number of firms are demonstrably worse off with automation than they were without it, at least in the short run. However, these new tools are becoming increasingly available and increasingly necessary for doing business in the present era. It is possible to learn something from successful implementations to avoid the problems experienced in horror stories.

The success of the introduction of office systems into an existing organization has been found to depend on a number of circumstances that surround the implementation. Although various researchers disagree on the relative strength of their influence, there seems to be some general agreement on their importance and direction.[51] These variables include the *reason for adoption,* the involvement of *key actors,* the use of *adaptive planning* procedures, level of *user participation* in planning and decisionmaking, and *training* and *incentives* for users, and *training.*

Reason for Adoption

In most discussions of successful installations of office systems, there was a clearly identified organizational objective. Organizational goals involving improved outputs have been associated with success more often than organizational goals defined only by cost reduction. Cases where a technological opportunity was seized, without demonstrated organizational need were those where there was least evidence of success.[52]

These findings are in line with admonitions to tie system planning closely to the office's *business function.*[53] Where there is a clear understanding of the output to be produced and the role of automation in improving that output, there is a greater likelihood of selecting and designing a system which achieves that objective.

Although cost reduction can be an important objective, a narrow focus on cost reduction alone may not have the desired results if the organization's goals and the work process leading to the achievement of those goals have not been thoroughly analyzed.

In the case of Company XYZ, an OTA case study site, use of information technology was seen as a competitive weapon, a means of both cutting costs and increasing market share. However, cost cutting was placed in context of the type of work done at XYZ and the corporate philosophy.

> The goal was to replace old, rigid, batch-oriented information systems and manual technology with flexible cutting-edge electronic tools, and concurrently to give users a renewed sense of power, insight and enthusiasm about their tasks, so as to improve organizational performance.[54]

This focus on user needs led to the criterion that any system selected should be manipulable by users and should:

> . . . augment the worker rather than automate the work. Being able to ask good questions, do insightful analyses, take the initiative, and make a decision are emphasized as distinctly human skills that computers can assist but not replace.

While other firms will have different goals and a different philosophy about the role of their workers, analysis of organizational goals and the role of computers in achieving them is still important.

Key Actors

Another important element in successful implementation is the "key actor." This can sometimes be a top management official who

[51] Tora Bikson, Barbara Gutek, and Don A. Mankin, "Implementation of Information Technology in Office Settings: Review of Relevant Literature," Rand Corp., Santa Monica, CA, November 1981.

[52] Ibid.

[53] Michael Hammer and Michael Zisman, "Design and Implementation of Office Information Systems," Laboratory for Computer Science, Massachusetts Institute of Technology, OAM-005, May 1979.

[54] Tora Bikson, Don Manken, and Cathleen Statz, "Individual and Organizational Impacts of Computer-Mediated Work: A Case Study," prepared for Office of Technology Assessment, 1985, p. 21.

clearly supports innovation, but in many cases a "technological entrepreneur" somewhere below the top level of the firm may be the prime motivating force in a successful introduction of new technology. In some studies it has been found that the role of the unit manager is essential in successful implementation.[55]

Support and understanding of top management are also crucial. In the case of XYZ, the CEO was the inspiration behind the move to automation, although actual responsibility was delegated. Having management support guaranteed needed resources and also provided guidance in developing a system that matched corporate philosophy.

On the other hand, lack of top management support seems to have aggravated some of the problems in the Aircraft Instruments Plant case study. For example, insufficient funds and time for training, both of which undercut the success of the implementation, were probably related to lack of senior management understanding of the need. Senior management did not ease production quotas when the new system was first introduced, even though it would be reasonable to expect some decline in productivity as people learned to use the system. Further, ongoing performance measures were not modified to fit the scheduling process inherent in the system. Thus, toward the end of each month managers all scrambled to bypass the system and manually schedule projects with high dollar value but low priority, in order to meet dollar quotas. This is likely to continue as long as management priorities and system priorities are in conflict.

Adaptive Planning

A planning process that is flexible and continuous, both before and during introduction, also seems to be associated with successful implementation. It is inevitable that both the organization and the system will change somewhat in the process of implementation. A plan "set in concrete," which cannot be modified to accommodate changed user needs or new information, can seldom be successful. In some cases, with sufficient flexibility on the part of the planners and the users, even a "drop it in their laps" approach to implementation—one where users have minimal involvement in planning—can work. A generic system can be modified to fit an organization's needs during the early days of operational use. However, users may not be sufficiently flexible, and adaptability may not be the only requisite for success.[56] In general, research in the literature as well as "how to" articles in the computer and management trade press agree that involving users in the planning process is highly desirable.

Users in the Implementation Process

There are at least three areas where users must be taken into account—design and implementation, training, and incentives for users. Before the user can be adequately involved in the process, however, it is necessary to ask "who is the user?"

Although the term "user-driven" is often used in designing office automation equipment, there are several conceptions of who the user is, and it is not always clear which "user" is being addressed or represented. Wynn points out at least three levels of "user."[57] One is the organization or department that intends to develop an automated system. Another is the person or group of people within the organization with the authority to make decisions about the purchase of equipment. This is often the "user" that the vendor is trying hardest to please. The third is the "end user," that is, the person who actually operates a computer or terminal. The needs, opinions, and level of knowledge about office practices of these different types of user are not necessarily identical; they may not even be in harmony in some cases.

[55]Ibid.; and Bikson, Gutek, and Mankin, op. cit.

[56]Ron H. Epstein, "An Approach to Introducing and Evaluating Automated Office Systems," *Electronic Office: Management and Technology* (Pennsauken, NJ: Auerbach Publishers, 1980).

[57]Eleanor H. Wynn, "The User as a Representation Issue," Proceedings of the Hawaii International Conference on System Sciences, 1983.

User Involvement in Design and Implementation

Successful implementations of office automation technology tend to include users of all types in the process. While there may be some difficulties in involving future end users in system selection when they are not yet familiar with computers, there are benefits to be derived from the investment of time and effort necessary to bring them up to speed. No one knows better than the actual end user exactly what he or she does and how it might be done better. User needs may not be well understood by system designers or vendors, or even by managers in the same firm. Attempts to divine needs without asking can too often lead to the use of social stereotypes (clerical workers do not make decisions, managers will not type) instead of fact. Getting the user perspective early in the planning process can save costly retrofitting or other problems later. Methods for involving the users in the design process can include interaction with the entire user community by collecting design data through surveys and polls, or by having user representatives on the design task force or committee.

Finally, involving users in the design process can help to overcome some of the resistance to use of new systems often classified as "fear of computers," "technophobia," or simply "fear of change." While some have assumed that certain types of people "naturally" resist new technology (e.g., older workers, less educated workers, etc.) Wynn notes that:

> The hidden assumption in these notions is that the reason people may not rush to be new users of technology is a) psychological rather than rational in nature; b) the fault of the user not of the equipment. Both of these assumptions, if acted upon, cause development organizations to do nothing at all to solve the problem, to go ahead and design as they see fit and see if people can be forced to use the resulting system, or to go to great lengths to cater to the users' supposed psychological and cognitive incapacity, mostly by trying to "advertise away" the problem.[58]

Several studies have shown that what managers or system designers sometimes perceive as clerical workers' irrational fears of technology are actually very rational concerns. Wynn found in open-ended interviews at several firms that clerical workers were concerned, for example, that they might not be able to learn the system, that the equipment chosen was wrong for the job, that new measures of job performance were wrong for the job, that they might lose their jobs and be unemployed. She concluded that "people can be seen to resist not change itself, but change for the worse."[59]

Managers often do not perceive these specific concerns, but view them as generalized irrational fear. In one survey of Fortune 500 firms, over half (57 percent) of the managers attributed employees' apprehension about new systems to general, unfocused fear, while only 8 percent attributed it to fear of computers and 4 percent to skepticism about management's ability to manage the change. On the other hand, only 20 percent of clerical workers attributed other workers' apprehension to general fears. Most (30 percent) identified concern about computers—presumably fear of being unable to learn to use the new system. About 25 percent cited skepticism about management choices, and 22 percent cited job security as the major worry.[60]

Training

Training employees to use automated equipment is essential to making most effective use of it, and most researchers agree that the importance of training to a successful implementation cannot be overemphasized. As Strassman notes, "Training, training, training: these are the top three priorities to changing work in the automated office."[61] A training plan is a necessary part of the implementation plan when an organization begins using office automation system. In addition, continuing efforts

[58]Eleanor H. Wynn, "Linking User Responses to the Design Chain," AFIPS Office Automation Conference, San Francisco, Apr. 5-7, 1982.

[59]Ibid.

[60]Research and Forecasts, Inc., *The Kelly Report on People in the Electronic Office II: How Office Workers View Automation* (Troy, MI: Kelly Services, Inc., 1983), p. 10.

[61]Paul A. Strassman, *Information Payoff: The Transformation of Work in the Electronic Age* (New York: The Free Press, 1985), p. 81.

are necessary—for training new employees and for upgrading the skills of current ones.

An adequate training program may often constitute one of the major costs involved in introducing automated office equipment. Unfortunately, many firms grossly underestimate the need. In a number of surveys, workers and managers in automated offices have cited lack of adequate training as one of the major problems related to the implementation of office automation equipment.[62] Training is discussed in more detail in chapter 3.

Incentives for Users

The introduction of new technology can cause, or at least be associated with, changes in the way people do their jobs; in the way they interact with other people; and in the amount of power, authority, and self-determination, they have at work. To the extent that people perceive the changes associated with a new system as changes for the worse, "disimplementation" or damaging resistance can result. Many successful implementations have featured incentives to encourage users to accept the new system, acquire new skills, or accept changes in the social or organizational context. While benefits for the firm, such as increased productivity, may be important to some workers, more personally relevant rewards are also important, for example higher wages, opportunity for other training or advancement. However intangibles such as protecting the worker's self-esteem are also extremely important. In this regard, involving workers in the change process can in itself be an incentive.

> [The employee] should see himself as the master of the machine, not its servant; not as a victim of the office design, but as a participant in it . . . When invited as collaborators, many office workers will respond with enthusiasm to office system automation.[63]

[62]See for example, Honeywell Technalysis, *Office Automation and the Workplace,* Honeywell, Inc., November 1984; and Kelly Services, Inc., *The Kelly Report on People in the Electronic Office,* results of surveys performed by Research and Forecasts, Inc., three volumes, 1984.

[63]Hammer and Zisman, op. cit., pp. 34-35.

Chapter 5

Office Automation and the Quality of Worklife

Contents

	Page
Section I: Stess and the Quality of Worklife	126
Sources of Stress	127
Strategies for Alleviating Adverse Stress Responses	136
Section II: Office Automation and Health, Illness and Disease	137
Visual System Outcomes	139
Musculoskeletal System Outcomes	141
Reproductive System Outcomes	144
Stress-Related Outcomes	148
Section III: Interventions	151
Office Design and Workstation Design	151
Public Policy and Quality of Worklife	155
Research Needs	162
Labor-Management Relations and Office Automation	163

Tables

Table No.		Page
5-1.	Working Conditions Likely to Produce Stress Responses in Offices	127
5-2.	Exposures in the Office Other Than the Video Display Terminal	138
5-3.	Epidemiological Criteria for Assessing Causality	139
5-4.	Individual and Work Environment Factors Associated With Visual System Outcomes	140
5-5.	Visual System Outcomes: Known Acute or Potentially Chronic	140
5-6.	Individual and Work Environment Factors Associated With Musculoskeletal Outcomes	141
5-7.	Musculoskeletal System Outcomes: Acute or Potentially Chronic	142
5-8.	Reported Cases of Reproductive System Outcomes in Computer-Mediated Workplaces by Work Site and Job	145
5-9.	U.S. Occupational Exposure Standards	147
5-10.	International Radiation Protection Association Occupational Exposure Limits to Radiofrequency Electromagnetic Fields	147
5-11.	Workers' Compensation Claims for Employees Working at Video Display Terminals	156
5-12.	Examples of Mental Stress—Mental Disability Claims for White-Collar Workers	157
5-13.	Union Membership by Industry and Occupation	166

Figures

Figure No.		Page
5-1.	Characteristics of the Office Setting That Can Contribute to an Individual's Quality of Worklife	126
5-2.	The Proportion of VDTs Installed in New Office Space Compared to Existing Space, 1984-90	151
5-3.	A Comparison of Workers' Compensation Claims for Mental Stress and Other Occupational Diseases	157
5-4.	Employed Wage and Salary Workers Covered by a Union or Employee Association Contract in 1983-84	166

Chapter 5

Office Automation and the Quality of Worklife

This chapter is concerned with the individual in the office and the way in which office automation affects the individual's quality of worklife. A traditional definition of the quality of worklife is "the degree to which members of a work organization are able to satisfy important personal needs through their experiences in the organization."[1] The relationship of the worker to the office environment affects health, well-being, and productivity. Office automation changes the physical and psychosocial dimensions of the workplace and the work process.

Of the many characteristics of the office, no one factor is the sole determinant of quality of worklife, especially not technology; but technology can change the social processes involved in producing an output or the way a person does a set of tasks. This chapter considers stress, office and workstation design, the human-computer interface and the way these relate to an individual's health, well-being, and productivity.

The discussion is two-pronged; one emphasis is on how new office technologies affect the quality of work life; the second is on public policy. It focuses on factors that contribute to organizational effectiveness by improving work quality and quantity, reducing turnover and absenteeism, and ultimately indirect labor costs.[2]

An emerging policy debate concerns the risk of illness and disease in office environments. The evidence for the potential risks associated with new office technologies is inconclusive. **However, heightened public concern and recent workers compensation awards for VDT-related illnesses indicate that a comprehensive and systematic examination of all office environment exposures[3] should be carried out to determine whether new office technologies are indeed increasing a worker's risk for illness or disease.**

A systems approach to examining the applications of office technologies indicates that there are many ways in which office automation is related to the quality of a person's worklife. Figure 5-1 shows the general framework used in the analysis. The core relationships are between the organization, the technology, and the individual. The VDT is part of the human-computer interface. The individual's personality or characteristics can mitigate the effects of office automation. For example, some workers enjoy and are more productive in a highly controlled office environment, while others seek to maximize their own control over the environment.

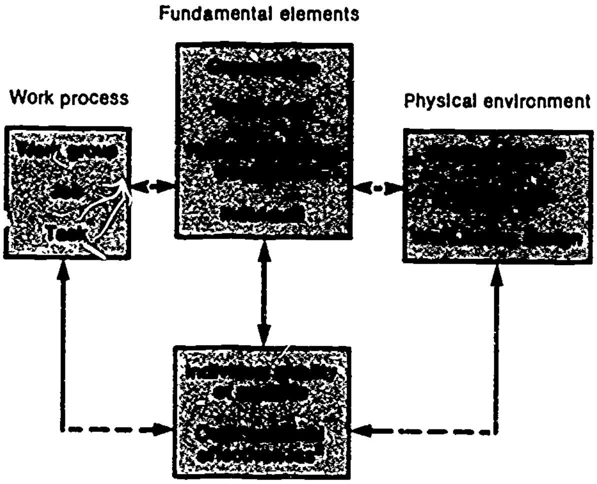
The arrows in the figure do not represent causal relationships, but rather indicate patterns of association. Ultimately, these patterns may be found to be causal, but at present the scientific evidence is not sufficient to determine causality. In some cases, the effect of office automation may be contingent on another factor, for example, the workers' response to some other characteristic of the office.

[1] J. Richard Hackman and J. Lloyd Suttle, *Improving Life at Work. Behavioral Science Approaches to Organizational Change* (Santa Monica, CA. Goodyear Publishing Co., 1977), p. 4.

[2] Supporting arguments for these contentions are found in Franklin D. Becker, *Workspace: Creating Environments in Organizations* (New York: Praeger Publishers, 1981); Thomas G. Cummings and Edmond S. Molloy (eds.), *Improving Productivity and the Quality of Work Life* (New York: Praeger Publishers, 1977), Arthur Rubin, *The Automated Office—An Environment for Productive Work, or an Information Factory?. A Report on the State-of-the-Art* (Washington, DC: U.S. Department of Commerce, National Bureau of Standards, 1983). The observations in these materials are based on studies in both blue-collar and white-collar settings and organizations of many sizes.

[3] The concept of exposure in public health refers to the conditions of the (work) environment that lead to the development of illness or disease. For example, a person who smokes cigarettes exposes his/her body to cigarette smoke. This can lead to the development of lung cancer. In this chapter, exposures to be discussed are the working conditions created by office automation.

Figure 5-1.—Characteristics of the Office Setting That Can Contribute to an Individual's Quality of Worklife



[a]Organizational effectiveness is defined in terms of the work quality and work quantity in the production process or delivery of services, but also as decreased turnover, absenteeism, and increased commitment to the organization

SOURCE Office of Technology Assessment

The subjects discussed in this chapter are:

- stress, and the quality of worklife;
- health, illness, and disease; and
- interventions, including office and workstation design and labor-management relations.

A discussion of labor-management relations ends this chapter because many of the problems cited in chapters 4 and 5 can potentially be solved or alleviated through some form of worker involvement in the decisionmaking process, such as collective bargaining.

SECTION I: STRESS AND THE QUALITY OF WORKLIFE

Stress is a term often used in both conversation and scientific debate to describe troublesome experiences in daily life, ranging from the illness of one's child to an acrimonious session with the boss. Some stress is routine, the daily hassles of work. But, typically, events that precipitate stress responses alter or intensify daily routines and roles of worklife.[4] Characteristics of office automation that lead to changes in the work role can thereby produce stress responses in the worker.[5]

Work-related stress is the psychological or biological response to conditions in the work environment. Stressors are the conditions that cause stress.[6] Stress can be either good or bad, but "good" stress is usually called "challenge." Office automation, by changing the conditions of work, can elicit psychological and biological responses; i.e., produce stress.

Psychological stress responses to working conditions include challenge, boredom, anxiety, mental fatigue, depression, satisfaction or dissatisfaction, and feelings of security or insecurity. Biological responses can include chronic or periodic arousal,[7] muscle fatigue, headaches, and psychosomatic symptoms. This list is not exclusive. Any of these can occur among office workers. Office automation offers the organization a unique opportunity to create working conditions that challenge the individual worker and at the same time decrease the frequency of adverse stress responses.[8]

[4]Leonard I. Pearlin, "Role Strains and Personal Stress," *Psychosocial Stress: Trends in Theory and Research* (New York. Academic Press, 1984).

[5]A worker's role is defined organizationally by the job he/she occupies.

[6]This model of stressor and stress response is a common model used and was originally developed by Hans Seyle and Walter Cannon in the 1920s and 1930s. For a good overview of this model of stress see, Hans Seyle, *The Stress of Life* (New York: McGraw-Hill Publishing Co., 1956).

[7]Chronic arousal refers to neural, hormonal, and immunological responses to external stimuli. In many instances the term neurohormonal arousal is used to refer to these distinct stress responses to indicate the controlling role played by the brain in initiating them.

[8]Traditional stress models emphasize that stress responses follow a U-shaped curve. Too little environmental stimulation leads to underload and stress responses such as boredom. Too

A stress response sometimes comes from anticipation of an event as much as from the event itself. The anticipation of a computer going "down," for example, can produce stress responses. New technologies often lead to new and conflicting expectations.

The term "technostress" has been used to describe consequences of office automation:

> Technostress is a modern disease of adaptation caused by an inability to cope with new computer technologies in a healthy manner. It manifests itself in two distinct but related ways: in the struggle to accept computer technology, and in the more specialized form of overidentification with the computer.[9]

The stress response is not technologically determined, although the word "technostress" conveys that impression. Many conditions that produce a stress response in the automated office are not the result of the new technology, and solutions to the problems can not often be achieved through modifications in the technology. The consequences are contingent on how an organization implements new office technologies. Most office workers look forward to working on computer systems that automate manual tasks they would rather not do.[10]

Table 5-1 shows a list of conditions that produce stress. These stressors are not unique to office work; they are also found, for example, in factory work. In fact, some people talk about the office becoming the factory of the future.

Table 5-1.—Working Conditions Likely to Produce Stress Responses in Offices

Working conditions in all offices:
- Increased workload coupled with: a) limited job control, b) expanded job control
- Repetitive task(s) in the job
- Machine pacing of work
- Lack of time for training to acquire new skills
- Competing roles at work
- Lack of career opportunities in the organization

Working conditions in automated offices:
- Electronic monitoring as a form of supervision and employee monitoring
- Electronic monitoring as a form of task feedback
- Higher expectations for speed of work coupled with computer system response delays
- Office work dependence on computer system and system delays
- The computer mediation of work and/or the problems with the human-computer dialog
- Social isolation with the primary interaction the computer
- Increased social contact and social participation via computer networks

SOURCE Office of Technology Assessment.

These conditions have always been felt in offices; new technologies can intensify them. They can also ameliorate them. Typically, the adverse conditions occur together and especially affect lower level jobs. Most have been associated with low job satisfaction or with illness. Each can be alleviated with work redesign strategies, contributing to better employee health and attitudes toward work.

Table 5-1 also shows a list of office conditions characteristic of office automation that produce stress that may permeate all levels of the organization.

Sources of Stress

Factors that bring about stress include increased workload, decreased control over work, repetitive work, machine pacing, inadequate training, ambiguity in role, consciousness of limited career opportunities, computer monitoring of work, unattainable expectations for speed, the abstraction inherent in computer-mediated work, and increased social isolation.

Workload and Control

Office automation can increase the number of tasks a person has to complete; increase the

much stimulation leads to overload and responses such as muscle fatigue. Somewhere in between is the ideal amount of environmental stimulation that leads to a challenging response. There is no standard data for determining normal responses, since no consensus exists on how either the environmental stimuli or the stress response is to be measured.

[9]Craig Brod, *Technostress: The Human Costs of the Computer Revolution* (Reading, MA. Addison-Wesley Publishing, 1984).

[10]The distinction must be made between satisfaction with the job and satisfaction with the technology. Many workers see the new technology as providing them with new skills and opportunities. It can also confer higher status. Others will argue that there is a "honeymoon effect" and, after a short-time period the worker becomes dissatisfied. However, this may be due more to characteristics of the job than the technology. Tora K. Bikson and B.A. Gutek, *Advanced Office Systems: An Empirical Look at Utilization and Satisfaction*, N-1970-NSF-Rand (Santa Monica, CA: Rand Corp., 1983).

complexity of the tasks; speed up the pace; or increase the amount of information needed to complete a task.[11] Even the change to an on-line system from a batch processing system can increase workload.[12]

These increases may or may not be transient. The ability to modify work strategies is a component of the worker's control over the job.[13] If the worker has the ability to modify his/her work strategies, the adverse stress responses can be buffered and transient. When the worker has little control, the adverse stress responses tend to persist. Workload and job control in conjunction affect attitudes about the job, the organization, and the worker's health.

Computer-based communication networks have been shown to lead to increased workload by making the transmittal of documents easier and thus more frequent. This leads to the professional having to sift through many memos to find the relevant one; the case of information overload. This also may be a transient effect that will disappear as the organization learns to utilize the system effectively.

A primary motive for office automation is increased productivity, but many stress responses lead instead to increased absenteeism and turnover (especially under good economic conditions when jobs are plentiful). These responses have also been associated with decreases in performance and even with some instances of sabotage.[14] To alleviate these problems, attempts are typically made to exert greater organizational control over what the worker does. This can be achieved more easily through office automation. Greater organizational control tends to increase the problems of repetitive or machine paced jobs, offering workers even less control and resulting in a vicious circle. The productivity of the worker is stabilized below optimal performance level.

Two patterns appear to be developing. The key difference is the level of control. When control is decreased, either through embedding decisions in the system, electronic monitoring, social isolation, or change in the job (e.g., the development of a single repetitive task), the interaction between increased workload and decreased control leads to adverse stress responses. Alternatively, when the increase in workload is associated with better opportunities to arrange the work, this can produce positive stress responses, or challenge, for employees.

Repetitive Tasks

Office automation can result in repetitive tasks, which lead to increased anxiety, boredom, and dissatisfaction with work. The introduction of a word processor or microcomputer can, however, also reduce the repetitiveness of tasks—for example, the secretary makes a few corrections rather than retyping a page.

Taking breaks from the monotonous repetition provides psychological relief, but sometimes a need for breaks is overridden by the pressure of work.[15]

Machine Pacing

When control over when to do a task is determined by the computer system, tasks are said to be machine paced.[16] When data entry or other tasks are machine paced, the office begins to mimic the factory assembly line. Machine pacing both increases the workload and decreases control. It can lead to anxiety, de-

[11] Workload is the level of demands the job places on the worker. Technological change can lead to decreases in the amount of time spent at a particular task. However, many studies have documented that workload more often increases with office automation: Jon Turner, *Computers in Bank Clerical Functions: Implications for Productivity and the Quality of Life*, Ph.D. dissertation, Columbia University, 1980; Michael J. Smith, et al., "An Investigation of Health Complaints and Job Stress in Video Display Operations," *Human Factors*, vol. 23, No. 4, 1981, pp. 387-400; Rob Kling, *The Impacts of Computing on the Work of Managers, Data Analysts, and Clerks*, Working Paper, Public Policy Research Organization, University of California, Irvine, 1978.

[12] Jon A. Turner, *Computer Mediated Work: The Interplay Between Technology and Structured Jobs—Claims Representatives in the Social Security Administration*, Working Paper, Department of Computer Applications and Information Systems, New York University, 1985.

[13] Control is the ability of the employee to arrange work in terms of speed, task priority, and ways of performing the task.

[14] Brod, op. cit.; see also Gavriel Salvendy and M.J. Smith (eds.), *Machine Pacing and Occupational Stress* (London: Taylor & Francis, Ltd., 1981).

[15] Brod, op. cit., p. 43.

[16] A task is said to be machine paced when the worker has no control over the initiation of the work cycle or the duration of the work cycle. Typically, machine pacing is associated with short-cycle repetitive tasks.

pression, boredom, dissatisfaction, frequent health complaints and, decreased productivity with increases in error rates.[17] It also can allow higher pay because of an increased rate of production.

Training

The employee is sometimes expected to learn how to use new equipment with very little time allocated for training. Management expectations about productivity gains rise quickly, so the worker is faced with simultaneously maintaining the prior level of productivity, acquiring and mastering the new skills, and demonstrating productivity increases. He/she can be caught in a circle of expectations and increased workload demands, and may never learn to use the system effectively. Without the time to develop skills, the worker has limited opportunities for moves up the career ladder. The daily frustration over lack of time to learn may lead to psychosomatic complaints, as well as anxiety, depression, and dissatisfaction.

Competing Roles

Formal recognition of the responsibilities of managers, technicians, professionals, and clerical staff serves to differentiate their work roles, also recognizing interdependencies among members of the office group.[18] Role ambiguity results from the rebundling of tasks through office automation. The professional can do word processing and the secretary can do statistical analysis. Who does what is a key management decision. Without role differentiation it is unclear who is responsible for particular problems.

Conflicting roles can develop when employees are expected to perform tasks that are not part of their job description or are not recognized or given social, monetary, or organizational rewards. With computer-based messaging systems, managers and professionals have to answer the phone, a task that the secretary may have done in the past.[19] One major source of role conflict for women is conflict between home and work roles.

Either ambiguous or conflicting work roles lead to uncertainty in responsibility and performance and to anxiety, dissatisfaction, and insecurity.

Lack of Career Opportunities

Lack of career opportunities can create feelings of job insecurity and belief that one will be replaced by the computer. These feelings are exacerbated by the impression of limited job mobility. Traditionally a worker came into an organization, learned skills, and moved up the job ladder. Today companies more often hire people from outside with the skills needed. As career opportunities become less apparent the employee can become frustrated.

Electronic Monitoring

Electronic monitoring can take two forms—supervision and feedback. This can be illustrated by the example of an information system that stores data on keystrokes and errors. One form of supervision has the computer system examine the worker's performance and send the supervisor a message about her performance compared with prior records and organizational standards. The worker has no responsibility for when the monitoring occurs or how the information is used.[20] Another form, job feedback, lets the employee use the infor-

[17] Salvendy and Smith, op. cit. See also: E. N. Corlett and J Richardson (eds.), *Stress, Work Design, and Productivity* (New York: John Wiley & Sons, 1981), and Robert Caplan, et al, *Job Demands and Workers Health*, USDHEW (NIOSH) 75-160 (Washington, DC. U.S. Government Printing Office, 1975).

[18] B.G.F Cohen, "Organizational Factors Affecting Stress in the Clerical Worker," *Human Aspects in Office Automation*, B G F Cohen (ed) (Amsterdam. Elsevier Science Publishers, 1984), pp. 33-42.

[19] B.C. Amick and J. Damron, "Considerations in Defining Office Automation: A Case Study of the Eastern Africa Region of the World Bank," *Proceedings of the First USA-Japan Conference on Human-Computer Interaction, Honolulu, Hawaii*, Gavriel Salvendy (ed.) (Amsterdam: Elsevier Science Publishers, 1984), pp. 439-445.

[20] This example also points out the problem of separating these factors from other stress factors. In this situation, the worker is not only being monitored but also may be machine paced and has no control over the task or the job.

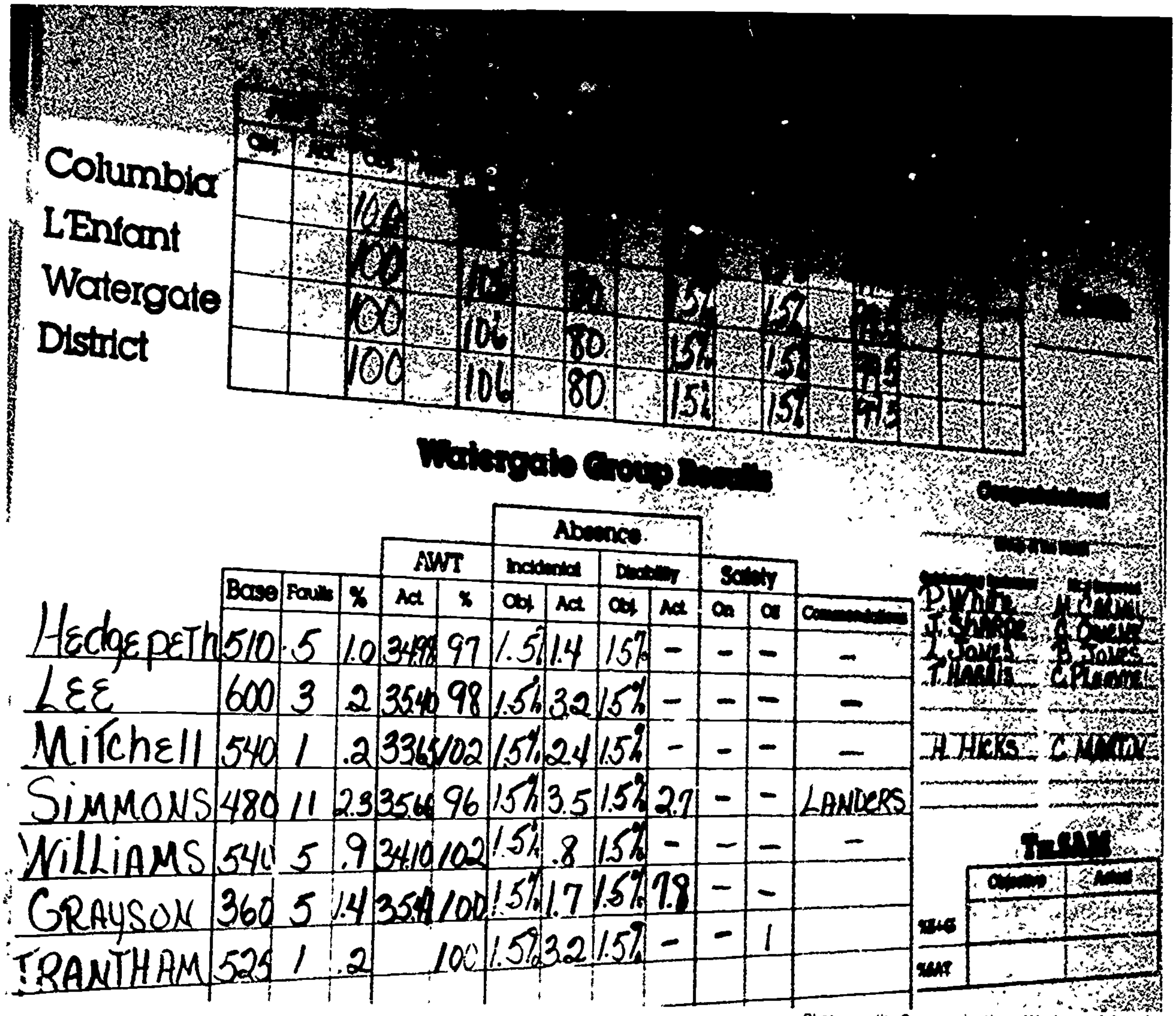


Photo credit Communications Workers of America

In the communications industry, workers can be continuously monitored These charts show the monitoring of employees by the Average Work Time System Every call is timed and the total volume of calls handled per day by all workers is then used to calculate an average number of calls for a given period of time An AWT figure of 100 means that the operator's performance was average

mation to find out, for example, how many files were completed in a given period of time, and modify her performance accordingly. The first often produces adverse stress response and the latter positive challenge.

With electronic monitoring for supervision, maximum consistency and reliability in performance are sought. One distinction between traditional work monitoring and electronic monitoring is that the former is intermittent and the latter continual. Continual monitoring places added pressure on the employee to produce at the pace and level established by the machine. This leads to increased anxiety, fatigue, psychosomatic complaints, and job dissatisfaction.[21] The employee, knowing he/she will be expected to perform at a specified

[21]Because the terminal provides the worker with all the necessary information to complete any task, there is no need for the employee to leave the workstation This constrained posture for extended periods of time is a key element in visual and musculoskeletal problems

level throughout the day, feels chronic arousal and job dissatisfaction.[22]

Electronic monitoring can also offer challenge and job satisfaction, if it is designed and used as a form of task feedback. Traditionally feedback on performance and product quality is usually notice that an error has been made. Or it is received infrequently (in quarterly or even yearly evaluations by the supervisor), and the worker begins to believe that quality is not a major concern. Quality checks through an on-line work monitoring system can improve the reliability of performance, and increase the responsibility for the product; this can lead to greater job satisfaction and greater commitment of the worker to the organization.[23]

Typically, electronic monitoring has been carried out among support staff and supervisory staff, but as microcomputers and minicomputers are linked with larger mainframe systems, any person can be monitored. One example of productivity monitoring of professionals is from a loan administrator using a Management Information System (MIS):

> Each employee is watched by the system, . . . To be tracked on the system is to be monitored by it on a daily basis with regard to every conceivable item of work which could be performed on the job. The MIS does perform some essential functions in helping to manage the enormous work load, but often it was looked upon as an excuse for increasing the work load even more. Preparing the daily MIS input sheets at the end of the day is a dreaded duty, done hurriedly before leaving the office. The MIS theoretically tracks everything which the loan administrator performs during the course of the day. The entire job of the loan administrator is dissected into every minute function which might be performed. Each function is assigned a certain time standard for how long it should take to be performed. The system calculates each worker's daily productivity as a percentage figure based on what the employee reported as having done that day.[24]

If a professional, manager, or secretary is making entries into a calendar, then the person's schedule can be examined through access to the files. In one large American company, the Chief Executive Officer plans to use the computer system for just this purpose.[25] Employees in the networked system can also get more immediate feedback about a project to which they have contributed. This provides them with a broader picture of what the organization is doing, and so leads to increased satisfaction and commitment.

Higher Expectations of Speed

A subtle effect of office automation is the generation of higher expectations of speed. This can lead to a distorted sense of time and distorted expectations about behavior. One characteristic of the computer system is the ability to respond quickly to commands. The manager and the clerical worker alike can develop a new time reference.

> Days, hours, and minutes take on new meaning as time is compressed and accelerated. . . . Jobs that took days before computerization are expected to be done in hours. . . . Software that was once appreciated for its speed, such as VisiCalc®, is suddenly viewed as clumsy and slow.[26]

The worker begins to notice response delays in the microcomputer or larger computer system. As he/she becomes more proficient, he/she develops a high expectation of speedy responses from the computer at known intervals. When delays occur, the pattern of work is interrupted as the worker is forced to "waste time" waiting for the system to respond. This leads to anxiety and dissatisfaction. When the delays persist above a certain time there is an increase in the error rate for keystrokes.

[22]For an example of how prior knowledge of an event can produce a stress response see the work of Marianne Frankenhauser, "Coping With Stress at Work," *International Journal of Health Services*, vol. 11, No. 4, 1981, pp. 491-510.

[23]Richard E. Walton, "From Control to Commitment in the Workplace," *Harvard Business Review*, vol. 35, No. 2, 1985, pp. 76-84.

[24]Alan Westin, *Privacy Issues in the Monitoring of Employee Work on VDT's in the Office Environment*, contractor report prepared for the Office of Technology Assessment, 1985.

[25]Mark Potts, "GE's Welch Powering Firm Into Global Competitor, Part I," *The Washington Post*, Sept. 23, 1984.

[26]Brod, op. cit.

This new time reference results in higher expectations of oneself and others. A worker may seek to discover ways of circumventing organizational procedures to get work completed more quickly. Going through channels or doing excessive paperwork becomes a barrier. This also can lead to increased anxiety and tension and feelings of work pressure, or to a desire for social isolation because one would rather work with the computer than with a person—only the terminal can respond quickly enough. This tension requires some form of stress management.

Like the individual, the office can become dependent on the computer system and vulnerable to system delays. This is perhaps largely a transient problem associated with the implementation of a new system, although changes in both software and hardware will continue, and the work process will become more and more dependent on the computer. When the system breaks down the worker looses control over the work and it piles up. Messages cannot be sent to coworkers in other buildings, memos cannot be printed or distributed. A sense of anticipation develops in the worker—when will the system be back up and running? One study in a Swedish insurance company found that when the computer system went down workers responded with increased arousal, higher blood pressure, fatigue, and feelings of being rushed (work pressure).[27]

Computer Mediation of Work

The computer mediation of work is likely to produce stress responses that vary from boredom and job dissatisfaction to challenge and increased productivity. Three characteristics of computer-mediated work that are likely to produce stress responses are: 1) human judgments being built into the system, 2) the abstraction of work, and 3) the human-computer dialog.

Judgment is fundamental to work, yet a principal goal of automated work can be to reduce judgment and therefore error. Alternatively, automation can be used to create more opportunities for exercising human judgment. The key to the former approach is the substitution of computer algorithms or decision rules for judgment. This necessitates a formalization of skills traditionally obtained through experience. Problems arise when the worker is not provided with new opportunities to exercise judgment.

For example, automated systems may assign priorities to tasks or refer accounts to employees as they complete previous assignments, decisions previously made by supervisors. This is usually done when automating tasks that in any case are very standardized.

The computer mediation of work extends to professionals and management. Attempts have been made to define decisionmaking so that a level of reliability and predictability in judgments can be maintained. The shifting of partial control from the individual to the computer system also is a defense against data contamination that could result from unlimited access to an on-line system.[28] Risk-taking behavior and creativity, especially of professionals and managers, can be constrained when decisions are embedded in the computer system. The meaning and challenge of work disappears and boredom and job dissatisfaction ensue. A constant state of chronic arousal places a biological burden on the worker. The airline pilot or the nurse who monitors a control panel instead of the plane or the patient, can become bored and dissatisfied, feeling that their training is useless if the computer is going to make the decision.[29] Although uncertainty may lead to errors, freedom of choice leads to creative and inspired decisions, which

[27]Gunn Johansson, "Computer Technology: Stress and Health Relevant Transformations of Psychosocial Work Environments," *Proceedings of the First USA-Japan Conference on Human-Computer Interaction, Honolulu, Hawaii*, Gavriel Salvendy (ed.) (Amsterdam. Elsevier Science Publishers, 1984), pp. 347-354. In this study, VDT operators performed data-entry tasks and were compared to non-VDT operators performing similar tasks.

[28]Shoshanah Zuboff, "New Worlds of Computer-Mediated Work," *Harvard Business Review*, vol. 60, 1982, pp. 142-152, (hereafter referred to as "New Worlds," 1982).

[29]Shoshanah Zuboff, "Problems of Symbolic Toil: How People Fare With Computer-Mediated Work," *Dissent*, winter 1982, pp. 51-61 (hereafter referred to as "Symbolic Toil," 1982).

sometimes go against the grain of organizational logic, and it is this logic that is typically programmed into the computer.[30]

Nowhere is the use of computers to approximate human judgments potentially so dramatic as in the area of expert systems.[31] The goal of developing an expert system is to place in the computer the knowledge and decisionmaking processes of the best workers at a particular job. This can enhance a job by providing large amounts of information in a manageable form, allowing a person to ask questions that were difficult to ask before. Expert systems can evaluate decisions and suggest alternative solutions to problems. The system can serve as a learning tool for new workers, who by asking questions and giving answers can simulate experience that may otherwise have taken years to encounter.

Expert systems for use in offices are still in an early phase, but one area already impacted is insurance underwriting.[32] (See box A for an example of the human-computer dialog.)[33] A dilemma the organization faces is that the expert underwriter is expert because of knowledge gained through field experience, and the dynamic nature of the insurance market will demand continual adjustments in the expert system to reflect current patterns. Therefore, the industry will be required to maintain and encourage the traditional pathways for the development of expertise. The extent to which the transfer of human judgment to a computer system produces a stress response in the worker is contingent on how the new job is defined and how the worker uses the system—as a tool to assist in decisionmaking or as the decisionmaker.

In office automation, a key movement is from physical to mental activities; or the abstraction of work.[34] Instead of manipulating physical objects, creating, storing, and distributing forms and documents, in automated offices, one moves symbols with the push of a button. Messages appear on the screen instead of on paper. For the person who is accustomed to being able to see and take part in the process of manipulation, this change can lead to a sense of removal from the work process.[35] As the worker becomes accustomed to the new form of work, this sense of abstraction can diminish.

One characteristic of the abstraction of work may not be as transient; it appears to demand more mental effort, but may not necessarily lead to a more challenging job. The worker may have to give undivided attention to the screen

[30] Historically, researchers have argued about whether the bureaucratic structure of the organization constrains human behavior by increasing centralized control and explicitly defining the rules by which the tasks should be performed and the job evaluated. These trends can reduce the effectiveness of the organization as well as the employee. The implementation of office automation can allow many of the rules to be embedded in the system. For discussions of this idea see, Max Weber, *The Theory of Social and Economic Organization*, translated by A.M. Anderson and Talcott Parsons (New York: The Free Press, 1947); Richard H. Hall, "The Concept of Bureaucracy: An Empirical Assessment," *American Journal of Sociology*, vol. 69, No. 1, 1963, pp. 32-40. For a discussion of the impact of office automation on the bureaucracy see Michel Crozier, "Implications for the Organization," *New Office Technology: Human and Organizational Aspects*, H.J. Otway and M. Peltu (eds.) (Great Britain: Ablex Publishing, 1983), pp. 86-101.

[31] "An expert system consists of a set of 'if-then' rules that express the knowledge and experience of an expert, and the actions one would take when faced with a set of conditions in the domain of [his/her] expertise. It also generally has a separate knowledge base that states facts about the domain, to which the program can refer to make inferences and deductions about situations and conditions." For a full description of expert systems and their development see, *Information Technology R&D: Critical Trends and Issues*, U.S. Congress, Office of Technology Assessment, OTA-CIT-268 (Washington, DC: U.S. Government Printing Office, 1985).

[32] Sherrie Shamoon, "AIG'S Smart Software: The 'Expert' That Thinks Like an Underwriter," *Management Technology*, February 1985, pp. 54 59. Much of the information used in this paragraph was based on interviews with Dennis White, Syntelligence, Inc., Sunnyvale, CA, and, Bob Pulka of American International Groups, Inc., New York, NY.

[33] The goal in underwriting is to decide whether a particular case should be insured and the costs of doing it. There may be over 100 factors to be considered. An expert can cull out the handful of variables that will be of importance in this decision and, based on the set of facts in a particular case, make a decision. In theory, the expert system makes this expertise available to any underwriter, providing him/her with another tool in the decisionmaking process.

[34] Zuboff, "Symbolic Toil," 1982.

[35] One interesting consequence of the abstraction of work may be an increase in the amount of paper used to store information at all stages of the production process. Even in a task like typing that is very similar when done on the screen and on the typewriter, the lack of any physical feedback about what has been done in word processing can lead to the printing of many more versions of a document. These physical objects allow the individual to have a sense of accomplishment not otherwise conveyed by seeing that 30,789 bytes of storage are remaining.

Box A.—Expert System Used in Insurance Underwriting

[illegible]

SOURCE: Based on an interview with Steve Weyl of Syntelligence, Inc., Santa Monica, CA, [illegible]

to perform the same task over and over within the rules defined by the computer system. In the extreme case, the worker monitors information as it comes to the screen, but all judgments are made in the system or by some other person at another location. For workers whose job involved interaction with people, this change can mean a loss of the sense of the meaning of the work.

Computer-mediated work is characterized by a human-computer dialog. The quality of the dialog is important to the quality of working life. The user gets from the software information about the current state of the system, the work, how to proceed or return to an earlier part of the process, the future stages of the production process, and the consequences of further command sequences. If the software does not provide the needed information, there is decreased control over the work, bringing anxiety, and job dissatisfaction.[36] The worker may use the system less and less, or not attempt to fully use the system capabilities; a circle develops leading to further anxiety and less productive use of the new office technologies. A satisfactory human-computer dialog can counter the sense of abstraction, giving the operator a greater sense of control. Thus, transitory problems with office automation may be alleviated with appropriate attention to the human-computer dialog.

When the dialog uses concepts and phrases that match the operator's task vocabulary,[37] this encourages the use of the system and increases the likelihood of greater productivity.

[36] Jon Turner and Robert A. Karasek, "Software Ergonomics Effects of Computer Application Design Parameters on Operator Tasks Performance and Health," *Ergonomics*, vol. 27, No 6, 1984, pp 663-690.

[37] Turner and Karasek, op. cit.

However, as users become more advanced they begin to prefer more formal dialog.[38] Menu driven systems guide the novice user; as the user becomes more knowledgeable, this may become tedious; the user feels held back by the system. This can also produce anxiety, boredom, and job dissatisfaction. More "transitionality" in the way that people and computers interact or interface will alleviate this source of stress. [39] In a dialog based on transitionality, the user can designate changes in the human-computer dialog as he/she becomes more proficient.

Social Participation or Isolation

The office is a social environment, and as the technology changes, the social relationships of work may also change. This is important because the social group can be a buffer between the worker and other characteristics of the work environment.[40] Communication and social participation in the work process is central to the productivity of the work unit and the maintenance of the organizational culture.

This social network can be particularly important in a dynamic work environment. At times of heavy workload, when peak worker performance is required, the resulting adverse stress responses affect the employees' capability to perform. A social environment capable of ameliorating these conditions for the worker is often not considered in evaluating the affects of office automation on the quality of working life. Yet, new office technologies can either create more opportunities for communication and supportive interaction or close off channels.

There is a tendency for workers to spend more and more of the day interacting with a computer terminal. In Japan, researchers have recognized this potential:

> There will be more need for lounges and discussion rooms and the like, to break the routine of stress from the machines. As tasks become more mechanical and isolating, more group activities and worker clubs and incentive systems need to be developed to keep up team spirit and morale.[41]

The worker may spend so much time at the terminal because he/she is electronically monitored and paced or because there is no need or opportunity to interact with others, resulting in social isolation, which has been shown to be associated with depression, anxiety, job dissatisfaction, muscular fatigue, and psychosomatic symptoms.[42]

When the computer becomes the primary source of interaction in the office, coordination of the work process is transferred from the social to the technological milieu. A technological form of communication develops and both work and communication tend to become more formalized. Whether this will adversely impact the quality of worklife is unknown at the present. One of the primary reasons for social interaction is to communicate value judgments via both verbal and nonverbal means. The content of the communication may be important although not directly pertinent to the work process. For example, the employee may be performing poorly because of circumstances at home, or an illness; when evaluation is based primarily on computer monitoring, supervisors may not recognize these circumstances.[43]

Alternatively, increased social contact can be provided via the computer system or via user groups, because computer-based communication can remove both time and distance

[38] Ben Schneiderman, *Software Psychology* (Cambridge: Winthrop Publishers, 1982).

[39] Albert Badre, "Designing Transitionality Into the User-Computer Interface," *Human-Computer Interaction: Proceedings of the First USA-Japan Conference on Human-Computer Interaction, Honolulu, Hawaii*, Gavriel Salvendy (ed.) (Amsterdam: Elsevier Science Publishers, 1984), pp. 27-34.

[40] Benjamin Amick and David Celentano, "Human Factors Epidemiology. An Integrated Approach to the Study of Health Issues in Office Work," *Human Aspects in Office Automation*, B G F Cohen (ed) (Amsterdam. Elsevier Science Publishers, 1984), pp. 153-166.

[41] Japan Information Processing Development Association, *Research Survey Concerning the Social Effects of Office Automation*, translation by Michael McCaskey, 1984.

[42] James House, *Work Stress and Social Support* (Reading, MA: Addison-Wesley Publishing, 1981).

[43] Workers at a Volvo automobile plant pleaded with management to replace computerized quality control with a human supervisor with whom they could discuss their evaluations and ratings. Brod, op. cit., p. 45.

constraints on communication.[44] This can lead to greater employee involvement and commitment to an organization along with increased job satisfaction.

Strategies for Alleviating Adverse Stress Responses

The strategies for alleviating adverse stress responses simultaneously encourage challenge, or positive stress responses. Three different approaches concentrate on different parts of the model that was shown in figure 5-1 and have different goals. Stress management programs focus on the individual, job redesign programs focus on the job, and sociotechnical programs focus on the work process. No single approach is always adequate. A participatory style of management in the implementation of new office technologies will help to identify the methods appropriate for a successful implementation.

Stress Management

Stress Management refers to stress reduction programs tailored to the needs of the individual,[45] providing training to deal with conditions either at work or home.[46] These programs can include meditation, progressive muscle relaxation and biofeedback, and cognitive/behavioral skills. The advantages of these approaches are that they do not require any changes in the work process, organization, or the physical environment. They assume no fault for the stress responses on the part of either management or the worker, but place on the worker the responsibility of coping with adverse stress responses.

Data have not shown conclusively that these programs are cost effective. Their disadvantage is that working conditions are not modified to remove the source of the adverse stress response. In fact, research has shown that to realize the benefits of stress management typically requires extensive and costly training of the worker, not the typical market offering of a two-day seminar. There is no credentialing of the trainers and there are vast differences in the quality of the training. Therefore, although stress management programs are popular, the employer is often faced with having to make a decision about them without sufficient information about the quality of the training and the likely results.

Job Redesign

Job redesign or task redesign are both ways to modify the working conditions to change stress responses. Office automation presents an opportunity to develop job or task redesign strategies. The central thesis of job design is that through changes in characteristics of a job such as feedback, autonomy, task identity, and skill variety, the internal motivation and thus the performance of a worker is enhanced.

Task redesign focuses specifically on task(s) rather than on a job. The scientific management philosophy is a method of task redesign, which in office automation primarily involves changes at the human-computer interface and the allocation of tasks between the worker and the computer system.

Unlike stress management, job redesign changes the conditions of work. When jobs are designed with little meaning and little responsibility, and the worker has no information about how well he/she is performing, there can be motivational problems.[47] For example, the overrationalization of clerical work results in repetitive jobs, lacking responsibility and offering little scope for personal development.[48]

[44] In one Swedish study, it was found that 50 percent of the system messages would not have taken place without the system Cited in Alexia Martin, *Office Automation. Catalyst for Change—Managing the Transition to the Automated Office*, SRI Research Report No. 694 (Stanford, CA: SRI International, 1984).

[45] Lawrence R. Murphy, "A Comparison of Worksite Relaxation Methods," *Human Aspects in Office Automation*, B.G.F. Cohen (ed.) (Amsterdam: Elsevier Science Publishers, 1984). pp. 257-265.

[46] Recently, new software has entered the market that assists the worker in managing stress. One such program is Relax®, which uses biofeedback techniques along with muscle relaxation methods for managing stress. See Joseph Hager, "The Stress Manager," *PCjr World*, September 1984, pp. 228-232.

[47] Richard J. Hackman and Greg Oldham, *Work Redesign* (Reading, MA: Addison-Wesley Publishing, 1981).

[48] These types of jobs may lead to high labor turnover, absenteeism, and recruitment problems. This leads to inefficiencies through lost time, recruiting and training, and costs asso-

(continued)

Many job redesign programs seek to expand these jobs.[49]

Job redesign, unlike stress management, requires that management recognize a problem, and change working conditions. This could involve relatively high initial costs. Another disadvantage is that job redesign efforts tend to focus on a single class of jobs rather than on the work process; and on internal motivators such as self-esteem rather than external motivators such as career ladders and pay.[50] There may be few opportunities for successful job redesign if an organization has only a limited set of tasks to be done.

Sociotechnical Systems

Sociotechnical systems developed as a counter strategy to the traditionally structured organization. Instead of each worker doing a single task or set of tasks with no clear connection to an end product, workers collaborate to produce a product. Many offices already have small working groups such as the secretary and the manager. However, office automation sometimes changes this, and may dissolve familiar interdependencies.

In sociotechnical work systems, members can share decisionmaking about who is to do what tasks and how they will be executed, with each person capable of doing a variety of tasks. The pay/reward system can be tied to the skills in order to encourage skills acquisition and career development. There are very few examples of such semiautonomous work groups in white-collar organizations; and those few typically involve lower level staff.[51]

The advantage of this approach to stress reduction is that it requires changes not just in the job but in the work process. The principle disadvantage is that changes required at the organizational level and training of workers in group processes such as decisionmaking may be costly. But in addition to reduction of stress there may be additional benefits such as changes in pay structure to reflect the new skills demanded by computer-mediated work, with the incentive to continue learning, increased sense of job security, and reconfigured job ladders. Continuous electronic monitoring may no longer be needed if the group makes its own decisions about the speed and pace of work, monitoring each other.[52]

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ciated with overmanning to deal with absenteeism. For an example of how to measure the impact of behavior on organizations see, Wayne F. Cascio, *Costing Human Resources: The Financial Impact of Behavior in Organizations* (Boston, MA. Kent Publishing Co., 1982).

[49]For an example of a job redesign program in white-collar work see, Rodger W. Griffeth, "Moderation of the Effects of Job Enrichment by Participation: A Longitudinal Field Experiment," *Organizational Behavior and Human Decision Process*, vol. 35, 1985, pp. 73-93. In this experiment, desk receptionist jobs were increased in terms of task identity, skill variety, autonomy, and job feedback, resulting in increased job satisfaction and self esteem.

[50]In reviews of job-redesign experiments conducted over the past 20 years, it has been found that a key predictor of maintaining the changes in productivity, quality of work, absenteeism, and turnover was an organizational recognition of the new tasks and skills a person was using in his/her work. Basically, the workers wanted changes in the reward system to reflect the new job If these changes did not develop, then many of the problems the job redesign strategy was intended to resolve returned John E Kelly, *Scientific Management, Job Redesign and Work Performance* (New York: Academic Press, 1982).

[51]Recently, there has been a growth in the use of sociotechnical system programs in all levels of the organization. For examples, see Calvin Pava, *Managing New Office Technology: An Organizational Strategy* (New York. Free Press, 1983).

[52]There also can be problems with autonomous groups such as exclusivity and excessive pressure to conform.

SECTION II: OFFICE AUTOMATION AND HEALTH, ILLNESS AND DISEASE

The video display terminal (VDT) is the device most often discussed in relating illness and disease patterns to office automation. It has become a symbol or a scapegoat. But as was depicted in figure 5-1, the VDT is only one part of the work environment. Much of this section will focus on the VDT, since most of the research has done so; but the VDT must be considered in the context of workstation design, office design, and the task and job.[53]

Occupational health research has traditionally focused on blue-collar work; office work has been considered the least hazardous of occupations. The growth of the white-collar labor force and the ubiquitous applications of the new office technologies demand that this assumption be reexamined. By the year 2000, it is estimated that most white-collar workers will use a terminal. **Therefore, office automation requires the attention of public health officials because of the magnitude of the work force at potential risk for any potential illness and disease outcomes.**[54]

The list of potential exposures in the office is large and diverse. Table 5-2 showed the list of exposures for workers in all workplaces, many difficult to measure because they occur at low levels.[55] New office technologies must be considered in conjunction with these exposures to understand their full impact. A major problem is the lack of long-term statistics on the illness and disease of office workers. The most comprehensive and thoroughly analyzed national statistics are 25 years old, from the 1960 Health Examination Survey.[56] An examination of the medical literature indicates that little valid data exists even on absenteeism and sick leave rates beyond specific industry studies. This makes it impossible to compare historical trends of the morbidity and mortality of office workers with present rates.[57]

Table 5-2.—Exposures In the Office Other Than the Video Display Terminal

Indoor air pollutants:
- Micro-organisms
- Cigarette smoke
- Dust and particulates

Chemical emissions from machines:
- Ozone from photocopiers
- Methyl alcohol from mimeographs
- Ammonia from blueprint machines

Chemicals in paper/office supplies:
- Formaldehyde from carbonless copy paper

Noise from office machines, ventilation systems, and conversation

Static electricity

Low humidity

Inappropriate lighting design:
- Excess lighting
- Insufficient lighting
- Glare

Overcrowding and lack of privacy

Poor ventilation

Awkward and static work postures

NOTE This list does not include any factors related to either the task, job, or organization which may be associated with stress responses These are discussed in another section.

SOURCE: Jeanne M. Stellman, "Office Automation: A Public Health Perspective on the Potential Acute and Chronic Effects," paper presented at the Office of Technology Assessment Symposium on the Impacts of Office Automation and Computer-Mediated Work on the Quality of Worklife, Dec 10-12, 1984.

Photo credit: Michael Smith

The VDT is sometimes placed alongside other technologies (such as the microfiche reader). Some of the symptoms workers report can be traced to the different lighting requirements of different technologies in the workplace

[53]Health has been defined by the World Health Organization as the state of complete social, psychological, and physical well-being and not the absence of disease. Illness is a subjective state where the individual is aware of dysfunction. Disease is generally a pathological process that creates and ends in an altered physiological or psychological state.

[54]Risk is the probability of a disease or an illness free individual developing a specific illness or disease over a specified period of time. It is conditional on that individual not developing any other illness or disease during that period of time.

[55]Jeanne M. Stellman, "Office Automation: A Public Health Perspective on the Potential Acute and Chronic Effects," paper presented at the Office of Technology Assessment Symposium on the Impacts of Office Automation and Computer-Mediated Work on the Quality of Worklife, Dec. 10-12, 1984.

[56]National Center for Health Statistics, *Selected Health Characteristics by Occupation: United States—July 1961-June 1963*, Vital and Health Statistics, Series 10, No. 21 (Washington, DC: U.S. Government Printing Office, 1965).

[57]The problem with using industry studies to establish national trends is exemplified by work conducted in the late 1960s on the relationship between social class and coronary heart disease. Industry studies showed a positive relationship between

(continued)

The four major categories of outcomes to be discussed are visual system outcomes, musculoskeletal system outcomes, stress-related outcomes and reproductive outcomes.[58] Causal relationships between some characteristic of the office environment and the outcome are assessed using the standard epidemiological criteria for determining causality, listed in table 5-3.[59] The risk of these outcomes can be reduced by job and task redesign, office design, and workstation design. The question remains open as to whether new office technologies lead to an increased risk of illness and disease.

Table 5-3.—Epidemiological Criteria for Assessing Causality

1. Strong association of factor to outcome
2. A dose-response relationship between the factor and the outcome
3. Clear temporal relationship between the factor and outcome
4. A consistency of findings across studies
5. A biologically plausible explanation for the observed association

NOTE: These criteria do not all have to be satisfied at one time and in one study to suggest a relationship or lack of a relationship between the new office technology application and a worker's health. For example, if no biologically plausible explanation can be offered for the observed association, that may be due to inadequate knowledge or measurement techniques. This makes it very difficult to refute a relationship between a factor and an outcome based on a lack of biological or biomechanical evidence.

SOURCE: A. M. Lilienfeld and D. E. Lilienfeld, *Foundations of Epidemiology* (New York: Oxford University Press, 1980).

Visual System Outcomes

Fifteen years of research has shown that VDT workers report a high prevalence of visual strain, ranging in various studies between 47 and 91 percent of all operators. Comparison to other workers suggests that VDT work is associated with an increase in visual symptoms across most occupations, but especially in those with heavy visual demands. Table 5-4 shows many of the factors that have been associated with asthenopia (visual fatigue) and perception problems in automated offices. Visual symptoms are associated with specific characteristics of the individual, the physical environment and the work process. But based on the current evidence, causal relationships cannot be established between office automation and visual pathologies.

Asthenopia and other acute[60] visual system outcomes reported by VDT workers are listed in table 5-5. A major problem is the lack of correlation between reported visual symptoms and clinically observable signs. Furthermore, there are no national data with which the prevalence rates can be compared. In those studies where visual functions (eye movement, visual acuity, pupil size, blinking, accommodation and vergence) have been objectively measured, no significant differences have been observed between non-VDT and VDT work, or over periods of time at VDT work. Yet some studies have shown that the amount of time spent at

social class and coronary heart disease. The higher the social class the higher the incidence of coronary heart disease (CHD). In community and national studies, the relationship found was negative: the lower the social class the higher the incidence of CHD. One reason for this inconsistency is selection bias. White-collar workers are likely to be kept longer by the organization, and may be more likely to return after serious illness. Thus blue-collar workers are no longer in the industry to be counted, but they are still found in the community, and are counted in community studies. This phenomenon is the "healthy worker effect" that over time leads to underestimates of the prevalence of an outcome in industry.

[58]Another health outcome whose appearance is associated with office work is dermatitis. There have been too few cases to reliably identify a single cause. Some researchers have hypothesized that this is due to an electrostatic field that builds up between the terminal and the operator. The unanswered question is why the dermatitis only appears on the face. It may be that when one cleans off the screen and then touches one's face the dust and fibers collected on the screen are transmitted to the face. In a recent study, it was found that several dermatological problems occurred in a greater frequency among VDT operators The researchers were unable to determine whether this was due to physical factors such as the electrostatic field, psychological factors, or pure chance. They concluded that working at the VDT may not create but exacerbate dermatological problems. Carola Linden and Jan E. Wahlberg, *Work at Video Display Terminals. An Epidemiological Health Investigation of Office Employees. V. Dermatologic Examination*, National Board of Occupational Safety and Health, Solna, Sweden, 1985.

[59]Epidemiology is a comparative discipline concerned with studying and comparing diseases and related phenomena at different time periods, in different places, and among different types of people. M. Abraham and David E. Lilienfeld, *Foundations of Epidemiology* (New York: Oxford University Press, 1980). For a more complete discussion of the role of epidemiology in assessing workplace exposures see the OTA report, *Preventing Illness and Injury in the Workplace*, OTA H 256 (Washington, DC: U.S. Government Printing Office, 1985).

[60]Acute outcomes are transient and closely associated in time with the exposure. Chronic outcomes are persistent and enduring and distantly or indirectly associated with the exposure.

Table 5-4.—Individual and Work Environment Factors Associated With Visual System Outcomes

Individual:
- Age
- Uncorrected refractive errors

Work environment:
- Glare on the screen
- Flicker and jitter
- Resolution of characters
- High contrasts between source document and screen
- Tasks requiring long continuous looks at the screen without a break
- Air humidity
- High visually demanding task, like data entry and data acquisition
- Low control jobs where the worker is unable to take a break to relieve the load on the visual system

NOTE Although the professional who works at the VDT is not as likely to report as many visual problems as people doing data entry, acquisition, or dialog tasks, it is important to recognize they tend to report more symptoms than workers not using the VDT For a comprehensive review of the literature see Ulf Bergqvist, "Video Display Terminals and Health A Technical and Medical Appraisal of the State of the Art," *Scandinavian Journal of Work, Environment and Health*, vol 10, Supp 2, 1984

SOURCE Office of Technology Assessment

Table 5-5.—Visual System Outcomes: Known Acute or Potentially Chronic[a]

Known acute outcomes:
- Asthenopia:[b]
  - Burning eyes
  - Itching eyes
  - Irritated eyes
- Perception problems:
  - Double vision
  - Blurred vision

Potential chronic outcomes:
- Acquired myopia

[a]There are no chronic outcomes that have been observed in any clinical investigations of VDT operators

[b]Asthenopia is a term used to describe visual fatigue or weakness No clear definition of visual fatigue is employed in the research and it is sometimes referred to as visual strain

SOURCE Office of Technology Assessment

a terminal is directly proportional to the number of workers reporting symptoms and to the extent of their complaints. That complaints cannot be tied to organic change does not, in other words, mean that they are not "real." There is also evidence that visual problems can influence the development of musculoskeletal symptoms. The acute outcomes in table 5-5 can be reduced with changes in the workplace, such as appropriate lighting levels, computer terminal design, workstation and job redesign, and prescriptions to correct refractive errors.

No existing data shows that working at a VDT can lead to the development of cataracts,[61] but neither has the VDT been thoroughly absolved. While in some industries people have worked at VDTs for years, no study has examined the prevalence of cataracts in such groups of workers. No long-term study has yet shown either clinically observable changes in the eye functions or pathological changes in the eye.

There is evidence that work at a VDT leads to more frequent changes in eye glasses.[62] This has been attributed both to the aging of the workers, and to a greater tendency for VDT workers, as compared to others, to identify minor visual problems. A possible alternative explanation is the development of acquired myopia (nearsightedness), which is characteristic of close visual work such as reading. If working at the VDT is found to increase the chance for acquired myopia, the visual health of a large sector of the population will be affected. As the debate about the effects of VDTs on the visual system of workers continues, there is a growing need for a well-designed longitudinal study to determine whether the acute conditions persist. Since little is known about potential biological or biomechanical mechanisms for the initiation of pathological changes in the visual system attributable to new office technologies, research should also focus here.

Eye exams are recommended by the National Institute for Occupational Safety and Health (NIOSH) before beginning VDT work and periodically thereafter.[63] In many in-

[61]National Research Council, V[illegible] Displays, Work and Vision: Panel on the Impact of Vide[illegible]wing on Vision of Workers (Washington, DC: National A[illegible]my Press, 1983). However, in a recent workers' compens[illegible]se, the worker received an award for incipient cataract[illegible] workers compensation board found there was a recogn[illegible]k between the employee's occupation and disability—[illegible]al Rights for VDT Users (Cleveland, OH: Working Women Educational Fund, 1985).

[62]Ulf Bergqvist, "Video Display Terminals and Health: A Technical and Medical Appraisal of the State of the Art," *Scandinavian Journal of Work, Environment, and Health*, vol. 10, supp. 2, 1984.

[63]J. Donald Millar, Assistant Surgeon General and Director of NIOSH, Statement before the Subcommittee on Health and Safety, Committee on Education and Labor, U.S. House of Representatives, May 15, 1984.

stances, visual complaints are in part due to uncorrected refractive errors. Eye examinations would identify and allow correction of this problem. There is no evidence as to how often eye exams should be given for good visual health. They are particularly important for people over 40 years of age, when the visual system begins to change with the onset of presbyopia (farsightedness).

Musculoskeletal System Outcomes

Musculoskeletal disorders rank very high among health problems in the frequency with which they limit activity.[64] Over 10 million people report limitation of activity due to musculoskeletal disorders as compared for example with about 7 million reporting limitation of activity because of circulatory problems. Musculoskeletal disorders are the leading cause of disability of people in their working years. From 1973 to 1983, industry data sources report low back pain as the primary cause in 20 to 25 percent of the yearly workers compensation cases.[65] As the working population ages, the prevalence of musculoskeletal disorders and the potential costs to individuals and society increase.

No recent data are available to provide more accurate estimates of the extent of musculoskeletal disorders in the aging U.S. population, and there is no breakdown of the older data by occupation. Therefore it is difficult to estimate the impact office automation has had on the prevalence of musculoskeletal disorders. A national data collection system is needed to determine the contribution of the workplace to the prevalence of musculoskeletal system outcomes.

NIOSH has identified musculoskeletal disorders of an occupational origin as one of the top ten health problems affecting workers today. Over the past 15 years, they have been one of the major categories of self-reported complaints by VDT workers, a high percentage of whom report pains, stiffness, cramps, and numbness in the back, neck, shoulder, arms, and hands. Comparison with other office workers reveals an association between VDT work and increase in self-reported symptoms in specific types of office work.[66]

Table 5-6 shows factors that have been found to be associated with musculoskeletal system outcomes among VDT operators. Few studies have weighed the relative contribution of each factor.[67] Characteristics of the individual, workstation design, and the work process are associated with the reported symptoms. There is a suggested association between length of time at the VDT and an increased levels of reported musculoskeletal symptoms,[68] but the current scientific evidence is inadequate to demonstrate a causal relationship between any

[64]Jennifer L. Kelsey, *Epidemiology of Musculoskeletal Disorders,* Monographs in Epidemiology and Biostatistics, vol. 3 (New York: Oxford University Press, 1982).

[65]Cited in Charles F. Spakell and William F. McKeon, "Preventing Low Back Pain in Industry," *Business and Health,* vol. 2, No. 6, 1985, pp. 16-19. This is supported by unpublished analyses of BLS data.

[66]The data used to make the observation are inadequate to make any strong assertion across all jobs where the worker uses the computer terminal.

[67]For example, see S.L. Sauter, et al., "Job and Health Implications of VDT Use: Initial Results of the Wisconsin-NIOSH Study," *Communications of the Association of Computing Machinery,* vol. 26, pp. 284-294, 1983.

[68]Michael J. Smith, "Ergonomic and Stress Aspects of Office Automation," paper presented at the Office of Technology Symposium on the Impacts of Office Automation and Computer-Mediated Work on the Quality of Worklife, Dec. 10-12, 1984.

Table 5-6.—Individual and Work Environment Factors Associated With Musculoskeletal Outcomes

Individual:
Age
Existing musculoskeletal disorders
Visual system characteristics:
Near-sightedness
Presbyopia
Bi or tri-focal eyewear use during VDT operation
Work environment:[a]
VDT/workstation-user interface.
Keyboard and hand
Body and chair
Eyes and screen
Repetitiveness of task(s)
Length of time spent at task(s)
Extent of physical constraints

[a]These factors will be discussed in more detail in the section on workstation design and the quality of worklife

SOURCE Office of Technology Assessment

characteristic of the automated office and any musculoskeletal system outcome.[69]

Acute musculoskeletal system outcomes are listed in table 5-7. Back, neck, and shoulder problems are reported more frequently (50 to 80 percent of VDT operators) than arm, wrist, and hand problems (20 to 40 percent of VDT operators). This ranking of self-reported symptoms by site corresponds to a ranking based on a national sample of U.S. adults.[70] Furthermore, in the national sample it was found that the level of self-reported symptoms corresponded to physician-observed abnormalities. There is, however, no evidence from studies of office workers using VDTs display that self-reported outcomes predict clinically recognizable changes in the musculoskeletal system.[71] There is a need for research to clearly identify the relationship between reports of musculoskeletal outcomes by the worker and medically verifiable outcomes.

Based on the current scientific evidence, it is impossible to determine whether the acute outcomes listed in table 5-7 lead to any pathological changes in the musculoskeletal system or to any disability for workers in automated offices. The chronic outcomes reflect potential long-term consequences based on evidence from other occupations and biological and biomechanical evidence. Potential long-term consequences of new applications of office technologies for the musculoskeletal system must be considered. As Kelsey notes:

> [I]mpairments of the back and spine and arthritis and rheumatism account for the greatest amount of time lost from work. In 1976, it was reported that a reduction of one day per year in the average annual absenteeism rate among the labor force of the United States would increase the gross national product (GNP) by $10,000 million. Accordingly, the GNP would have increased by $19,000 million had musculoskeletal disorders been prevented.[72]

If absenteeism rates can be affected by design of new office technologies, this has far reaching implications for health care costs. Therefore, research should be conducted to determine the relative contribution of office automation to the incidence of the chronic outcomes listed in table 5-7.

Table 5-7.—Musculoskeletal System Outcomes: Acute or Potentially Chronic

Known acute outcomes:
- Pain in shoulder
- Cramps in arms and legs
- Pain in back:
  - Upper
  - Lower
- Cramps in shoulder and neck muscles (stiff neck)
- Soreness, tingling or numbness in wrist and fingers

Potential chronic outcomes:[a]
- Cervicobrachial syndrome[b]
- Prolapsed lumbar intervertebral disc
- Cumulative trauma disorders[c]

[a]The chronic outcomes have not been observed in any population of office workers They are potential chronic outcomes based on self-reported acute musculoskeletal outcomes and biological and biomechanical plausibility

[b]Cervicobrachial syndrome is a term used to define a cluster of signs in the shoulder and neck region. It is a functional and organic disorder occupationally produced on the basis of muscular and mental fatigue resulting from static and/or repetitive exertion of the arm and hand muscles Chronic pain can result from the compression of nerves in the neck radiating down the arm

[c]Cumulative trauma disorders are a class of musculoskeletal outcomes that are potentially important Those in the literature associated with office workers are tenosynovitis and carpal tunnel syndrome Carpal tunnel syndrome is a disorder of the wrist in which the median nerve is compressed against the transverse carpal ligament within the carpal tunnel

SOURCE Office of Technology Assessment

[69]Although no experiments have been conducted showing a causal relationship between new office applications and musculoskeletal outcomes, there are biologically plausible explanations; for example, the experience of pain and discomfort by the worker who sits at the terminal for extended periods of time in constrained postures. Static loading of muscles results from the efforts of the human body to maintain a fixed posture for extended periods of time. This keeps the muscle in a constant state of contraction instead of a dynamic state of contraction and relaxation. Thus, waste products build up in the muscle and blood is not circulating in the muscle to provide the needed nutrients. This results in cramping and pains. Tichauer has shown that the peritendinitus that occurs in the lower arm of typists is caused by excessive static workload. (E.R. Tichauer, "Biomechanics Sustains Occupational Safety and Health," *Industrial Engineering*, vol. 27, 1976), pp. 46-56.

[70]Linda S. Cunningham and Jennifer L. Kelsey, "Epidemiology of Musculoskeletal Impairments and Associated Disability," *American Journal of Public Health*, vol. 74, No. 6, 1984, pp. 574-579.

[71]Studies that have attempted to correlate self-reports with medical exams have not demonstrated a clear relationship. For an example see the work of W. Hunting, T. Laubli, and E. Grandjean, "Postural and Visual Loads at VDT Workplace, I, Constrained Postures," *Ergonomics*, vol. 24, No. 12, 1981, pp. 917-931.

[72]Kelsey, 1981, op. cit., p. 7.

Photo credit: Communications Workers of America

Workers adjust to their working conditions. Sometimes this can lead to musculoskeletal strain.

The first two, cervicobrachial syndrome and prolapsed lumbar intervertebral discs, can potentially develop among either professionals or clerical workers.[73] They can be related to increased time spent sedentary and in constrained postures, which could be blamed on the job or the design of the office or workstation, but most likely is related to all three. Cumulative trauma disorders are more likely to develop among workers doing highly repetitive keying operations at the VDT for extended periods of time, mostly data-entry clerks who key as much as 12,000 keystrokes per hour. These are the wear and tear disorders. Many of the early warning signs (tingling, numbness, and pain) of these chronic conditions can be alleviated with changes in the working conditions.[74]

There is a relationship between visual system outcomes and musculoskeletal system outcomes. For example, a person who is nearsighted most likely will get a pair of reading glasses that typically allow the person to read clearly at about 33 cm. However for work at the VDT, a person is on average only as close as 50 cm from the screen. The worker then leans forward, and the posture results in mus-

[73] A prolapsed intervertebral disc occurs when the nucleus pulpous of the disc protrudes outside the annulus fibrosis. The disc tends to protrude onto a nerve root causing pain. In the lumbar region this pain radiates down the leg. Kelsey estimates the incidence of prolapsed lumbar intervertebral disc at around 0.1 to 0.5 percent per year (Kelsey, op. cit., 1981, p. 151) in the population of ages between 24 and 64 years.

[74] Much of the research on the prevention of cumulative trauma disorders is based on redesign of the machines in assembly line operations. See *Preventing Illness and Injury in the Workplace* (op. cit.) for several examples of the prevention projects.

culoskeletal strain. As the pain gets worse through the day, the worker adjusts by moving her body back in the chair, increasing the visual distance, which can lead to visual strain.

NIOSH recommends that a worker take periodic rest breaks every 2 hours when doing work at the VDT to prevent acute asthenopia and musculoskeletal fatigue.[75] This can be enforced through organizational rules, through a job redesign strategy giving the worker a variety of tasks to break up the VDT work, or by allowing the worker the discretion to take breaks when she feels the need. The last is especially advantageous in settings where the work is unpredictable or there is a high worker-to-VDT ratio with competition for terminals, but may demand more flexibility than an organization would normally provide. Sometimes people will not take breaks unless they are required.

Reproductive System Outcomes

Many occupational hazards affect the reproductive system.[76] The concerns about the reproductive hazards of working in an automated office focus primarily on the VDT. Most of the early studies considered only female operators, but both genders should be considered in discussing reproductive system outcomes.

The concern over working at the VDT developed because of reported clusters of spontaneous abortions and birth defects among VDT operators. Table 5-8 shows a list of the work sites where these clusters have been reported. No adequate explanation has been offered for these observed clusters,[77] which include a wide variety of pregnancy outcomes with the majority being spontaneous abortions. The estimated prevalence rate for spontaneous abortions in the general population is between 10 and 20 percent.[78] No site has enough data to show conclusively any association between office automation and any adverse reproductive outcome.[79]

A Finnish study looked at the relationship between occupation and spontaneous abortions, and found that industrial and construction workers had one of the highest ratios (13.01), and clerical and managerial workers one of the lowest estimated ratios for spontaneous abortions (9.91);[80] the lowest ratio was in administrative work (8.16).

Two studies in Sweden and Japan examined the relationship between VDT work and reproductive system outcomes. Little information is available on the Japanese study.[81] The Swedish study infers VDT exposure from occupations; the measure of work at a VDT is indirect.[82] Nevertheless, this retrospective

[75]Millar, op cit; this recommendation has been challenged in the scientific community.

[76]For a complete listing and a discussion of the potential control technologies see *Reproductive Hazards in the Workplace*, Office of Technology Assessment, Washington, DC, 1985.

[77]The argument is made that these clusters are chance occurrences The rate of spontaneous abortions is not at odds with the normal rate that occurred during the time period of the reported clusters For a lengthy statistical discussion on this see Bergqvist, op. cit.

[78]In an analysis of the ability of women to recall whether they had a spontaneous abortion or not; one in four cases of spontaneous abortion was not reported. Gestational age of the time of abortion was the major determinant of recall. Allen J. Wilcox and Louise F. Horney, "Accuracy of Spontaneous Abortion Recall," *American Journal of Epidemiology*, vol. 120, No. 5, 1984, pp. 727-733.

[79]There are several methodological problems with examining reproductive hazards in the workplace. First is the problem of selection bias. It is known that a predictor of an adverse pregnancy outcome is prior adverse outcomes. Women who have a full-term pregnancy tend to leave the work force, and therefore women with prior adverse pregnancy outcomes will be over represented (Gosta Axelsson, "Selection Bias in Studies of Spontaneous Abortion Among Occupational Groups," *Journal of Occupational Medicine*, vol. 26, No. 7, 1984, pp. 525-528).

[80]The ratio is calculated as the number of spontaneous abortions times 100 divided by the number of births. K. Hemminki, M. L. Niemi, I. Saloniemi, H. Vainioh, and E. Hemminki, "Spontaneous Abortion by Occupation and Social Class in Finland," *International Journal of Epidemiology*, vol. 9, No. 2, pp. 149-153, 1980.

[81]Conducted by the General Council of Trade Unions, it has only been reported in "Japanese Miscarriages Blamed on Computer Terminals," *New Scientist*, vol. 106, No 1457, 1985, p. 7 Among 4,500 women, 250 became pregnant or gave birth after work at the VDT and 91 had problems with pregnancy. There was a reported association between hours per day, work at the VDT, and problems with pregnancy or labor: for more than 6 hours VDT work per day—66 percent had problems; for 3-4 hours VDT work per day—46 percent had problems; for less than 1 hour VDT work per day—25 percent had problems. It is impossible to draw any conclusions from this data since no information on the research design is known.

[82]Bengt Kallen, *An Epidemiological Study of Work With Dataterminals and Pregnancy (En Epidemiologisk Studie over Arbete med Dataskarm och Graviditet)*, translated by Anita Dvorak, research report from the University of Lund, Sweden, 1985. Data reported herein is taken from a second report, Ad

(continued on p. 146)

Table 5-8.—Reported Cases of Reproductive System Outcomes in Computer-Mediated Workplaces by Work Site and Job

Company city (date)	Job	Outcomes: VDT	Outcomes: Non-VDT
Sears-Roebuck/ Dallas, TX (5/79-6/80)	Financial records processing clerk[a]	2 miscarriages 4 full-term[b]	5 miscarriages 1 premature birth 8 full-term
Toronto Star/ Toronto, Ontario (5/79-5/80)	Classified ads processing clerks	4 birth defects	3 full-term
Air Canada/ Montreal, Quebec (2/79-4/81)	Part-time ticket agents	7 miscarriages 6 full-term	NIA[c]
Defense Department/ Marietta, GA (10/79-10/80)	NIA	3 birth defects 7 miscarriages 5 full-term	NIA
Defense Department/ Marietta, GA (10/80-10/81)	NIA	14 full-term	NIA
Pacific Northwest Bell Telephone/ Reston, WA (7/80-12/81)	NIA	2 birth defects 1 still born	NIA
Solicitor General Offices/Ottowa, Ontario (4/79-4/82)	NIA	4 miscarriages 1 premature 2 respiratory diseases	1 full-term
Surrey Memorial Hospital/Vancouver, British Columbia (1978-82)	Accounting department clerks	3 miscarriages 1 birth defect 1 premature 1 bronchitis/full-term 1 full-term	NIA
Toronto, Old City Hall Ministry of Attorney General (1980-81)	Clerks Secretaries	10 miscarriages 9 full-term	NIA
United Airlines/ San Francisco, CA (1984)	Airline reservation clerk	23 miscarriages 61 full-term[d]	NIA
Southern Bell Telephone/Atlanta, GA (3/81-9/83)	Telephone operators	7 miscarriages 15 full-term	26 miscarriages 159 full-term
General Telephone/ Alma, MI (1983-84)	Telephone operators	12 miscarriages 2 still births 3 premature 15 full-term	NIA
Library/ Aarhus, Denmark	NIA	8 miscarriages 2 full-term	NIA
Department of Public Employees/Runcorn, England (1974-82)	Full-time VDT operators	8 miscarriages 4 still births 12 malformations	NIA

[a]Compares only full time VDT operators with non-VDT operators who may have worked as much as 5 hours per month at the terminal
[b]Full-term refers to the healthy delivery of a newborn after three trimesters These are commonly termed live births
[c]NIA means no information reported
[d]This excludes 23 induced abortions and 9 full term deliveries of wives of employed men

SOURCE Office of Technology Assessment, compiled from several reports and news sources study found that women who worked at the VDT were 50 percent more likely to have miscarriages (crude risk ratio was 1.5 with 95 percent confidence limits of 1.1-1.9) than other women of similar age and occupational group. With adjustment for smoking and stress, confidence in the risk ratio being greater than one decreased.[83] For all types of adverse reproductive outcomes, there was a significantly greater risk for those who spent over 40 hours per week at the VDT. This suggests that further investigations are needed that directly measure VDT work and follow a group of men and nonpregnant women to see whether there is an excess of adverse reproductive system outcomes. No epidemiological study has provided reliable data comparing VDT to non-VDT operators.

Two explanations other than chance have been offered for the clusters—stress, and radiation emissions. There is no epidemiological evidence linking stress in office work (either physical or mental) to spontaneous abortions or still births. But while no evidence exists, no research has thoroughly explored the issue.

The greatest interest has been in the impact of radiation[84] and whether radiation from the VDT is the single source exposure. There is no evidence that ionizing radiation above established safe thresholds is being emitted from currently sold terminals.[85] Ionizing radiation from the VDT is not a likely explanation, according to NIOSH, the Federal Drug Administration, and the Government of Canada.[86] The possibility of nonionizing radiation must be considered; but future developments in flat panel display technologies may eventually replace cathode ray tubes as the dominant human-computer interface.

Recent concern has focused on very low frequency radiation, particularly the magnetic pulse generated from the coil of the cathode ray tube. This concern developed because studies in Spain related a magnetic pulse to morphological abnormalities in chicken embryos.[87] The evidence has not been confirmed in any other investigation trying to reproduce the patterns of electromagnetic radiation emitted from a VDT.[88] Currently, there are international efforts to study the effects of pulsed electromagnetic exposure on chick embryo development, but measurement of this and other forms of nonionizing radiation in the field is difficult. Further research should be concerned with the development of reliable instruments for the monitoring of radiation being emitted from VDTs.

Based on current evidence, no long-term risk is associated with very low frequency radiation emitted from the visual display terminal, but continuing evaluation is warranted in light of

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Hans Malker, *Critical Comments on the Report "An Epidemiological Study of Work With Video Screens and Pregnancy Outcomes,"* Memorandum, Swedish National Institute of Occupational Safety and Health, Feb. 2, 1985.

[83] This risk ratio dropped only 10 percent when the effects of smoking and stress were entered into a logistic regression analysis (adjusted risk ratio 1.4 with 95-percent confidence limits of 1.0-1.8). No data was reported on the effects of chemical exposure or heavy lifting on the relationship of work at the VDT and miscarriages. If the relationships persist after adjusting for these potential confounders along with other predictors of miscarriages (e.g., prior spontaneous abortions and parity) then the researchers can make a stronger inference. This will always be limited by the absence of a direct measure of VDT use.

[84] Three major types of radiation are associated with biological effects. They differ by the energies involved. Ionizing radiation has the most energy and is known to cause cancer and birth defects. Microwaves and radiofrequency nonionizing radiation have been associated with fertility problems and blood abnormalities. Extremely low frequency and electromagnetic nonionizing radiation is the least energetic of the three categories and has not been associated with any adverse biological effects.

[85] William E. Murray, "Video Display Terminals: Radiation Issues," *IEEE Computer Graphics and Applications,* April 1984.

[86] Millar, op. cit.; FDA, *Drug Bulletin,* vol. 14, No. 1, April 1984; Environmental Health Directorate, *Investigation of Radiation Emissions From Video Display Terminals,* Department of National Health and Welfare, Ottawa, Canada, 1983.

[87] This evidence comes from two reports: J.M.R. Delgado, J. Leal, J.L. Monteagudo, and M.G. Garcia, "Embryological Changes Induced by Weak, Extremely Low Frequency Electromagnetic Fields," *Journal of Anatomy,* vol. 134, 1982, pp. 533-551; and A. Ubeda, J. Leal, M.A. Jimenez, and J.M.R. Delgado, "Pulse Shape of Magnetic Fields Influences Chick Embryogenesis," *Journal of Anatomy,* vol. 137, 1983, pp. 513-536.

[88] Arthur W. Guy, *Health Hazards Assessment of Radio Frequency Electromagnetic Fields Emitted By Video Display Terminals,* report prepared for IBM Office of the Director of Health and Safety, 1984; Kjell Hansson Mild, Personal Communications, Swedish National Board of Occupational Safety and Health, 1985; S. Maffeo, M.W. Miller, and E.L.Carstensen, "Lack of Effect of Weak Low Frequency Electro-Magnetic Fields on Chick Embryogenesis," *Journal of Anatomy,* vol. 139, No. 4, 1984, pp. 613-168.

Table 5-9.—U.S. Occupational Exposure Standards

Radiation type	Occupational exposure standard	Source
X-ray	2.5 mR/hr	OSHA[a]
Ultraviolet (near)	1,000 microW/cm[a]	ACGIH[b]
Visible	2,920 fL	ACGIH[b]
Radiofrequency electromagnetic fields, frequency range (MHz):		
0.01-3	100 mW/cm[b]	ACGIA[b]
10-100,000	10 mW/cm[b]	OSHA[c]

[a]Code of Federal Regulations, Title 29, Chapter XVII, Part 1910 96, Ionizing Radiation, Occupational Safety and Health Administration, Washington, DC, 1980
[b]Threshold Limit for Chemical Substances and Physical Agents in the Work Environment With Intended Changes for 1983 and 1984. American Conference for Government Industrial Hygienists, Cincinnati, OH, 1983.
[c]Code of Federal Regulations, Title 29, Chapter XVII, Part 1910 97, Nonionizing Radiation, Occupational Safety and Health Administration, Washington, DC, 1980.

SOURCE Adapted from William E Murray, "Visual Display Terminals: Radiation Issues," *IEEE Computer Graphics and Applications*, April 1984

Table 5-10.—International Radiation Protection Association Occupational Exposure Limits to Radiofrequency Electromagnetic Fields

Radiofrequency electromagnetic fields, frequency range (MHz)	Occupational exposure limit (mW/cm²)
0.1-1	10
>1-10	10/F[a]
>10-400	1
>400-2,000	F[a]/400
>2,000-300,000	5

[a]F refers to the frequency in MHz, thus to calculate the specific limit within the range the frequency must be factored in according to the expression.

SOURCE International Non-Ionizing Radiation Committee of the International Radiation Protection Association, "Interim Guidelines on Limits of Exposure to Radiofrequency Electromagnetic Fields in the Frequency From 100 kHz to 300 GHz," *Health Physics*, vol. 46, No 4, 1984, pp 975-981.

the large number of people exposed, to see if modified or new standards need to be developed.[89]

Standards shown in table 5-9 reflect the available evidence on the potential effects of chronic exposure at low levels. The American Conference of Government Industrial Hygienists (ACGIH) exposure limit for electromagnetic fields in the frequency range of 0.01-3 MHz is 100 mW/cm². This threshold level is 10 times higher than the VDT emissions in the 0.01-100 MHz range measured in a study by the Bureau of Radiological Health of the Environmental Protection Agency.[90] The International Radiation Protection Association (IRPA) standards are 10 times lower for a similar frequency range than standards set by ACGIH (0.01-3 for ACGIH and 0.01-1 for IRPA). Because there are differences in the limits of exposure, the standards should be constantly reexamined in the light of further research. NIOSH is currently conducting a retrospective study to ascertain whether working at a VDT is associated with spontaneous abortions. Similar studies are being conducted by Dr. Irving Selikoff at Mt. Sinai Hospital (in conjunction with 9 to 5, the Working Women's Association), by Dr. Kelley Brix at the University of Michigan and in Sweden, Finland, Canada, and Denmark.

Again, there is no reliable national registry for monitoring the prevalence of reproductive system outcomes as they relate to occupations. The establishment of such a system could help prevent the public fear that has arisen about VDT work.

Metallic shielding has been discussed as one way to avoid any possibility of radiation being absorbed by the operator, especially shielding the flyback transformer. This shielding is relatively inexpensive and is usually provided in newer models to satisfy FCC requirements for reducing electromagnetic interference.[91]

The government of Sweden has recommended that any pregnant employee have the right to be moved, at full pay, to a job with no exposure until the baby is born. The International Labor Organization recommends that a worker who is considering becoming pregnant be allowed to transfer to another job.[92] However, the risk of reproductive system damage, if it exists, may be just as great for a man as for a woman. Most recently, the Service Employees International Union (SEIU) has negotiated

[89]A recent report from the U.S. Environmental Protection Agency concluded there were no consistent biological effects at the molecular and subcellular level in laboratory experiments. The report suggested continued revision of general conclusions because of limited knowledge about chronic low-level exposures and the existence of frequency-specific effects and power-density windows. (U.S. Environmental Protection Agency, *Biological Effects of Radiofrequency Radiation*, Joe A. Elder and Daniel F. Cahil (eds. EPA-60018-83-026F (Research Triangle Park, NC: Health Effects Research Laboratory, 1984).)

[90]Cited in *Reproductive Hazards in the Workplace*, op. cit.
[91]Guy, op. cit.
[92]International Labor Organization, *Guidelines for VDT's*, Geneva, Switzerland, 1985.

in collective bargaining with Equitable Life Insurance the rights of employees to leave VDT jobs where the believed risk for an adverse pregnancy outcome is high. These measures would at a minimum alleviate fears.

Stress-Related Outcomes

Work-related stress is not new to offices, but recent epidemiological evidence has called attention to the potential long-term consequences of stressful office working conditions. One study of the health records of 22,000 workers in 130 occupations found that clerical workers had the second highest rate of stress-related diseases.[93] Analysis of the Framingham Heart Study data showed that women clerical workers developed coronary heart disease (CHD) at about twice the rate of other women workers and women at home.[94] The workplace factors that predicted the development of CHD among clerical workers were a nonsupportive boss and low-job mobility. Any conclusions about the contribution of the new office technologies to the incidence of disease must thus consider that women clerical workers were already at a greater risk for the development of certain stress-related diseases. The new technology may or may not intensify those characteristics of the work environment that are associated with the elevated risk, increasing one's chances of developing disease; they could also improve working conditions, decreasing the likelihood of disease.

There are no reliable estimates of the costs to the organization or to society of stress-related illnesses, absenteeism, tardiness, employee turnover, decreased quality and quantity of output, unscheduled machine downtime (due to employee tampering) and worker's compensation awards. These outcomes can lead to increased medical care costs and decreased organizational effectiveness.

Stress-related outcomes can be divided into those that are acute and transient[95] and those that are persistent and enduring. Anxiety and depression have been shown to be related to myocardial infarction, angina pectoris, and coronary death.[96] Therefore, correction of working conditions that produce these stress responses can help to prevent stress-related diseases.[97]

As important as are acute conditions, the potential for chronic diseases is the key public health issue. The population potentially at risk in offices is large. If conditions that can lead to chronic illness and disease can be identified, management can use this information to guide implementations.

The biological plausibility of changed working conditions leading to a pathological change in the body has been the subject of debate for decades. Chronic arousal is one currently acceptable biological pathway (see box B for an example of a plausible link to disease). Chronic arousal is a biological adaptation to the environment. When one continues to respond daily to the same stimuli, arousal can become part of the normal biological adaptation to, for example, work—a method of activating the body's resources to meet the demands. This can lead to a form of "healthy maladaptation," in which the worker completes tasks, but at some biological costs. The eventual cost can be illness due to lowered immunological resistance, or chronic illness that lowers the ability to perform, such as cardiovascular disease or peptic ulcers. The danger is hidden in that the chronic heightened state of arousal does

[93] Michael J. Smith, Michael J. Colligan, and J.S. Hurrell, "A Review of NIOSH Psychological Stress Research–1977," *Occupational Stress Proceedings of a Conference on Occupational Stress* (Washington, DC U.S. Government Printing Office, 1977).

[94] Suzanne G. Haynes and Manning Feinleib, "Women, Work and Coronary Heart Disease Prospective Findings From the Framingham Heart Study," *American Journal of Public Health,* vol. 70, 1980, pp. 133-141

[95] Stress can contribute to the development of acute visual and musculoskeletal system outcomes. For example, muscle fatigue can be the direct result of a stressful working condition, which can stimulate brain stem activity, which in turn can cause muscle fatigue.

[96] C. David Jenkins, "Psychosocial and Behavioral Factors," *Prevention of Coronary Heart Disease: Practical Management of the Risk Factors,* Norman M. Kaplan and Jeremiah Stamler (eds.) (Philadelphia: W. B. Saunders, 1983), pp. 98-112.

[97] This type of prevention strategy may be found to be the most cost-effective, since it has the potential to reduce the long-term development of disease. Also, if the working conditions that produce stress responses in workers are modified, this may alter certain behavioral outcomes including smoking, drinking, and overeating—all considered socially acceptable ways to cope with the stresses of life, but primary determinants of premature morbidity and mortality.

Box B.—Chronic Arousal: The Link Between Working Conditions and the Natural History of Disease, The Case of Cardiovascular Disease[a]

Early theories of stress and disease held that humans instinctively respond to challenging conditions from their environment through activation of pituitary and adrenal gland functions. Walter Cannon in the 1930s showed the importance of the sympathetic adrenal system in the flight-or-fight syndrome. He showed there were limits to how well the system could adapt to stimuli; afterwards bodily harm could result. Only in the last 20 years have scientists begun to unravel the complex interrelationship between the brain, immune system, and endocrine system.

There are competing models of this complex system, but several conclusions can be stated. Sympathetic adrenomedullary (SAM) stimulation is accompanied by evaluated blood pressure and heart rate, heightened myocardial oxygen requirements, increased levels of circulating epinephrine (E) and norepinephrine (NE), elevated plasma concentrations of free fatty acids (FFA), and increased plasma renin activity. These can predispose the individual to cardiovascular disease (CVD). The release of the neuroregulator, catecholamine, as a consequence of SAM activity is central to the most prominent theories of stress and CVD. In its efforts to mobilize reserve energy resources, catecholamines hydrolyze triglyceride stores into FFA and glycerol. FFAs are either utilized in the production of energy or taken up by the liver and adipose tissue then resynthesized into triglycerides that are secreted as a component of very low-density lipoproteins (VLDL). VLDLs have been shown to be significant components of the atherosclerotic process. When catecholamines are chronically secreted in great excess of the body's energy requirements to meet the demands of the work environment, the abundance of FFAs can ultimately result in damage to vascular walls caused by circulating VLDLs. Damage to vascular endothelium can also occur as a result of increased arterial blood pressure or turbulance caused by SAM hemodynamic responses. Damaged vascular endothelium is more susceptible to atherosclerotic deposits than healthy vessel walls. These processes suggest several possible pathways between the challenges created by working conditions and the development of cardiovascular disease.

[a]This section is based on a summary prepared by Dr. Andrea LaCroix. For a full description see Andrea LaCroix, *Occupational Exposure to High Demand/Low Control Work and Coronary Heart Disease Incidence in the Framingham Cohort*, doctoral dissertation, University of North Carolina, Chapel Hill, 1984. A more complete description of the various biological processes can be found in The Institute of Medicine, *Research on Stress and Human Health* (Washington, DC: National Academy Press, 1981).

not necessarily correlate with the worker's attitudes about work. High motivation and satisfaction does not obviate the possibility that a person could be at risk.

Three working conditions have been associated with chronic arousal:

- social isolation or lack of social support;
- lack of control over the timing, speed, and variety of tasks; and
- heavy workload (especially repetitive and machine-paced tasks).

Each of these conditions has also been postulated as likely to arise from office automation. No evidence has shown that all three must occur to elicit deleterious biological responses; however, in some jobs they all occur.

Epidemiological evidence has shown the most consistent links between heart conditions and workload and control. In a 6-year prospective analysis, men with jobs characterized by a heavy workload and limited job control were found to have 1.4 times the normal risk of CVD morbidity.[98] In a case-control study of myocardial infarction and occupational exposures, it was found that hectic work and low control over work tempo and skill variety were associated with myocardial infarction in men under 55.[99] In a study of Swedish workers who had changed jobs, those whose new job had greater control had fewer coronary symptoms

[98]The CHD morbidity measure was a self-report indicator of chest pain, dyspnea, hypertension, and heart weakness. R. Karasek, et al., "Job Decision Latitude, Job Demands, and Cardiovascular Disease: A Prospective Study of Swedish Men," *American Journal of Public Health*, vol. 71, No. 7, 1981, pp. 694-705.

[99]L. Alfredsson, et al., "Myocardial Infarction and Psychosocial Work Environment: An Analysis of the Male Swedish Working Force," *Social Science and Medicine*, vol. 16, 1982, pp. 463-467.

than workers whose new job had less control.[100] In the only American prospective study, women who described their job as having a heavy workload with limited job control had a threefold greater risk of developing coronary heart disease (CHD) as women reporting a heavy workload but having control over their work. Men did not exhibit the same relationship. At greatest risk were clerical women, who had a 420 percent greater chance of developing CHD (relative risk 5.2 with 95 percent confidence interval of 1.80-15.08). These associations persisted after controlling for the traditional risk factors for CHD.[101]

Based on the available evidence, lower level staff appear to be at greater risk for the development of stress-related diseases. This however need not be true with office automation because the changes in the working conditions can affect all levels of staff. Alternatively, office automation can be implemented so as to add control and encourage more social interaction.

Currently, the evidence for a relationship between stress-related diseases and VDT work is still sparse. A principle problem in drawing conclusions is that the long latency of chronic diseases prevents early recognition. However, in the natural history of disease certain early indicators could be expected such as psychosomatic symptoms (sleeping problems, dizziness, nausea, and stomachache), high blood pressure or angina pectoris.[102] Only preliminary evidence exists for the likelihood of deleterious long-term health effects on office workers, or specifically on VDT workers. Most studies show that support staff who work at a VDT report more psychosomatic symptoms than either other support staff or professionals who work at VDTs. These studies, in general, also show that women report more psychosomatic symptoms, as do people in jobs characterized by little control over pace, a heavy workload, and lack of social support. This is consistent with the general literature on stress-related disease. No study can fully answer the question—what contribution to the risk of disease can be attributed to office automation?

But two recent studies suggest that there is a potential for these psychosomatic symptoms to develop into chronic conditions. In a cross-sectional study of clerical workers in the communications industry, those who worked at the VDT were at about a two-fold greater risk for the development of angina pectoris.[103] This is the first study to demonstrate a relationship between automated office work and a valid precursor of CVD. A second study of Finnish workers found that workers in automated offices were at a 106 percent higher risk (relative risk 2.06, 95 percent confidence interval 1.43-2.69) for one or more chronic illnesses.[104] These projects point to the need to examine the potential effects of office automation to determine under what conditions a worker is likely to be at a greater risk for the development of a chronic disease.

[100] R. Karasek and B. Gardell, *Managing Job Stress*, Working Paper. Columbia University, Department of Industrial Engineering and Operations Research, 1984.

[101] LaCroix, op. cit.

[102] These can also be explained by other factors such as situations outside of work or biological predisposition. Research efforts should in the future attempt to differentiate between the risks associated with work and those associated with leisure. Also, physical and psychosocial working conditions can produce similar adverse stress responses and should be differentiated in future research.

[103] The analysis of angina was restricted to a sample of 650 women. There were no significant differences between respondents and a 10-percent sample of nonrespondents. For a full description of the results of the study along with the limitations of the study see, Suzanne Haynes and Andrea LaCroix (University of North Carolina at Chapel Hill), "A Cross-Sectional Study of the Health of VDT Operators in the Telephone Industry," unpublished manuscript, 1985. The measure of angina used was the Rose Angina Questionnaire. Several studies have shown that this self-report measure is as valid and reliable a predictor of angina pectoris as a physical exam by a physician. (Lawrence M. Friedman, et al., "Assessment of Angina Pectoris After Myocardial Infarction: Comparison of 'Rose Questionnaire' With Physician Judgment in the Beta-Blocker Heart Attack Trial," *American Journal of Epidemiology*, vol. 121, No. 4, 1985, pp. 555-563.)

[104] The ratio reported is after adjustment for age, sex, baseline health status, health risk factors and baseline systolic blood pressure. The risk did not change when ergonomic strain, job strain and social support from the supervisor were taken into account. There was a 21-percent increase in the risk when the control over the pace of work was taken into consideration. Again, the unanswered question is whether the job was characterized by low control prior to automation or whether working conditions were exacerbated by the automation of the work process? The chronic illness measure was composed primarily of heart disease (70 percent) with cases of cancer, chronic musculoskeletal disorders, and gastrointestinal diseases. These results are preliminary and further analysis is currently being carried out. For a description of the study see Mary Haan, "Health Effects of Automated Office Work," paper presented at the Office of Technology Assessment Symposium on The Impacts of Office Automation and Computer-Mediated Work on the Quality of Worklife, December 10-12, 1984.

Since the evidence relating working conditions in automated offices to stress-related diseases is still limited, it may be thought premature to begin job and organizational redesign strategies. The major dilemma facing managers is whether it is more cost effective to wait and make job and organizational changes later, or to use the new technologies to usher in job and organizational changes. **The major dilemma facing public health officials is that by the time the population of VDT users has worked long enough to manifest chronic outcomes there will be few people to use as controls, since most office workers will be working at the VDT.**

SECTION III: INTERVENTIONS

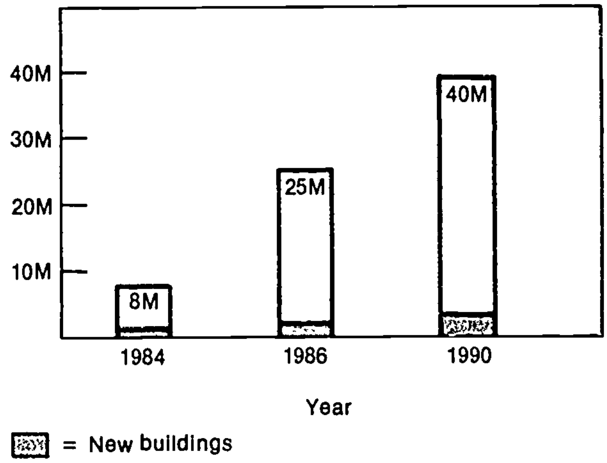
Office Design and Workstation Design

More and more organizations consider the design of the office, building, and workstation as integral parts of the new technology. These characteristics of office environments can contribute to quality of worklife both directly, and indirectly by ameliorating stressful working conditions.

Office Design

The introduction of new office technologies into a building can affect the way the building performs—the distribution of office space, heating, ventilation and air conditioning, power and wiring, and acoustics.[105] Running of cables through offices can be the cause of falls. Office design can balance the impersonality of some computerized office tasks. However, new buildings will only accommodate about 5 percent of the computer terminals installed between now and 1990 (see figure 5-2). The single greatest area of impact will be the retrofitting of older buildings to accommodate new technologies. Retrofitting can be as simple as putting in a new lighting system or as complex as complete rebuilding of the internal structure of the building. When new office technologies are haphazardly introduced without considering the extra demands placed on the building, new health and performance problems can develop or old ones can be amplified.

Figure 5-2.—The Proportion of VDTs Installed in New Office Space Compared to Existing Space, 1984-90



Most video display units will be installed in existing office space. Even if every person in new office construction in the United States had a VDU, only about 5 percent of the VDUs would be in new buildings. Therefore, accommodating them is mainly a retrofit job. (Assuming approximately 200 gross square feet for each workstation with a VDU, then if the height of each bar represents the total space occupied by workstations with VDUs, the shaded part of each bar represents the cumulative total of VDUs in new office space.)

SOURCE Michael Bell, © Harbinger Group, Inc., 1985

Office Space

Office automation allows the redesign of workspace to accommodate private and shared

[105]It has been estimated that only 2 percent of the costs of conducting business in an office building over 40 years are devoted to building design. Six percent goes to operation and maintenance and 9.2 percent to labor. Therefore, improvements in the quality of worklife through building design offers a potential cost-effective lever for organizations. This estimate is based on 1971 dollars, but the differences in scale still exist today, see Francis T. Ventre, *Documentation and Assessment of the GSA/PBS Building Systems Program: Final Report and Recommendations*, NBSIR 83-2777, General Services Administration, Washington, DC, 1983. This general ratio of costs has been reproduced in another 7 year study of office design and its impact on the quality of work (Michael Brill, presentation at Conexion '85, Atlanta, GA, Nov. 6-9, 1985).

work. Allocation of space is always a critical factor in offices; it signifies status and organizational commitment to the worker. It provides some control over interruptions and privacy and encourages or discourages social interaction, factors associated with job satisfaction and performance.

A personal computer and attachments take about 12.5 square feet of office space, which increases individual workspace needs.[106] With the cost of office real estate rising, new technology is sometimes being crammed into inappropriate spaces that can lead to shifts in status, and awkward work postures associated with visual and musculoskeletal strain. Noise levels can be distracting, especially for workers in an open plan office,[107] and devices such as acoustical printer covers may be needed to reduce noise levels. Changes in office layout may be necessary to reduce the isolating effects of computer work.

Air quality is a major problem in modern offices. Heating and cooling problems can be exacerbated by office equipment that generates heat, and by changes in lighting that are made to accommodate VDT users.[108] Hot spots caused by concentrations of office equipment can change the way the building distributes air, heat, and cooling, and make indoor air pollution and thermal discomfort worse. It is recommended that in refitting a building for extensive office automation, the building be remodeled as a set of microzones composed of comparable offices with localized control of the heating, cooling, and ventilation system.

Workstation Design

The workstation includes the table or desk holding the terminal, the chair, and the equipment that an operator users. In many offices these have not changed, and the microcomputer merely replaces, or even sits next to, the typewriter. Yet several characteristics of the VDT[109] differ from conventional office technologies and impose different physical demands on the worker:

- The terminal is self-luminous.
- There is a transient display on the screen, whereas the display in printed text is constant.
- VDTs usually have highly specular curved glass surfaces that reflect light.
- Information is presented in a vertical plane as compared to the horizontal plane of paper or the angled plane of the typewriter.

In conventional offices the illuminance has been kept high for reading, with other light sources, such as windows, contributing to the illumination. For VDT work, much lower illumination is best.[110] But the worker often looks back and forth from the VDT to printed text and other equipment, so a compromise is required; task lighting (lamps) can be used for additional illumination where needed. Tradi-

[106] In one study, "Office Research Into Buildings and Information Technology (ORBIT)" it was found that new information technology only increased the secretaries' space requirements by 50 percent (Duffy, Eley, Giffone, and Worthington—Architects, *ORBIT Report*, 1983).

[107] It has generally been argued that open space offices are most beneficial to workers doing repetitive and boring tasks; they provide needed social stimulation. Alternatively, people doing creative work require private space. However, this has recently been challenged by researchers who have found that even workers with boring and repetitive jobs prefer private spaces to open spaces and giving it to them increased their job performance (E. Sundstrom, et al., "Privacy at Work: Architectural Correlates of Job Satisfaction and Job Performance," *Academy & Management Journal*, vol. 23, 1980, pp. 101-117).

[108] It is generally estimated that a workstation and operator can generate 18.0 Btu/square foot of heat throughout a building. For discussion of these problems see American Society of Heating, Refrigerating, and Air-Conditioning Engineers, *ASHRAE Standard 62-73. Standards for Natural and Mechanical Ventilation* (New York, 1973); *ASHRAE Standard 55-1981. Thermal Environmental Conditions for Human Occupancy* (New York, 1981); *ASHRA Standard 90-75. Energy Conservation in New Building Design* (New York, 1977); and *ANSI/ASHRAE Standard 62-1981. Ventilation for Acceptable Indoor Air Quality* (New York, 1981); also Ventre, op. cit.

[109] The discussion of VDTs usually is about the monochromatic raster scan CRT, which is like a television screen with some additional electronics. Other kinds of VDTs that may be much more common in the future are the plasma panel, liquid crystal, and electroluminescent displays See App. A for descriptions of the technology.

[110] The American National Standards Institute recommends a general lighting level of 750-1600 lux for traditional desktop reading; other groups recommend no more than 200 lux for rooms where VDTs are used. *American National Standard Practice for Office Lighting, ANSI A132.1* (1973); AT&T Bell Laboratories, *Video Display Terminals: Preliminary Guidelines for Selection, Installation, and Use* (1983); NIOSH, *Potential Health Hazards of Video Display Terminals* (1981).

tional office and office furniture design assumes a depressed line of sight, but the vertical position of the VDT brings windows, ceiling lights, etc., into the line of sight, causing glare. The reflective surface of the screen can also contribute to eye strain.

On a VDT the display is transient and there is a characteristic flicker (assuming that the VDT is a cathode ray tube) which is often imperceptible to the worker, but can probably lead to visual fatigue and asthenopia although it has not been linked to visual performance.[111]

The readability of the screen is also related to the structure of the dot matrix used to create characters, the contrast between the characters and the background, and the viewing distance of the person from the screen. Increases in the size of the matrix have been shown to increase reading performance,[112] but this is not within the control of the user or, generally, the purchaser. The contrast between characters and screen can be controlled by the user, and should be placed for ease of use. The fonts used in VDTs are chosen by engineers for convenience in design, and are less easy to read than print fonts evolved through years of practical experience and user preference.[113] They assume a set viewing distance between viewer and screen, but some people lean back in their chairs and put the keyboard on their lap or in other unlikely places.[114] This is especially likely when the worker has such a small table or desk that cannot hold documents as well as the keyboard and screen. Many office furniture designers have evidently not realized that office workers frequently use both paper and a terminal in the same task. The visual and musculoskeletal strain that can result from the wrong viewing distance is best managed by providing fully adjustable equipment so that each user can adapt the workstation design to fit his/her own needs. A tiltable screen and adjustable desktop can solve many problems.

Photo credit: Optical Coating Laboratories, Inc.

One way to control glare and enhance readability is to use a filter

The keyboard is likely to remain the dominant input technology for most office workers;[115] keyboard work has been associated with carpal tunnel syndrome and cervicobrachial syndrome. The physical characteristics of the

[111] If the refresh rate is at least 65 flashes per second, there is no perceptible flicker; VDT refresh rates are about 30-70 Hz. Television set flicker has occasionally been associated with photosensitive epileptogenic seizures, but the refresh rates known to induce such seizures are low, from 8-14 Hz. It is thus highly unlikely that such seizures would be induced by VDT work.

[112] A 14-percent increase in reaction time and a 10-percent decrease in errors was shown in a study by Haubner, et al., *Visual Display Units—Characteristics of Performance*, Commission on International Lighting, 20th sess., 1983, as reported in Bergqvist, op. cit.

[113] National Academy of Sciences, op. cit.

[114] For further discussion see E. Grandjean, W. Hunting, and M Pidermann, "VDT Workstation Design. Preferred Settings and Their Effects," *Human Factors*, vol. 25, No. 2, 1983, pp. 161-175.

[115] The usual QWERTY keyboard dates back to the 1870s, and was recognized as an international standard in 1966 although it has been challenged by the Dvorak keyboard, with a different arrangement of the keys. Some studies indicate the Dvorak would improve typing speed by 25 percent and shorten the time needed to learn to type. It was designed (after World War II) to avoid excessive wrist movement by locating the most commonly struck keys in the center row, possibly reducing musculoskeletal strain. There is currently a resurgence of interest in the Dvorak, but both employers and employees are seemingly unwilling to undertake the retraining that would be necessary to make the change. See Jan Noyes, "The QWERTY Keyboard. A Review," *International Journal of Man-Machine Studies*, vol. 18, 1983, pp. 265-281.

keyboard associated with precursors of these syndromes, such as its height, can be altered. Some keyboards are attached to the terminal and resemble the typing keyboard in height from the table (generally over 40 mm); others are detached and built lower, which has many advantages since a determinant of musculoskeletal symptoms in forearms and wrists is the ability to intermittently rest the arms or wrists on the table.[116] A detachable keyboard can also be arranged for comfort and viewing distance.

Chairs are critical to the comfort of any office worker; and with office automation people tend to spend longer blocks of time in one place. The chair should allow one to change the seated posture without adopting an awkward position;[117] and it should be easily adjustable. To prevent lower back problems, office chairs should have an adjustable lumbar back support and the back rest height should extend beyond the lumbar region to the thoracic region and be adjustable for height, angle, and pressure. The seat should also be adjustable to allow people of different sizes to get about a 90-degree angle between upper body and thighs.

Table height is also important. If used alternately by several workers it should be easily adjustable to accommodate different heights. Desks should not restrain knee and thigh movement, and should have enough space for working documents, screens, and keyboards to be moved around.

One of the most important elements of office design strategy is to make sure that office workers understand why adjusting lighting, furniture, and temperature controls is important, and how to do it.[118] A Finnish study found that if data-entry workers were trained to recognize ergonomic problems and prevention strategies, the level of clinically recognized

Photo credit: Michael Smith

When tables and/or chairs are not adjustable, the user sometimes must assume awkward postures. This woman may eventually develop neck cramps from continually looking down

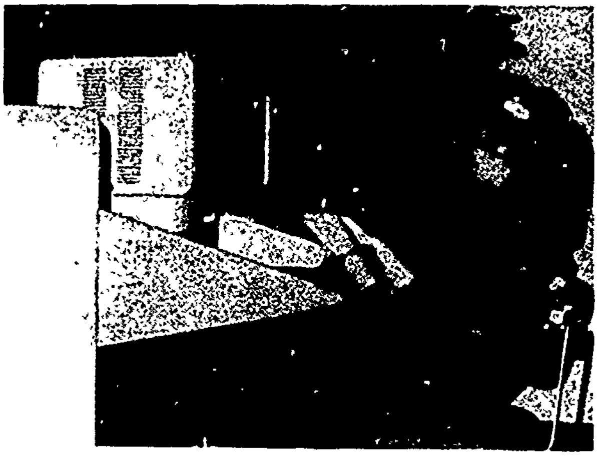


Photo credit: Michael Smith

Sometimes the worker finds her own way to sit comfortably

[116]Operators may not prefer suggested optimal keyboard heights and their preference may not affect performance. Teresa Burke, "Effects of Keyboard Height on Typist Performance and Preference," *Proceedings of the Human Factors Society*, 28th Annual Meeting, 1984, pp. 272-276. See also Grandjean, op. cit.

[117]Most keyboard operators maintain an erect posture for only 2 to 3 minutes at a time Standards and recommendations are usually based on this position, even though studies show that people prefer leaning slightly forward or slightly backward.

[118]This has in fact been mandated in the OSHA Act (Sec. 21c), which says that the Department of Health and Human Services must provide for "the establishment and supervision of programs for the education and training of employees and employers in the recognition, avoidance, and prevention of unsafe or unhealthful working conditions."

neck, shoulder, and elbow problems was significantly reduced over a 6 month period.[119]

Public Policy and Quality of Worklife

Public policy interventions must be considered in light of both the scientific evidence and the political and economic climate. Many organizations look to new technologies to provide them with the competitive edge, and some argue that health and safety regulations inhibit the full use of new technologies and further innovations. A report issued by the President's Commission on Industrial Competitiveness recommended that no new health and safety regulations be established; society should not seek to eliminate risk, and risk below minimum levels should be left unregulated, or to industry self-regulation.[120] Executive Order 12291 (1981) provided that except where expressly required by law, the costs of a regulation should not exceed its benefits. This must be considered in discussion of the potential effects of office automation. Cooperative actions by employers and employees, when they are sought in good faith and are successful, are in theory a more cost-effective strategy than regulation because they can be self-enforcing.

Investment tax credits have encouraged the adoption of capital-intensive technology to improve the efficiency and productivity of the work process, yet often working conditions that emerge from this technology adoption produce adverse stress responses.[121] Tax policies can also directly affect the way physical characteristics of the office are designed. For example, some experts suggest that technicalities in the way depreciation is allowed have encouraged open plan offices so that partitions separating office spaces can be depreciated. In developing standards or guidelines, current tax codes should be examined to ascertain that they will not act as a barrier to intended change.

Workers' Compensation

Under common law, employers have a duty to exercise reasonable care in protecting their employees from harm in dangerous situations. Remedies under the common law of torts have been proposed for many health and safety problems.[122] But in the United States, the laws creating workers' compensation generally make this system the exclusive remedy for employee disability,[123] although in many instances this exclusionary principle has been circumvented by third-party liability suits in which the employee sues the manufacturer of equipment or material (e.g., the thousands of suits against Johns Manville as the producer of asbestos materials).

Workers' compensation does not cover spontaneous abortion, miscarriage or birth defects, since this class of injury does not impair the

[119]R. Kukkonen, et al., "Prevention of Fatigue Amongst Data Entry Operators," unpublished manuscript. Using a quasi-experimental design, the researchers were able to demonstrate significant decreases in neck and shoulder symptoms, back symptoms, and clinically defined neck/shoulder tenderness and hardening.

[120]Report of the President's Commission on Industrial Competitiveness, as cited in *The Occupational Health and Safety Newsletter*, vol. 15, No. 5, p. 3, 1985.

[121]Michael Beer and James W. Driscoll, "Strategies for Change," *Improving Life at Work*, op. cit, 1977, pp. 364-453.

[122]These typically fall into three categories—negligence, product liability, and strict liability. In negligence actions, the employee must demonstrate that the employer was negligent in the maintenance or inspection of equipment or did not adequately warn the employee about risks inherent in its use. These actions must be shown to cause proximate harm to the employee and not to be a part of normal dangers inherent in the job. Since it is very difficult to demonstrate a causal link between VDT use and any adverse health outcome, this area of legal action has limited utility. The same analysis can be applied to product liability and strict liability. William Prosser, *Handbook of the Law of Torts*, 4th ed. (St. Paul: West Publishing, 1971).

[123]Workers compensation is a broad disability insurance program in which awards based on loss of earning power are paid to workers whenever they are injured on the job. Under workers' compensation the employee must establish that the condition arose from employment. (Typically the terms proximate cause, producing cause and contributing cause are used to refer to the relationship between the working conditions and the injury or disease.) Where a claim is upheld, a schedule of payments is set up for . worker based on some formula that determines the extent that the worker is disabled or suffers a decrease in wage-earning capacity. The clear intent of the statute is to compensate all work-related injuries. (This section draws on the work of the National Council on Compensation Insurance report, *Emotional Stress in the Workplace—New Legal Rights in the Eighties*, New York, 1984.) When an injury is found to be covered by a workers' compensation act, it is usually held that the statutory compensation is the exclusive remedy and any recovery at common law (tort law) is barred. (Prosser, op. cit.)

worker's earning power.[124] It has allowed for compensation for stress-related diseases and disabilities along with visual and musculoskeletal system injuries. Table 5-11 contains three examples of workers' compensation claims for injury in automated workplaces. The worker must show a causal link between work in an automated office and the injury. Currently, for the VDT operator there is very little direct causal evidence for visual and musculoskeletal injuries and for stress-related injuries. Where an organic cause can be found to explain the injury the claim is easier to interpret. Thus, demonstrating that some characteristic of the automated office environment led to a biological change in the worker is the clearest vehicle for establishing a compensation case. These conditions while impairing the worker's ability to work, may not be medically detectable, so the primary instrument for identifying illness and injury to the office worker is through the reporting of symptoms. Thus, it is difficult to demonstrate proximate causality.

If the condition predated employment or was aggravated by conditions outside the job the claim may be disallowed or the compensation reduced. For the VDT operator who goes home and watches television (also a cathode ray tube) or has personal problems that produce adverse stress responses, it is difficult to argue that the work was the source of the injury, although workers who spend over 7 hours a day at a terminal may make such an argument effectively. In addition, many chronic debilitating visual and musculoskeletal injuries do not occur suddenly and unexpectedly, so that claims are likely to be awarded only in States that accept gradual developments of an injury over time.

The workers' compensation system was meant to also serve as a preventive measure; forcing employers to pay for injuries and diseases arising from employment should encourage them to develop preventive strategies. Emerging office problems may develop into compensatable disabilities, but the current work force would not benefit from the incentives for prevention created by the rise in compensation claims. Yet today's employee cannot sue the employer in most States through the common law of torts since visual, musculoskeletal, and stress-related conditions are compensable.

Mental Disability.—There has recently been an increase in workers' compensation claims related to mental stress. The California Worker's Compensation Institute found that stress claims doubled from 1980 to 1982, while claims for other disabling work injuries decreased during the same period.[125] Workers' compensation for mental disability arising from employment is greatest among younger workers, as shown in figure 5-3. Mental stress is significant by itself, and may also predict future development of stress-related diseases. If it does, any increase in claims because of office automation could be costly to society. Table 5-12 provides several examples of successful workers' com-

[124] John Parry, Jeanne Dooley, David Rapoport, and John Taylor, "Are VDTs Hazardous to Your Legal Health?" *Mental and Physical Disability Law Reporter*, vol. 8, No. 4, 1984, pp. 342-360. For a more complete discussion of the workers' compensation system and its evolution see *Reproductive Hazards in the Workplace*, op cit.; or Peter Barth and H. Allan Hunt, *Workers' Compensation and Work-Related Illnesses and Diseases* (Cambridge: MIT Press, 1980).

[125] California Worker's Compensation Institute, *Bulletin*, Apr. 20, 1983.

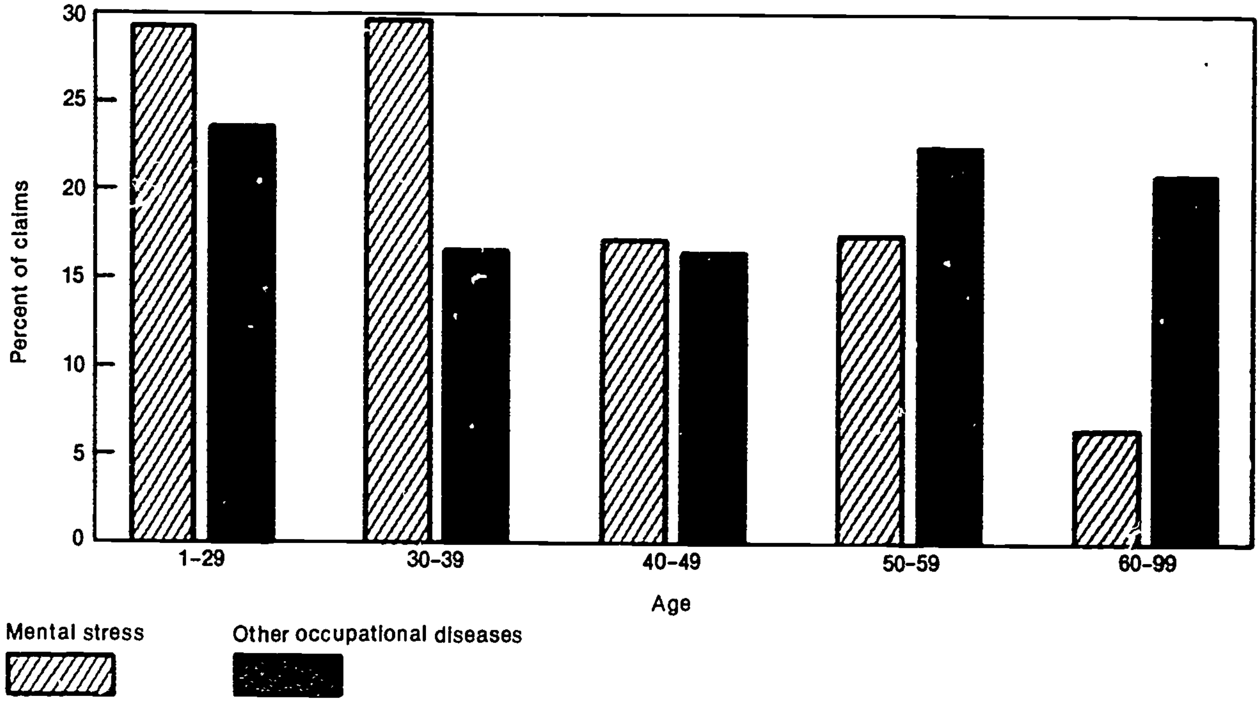
Table 5-11.—Workers' Compensation Claims for Employees Working at Video Display Terminals

Job	Problem	Injury
Word processing	Stress of 6 to 8 hours VDT work per day	Nervous breakdown[a]
Insurance claims processor	Repetitive work at VDT lead to wrist pain	Carpal tunnel syndrome[b]
Word processing	Severe headaches Sensitivity to light Visual pain	Accommodative spasm[a]

[a] Settled prior to judgment
[b] Claim awarded

SOURCE *Legal Rights for VDT Users* (Cleveland, OH: Working Womens' Educational Fund, 1985)

Figure 5-3.—A Comparison of Workers' Compensation Claims for Mental Stress and Other Occupational Diseases



SOURCE: National Council on Compensation Insurance, *Emotional Stress in the Workplace—New Legal Rights in the Eighties* (New York, 1985).

Table 5-12.—Examples of Mental Stress—Mental Disability Claims for White-Collar Workers

Occupation of claimant	Alleged work-related mental stress	Alleged mental disability
Advertising manager	Overworked, supervisor requested early retirement	Anxiety, depression
Claims director	Job pressures	Psychiatric illness
Data analyst/control clerk	Inability to perform job duties	Psychological disability
Insurance underwriter	Increase in job duties	Mental breakdown
Secretary	Increase in job duties	Depressive neurosis

SOURCE: *Emotional Stress in the Workplace—New Legal Rights in the Eighties* (New York National Council on Compensation Insurance, 1984).

pensation claims for mental disability, showing the variability in both the alleged cause and the disability. The workers' compensation system can be considered as an early warning system for the effects of office automation on the mental health of the worker.

Claims for mental stress and mental disability decrease with increasing age and are greater among women than men.[126] This could be the result of a cohort effect; younger workers are probably more likely to demand rights in the workplace than are older workers. It also corresponds to the trend of increasing automation of the workplace that affects younger workers. Since a majority of the claims have been filed by women (54.2 percent), it may be logical to infer a relationship with the recent technological changes; the workers first affected by office automation in the 1960s and 1970s were predominantly women.[127]

[126] These results are based on a random sampling of claims from 1980 to 1982 in 13 States representing geographic variability. The study is described in National Council on Compensation Insurance, op. cit.

[127] It has been suggested that the highly publicized mental disability claims associated with stress may lead to a greater reporting and filing of similar claims. It may be that the legal recognition of mental disability claims has led to an increase in the number of claims. This is important in mental stress claims because of the universality of stress across all occupations.

Indemnity costs for gradual mental stress claims were less than 60 percent as high as the costs for other occupational diseases per average claim in 1980, but surpassed these claims in 1982. Also, the average medical costs incurred for gradual mental stress claims passed other occupational diseases in 1981.[128] Mental disability awards could become an economic burden for industry.

If workers attribute their adverse stress responses to the VDT and workers compensation claims become a common avenue for compensation, then the system may become overburdened, with the employer becoming a universal insurer. The workers' compensation system is at a crossroads in determining whether a worker who is unable to work because of mental disability is to be treated differently from a worker unable to work due to a physical injury arising out of employment.

There have been relatively few compensation claims specifically related to work at a VDT (about 30), most for physical injury but some for mental injury. In one case a VDT operator claimed that the VDT contributed to an already high-pressure atmosphere, leading to three stress reactions during a 7-month period. Her claim was upheld by the New Jersey workers' compensation board.

There seem to be three compensable categories of mental stress. The stress response as a usual condition of the work environment is perhaps the most liberal and far-reaching of the categories. The recognition that gradual accumulation of mental stress is a cause of the mental disability is important since many stress responses in offices result from the incremental or chronic conditions of work rather than from any single acute event. Second, the stress responses can result from a continuing set of unusual conditions in the work environment, for example, an increase in job duties because of new office technologies. Third, the stress reaction can be due to a sudden and unusual event in the work environment, for example, the witnessing of a coworker's heart attack. The only condition under which this could be associated with office automation is if the technological change itself were construed as a traumatic event. Perhaps an acute fear of being exposed to a terminal that purportedly emits hazardous radiation could lead a person to an episode of mental disability.[129]

Fifteen States have no relevant statutory limitations. Seven State courts have concluded that mental disability is to be treated no differently than physical disability if working conditions are the cause of the disability; nine have ruled mental disability is not compensatable. Most of the States that have taken the position that mental disability claims are not compensable have strictly interpreted the statutes defining injury to be of a physical nature. Eight States have adopted the idea of an acute event in employment as proximate cause. They allow mental disability claims when there has been some traumatic event that can be identified as the proximate cause of the disability. Eleven States have upheld the right of the worker to claim a mental disability if the stress exceeds the stress of everyday work. In these States, there have been cautions about limiting the scope of the compensation system to avoid the development of a social health insurance program.

The Federal Government acted first (1908, 1916) to establish workers' compensation for Federal railroad and then for other employees.[130] Since then, the workers' compensation system has evolved at the State level relatively without Federal interventions, although there have been proposals from time to time to create a Federal system. One role the Federal Government might play is to serve as an information clearinghouse for issues of office automa-

[128] National Council on Compensation Insurance, op. cit., p. 6.

[129] This is analogous to the idea of a pollutant on the job, where the effects of the pollutant are unknown. The Montana Supreme Court has allowed such a compensation to be awarded to a worker who developed psychological problems on exposure to pollutants at work (*McMahon* v. *The Anaconda Company*, No. 81-34 (Montana Supreme Court, Mar. 29, 1984), 8 MPDLR 291).

[130] M.B. Kent, *A History of Occupational Safety and Health in the United States*, 1983, as cited in *Preventing Illness and Injury in the Workplace*, op. cit.

tion and stress responses, to provide States with the most recent scientific evidence for making decisions. Clearly, automation is the dominant change in office work and many mental disability claims in the next two decades are likely to revolve around the effects of the new office technologies.

Standards or Guidelines

Since ergonomic factors in office equipment are important to the health of the American worker and the productivity of American business, there have been proposals that ergonomic standards or guidelines be developed, either by government or other institutions.[131] A recent discussion of regulatory policy pointed out that health and safety regulations should focus on threshold limit values on exposure as oppposed to means for reducing exposure such as design standards.[132] Standards can only be developed with the appropriate measurement techniques.[133] Working conditions that produce adverse stress responses can be measured in many different ways and scientists disagree on which ways are best. Therefore, the development of standards for working conditions that produce psychological and biological stress responses in individuals may be an option to consider only when there are valid and objective measures of the working conditions.[134]

Any standards development process would have to consider issues raised in the recent benzene standard case decided by the U.S. Supreme Court and the noise standard case decided by the U.S. Circuit Court of Appeals in Richmond, Virginia, which exemplify the impact judicial decisions may have on occupational health and safety policy. In the noise case the judges invalidated a standard on the grounds that it might on the basis of medical examiniations require employees to take actions concerning hearing loss caused by nonoccupational factors.[135] While progressive hearing loss can be identified through medical exams, the exams can not distinguish between loss resulting from occupational and nonoccupational sources of noise. The ruling has been reversed by the same court. If upheld, it would have probably severely restricted the development of Federal standards for automated offices where most exposures are chronic and confounded by nonoccupational factors.

The Supreme Court in 1980 upheld an earlier lower court decision striking down the 1978 OSHA benzene standard. They found (5 to 4) that OSHA had not established a threshold limit for benzene posing a significant risk to the worker. The Secretary of Labor must demonstrate that a workplace threatens the worker with a significant risk of harm.[136] Although providing limited guidance as to what significant risk means or how it should be calculated, the Supreme Court decision has demanded a more rigorous scientific treatment of occupational safety and health standards.[137] The setting of standards designed to improve the health and well-being of the office workers would have to take into account this decision.

However, standards can be developed and adopted voluntarily. There are three general types of standards; engineering, informational, and administrative. Engineering standards (which include design standards) establish alternative means of interfacing with the technology or alternative means of building the technology to ensure the health and safety of

[131] In 1981, the Science and Technology Committee of the House of Representatives held hearings, "The Human Factor in Productivity." These hearings are the most recent attempt to gather information about the role of human factors in industrial competitiveness (see, *The Human Factor in Innovation and Productivity*, U.S. House of Representatives, Committee on Science and Technology, Subcommittee on Science, Technology, and Research, 97th Cong., 1st sess., 1981).

[132] Douglas H. Ginsburg, "Administrative Efforts to Enhance the Opportunities for Self-Regulation," *Labor Law Journal*, vol. 35, No. 12, 1984, pp. 731-735.

[133] Becker, op. cit.

[134] Edward E. Lawler, "Should the Quality of Work Life be Legislated?" *The Personnel Administrator*, vol. 21, No. 4, 1976, pp 17- 21. See also, Edwin A. Locke, "The Case Against Legislating the Quality of Work Life," *The Personnel Administrator*, vol. 21, No. 4, 1976, pp. 19-21.

[135] Reported in the *Occupational Safety and Health Letter*, vol. 15, No. 1, 1985, p. 2.

[136] Industrial Union Department, *AFL-CIO* v. *American Petroleum Institute*, 448 U.S. 607 (Supreme Court, July 2, 1980).

[137] For a full discussion of the implications of this decision for OSHA standards setting see, *Preventing Illness and Injury in the Workplace*, op. cit.

the worker. Informational standards include product labeling, instructions for proper use, and other means of transferring information from the employer or manufacturer to the worker. Administrative standards establish organizational policies such as rest breaks. A key policy issue is how to ensure that the standards development process is based on sound scientific evidence.[138]

Design Standards.—The possibility of office and workstation-design standards has received much attention, spurred on by bills introduced into at least 18 State legislatures, and by the development of standards in other countries. The Governor of New Mexico has issued an executive order (No. 85-11) mandating ergonomic guidelines for State employees. Such proposals and actions are based on the assumption that there are definable and measurable characteristics of both the office and the workstation that, if modified, will improve health and worker performance. A major issue is whether standards should be voluntary or required—self-regulation or governmental regulation. It is argued that self-regulation is more flexible, and standards can be tailored to meet the specific office automation application. However, a second question is whether many organizations would voluntarily pay the front-end or retrofitting cost that might be entailed.[139]

Another issue is that of fairness; standards development committees composed of special interest groups are often suspect. Especially in promulgating mandated standards, balanced groups of consumers, producers and other affected parties may be preferable for the development and enforcement of standards.[140] A major impetus for currently proposed State bills is a concern over the inadequacy of voluntary standards for these reasons. One option at the national level would be to establish a national commission to oversee standards development or to empower the National Bureau of Standards with such duties.[141]

A third problem is that of the appropriate level of specificity for design standards. The level of specificity in State bills varies widely, indicative of the uncertainty as to the most effective way to modify the work environment to accommodate new office technologies.[142] International standards reflect differing approaches, different populations, and different goals. The very specific German standards are meant to standardize the building and production of office equipment, while Swedish standards are more like guidelines to be used in negotiation between the unions and management. Japanese guidelines are not binding and are very general.

Other major issues in standards development are how to define enforcement mechanisms for government standards and how to ensure that the development of standards spurs rather than impedes the development of more protective technology in the future. Standards can be established at either the Federal, State, or organizational level by the use of procurement schedules.[143] California, New Mexico, Massachusetts, and Wisconsin have all developed procurement guidelines for the purchase of workstation equipment in the public sector.

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[138]An examination of the currently proposed office standards for State bills demonstrates problems in the standards development process; general lighting levels vary from 500 lux or less to greater than 700 lux. International standards also do not agree. There is no general national or international consensus on the best way to establish standards for office automation. The lack of consensus may reflect the generally agreed need to maximize flexibility in current design to accommodate a variety of future needs. This need for flexibility is clearly reflected in the mechanisms for controlling glare in proposed State bills, which range from installing indirect lighting; to antiglare filters; to proper placement of the terminals with respect to windows; to task lighting; to screen hoods.

[139]Francis Ventre, "Transforming Environmental Research Into Regulatory Policy," *Responding to Social Change*, Basil Honikman (ed.) (New York: Halstead Press, 1984).

[140]Ginsburg, op. cit.

[141]Currently, the National Bureau of Standards coordinates within the Federal Government and assists the private sector in the procedures and policy for the development and application of standards; however, they have no enforcement powers.

[142]Currently, the Human Factors Society in conjunction with the American National Standards Institute is developing a set of standards for the physical and perceptual ergonomics of visual display terminal workstations. These standards contend that ergonomics is highly applications dependent and looks only at word processing, data-entry, and data-inquiry tasks.

[143]O. Ostberg, et al., "Ergonomic Procurement Guidelines for Visual Display Units as a Tool for Progressive Change," *The Proceedings of the Eleventh International Symposium on Human Factors in Telecommunications*, Sept. 9-13, 1985, Cesson-Sevigne, France.

Information Standards.—These might provide the employee and employer with information about, for example, the recommended lighting levels for using a particular display terminal. Rhode Island has just passed a law requiring the State Department of Labor to develop a brochure on VDT use and to hold training sessions throughout the State.

Health and Safety Standards.—They are administrative standards. At the Federal level, an initial policy consideration would be to decide whether they should be developed within a single agency or by several agencies. The former would eliminate replication, while the latter would ensure that all areas are covered. Currently, OSHA, the Consumer Products Safety Commission (CPSC), and the Department of Health and Human Services (DHHS) can develop standards that might be adapted to address new office technologies. For example, the OSHA Health Hazard Communication standard is intended to disseminate information about chemical health hazards and only applies to the manufacturing sector. For OSHA to disseminate information about health and safety issues in office automation under the Health Hazard Communication Standard, that authority might have to be broadened.[144] Alternatively, the recently proposed High Risk Occupational Disease Notification and Prevention Act of 1985 (H.R. 1309), would establish within NIOSH the authority to disseminate information to persons at an elevated risk for the development of disease. Only workers at an elevated risk will receive counseling and medical monitoring. The disadvantage to this approach is that it requires prior knowledge about the development of the disease and the risk to the worker. A broader approach is to provide information to all employers and employees so that the factors associated with health and safety can be discussed before the equipment is installed. This would require input from many sectors of the Federal Government.

[144]A recent court decision suggested that OSHA expand the scope of the standard to include nonmanufacturing industries, U.S. Court of Appeals, 3rd Circuit, Case No. 83-3554.

Eye examinations, rest breaks, semiannual equipment inspections, and transfers for pregnant VDT operators could be handled through administrative standards. Several countries have standards or guidelines regarding visual exams.[145] Legislation calling for rest breaks has been proposed in several States, and several nations have guidelines or standards with respect to rest breaks.[146] Although Sweden's practice of 15 minute rest breaks after every hour or 2 hours (depending on the work) is often cited, this is not a national standard but results from agreements between labor organizations and management. This will change with the issuance of the *Ordinance Concerning Work With Computer Displays.*[147] This ordinance requires that employees who work more one-half hour consecutively on the VDT on a daily basis, must receive eye exams. In Britain, the Health and Safety Executive recognizes that "the most satisfactory length of pause can only be determined by consideration of the individual operator's job . . . ,"[148] and recommends that natural breaks be built into jobs, with a mix of VDT and non-VDT work; goals are provided to be used in labor-management bargaining.

Guidelines.—The examples above point to the problems of standards development, which is both a scientific and a political process. Communications between the scientific and political communities are sometimes lagging and mechanisms for encouraging more dialog are needed.

[145]Japanese provisional guidelines for VDT work call for a visual exam as part of the preemployment medical exam, with regular eye tests thereafter. West German regulations say that VDT workers should have eye exams every 5 years until age 45 and every 3 years thereafter. In France, two regulations stipulate eye exams and special medical surveillance for VDT users. But Great Britain does not recognize the need for visual standards for VDT usage "which are any different from other clerical work."

[146]Two Swedish standards call for periodic intermissions without specifying length or frequency; Japan's provisional guidelines call for at least a 10-15 minute break after each hour of VDT work.

[147]*Ordinance Concerning Work With Computer Displays,* translated by Dr. Olov Ostberg. This ordinance has not gone into effect yet.

[148]Great Britain, Health and Safety Executive, *Visual Display Units* (London. Her Majesty's Stationary Office, 1983), p. 13.

An alternative to mandated standards is the development of guidelines articulating goals. Both Sweden and Japan have established goals for workstation design. In Japan, these are wholly voluntary; in Sweden the guidelines are presented as the government's position and are used in collective bargaining. Guidelines recognize the variability in the way office technologies can be implemented. They can be established within the broader context of an institutionalized change process. In some countries this is environmental legislation;[149] for example, the Work Environment Act of Norway (1977) says, "An effort shall be made to avoid monotonous repetitive jobs and jobs which are determined by a machine . . . to such an extent that the worker is prevented from altering his rate of working." Such acts give those involved in the change process a national policy against which to evaluate their efforts. Such goals and guidelines are only as effective as the commitment on the part of employers and employees to cooperatively achieve them, and on the part of government to monitor and actively encourage their progress.

Research Needs

Congressional hearings have addressed the issue of possible hazards of VDT work,[150] and much has been written on the subject, but workers still wonder if new technology is dangerous. A possible public policy response is to encourage research on various illness and disease outcomes associated with the computer mediation of work, both to answer the questions in the minds of the public and to demonstrate the feasibility of using new office technologies as both a public health and a productivity tool.

The OSHA Act (section 20) mandates continued research and demonstration projects exploring emerging problems including psychological factors (such as stress) created by new technologies. Office automation is one technological change with such a broad exposure that Congress may wish to insist that the Department of Health and Human Services put high priority on investigating the health and safety issues, demonstrating practices to reduce any potential effects, and disseminating such information.

There is a need for at least three directions in the research. The first is to follow office workers over time to develop risk estimates of the relative contribution of office automation to the natural history of a disease, focusing on those populations at greatest risk today (clerical and technical workers), and also considering the changes in the work of managers and professionals. This field research should be complemented by lab research to test relationships between working conditions and biological processes.

The second is to define the appropriate measures of the physical conditions of work. Field evidence that compares objective measures of the physical environment to subjective measures of the quality of worklife is limited. The tools for measurement must be sharpened and refined to assess the many subtle causes and outcomes characteristic of office work. If it could be demonstrated that subjective measures are valid indicators of the physical environment and discriminate the various health, performance and job attitudes, less costly evaluations of the work environment would be possible.

Third, intervention and field evaluation studies are needed to verify claims that changes in ergonomic or other working conditions can improve worker productivity and reduce health problems. These efforts should focus on high risk groups of office workers or identify high risk working conditions and develop modification strategies.

[149]Federal Republic of Germany: The Works Constitution Act of 1972; The Netherlands: Working Environment Act of 1980; Norway: Work Environment Act of 1977 (also known as the Act Respecting Workers' Protection and the Working Environment); Sweden: Working Environment Act of 1974; Denmark: Act Respecting the Working Environment; German Democratic Republic: Labour Code as Amended June 1977. These acts deal with all working conditions, including office automation.

[150]U.S. Congress, Committee on Science and Technology, Subcommittee on Investigations and Oversight, *Potential Health Effects of VDT Terminals and Radiofrequency Heaters and Sealers*, 97th Cong., 2d. sess., May 12-13, 1981. U.S. Congress, Committee on Education and Labor, Subcommittee on Health and Safety, *OSHA Oversight: Video Display Terminals in the Workplace*, 98th Cong., 2d sess., 1984.

The Health Promotion and Disease Prevention Amendments of 1984, which establish research centers for disease prevention and health promotion across the country, administered by the Centers for Disease Control. These centers could conduct the research projects mentioned above.

Finally, it is important to know the true extent of the problem. How prevalent are poor working conditions? Section 20(a)(7) of the OSHA Act stipulates that the Department of Health and Human Services conduct industry-wide studies of the effects of chronic low-level exposures on the health of workers. This need for reliable data also points to a need for a centralized data collection system for monitoring the emerging problems. There is now no single source of this data. The current industry and occupational surveillance systems are disparate and difficult to link together. In testimony before Congress the Assistant Surgeon General noted:

> The activities do not provide a comprehensive epidemiologic surveillance of occupational diseases and injuries in the United States ... Unless our efforts are targeted toward comprehensive data collection and synthesis, the confusion will only grow worse.[151]

The current data collection system at the Bureau of Labor Statistics (BLS) is not able to identify the extent of office automation in white-collar occupations. There is a need to develop not only reliable indicators of national trends in morbidity, but also broad national descriptions of those working conditions likely to place the worker at highest risk. The Job Training Partnership Act of 1982, Section 462(b) states: "the Secretary shall maintain descriptions of job duties, training and education requirements, working conditions, and characteristics of occupations." There is a need to further refine the definitions used in the Dictionary of Occupational Titles to reflect the current changes in the workplace. An early warning system could be developed by linking these data sources.[152] This would allow researchers and policymakers to estimate the relative severity of problems among different classes of workers.

Legislation recently introduced into the House of Representatives would establish an early warning system to identify workers at an increased risk for occupational disease (H.R. 1309). This bill could be amended to include language establishing a national morbidity surveillance system for the development of chronic diseases related to technological changes.

Labor-Management Relations and Office Automation

As has been pointed out, one strategy for improving quality of worklife is through standards development, and a second is the setting of goals or objectives, encorporated in public or private sector guidelines. Another way to work toward goal-directed change is through collective bargaining. In Europe, there is much emphasis on involving worker representatives in office automation planning. In some countries there is a national or local work council to which industry supplies information about office automation plans. This creates the framework for monitoring how well organizations are moving toward established goals, minimizing the need for government enforcement.[153] This process of involving workers in technology planning is part of a process called codetermination, a phrase that has gained some popularity in this country.

While the legal right to be kept informed about technological change has not been ex-

[151] Assistant Surgeon General J. Donald Millar, cited in *Occupational Illness Data Collection: Fragmented, Unreliable, and Seventy Years Behind Communicable Disease Surveillance*, U.S. Congress, Committee on Government Operations, House Report 98-1144 (Washington, DC: U.S. Government Printing Office, 1984).

[152] For the importance of linking databases to inform policymakers, and current impediments see, *Legal and Administrative Impediments to the Conduct of Epidemiologic Research*, Task Force on Environmental Cancer and Heart and Lung Disease, 1984.

[153] Federal Republic of Germany: Works Constitution Act of 1972; The Netherlands: Works Council Act of 1979; Norway: Work Environment Act of 1977; United Kingdom: Employment Protection Act of 1975, France: Act No. 82-915 of Oct. 28, 1982 and Act No. 82-689 of Aug. 4, 1982; Sweden: Act Representing Co-Determination of Work, 1976. For further detail see *Automation, Work Organization, and Occupational Stress* (Geneva: International Labour Organization, 1984).

tended to American workers, the National Labor-Management Relations Act guarantees the right to bargain collectively with management. Thus rather than intervening directly in office automation related quality of worklife problems, the Federal government can choose to leave this to industry self-regulation, judicial decisions, and labor-management relations, with National Labor Relations Board interventions when they are called for.

Collective bargaining could function as a forum for r :olving quality of worklife issues related to office automation.[154] The National Labor Relations Act (NLRA) established collective bargaining to reduce the need for government regulation by providing bargaining power to all parties.[155] But the ability to use collective bargaining as an avenue for discussion of stress, health, and ergonomic problems surrounding office automation is limited by the low level of participation of office workers in collective bargaining units.

Fair representation in this process also depends on judicial decisions and National Labor Relations Board (NLRB) decisions about the scope of the law and whether a series of acts and amendments designed to deal primarily with blue-collar occupations applies equally well to white-collar occupations. A complicating factor is that in white-collar work, distinctions between management and labor tend to be blurred. In recent cases over whether a group of workers has the right to organize, the courts have been confronted with problems of determining whether professionals are workers or part of management, and who makes decisions for the employer.[156] As office automation leads to task bundling, the distinctions between management and workers will blur further. A recent Supreme Court decision reemphasized earlier questioning of the intent of Congress in several sections of NLRA:[157] was the intent to prohibit certain types of collective bargaining over technological change? Current laws may require clarification in this regard.

While some labor contracts contain clauses concerning automation, negotiation about the decision to automate is not construed as mandatory by either NLRB or the courts. However, it is also not clear that management has an absolute right to automate. The employer does have the right to determine equipment needs and the size of the work force, and can change the nature and scope of the business, but only if it does not affect contract terms and conditions of employment. Technology bargaining has become a focus of the collective bargaining process and the extent of employee rights and employer prerogatives is decided on a case-by-case basis by NLRB and the courts.

[154]There are other mechanisms through which workers can participate in organizational decisionmaking about technological change, but they are specific to an organization or industry. There has been, for example, great interest in the Japanese system of quality control circles. One observer notes: "Predecision joint consultation to solve the problems of manpower and employment due to drastic technological changes developed around 1960, and . . . built up to become a basic part of the later Japanese industrial relations. . . . This practice often takes the place of collective bargaining in Japanese industry. Akihiro Ishikawa, "Microelectronics and Japanese Industrial Relations," *Microprocessors, Manpower, and Society*, Malcom Warner (ed.) (New York: St. Martin's Press, 1984).

In Germany, the development of Work Councils at the local shop-floor level came after World War II. These councils are separate from unions in Germany and make many decisions at the local shop-floor level. These alternatives to collective bargaining never developed in the United States to any significant degree.

[155]NLRA gives employees the right to organize and join a union. At least 30 percent of the employees of an organization must petition NLRB to have an election, and to win certification as a bargaining representative the union must win the votes of a majority of the employees. Once the union is certified, the employer is obligated to enter into collective bargaining over wages, hours, and other terms and conditions of employment to develop a contractual agreement, which typically will last 1 to 3 years. NLRB does not oversee specific contract terms, but can be asked to intervene if either party does not act in good faith. Any worker has the right to file an unfair labor practice charge if she believes constraint, coercion, or discrimination has been used.

[156]Marina Angel, "Professionals and Unionization," *Minnesota Law Review*, vol. 166, 1982, pp. 383-457.

[157]In *NLRA* v. *International Longshoremen's Association*, AFL-CIO, et al. (Case No. 84-861, June 27, 1985), the court said "The only question thus to be decided . . . is whether Congress meant, in enacting Sec. 8(b)(4)(B) and 8(e) . . . to prevent this kind of labor-management arrangement designed to forestall possible adverse effects upon workers arising from changing technology."

The strategy of using collective bargaining for addressing quality of worklife issues related to office automation is limited both by the relatively small number of office workers covered by union agreements and by the nature of the process; both topics are addressed below.

White Collar Unions and Worker Representation

According to BLS statistics, only 19 percent of all U.S. workers belong to labor unions and among office workers the level of unionization is much lower. About 14 percent of clerical workers belong to unions and about 17 percent are in bargaining units covered by union contracts.[158] Professional specialty workers have a higher level of unionization, 23 percent, but this reflects the large number of teachers belonging to unions or professional associations. Only 6 percent of executive, administrative, and managerial workers belong to unions.[159]

Unionization of office workers tends to follow industry lines; in industries where manufacturing workers are highly organized (see table 5-12) they are more likely to belong to unions than in other industries, such as the insurance industry, where office automation has been heavily adopted. The figures show levels of union membership for broad industry categories; the first two rows include most office workers.[160] It has traditionally been difficult for unions to organize office workers, primarily because of their close relationship with management and identification with the middle class. In every occupational category, the number of workers covered by a union or employee association contract decreased slightly from 1983 to 1984 (see figure 5-4).

The influx of women into clerical jobs may have retarded unionization,[161] because they were a ready supply of low-paid workers, and have historically been slower to join unions. It has been suggested however that the changes in the office workplace brought on by office automation will increase the level of unionization among clerical workers, in those places where office work is becoming routinized and more like factory work. Alternatively, office automation can improve jobs; if unions can present themselves as mechanisms for ensuring these improvements, they may have greater appeal to office workers.

A policy question to be considered then is whether the Federal Government should take steps to encourage technology-related bargaining in labor-management negotiations, and also encourage other mechanisms to improve the opportunity for office workers to be represented in discussions about office automation.

Technology Bargaining

Traditional subjects for collective bargaining have included wages, fringe benefits, and hours. Increasingly unions are also dealing with questions of health and safety, electronic monitoring, and job security. Technological change is also a major issue, but technology is a difficult subject for collective bargaining. One recent survey found technological change provisions present in fewer than 20 percent of current agreements.[162] Labor organizations can seek to deal with technological change issues by trying to influence: 1) the introduction of new technology per se; 2) the changing nature of the jobs; 3) changes in skills requirements or status; or 4) work force reductions.

The choice of what technology to use (for manufacturing or for office work) has traditionally belonged to management, and many

[158]Bargaining units cover all workers whether or not they belong to the union.

[159]Paul O. Flaim, "New Data on Union Members and Their Earnings," to be published in *Monthly Labor Review*.

[160]Office workers are represented by a large number of unions including the Communications Workers of America, Office and Professional Employees (OPEIU), the Newspaper Guild, the United Food and Commercial Workers, the Service Employees International Union (SEIU), American Federation of Government Employees (AFGE), American Federation of State, County, and Municipal Employees (AFSCME), and others. District 925 is a new nationwide office workers union formed by SEIU and Nine to Five: the National Association of Working Women, in 1981.

[161]Roberta Goldberg, *Organizing Women Office Workers: Dissatisfaction, Consciousness, and Action* (New York: Praeger Publishers, 1983).

[162]Cited in Kevin Murphy, *Technological Change Clauses in Collective Bargaining Agreements*, Department for Professional Employees, AFL-CIO, Publication #81-2, August 1982, p. 5.

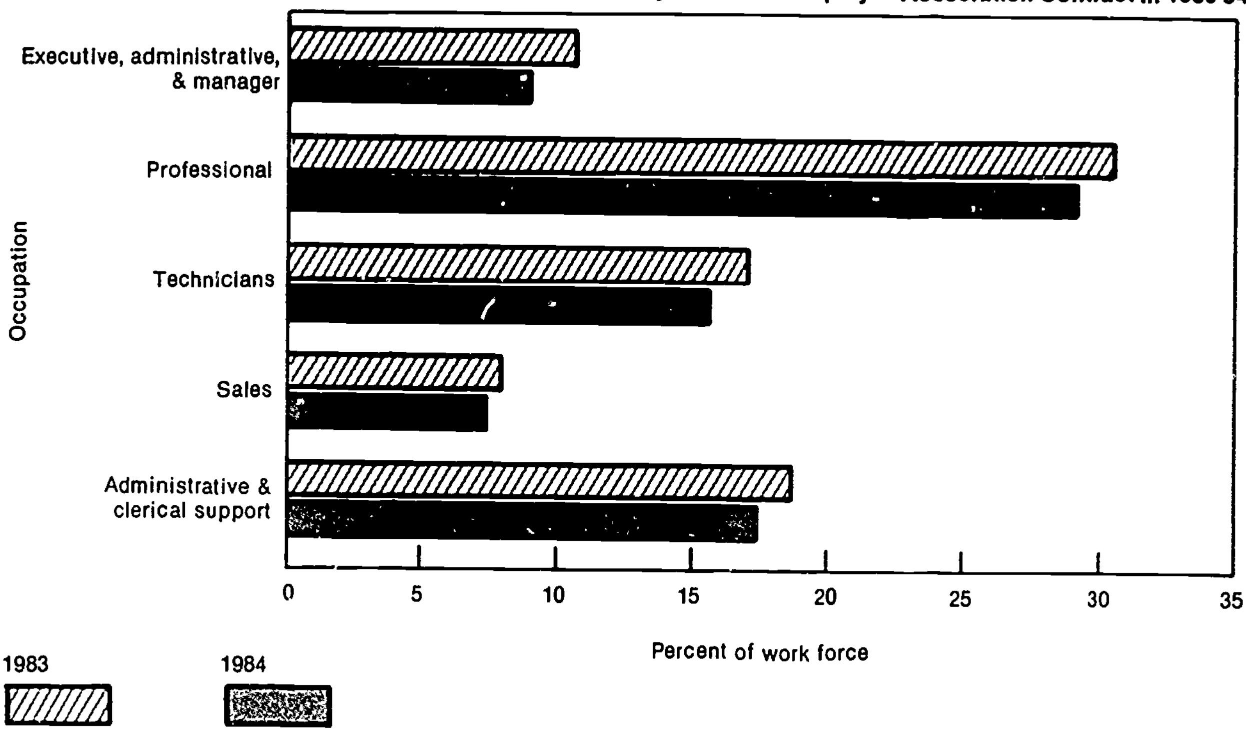
Table 5-13.—Union Membership by Industry and Occupation

Occupation	Industry: Total[a]	Mining	Construction	Manufacturing	Transportation, communication, utilities	Trade	Financial, insurance, real estate	Service	Government
All occupations	15.6	17.9	24.3	26.5	39.6	8.2	2.7	7.2	35.9
Management/professional specialist	5.2	1.7	8.6	4.0	11.1	1.8	1.7	6.7	38.1
Technicians/sales/administrative	8.0	3.3	2.9	10.4	34.8	6.6	2.2	5.1	30.2
Service	8.7	(b)	(b)	35.2	49.0	4.4	12.4	8.6	39.4
Operator/fabricator/laborer	33.6	32.9	25 7	39 2	47.1	20.4	(b)	11.3	36 2

[a]The totals include agriculture, forestry, and fishery occupations which are not listed separatel,. This number includes private sector union membership, excluding government membership.
[b]The data do not meet publication standards.

SOURCE: Larry T Adams, "Changing Employment Patterns of Organized Workers," *Monthly Labor Review*, February 1985, pp. 25-31, uses data from Current Population Survey, Bureau of Labor Statistics.

Figure 5-4.—Employed Wage and Salary Workers Covered by a Union or Employee Association Contract in 1983-84



SOURCE Paul O Flaim, "New Data on Union Members and Their Earnings," to be published in the *Monthly Labor Review*

labor agreements include a "management rights clause" that gives management sole authority over "processes and types of machinery and equipment to be used, types of products to be manufactured, quality of material and workmanship required, selling prices of products . . . "[163]

[163]Murphy, op. cit., p. 5.

NLRA does not specifically identify technology as a subject for the bargaining process. There has been no definitive decision on whether or not management has a duty to bargain about implementation of new technology. In the past, the NLRB has:

> . . .shown a willingness to extend the duty to bargain over the introduction of technological change to the decision making stage. The

courts have tended to restrict the duty, requiring only that the employer bargain with labor over the effects of its unilateral decisions . . . [164]

In recent years, both the NKRB and the Supreme Court have tended to favor management's prerogative to effect unilateral change. Yet, a recent Supreme Court decision has partially countered this trend. In a decision regarding the longshoremen, the Supreme Court ruled that:

> Elimination of work in the sense that it is made unnecessary by innovation is not of itself a reason to condemn work preservation agreements . . . ; to the contrary, such elimination provides the very premise for such agreements.[165]

Modified forms of the management rights clause have given the union or the employees right to advance notice of technological change and in some cases the right to consultation in the change. While there is no single blueprint, advance notice and joint consultation seem to be the hallmarks of building a cooperative dialog between labor and management; they reduce opposition and resistance to the change.[166] The Communications Workers of America (CWA), in its agreements with AT&T and the Bell operating companies, has negotiated the right to advanced notice.[167]

Consultation might in rare cases mean participation in the planning and implementation of technological change, but more often it means the right to negotiate about the adjustment mechanisms that will accompany the change, for example, layoffs or retraining.

In Europe, advance notice and the provision of information are usually the first steps in collective bargaining agreements.[168] Advance notice typically means that management must give the workers and their representatives enough time to consult, negotiate, and prepare for the changes. Implementation of the new technology can be made contingent on a collective bargaining agreement. Some agreements specify that the employee be involved in any job redesign.[169]

Close cooperation of unions and management in planning automation systems is rare. The NLRA precludes any person acting in the interest of the employer from being a member of the union.[170] Historically, this has meant that supervisors were excluded. Therefore, if decisions of the planning of technological change are construed to be employer or managerial decisions, union members may be precluded from actively participating in some stages of the decisionmaking.

One policy question for Congress to consider is whether the NLRA needs revision so that the traditional boundaries and relationship between labor and management does not prevent a cooperative planning process.

Cooperative planning is not easy to achieve. Union leaders may be uninformed about techological choices, long-term company, plans or industry conditions. Management decisions may be made at the national headquarters while labor negotiations may take place on a regional basis. Even in Norway, where white-collar unionization is high and where law requires management to inform unions about

[164] Nicholas A. Ashford, "The Impact of Office Automation on the Quality of Worklife. Policy Implications," paper presented at the Office of Technology Assessment Symposium on the Impacts of Office Automation and Computer-Mediated Work on the Quality of Worklife, Dec. 10-12, 1984, p. 30.

[165] *National Labor Relations Board* v. *National Longshoremen's Assn.*, op. cit.

[166] Steven Deutsch, "Technological Change and Labor Management Relations," draft report to the Bureau of Labor-Management Relations and Cooperative Programs, Department of Labor, 1985; used with permission.

[167] Dwight B. Davis, "Workplace High Tech Spurs Retraining Efforts," *High Technology*, November 1984, pp. 60-62.

[168] Examples of the collective bargaining agreements are provided in *Automation, Work Organization and Stress*, op. cit., 1984.

[169] For example. "The employees shall, individually or in groups, be given proper information . . . about conditions at the workplace that affect their own job . . . The employees shall be given an opportunity to take part in designing their own job situations as well as in the work of change and development that affects their jobs " *Agreement on Efficiency and Participation SAF-LO/PTK. Swedish Employer's Confederation* (Stockholm: Andren & Holm, 1982).

[170] Recently, in the case *Yeshiva University* v. *The NLRB*, the Supreme Court ruled that faculty members were managerial employees and therefore not entitled to organize under the NLRA, see *NLRB* v. *Yeshiva Univ.*, 444 U.S. 672 (1980).

industry plans and conditions, actual participation of unions in technological planning is rare. The process of alternating cooperation, conflict, and negotiation requires a large commitment of time and resources from the union.[171]

Several recent labor-management agreements have centered around quality of worklife issues related to VDT use. In late 1984, claims processors at Equitable Life Assurance Company became members of District 925 of SEIU after a 3-year long effort. Points covered in the contract include requirements for detachable keyboards, adjustable chairs, an additional rest break from VDT work, and (in some cases) transfers to non-VDT work for pregnant workers.[172] One strongly worded agreement seeks to prevent the routinization of work through technological change. The contract between District 925 and a legal services organization states that:

> . . . [t]he Employer recognizes that as a general matter the routinization of the secretarial profession through the introduction of new technological changes, such as mag cards, is undesirable, and the Employer has no present intention of doing so.[173]

The problem of electronic monitoring has drawn the attention of at least 30 unions, many of which represent office workers. Several, including the International Federation of Clerical and Technical Employees and the AFL-CIO, have adopted the position that "no VDT monitoring" clauses should be included in contracts, but thus far, no contracts have prohibited monitoring. CWA has won contract language providing that electronic monitoring will be used for training and not for discipline. The SEIU-Equitable contract provides that employees will be given full information about the monitoring system, access to their own records, and the right to file a grievance if they believe their record is inaccurate.[174]

Some union contracts have focused on new job classifications and higher pay for new skills in office automation. AFSCME contracts with the cities of Los Angeles and New York require wage increases when word processing systems are introduced. The contract between Equitable and District 925 also modifies the "piece rate" pay system previously used for VDT workers.[175] The CWA contract with AT&T and the Bell operating companies established quality of worklife committees to deal with the retraining issue, and workers are notified in advance when a job will end so they can be retrained.[176] An agreement between OPEIU and the New York Stock Exchange binds the employer to train displaced employees "for an available job resulting from such technological change or for other jobs which the producer has available . . . ."[177] In some cases, contracts have specified that some form of income maintenance will be available to employees who must be moved to lower paying jobs as a result of automation.[178]

Few unions have been able to negotiate a contract that guarantees no layoffs as a result of technological change, but some contracts have set forth who can be laid off and what severance pay, relocation benefits, or rehiring preference will be given to laid-off workers. However, the recent Supreme Court decision in favor of primary work preservation for longshoremen does uphold the right of the employees to keep secure their work:

> When the objective of an agreement and its enforcement is so clearly one of work preservation as is the one involved here, the lawfulness of the agreement under Secs. 8(b)(4)(B) and 8(e) is secure, absent some other evidence of secondary purpose.[179]

[171] U Briefs, C Ciborra, and L. Schneider (eds.), *Systems Design For, With and By the Users* (Amsterdam: North Holland Publishers, 1983).

[172] Stephanie K. Walter, "A VDT Victory at Equitable Life Dents the Anti-Union Armor," *Management Technology*, January 1985, pp. 6-8.

[173] Ibid.

[174] Alan Westin, *Privacy Issues in the Monitoring of Employee Work on VDTs in the Office Environment: Practices, Interests, and Policy Choices*, prepared for Office of Technology Assessment, December 1984, pp. 119-125.

[175] Walter, op. cit.

[176] Davis, op. cit.

[177] Murphy, op. cit., p. 14.

[178] Ibid.

[179] Supreme Court, op. cit., 1985.

Chapter 6

Confidentiality and Security Issues With Office Automation

Contents

	Page
Privacy, Confidentiality, and Security—Definitions	171
Office and Data Protection	172
The Period 1960-78	174
The Political and Legislative Climate	175
The Third Phase of Office Automation	178
The Handling of Client Data	178
Security and Confidentiality Issues	179
Privacy Issues in Work Monitoring	181
Security and Confidentiality in Automated Public Offices	182
Government Guidelines	183
The Special Concern About Employee Privacy	183
Accidental Losses	184
Comparisons With the Private Sector	185
Policy Considerations	185

Chapter 6

Confidentiality and Security Issues With Office Automation[1]

Protection of privacy or confidentiality in recordkeeping (and security measures to accomplish such protection) is a concern that has continued from the constitutional era of quill, pen, and copybook through the invention of the telegraph, telephone, typewriter, microphone, duplicating machine, large-scale manual filing systems, teletype, electric accounting machinery (EAM), and first-, second-, and third-generation computers. How much data about individuals and groups is needed? Who will use the data? How does one determine what information about oneself should or must be made available to others? What uses will be made of the information?[2] The third phase of office automation—small computers linked or networked—further raises these questions, as the ubiquitous placement of computing devices in offices gives more people more opportunities to access records.

[1]This chapter as a whole draws on a report to OTA, *Privacy and Security Issues in the Use of Personal Information About Clients and Customers on Micro and Personal Computers Used in Office Automation*, prepared by The Educational Fund for Individual Rights, Alan Westin and Lance Hoffman, principal investigators, 1985.

[2]Alan Westin, "New Issues of Computer Privacy in the Eighties," *Proceedings of IFIPS World Congress*, Paris, France, 1983.

PRIVACY, CONFIDENTIALITY, AND SECURITY—DEFINITIONS

Since analysts from various fields and disciplines write about privacy and security issues, there are differences in the use of terms and concepts by these practitioners. In the broadest sense, privacy is a set of values dealing with individuality, autonomy, personal space, and personal information.[3] Privacy deals with the rights of an individual to limit others' access to information about oneself, and the social or legal rules by which such claims are accepted or rejected in particular contexts. Viewed as a desirable attribute of the data and the way it is handled, this is better termed "confidentiality"—the protection of privacy. Security deals with a data-collector's capacity to safeguard the existence and integrity of the data it has collected and to provide the proper degree of confidentiality as set by organizational or legal policy.

Confidentiality and security are related but not synonymous. Confidentiality addresses the use of data about individuals. Security is concerned with the accidental or intentional theft, modification, or destruction of data. Breaches of security may compromise privacy; for example, the theft of a mailing list stored on magnetic tape is a result of poor security and may compromise the privacy of individuals on that list. The breaches of security may also be unrelated to privacy or confidentiality.[4]

Respect for privacy in office automation involves three components:

1. Data collection—what personal information is relevant, necessary, and socially acceptable for an organization to collect to carry out its missions?
2. Protection—when should an organization record and preserve identified personal data, who should have access to it within

[3]For a general discussion of privacy and how it is defined and used in policy see Priscilla M. Regan, "Personal Information Policies in the United States and Britain. The Dilemma of Implementation Considerations," *Journal of Public Policy*, vol. 4, No. 1, 1984, pp. 19-38.

[4]A representative discussion by EDP experts of the relation between privacy and security considerations appears in Alexander Gaydasch, Jr., *Principles of EDP Management* (Reston, VA: Reston Publishing Co., 1982).

the collecting organization, and under what circumstances can it be released outside the organization to third parties?

3. Notice and access—when can the subject of data collection know that an identified record has been created about him or her, have the right to examine the record, and be able to challenge the accuracy, completeness, or proper use being made of the record?

Survey evidence suggests that Americans' concerns about privacy are rising. A Louis Harris Survey indicated that during the period of 1970-78 American concern about the invasion of privacy rose from about 33 to 64 percent.[5] This public concern was a factor in bringing about Federal privacy legislation. There was also a shift in employee attitudes about the prerogatives and responsibilities of employers with regard to employee data, adding further impetus to Federal policy activity. By 1983, another survey by Louis Harris[6] indicated that the proportion of the public concerned with privacy had increased further, from 64 to 77 percent.

This chapter is concerned with both confidentiality and security issues raised as more and more organizations introduce new office technologies, in both the private and public sectors. While privacy or confidentiality and security are interrelated, this chapter first discusses confidentiality and privacy issues, then security issues in the protection of personal and client data.[7]

[5]*The Dimensions of Privacy: A National Opinion Research Survey of Attitudes Toward Privacy*, conducted for Sentry Insurance by Louis Harris & Associates and Alan Westin, 1979.

[6]Louis Harris & Associates, Inc., *The Road After 1984: The Impact of Technology on Society—A Nationwide Survey of the Public and Its Leaders on the New Technology and Its Consequences for American Life*. Harris study No. 832033, 1984.

[7]Confidentiality and security of data involved in off-shore sourcing of data-entry work are discussed in ch. 8. Issues of software security are being addressed in another OTA report, *Intellectual Property Rights in an Age of Electronics and Information* (winter 1985). Issues related to the security of Federal information systems are being covered in the OTA report, *Implications of Federal Government Information Technology* (winter 1985). Privacy issues in electronic surveillance are covered in *Electronic Surveillance and Civil Liberties*, OTA-CIT-293 (Washington, DC: U.S. Government Printing Office, October 1985).

OFFICE AND DATA PROTECTION

Much of the rising concern about confidentiality and security has been occasioned by the advent of computers and large data banks, and these concerns have repeatedly been subjects of congressional action, resulting in new laws.[8] End-user computing, in which many people may access and use organizational databases, raises new questions about how claims to privacy can be respected and the confidentiality of information be assured. In a recent survey of privacy and security professionals, almost half, 47 percent, believed that as a result of the third phase of office automation there is a trend for broader or more detailed personal information to be collected.[9] Concurrently, this proliferation of computers is leading to decreasing compliance by managers with government-privacy regulations (45 percent). Networking, computer-based messaging systems and electronic mail will exacerbate these problems still further as personnel data can be circulated among more people.

Computer crime legislation passed in the 98th Congress established penalties for indi-

[8]In the mid-1960s, a Senate investigation was held to examine the kinds and amounts of personal information collected by the Federal Government. This investigation is considered by many to be the beginnings of the national expression of concern about the collection and use of computerized personal records systems. (U.S. Congress, Senate Committee on the Judiciary, Subcommittee on Administrative Practice and Procedures, *Government Dossier*) (Washington, DC: U.S. Government Printing Office, 1967).

[9]Westin and Hoffman, op. cit., 1985. This survey was not a representative sample of all types of organizations affected by office automation. Rather, the participants were chosen based on their reputation in computer and business circles as active, advanced, and unusually skillfull users of office-systems technology and as leaders in dealing with the employee-relations and organizational change aspects of new office technologies. However, there is a paucity of quantitative data on the extent of the privacy and security problems. Thus, the information reported from this survey should be treated as indicators of problem areas and not as indicators of the extent of the problem.

viduals convicted of theft, fraud and abuse associated with Federal computer systems.[10] The first indictment and conviction under the new Computer Crime Act involved a person convicted of misrepresenting himself as a valid user of the computer system, establishing a super user code allowing future access to the computer he worked on and other systems to which it was linked.

As organizations rely more and more on computer-based information to conduct their business and to keep track of their personnel, the privacy rights of clients and employees must be considered. Coupled with the fact that the purchase and installation of microcomputer systems is often haphazard and uncontrolled within organizations, an appropriate degree of confidentiality is more difficult to assure when access to data is widely distributed. Personal information is required to effectively run a business, and with telecommunications linkages between computers and between organizations information can be collected in greater quantity and shared more easily. Client information can be processed at the client's workplace and sent via phone lines to the organization's computer system for processing. Office automation also raises questions about traditional security measures in central electronic data processing (EDP) environments. The purchase and use of computers in office automation is not controlled by a single department. Once microcomputers are linked with larger computer systems, any individual on the system has the potential for unlimited access and distribution of information.

Before the recent wave of office automation, the principle users of a computer system were professionals, and the two chief dangers were theft of funds or data by employees, and that of novices external to the organization breaking into the system. The dispersal of computers throughout an organization has extended accessibility to noncomputer-professionals. The computer professional's sociocultural system had within it values, beliefs, and concerns about privacy and security of information. Today, people who never participated in the sociocultural system of EDP environments, who have not been informed about the fine points of the law and ethics of protecting confidentiality or assuring data security, have easy access to an organization's databases. Violations can result from carelessness as well as through intent.

This chapter differentiates current office automation issues from the confidentiality and security problems that have been present in many organizations for two decades as part of an EDP system. This distinction between centralized and end-user automation is probably transient and likely to disappear as offices tie their small computers into the larger EDP systems highly integrated information systems. The transient nature of current systems is important for policy considerations later, and the distinction is useful in discussing new problems that arise with office automation.

Three developments in office automation are central to confidentiality and security issues, not only because they deal with the technological changes mentioned above, but with how the technology is procured and installed:

- the arrival of stand-alone word processors and text editors in the late 1970s, perceived as higher-order typing instruments and generally procured and controlled by office administration staffs or user departments;
- the move to widespread professional microcomputers, now available at prices and with features that allowed organizations to procure them for stand-alone work, and not only when linkage to on-line mainframes and minicomputers was involved. Generally, these machines were ordered by user departments; though often with EDP-department guidance; and
- the explosion of personal computers (PCs) in the early 1980s, for professional, sales, and executive use as stand-alone computing devices, and increasing linkage of such PCs to minis and mainframes. PCs in most organizations were ordered by individuals or by user departments, with limited guidance or control by EDP departments or central administrative service functions.

[10]Counterfeit Access Device and Computer Fraud and Abuse Act of 1984, Public Law 98-473.

Each of these developments fostered new ways of carrying out office work. By 1984-85, each of these three original types of stand-alone terminal/software machinery were being linked to minicomputers and mainframes. This building of communication between computers makes possible access to central or distributed databases. In the survey of computer security professionals mentioned above, 64 percent believed that the spread of electronic mail and messaging systems poses a real problem in maintaining confidentiality. The ability to download (take data from) or upload (add data to) mainframe databases, using small computers, makes it possible for any employee with access to the building or computer to generate a file of personal information. Seventy-six percent of the survey respondents felt the automated office environment allowed more people physical access to workstations and disks as compared to earlier waves of automation. Finally, the interconnection of microcomputers allows the exchange of data within units or across units of the organizations, independent of mainframe system controls.

The following quote demonstrates the capabilities of the convergence of the various office technologies:

> In IBM we now have a world-wide network of more than 1,500 mainframes and 200,000 terminals. Any user at any terminal can send a message or a file to any other user. A user at any of those more than 200,000 terminals can connect to any application in any of those 1,500 systems. Programs and even entire applications spread spontaneously through the network, usually without management direction or intent and often without management understanding or knowledge. Employees can access the network from their homes. Some vendors and contractors use it . . . [DP] management did not plan it. They bought it and built it but they were just as surprised as anyone else when they saw what 'God had wrought.'[11]

[11] W.H. Murray, "Security Programs, Functions, and Concepts for the New Computer Economics," *Proceedings of the 11th Annual Computer Security Conference* (Northboro, MA: Computer Security Institute, 1984).

THE PERIOD 1960-78

EDP systems made it possible for client data to be:

- collected and recorded more easily;
- analyzed, compared, and collated more fully;
- distributed to or made accessible to more people within the organization;
- amalgamated with data on individuals obtained from other organizations having computerized record systems; and
- disseminated more widely, both in intraorganizational networks and in response to specific demands from other organizations.

These capabilities made it possible to provide more customized and personal services by business and government. They also raised the possibility of greater aggregation of data—computerized databases can break down the vital compartments and boundaries that helped keep client information confidential. This is what the privacy-and-data banks debate of the 1970s was about.[12]

There were also several aspects of internal organizational control in the 1960-78 era, before end-user computing, that provided the framework for carrying out new privacy rules that were developed:

- in the EDP era, small staffs of EDP professionals ran the data centers and controlled access to automated files; and
- centralized security procedures of access and audit were available to check (if necessary) that terminal users followed the legal and organizational rules.

[12] For an early discussion of the debate see, U.S. Senate, Committee on the Judiciary, Subcommittee on Constitutional Rights, *Federal Data Banks and Constitutional Rights*, 1974.

Computer-system security measures originally evolved from manual techniques for physical security carried over from the electronic accounting machines of the 1950s. Usually physical security (locking up sensitive card decks and tapes) was the prime technique. As first and second generation batch processing computer systems were introduced, followed by remote terminals and third generation systems, computer security techniques became more technological and sophisticated. Passwords were used to restrict access to information based on a user's or terminal's privileges or on the type of function being performed. A few systems, especially those involved in national defense, used cryptography or encyphering. Some systems provided other mechanisms to assist proper authorization, most notably the hardware rings provided by the GE/Honeywell machines of the late 1960s and early 1970s. During this period, it was hard enough to get a program to run at all on a given hardware system, and security took a back seat to other design criteria such as correctness, speed, cost, and utility.

As third generation computer systems became more common in industry and government, the use of data within organizations changed and networks were built up. Rather than use one computer center, one or more systems could be accessed via user terminals. Indeed, commercial time-sharing networks grew to service the needs of organizations without the resources or inclination to start their own networks. Minicomputers (minis) appeared, but in contrast to today's microcomputer systems, minis were generally still purchased and operated by data processing specialists within the organization.

At the same time, there was growing public awareness of potential loss of privacy and problems of fairness or due process. Thus, the security of computer systems took on added importance and led to additional safeguards such as logs, journaling, of important operations and more specific policies with respect to computer security, as a means to guarantee confidentiality and accountability. However, the most sensitive narrative information was still not computerized at this time; it remained on paper in manual files. Thus, most problems involving personal data in the 1970s still were associated with paper records. In the early 1980s, medical, banking, credit and employment information was placed in large databases, beginning the current rapid move to store personal, employee, and client data on-line.

The advent of commercial products to enhance computer security, such as the ACF2 access control package for IBM mainframes and various vendors' versions of the National Bureau of Standards Data Encryption Standard had not yet been introduced. Leading manufacturers were starting to take seriously the task of educating users about these issues. An advance guard of computer practitioners were becoming knowledgeable about computer security issues. "Second-generation" technological security issues (e.g., the idea of kernels in software engineering)[13] were just starting to be investigated.

[13]A security kernel is a small nuclear piece of the operating system that controls access to other parts of the computer system—either information or data. This nucleus itself must be tamperproof so that its programs may not be modified, allowing system operators to verify whether it has implemented the systems security policy through the programs. See G.J. Popek and C.S. Kline, "Issues in Kernel Design," *Advances in Computer Security*, Rein Turn (ed.) (Dedham, MA: Artech House, Inc., 1981), pp. 139-144; and R.C. Summers, "An Overview of Computer Security," *IBM Systems Journal*, vol. 23, No. 4, pp. 309-325. This development has been primarily in the Department of Defense; there are no commercially available security kernels.

THE POLITICAL AND LEGISLATIVE CLIMATE

The response of American society to both the social change aspects of privacy protection and the computer-based handling of personal data by organizations has been well studied.[14] By the late 1970s, a detailed latticework

[14]See for example, W.H. Ware, "Information Systems Security and Privacy," *Communications of the ACM*, vol. 27, No. 4, 1984, pp. 315-321.

of laws, regulations, organizational policies, and social expectations regarding privacy protection in EDP systems had been put into place. Codes of "fair information practices" were embodied in law or organizational standards to govern the collection, use, and release of personal data on clients and customers, and to make this process visible and accountable to both data subjects and the public.

Laws and regulations were promulgated to deal with privacy in particular fields of organizational recordkeeping—Federal agencies, banking, insurance, health care, education, credit-reporting, employment, law-enforcement, etc.[16] The earliest statute was the Fair Credit Reporting Act of 1970 (15 U.S.C. 1681). This act requires all credit investigating and reporting agencies such as banks and retail charge card firms to make the records they collect available to the subject. Furthermore, it provides procedures allowing the subject to correct the information. Finally, it only allows disclosure to authorized customers. Since this statute, many more have been enacted providing protection policies for information privacy.

> The Crime Control Act of 1973 requires that State criminal justice record keeping systems, developed with Federal funds, ensure the privacy and security of the information collected.
>
> The Privacy Act of 1974 (5 U.S.C. 552a) restricts the collection, use, and disclosure of individually identifiable information by the Federal Government. It gives the individual rights to access the information and to correct it.
>
> The Tax Reform Act of 1976 (26 U.S.C. 6103) protects the confidentiality of personal tax information. It restricts disclosure of tax information for nontax purposes.

In furtherance of such laws, and in many areas where no legislation had yet been enacted, many private and public organizations developed "privacy codes" or "fair information practices standards" to govern their own handling of client or employee personal data. The motives for such action were a blend of concern to meet legitimate privacy concerns of clients and employees; the desire to avoid the necessity of detailed legal regulation; and the judgment that fair-information-practices rules had a generally positive effect on accuracy, completeness, and timeliness in the management of automated data systems, and could be initiated without heavy costs in money or efficiency. A few corporations such as IBM, Bank of America, and Control Data Corp. had also developed employee privacy codes in the early to middle 1970s, but most of the 10,000 large private employers in the United States had not.

By the time that end-user computing began to add new dimensions to the handling of personal data in office work in the early 1980s, there were still debates among privacy advocates as to whether the data collection and the confidentiality aspects of privacy had been adequately dealt with, in what was coming to be called the "first-generation" of privacy protection measures. In spite of the emphasis on notice, challenge, and due process rights of data subjects, and workable procedures for strengthening confidentiality rules, critics argued that there had been too few limitations on what was appropriate information to collect about people's transactions and activities in many sectors of business and government life. They also argued that merging data from different organizations about the same individual (e.g., in computer matching programs) threatened to shatter basic confidentiality standards.

There was also debate among informed observers and the media about whether the necessary machinery with which to enforce privacy rights had been created, and about other questions—the implementation of the Federal Privacy Act of 1974, the desirability of a continuing Privacy Commission or Privacy Ombudsman (as Canada and many European countries have), and U.S. Supreme Court rulings

[16] Examples would be the Federal Privacy Act of 1974 (5 U.S.C. 552a); the Federal Freedom of Information Act Amendments of 1974, and similar "jurisdiction-wide" statutes in 12 States. At the statutory level, this is exemplified by the Family and Educational Privacy Amendments of 1974 (20 U.S.C. 12239), and by State medical, banking, insurance, and employee-privacy legislation.

in matters of data collection by business and government organizations.[16]

The report of the U.S. Privacy Protection Study Commission in July 1977 urged new laws and voluntary codes in the private sector. What followed was a new series of statutes that affected information privacy.

The Right to Financial Privacy Act of 1978 (12 U.S.C. 3401) limits the access of Federal agencies to information about the customers of financial institutions, by describing the procedures necessary to obtain that information. It also provides bank customers other assurances of privacy about some aspects of the bank records.

The Privacy Protection Act of 1980 (42 U.S.C. 2000aa) prohibits government agents from conducting unannounced searches of press office and file records if no person in the office is suspected of having committed a crime.

The Electronic Funds Transfer Act of 1980 states that any institution providing EFT or other services must notify customers about third party access to customer accounts.

The Debt Collection Act of 1982 (Public Law 97-365) establishes due process procedures that Federal agencies must go through to release any information about bad debts to credit bureaus.

The Cable Communications Policy Act of 1984 requires any cable service to inform the subscriber of any personally identifiable information collected. They must inform the user about how the information is to be used and how long the information is maintained on record. If the information is disclosed, the individual must be informed and restrictions are placed on how and to whom information is disclosed.

Only after the passage of new privacy legislation in 1978-82 protecting bank depositors, and State laws on insurance, employment, and medical privacy did broad private sector institutionalization of privacy rules take place. The establishment of organizational procedures and regulatory or judicial enforcement of privacy was just becoming the norm when end-user computing began to spread in the early 1980s.

In the mid-1980s as office automation is spreading, an extensive set of confidentiality protections for manual and EDP systems has been put into place; but debate continues as to whether these protections are adequate in scope and are being vigorously administered.

The laws above basically deal with rights to confidentiality. Until recently, no Federal law dealt specifically with sanctions against the use of computers by individuals to commit a crime, or with trespassing by reading private computer files.[17] In October 1984, Congress passed the Counterfeit Access Device and Computer Fraud and Abuse Act of 1984, which makes it a felony to access confidential or restricted information related to national security without authorization, and makes it a misdemeanor for unauthorized persons to access the data banks of financial institutions, or to use, modify, destroy, or disclose information in a *government* computer.

There are of course many criminal laws that can be used in prosecuting computer-related crime, but there are problems in applying many of the laws defining theft to cases where only "virtual property" (nonphysical property) is concerned. Thirty-three States now have computer crime laws, but some do not cover hackers who penetrate systems for fun rather than profit.[18]

[16]There were debates over whether new systems or applications were covered by "first generation" privacy measures; for example, electronic funds transfer (EFT) systems, two-way cable systems, and Postal Service electronic-mail projects. There was also concern that plans for large sophisticated computer systems as replacements for older systems in the Federal Government might go forward without sufficient attention to privacy risks, for example, the proposed FBI "Triple I" system for processing criminal history records, and the planned IRS, Social Security, Secret Service, and Veterans Administration systems.

[17]The Privacy Act of 1974 (Public Law 93-579) and the Crime Control Act of 1973 (Public Law 93-83, sec. 524(b)) are, however, designed to prevent misuse of Federal *records* of all kinds in ways that would violate the privacy of citizens.

[18]List provided by the National Center for Computer Crime Data (Los Angeles) includes Alaska, Arizona, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Iowa, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nevada, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Dakota, Tennessee, Utah, Virginia, Washington, Wisconsin, and Wyoming.

THE THIRD PHASE OF OFFICE AUTOMATION

The Handling of Client Data

Confidentiality in an organization with new decentralized or networked office technologies requires consideration of a number of new factors:

Low-security or no-security physical environments in offices. Except for military, diplomatic, and a few private-sector settings that operate in "highly sensitive data" modes, most organizations have put microcomputers onto desks in working areas that are open to passing fellow workers, service personnel, invited visitors, or even the general public. Storage of diskettes, location of printers, and other peripheral equipment is also usually in unsecured environments.

More finished and refined information in office automation systems. In most organizations, word processors contain finished correspondence, memoranda, documents, charts, and reports. These stored materials may contain sensitive personal information on clients, proprietary data of the organization, information confidential to particular employees or units, and data about terms of contracts and other legal responsibilities. While much raw data and some reports of this kind are in mainframe storage, the information in word processors or professional/executive microcomputers is generally more complete, revealing, and easily found, because it includes explanatory text.

More readily accessible information in office computer systems. An interloper, whether an employee or someone from outside, who seeks to extract sensitive data from the mainframe database generally has to know specialized mainframe software codes, as well as how to deal with special security protections that most organizations have built into mainframe databases. With microcomputers, unskilled interlopers are more able to call up data on screens, print out documents, or copy diskettes than they would be in EDP systems.

The mobility of microcomputers and their data-storage media. Dumb terminals connected to mainframes are known to the system, and their uses are usually logged or monitored. Microcomputers can be moved around within organizational offices without central control or notice, and portable versions can be taken home or on trips. Information is archived on floppy discs rather than magnetic tapes.

Less sophisticated office automation users. While 10 percent of organizational personnel may have been using terminals in the middle 1970s, either in EDP units or as EDP-trained operators in users' departments, at least 25 to 35 percent of personnel in large organizations are probably using microcomputers today, and eventually this may approach 100 percent. Typically, new users have not been educated about confidentiality issues or security protections.

Uncontrolled channels of data communications. Electronic message systems, bulletin boards, and microcomputer networks encourage users to send messages to everyone using these systems or to create their own distribution lists. As a result, messages with confidential data can move around either anonymously, or without control for their confidentiality. Fraudulent memos can be circulated for political purposes without an easily traceable origin. Reproducing machines, and before them. mimoegraph machines had the same effect, of course; computers merely allow this communication to be done in the privacy and safety of one's own office or home.[19]

Wide ability to add information to or copy or extract information from corporate databases. Controls over alteration of data or unauthorized access become critical.[20] Microcomputers can be used to attack the security of mainframe and mini data, and obtain confidential client data improperly. This can in fact be done from any terminal, including those developed for mainframe use, but more understandable

[19]This situation may seem trite, but a recent State supreme court ruling stated that an employee's privacy had been violated by an interoffice memorandum. "SJC Outlines Rules on Employer Rule in Workers' Privacy," *Boston Globe*, July 7, 1984, as cited in Philip Adler, et al., "Employee Privacy: Legal and Research Developments and Implications for Personnel Administration," *Sloan Management Review*, winter 1985, pp. 13-22). In this case upheld by the U.S. Court of Appeals, First Circuit on Aug. 6, 1984; the memorandum was on paper.

[20]This does not address the problem of unauthorized users external to the organization accessing the databases. One commonly suggested procedure is the use of tiered passwords for accessing the computer and then the particular volume or file the information is stored in.

software instructions are expanding the number of persons able to probe password security, attempt unauthorized entry, or alter confidential data.

Little or no hardware or software security protections. Because of the ways that word processors and microcomputers entered office work, there was neither a perceived necessity or an assumed "market demand" for built-in terminal hardware protections such as locks on the machines. Similarly, in buying or designing software for office systems, organizations have generally not specified audit trails, cryptographic protections, and other measures that could have been installed—though at added costs.

Unpredictable individual and group behavior. There is no way to predict with any assurance how office employees and managers will use these powerful new capacities. There will be some conduct by insiders and outsiders arising out of the new opportunities in microcomputer use that pose risks, and this has to be the perspective from which managers assess risks to confidentiality and security.

Security and Confidentiality Issues

The potential vulnerabilities to client data emerging in office automation can involve either new situations created by microcomputer use, or can be extensions of familiar risks in manual and EDP recordkeeping. The types of potential end-user conduct that could violate existing privacy standards are discussed below.[21]

Data Collection

Microcomputers permit the creation of any files or databases that the end user wishes to maintain. Either without awareness of or in deliberate disregard of privacy, end users may put personal client information into "their" files that violate laws, regulations, organizations rules, or ethical guidelines. If there is no auditing or physical inspection of end-user files, then management may be unaware of such conduct, and suffer legal sanctions or have the companies reputation compromised.

Confidentiality

End users may take client information from central files and merge it or match it with other client data in ways that violate privacy standards. Through electronic mail and message systems, end users may send confidential client information inadvertently to those not entitled to have it, especially if "automatic" distribution lists are used.

Subject Notice and Access

Where end users create files improperly or record confidential data they should not have accessed, failure to inform clients that such files have been created and might be used in making decisions about clients could be a violation of several basic privacy laws (the Federal Privacy Act, State fair information practices acts, Fair Credit Reporting Act, State insurance privacy acts, etc.), as well as the organizational rules of many banks, insurance firms, brokerage houses, medical facilities, educational institutions, and other private organizations. Failure to provide opportunities for individual clients or potential clients to examine and challenge these files would be a violation of such laws or rules.

It is critical to distinguish the privacy issues generated by the transition from manual record systems to EDP systems, from those of the current progression from centralized to decentralized computing. The arrival of EDP brought about revolutionary increases in two areas: 1) data-collection capacities (reducing costs and time constraints, magnifying data-analysis capabilities, etc.); and 2) data-sharing capacities (circulating personal data within and between organizations). The response in terms of privacy laws and organizational codes was: 1) to increase the visibility of organizational activities affecting sensitive personal data

[21] Examining such potential vulnerabilities in office automation follows the studies of EDP systems impact done by the National Academy of Sciences in 1969-72; the HEW Advisory Committee in 1972-73; and the U.S. Privacy Protection Study Commission in 1975-77. Hopefully, the examination of potential office automation vulnerabilities can benefit from the experiences with risk-assessment and reality-testing that were developed in 1969-77 EDP studies, as well as the practical experiences gained over the past decade in administering the standards promulgated (for client data) as the "first generation" of privacy and security rules.

(changing these from private "kitchen work" to public notices and descriptions, with specific rights of data-subject inspection challenge); 2) to stipulate broad relevancy and social acceptability standards for data collection; and 3) to provide rules and procedures for confidentiality or data sharing.

The use of microcomputers in the office has the following characteristics:

- They *do not* significantly increase the scope of data-collection capacities over existing EDP systems. However, because of their ease of use or cost, data not entered into the mainframe system can now be entered, potentially increasing the quantity of data collected. This requires managers to provide greater education and oversight of users to see that they know the limitations on data collection set by law or code, and do not violate these in "personalistic" data recording.
- They *do* increase the risks of improper circulation of personal client (or personnel) data within the organization and to outside organizations, threatening confidentiality, because they provide many more employees with a tool for accessing the records or information.
- They *do* increase due process problems. To the extent that stand-alone diskettes and off-line storage of personal client data would not be known to data subjects, the use of that data for decisionmaking could not be challenged under privacy rules for subject access.

Security

How to protect records from accidental or deliberate destruction, loss, or theft is a security question. There are also differences between EDP and decentralized office automation. Surveys of private organizations show general agreement that by the end of 1984 there were significant security issues in use of microcomputers, not just for sensitive client and personnel data but also for general proprietary business information, financial data, national security information, and legally sensitive information. These problems have not been taken up yet by most top managements, and thus the policy directives and budget authorizations necessary to address this problem adequately have not existed in most private-sector organizations. The major problems developing with decentralized office automation are:

Lack of clear identification of sensitive information. The basic requirement for sound security is to identify information that is sensitive and needs special protection. Any effort to protect all personal information in ordinary business or government organizations would be too costly and would virtually paralyze organizational programs.[32]

Failure to provide adequate physical security for machines and storage media. Many microcomputers are not kept in locked rooms and diskettes are often not kept in locked cabinets or desks. Easy physical access to such microcomputer equipment poses real security risks; for example, diskettes can be copied on another machine on or off the premises.

Failure to have key locks on terminals. Most microcomputers do not have key locks that control on-off functions, enabling third parties to activate them.

Weaknesses in password systems governing access to central databases. Microcomputers connected to mainframes in many organizations suffer from the same security problems as dumb terminals; users are casual about writing down or telling their passwords to others. But microcomputer users are probably less disciplined in handling password regulations than EDP-trained personnel.

No logs or journals. Though central databases of confidential client data are often provided with audit trails, transaction logs, or journaling capabilities, these techniques are often not used when groups of microcomputers are connected to minicomputers or, through them, to mainframe files.

Not recording efforts to penetrate security. Unlike mainframe systems, microcomputer-based office systems generally do not record efforts to enter restricted files without proper identification or passwords, or warn security officers that such efforts have taken place or are under way.

[32]Many European countries do attempt to protect a large amount of the personal data collected.

Absence of either security education for users or auditing of their practices. Even if sensitive information was identified, security measures were adopted, and records were kept of efforts to access databases improperly from microcomputers, most experts would agree that security of sensitive client data also requires that users be educated about security policies and procedures. Second, it requires that inspections or auditing be carried out to learn whether security policies are being followed.

When it comes to security measures needed to safeguard sensitive client data in microcomputers and end-user office automation, current evidence shows that: 1) the techniques for installing security protections are well known; 2) the process of risk-assessment and vulnerability analysis to determine cost-beneficial policies is well known; but 3) these techniques and processes have just begun to be undertaken in the private sector, and are only somewhat further advanced in the Federal establishment. The first task in dealing with security is not to identify wholly new security approaches or methodologies, but to stimulate organizations to provide directives and resources with which to modify and apply known techniques and processes.

There are some situations in which new forms of office automation may require special measures. For example, if combined voice/data terminals are widely used, manufacturers may have to provide means of preventing the undetected turning on of the microphone capabilities of terminals, to ensure that neither officials within the organization nor outside hackers, or more serious intruders, used these terminals for organizational espionage.

Local area networks present particular problems. Three different types of network configurations exist and present different security problems. In a star network, several terminals are connected to a central controlling device; the central computing power can be used to control data and software, maintaining a high degree of security. In a ring configuration (or a loop) the workstations are arranged in a circular network. Each station is linked by a repeater mechanism that monitors all passing information to see if any are addressed to that workstation. This configuration has gained more acceptance in Europe than in the United States. Because information travels around the ring, any workstation has the capability of accessing it. The tree or bus network, the most easily expandable of the three, does not require a central controller and, security is therefore contingent on the security capabilities of individual workstations.

PRIVACY ISSUES IN WORK MONITORING

The monitoring of office work by computers was discussed in chapter 5; but it is sometimes discussed as a privacy issue rather than as a quality of worklife issue. The privacy issue raised by computer-mediated work monitoring is whether the collection of operator performance data through "machine capacities" and its use to evaluate employees constitutes an intrusive form of "employer surveillance" that violates reasonable expectations of personal privacy by the employee. Whatever the pros and cons of computerized-work monitoring, it is probably not best posed in terms of privacy. The work is done on the employer's premises; the activities are usually group settings open to view rather than individual activities taking place in closed or private rooms; supervision is a normal condition of the employer-employee relationship; and collecting quantitative data as to employee output has long been used in evaluating and compensating work performance in factories and offices.

Unlike the use of TV-monitors to watch assembly lines, or of hidden microphones to overhear workers in cafeterias or restrooms, the collection of operator-production statistics generated by system software does not represent an intrusive act *per se*, provided that employees know that monitoring systems are used, employees have access to their individual records; and a procedure is provided for contesting the accuracy or fairness of applying records for evaluative purposes.

SECURITY AND CONFIDENTIALITY IN AUTOMATED PUBLIC OFFICES

The protection of data is a major concern in public-sector offices, especially in regard to matters of national security, diplomacy and foreign relations; the Federal role in monetary transactions; government funds transfers; and foreign trade. Most of the sensitive information about such subjects, however, is usually in large computer and communication systems, and is usually protected by encryption and a variety of other mechanisms. However, shared databases and the downloading of data to microcomputers for end-user computing is raising new concerns, especially since data that are not per se identified as sensitive can, when aggregated, reveal information that is highly sensitive.

The Federal Government collects large volumes of detailed personal data about citizens and in particular about Federal employees. As early as 1967, a study of computerized Federal records revealed that the files contained more than 3 billion records and that over half of them could be accessed via computer terminals.[23] Several years later in 1974, another congressional committee found that 86 percent of the 858 known government data banks were computerized.[24] Successive waves of office automation have continued to provide greater access to these expanding data files. This information can be integrated through computer matching and other techniques and through the exchange of data between agencies and with State governments, in ways that cause deep concern about confidentiality. For example, when one applies for Food Stamps, the Department of Health and Human Services, which administers the program, matches one's name with those in the Internal Revenue Service (IRS) earnings file (which is in fact maintained and used by the Social Security Administration (SSA) to verify eligibility. SSA checks the data in the IRS earnings file to verify income reported by recipients of SSA retirement benefits.[25]

In general, information-handling associated with end-user office automation is not classified information, but it is often sensitive information, especially when aggregated in certain ways.[26] Routine records, forms, and correspondence often contain information that would allow individuals to put together and profit from advance knowledge of government actions. For example, plans for siting highways and government facilities, impending regulations, actions that affect interest rates, sales of minerals and timber rights, etc., are very tempting. Personal data about Federal employees can be used to discourage whistleblowing. Less often voiced, but still important, is the concern about unauthorized access to

[23] *Government Dossier*, op. cit.

[24] *Federal Data Banks and Constitutional Rights*, op. cit.

[25] According to briefings and interviews provided for OTA by SSA.

[26] This has chiefly been of concern to the Department of Defense; for example, the problem was exhaustively discussed in a planning conference held for the U.S. Army Information Systems Command by SRI in Tucson, AZ, in December 1984. Hypothetical examples given in an informal talk concerned the possibility of aggregating routine travel orders or schedules for key individuals to reveal the (undisclosed, sensitive) location and timing of small meetings; or the possibility of aggregating data on materials delivery to a site to reveal information about development of weapons systems. However, some civil liberties specialists have long been concerned about the ability to aggregate information from many sources about one individual to produce a profile of his or her marital, financial, social, business, professional, and political activities.

information that is simply embarrassing or politically fatal to officials or to their nominees for official positions. In congressional members' offices, there are grounds for concern about protection of information in computers, which is chiefly protected by ID's and passwords. (The privacy and security issues related to large Federal computer systems and databases will be covered in a forthcoming OTA report.)[27]

Even when nonclassified Federal data is normally stored in large databases or processed in central EDP centers, it is increasingly liable to be at some point accessed, handled, analyzed, or even generated using personal computers or terminals scattered throughout agency headquarters and field offices. Most of the concern about government security has focused on large information systems. There has been much less attention to the protection of data in day-to-day agency operations in which decentralized office automation is used. Violations of security and confidentiality need not be intentional or malicious; they are often the result of ignorance or carelessness. Office workers have not yet been acculturated to think routinely about computer security; there are stories of government workers routinely locking away sensitive papers but leaving the disks from which the copy was made lying next to their personal computer or word processor.

Government computers are thus subject to the same risks that plague banks, corporate payroll and financial management operations, and other private-sector computer systems, plus some risks that are particularly political in nature. As extreme examples, records could be destroyed to cripple a government program or project; or calendars and trip schedules could be used to plan the assassination of a political leader or a foreign dignitary.[28]

Government Guidelines

Security and confidentiality for nonclassified government information is covered by the Privacy Act of 1974 and:

- OMB Circular A-71 Transmittal Memo No. 1, July 17, 1978, which provides general guidance to agencies, on administrative, technical, and physical measures to increase security; and
- OMB Circular A-123, which sets standards for internal controls implementing the Federal Managers Financial Integrity Act and directs each agency to review and update its security provisions.

The General Services Agency (GSA) and the National Bureau of Standards (NBS) in 1983 began development of guidelines for security in end-use computing and small office systems. The Office of Personnel Management (OPM) recommends personnel security policies for computer-related jobs. However, the General Accounting Office (GAO) has repeatedly criticized the lack of compliance with guidelines established in the circulars by Federal agencies.[29] In 1982, GAO said that:

> ... increasing Federal investments in automated systems ... have resulted in growing vulnerability to fraudulent, wasteful, abusive, and illegal practices because greater concentrations of information are accessible from remote terminals.

The Office of Management and Budget (OMB) is now updating A-71, A-123, and other circulars related to computer security. It is expected that they will be combined into one broad policy statement.[30]

The Special Concern About Employee Privacy

An aspect of Federal computer security that deserves—but has not received—special atten-

[27] *Implications of Federal Government Information Technology for Civil Liberties and Congressional Oversight*, op. cit.

[28] According to the *Washington Post*, an air traffic controller, angry about the Soviet invasion of Afghanistan, deliberately endangered an Aeroflot jet carrying Soviet Ambassador Dobrynin, by manipulating a signal so that a computer read the jet as a small craft and did not properly monitor and control its landing at a busy airport. (Mary Thornton, "Age of Electronic Convenience Spawning Inventive Thieves," *The Washington Post*, vol. 107, May 20, 1984).

[29] U.S. General Accounting Office, *Central Agencies' Compliance With OMB Circular A-71*, Transmittal Memorandum No. 1, LCD-80-56-1, Apr. 30, 1980; and *Federal Information Systems Remain Highly Vulnerable to Fraudulent, Wasteful, Abusive, and Illegal Practices*, MASAD-82-18, Apr. 21, 1982.

[30] Susan M. Menke, "Survey of Agencies Finds Many Are Implementing Standards," Special Section. Security, *Government Computer News*, November 1984.

tion is the question of the ability to protect the privacy of Federal employees. Agencies collect and keep much personal data about employees and even applicants for Federal jobs. Much more data is likely to be collected than would be sought by corporation personnel offices.[31] These files may be, and usually are, widely dispersed and only superficially protected. As files are computerized, they can more easily be aggregated and accessed, or tampered with. If files are stored in personal computers or can be accessed or downloaded, more and more people will have access to them, and may use them for satisfying curiosity, for mischief, for exerting political pressure, or for sheer malevolence. This raises significant questions about protection of privacy in Federal computer systems and databases.

Federal employees are the subject of much computer matching, which was described earlier; that is, the comparison of two or more computerized lists of individuals. For example, Federal employee lists were checked against lists of people earlier defaulting on student loans. A very early example of computer matching occurred during the Carter Administration; this was Project Match, through which names of Federal employees were matched with names on the roll of the Aid to Families with Dependent Children, in an effort to discover ineligible recipients.[32]

Accidental Losses

Telecommunications and computers are vulnerable to crime, mischief, and terrorism, but they are also vulnerable to unintended disruption, a point that is sometimes overlooked. This includes error or accident, and the simple breakdown or failure of equipment; it also includes destruction by fire, flood, earthquake, and other natural and technological disasters.

Data can also be lost permanently, or made temporarily inaccessible, by electrical outages. As government activities become more and more dependent on microelectronics there is the strong possibility—and given enough time the virtual inevitability—of electrical failures that affect critical activities or whole regions of the country, bringing all computer-mediated activity temporarily to a halt. Emergency response systems may be unable to respond adequately because some step or link depends on office automation that is down because of the same emergency. Routine recovery procedures may be hampered by loss of data in the same incident. GAO called attention to this danger in a strong report in 1981, identifying the need for further emergency planning by the Department of Energy and the Federal Emergency Management Administration.[33]

Some government operations are highly time sensitive (e.g., transfer of funds, transmittal of orders to the armed services, air traffic control, response to natural disasters, law enforcement actions). Others are dependent on ready access to individual and case records (tax collection, processing of welfare payments, payrolls, etc.). As the government becomes more and more dependent on office automation for orderly performance of necessary activities, the result of any disruption—whether irreparable or of brief duration and narrow scope—becomes more severe.

Federal agencies have not adequately prepared for natural or technological disasters that might wipe out electronic information, according to GAO.[34] Many still have no contingency plans or rely on letters of agreement from other agencies to supply equipment in emergencies. This course assumes that the other agency will: 1) be able and willing to live up to its agreement even at the cost of prejudicing some of its own activities, and 2) will not

[31]See Alan Westin, "Personnel Practices in the U.S. Civil Service," *Information Age*, July 1982, pp. 149-169.

[32]According to information supplied by Federal officials to OTA.

[33]U.S. General Accounting Office, *Federal Electric Emergency Preparedness Is Inadequate*, EMD-81-50, 1981.

[34]U.S. General Accounting Office, *Most Federal Agencies Have Done Little Planning for ADP Disasters*, AFMD-81-16, 1980; and *Federal Electrical Emergency Preparedness Is Inadequate*, EMD-81-50, 1981.

A contingency plan should have most or all of the following features: backup files at external storage sites, standby arrangements for renting processing time or services, a recovery operation center, a multilateral aid agreement involving five or more agencies, or a plan for reverting to manual (nonelectronic) operation if necessary.

have been disrupted at the same time by the same events. Nonelectronic equipment is often not available, and reversion to manual systems not possible; data may exist only in electronic, machine-readable form.

The cost of downtime or time lost because the computer is malfunctioning, is seldom calculated in justifications or cost-benefit analyses of office automation. In most cases, the downtime is merely an annoyance and a temporary problem. In some cases, it significantly aggravates the workload peaks and degrades the quality and timeliness of important services. In time-sensitive situations, such as response to local emergencies, it can mean catastrophe.

Comparisons With the Private Sector

In spite of these problems and concerns, the Federal Government is probably well ahead of the corporate sector in attention to the need for safeguarding privacy and security in the use of microelectronic office automation.[35] This reflects the implementation of provisions of the Privacy Act over the last 10 years, including annual reporting requirements; OMB guidelines; agency implementation procedures; and continuing attention from congressional committees, media, interest groups, and scholars.

However, if the government is ahead of the private sector, this says more about the lack of systematic attention to these issues within corporations, than about the effectiveness of government attention. It does not mean that the problems have been taken care of. The particular vulnerabilities of office automation systems to casual misuse, and even serious abuse and fraud, are still not realized by most of the users.

But the openness of these small office automation systems, which makes them especially vulnerable, is probably also their best protection. The many users and the open office environment means that abuses are likely to be observed and reported, if they are recognized as abuses. They will be recognized only if office workers understand the ethical, legal, and policy issues involved and are sensitive to their importance. A thorough attempt to educate Federal office workers about this problem is in order.

Individual workers, however, can do relatively little about protecting their data in the case of power outages, system malfunctions, and technological or natural disasters. The primary responsibility for backup and fall-back systems, and other kinds of contingency planning must rest with top-level agency managers.

[35]This is the conclusion from an OTA contracted study, *Privacy and Security Issues in Office Automation*, Alan F. Westin and Lance J. Hoffman, 1985. Their study used documentary material from 44 Federal agencies and interviews at 7 agencies. Federal policies and practices were compared with findings from site visits and interviews in approximately 100 corporations and nonprofit organizations in 1982-84. The researchers did not do on-site studies of the implementation and efficacy of security measures in Federal agencies, but relied on reports of the manager and staff.

POLICY CONSIDERATIONS

Nearly a decade ago, the Senate Government Operations Committee investigated computer abuse in both the public and private sector;[36] as a result there have been proposals in the last three Congresses related to computer security in general and in particular to the security of computerized government information.[37] In April 1984, the House Committee on Science and Technology issued a special report on *Computer and Communications Se-*

[36]U.S. Congress, Senate Committee on Government Operations, *Problems Associated With Computer Technology in Federal Programs and Private Industry: Computer Abuses*, Committee Print, 94th Cong., 2d sess., 1976, and *Computer Security in Federal Programs*, Committee Print, 95th Cong., 1st sess., 1977.

[37]Federal Computer Systems Act of 1977, S. 1766 and H.R. 8421, S. 40 and H.R. 6196, 1979, Federal Computer Systems Protection Act of 1981, H.R. 3790.

curity and Privacy[38] that recommended that Congress charter a national commission to study the issues and outline a framework for policy. While recognizing the threat from "hackers and other outside intruders," the report said that the greatest threat is from personnel who are authorized users of the computer resources that they attack. The report was highly critical of recent policy and programs related to computer security.

OTA concurs that violations of data confidentiality are most likely to occur within the organization by authorized users. External threats, whether from hackers, ordinary thieves, political opportunists, disgruntled former employees, terrorists, or others, nevertheless deserve greater attention. But these threats chiefly concern large systems. With small computers violations by insiders are most likely, and there are fewer safeguards against them. Both large systems and small computers are at risk from accidental disruption because of natural events, human error, and technological failure.

Because decentralized end-user computing is raising new uncertainties about how well data is protected, Congress may wish to reexamine the structure of privacy laws and their application to these technologies, perhaps through a special commission or task force.

Stringent actions have been suggested. One possibility is to establish a new authority to implement, oversee, or enforce current and future statutes. This organization would have no responsibility for collection and distribution of data. There are precedents for this: Sweden for example has a Data Commission to oversee all records and their linkage. Another possible strategy is to have an ombudsman within each data-collecting organization. This is the approach used, for example, in Germany.

However, current laws may be adequate to address the problems of decentralized automation. Whether organizations treat "office automation" and centralized EDP as one or separate and distinct components of office activity, the critical element is to adapt existing rules to apply to predictable oversights, carelessness, or misuse by some persons in the large end-user population, and to assign organizational responsibility and continuing oversight duties to effective units at various levels of the organization. **If organizations are not willing or able to create and enforce policies to ensure that existing safeguards and guarantees are applied in end-use computing to protect their clients and their employees, Congress may wish to clarify and strengthen through legislation the liabilities that such organizations incur by their failure.**

Current laws chiefly strengthen the right and the ability of an individual to control information about himself or herself. Thus, the individual is the final enforcer of principles of fair information use. Given the ubiquitous nature of the new information technologies and their linkages and systems integration, more specific *data* collection and *data* protection policies may become necessary as opposed to traditional policy approaches strengthening individual rights.

For Federal agencies, strong oversight attention is merited to make sure that reasonable security provisions are enforced. Special attention should be given to the questions of: 1) the ability of essential day-to-day government operations to continue when computers cannot operate, 2) the need for protecting employee data, and 3) the adequacy of procedures for protecting correspondence and records with congressional offices.

[38]U.S. Congress, House Committee on Science and Technology, *Computer and Communications Security and Privacy*, report prepared by the Subcommittee on Transportation, Aviation and Materials, Committee Print, 98th Cong., 2d sess., April 1984.

Chapter 7

Home-Based Automated Office Work

Contents

	Page
The Controversy Over Home-Based Office Work	189
Historical Roots	191
The Status of Home-Based Office Work	192
How Many Home-Based Office Workers Are There?	192
How Many May There Be in the Future?	193
Mechanisms for Home-Based Work	194
What Work Can Be Done at Home?	196
Parties at Interest	197
Employers	197
Productivity	198
The Workers: Why Are They at Home?	199
The Benefits and Costs for Home-Based Workers?	200
Family Considerations	203
Effects on Society	204
Legal and Regulatory Barriers to Home-Based Work	205
Public Policy Issues	206
Encouragement or Prohibition of Home-Based Office Work	206
Regulation of Home-Based Office Work	208

Chapter 7

Home-Based Automated Office Work[1]

New information technologies allow the dispersion of office work over time and space. As many functions of an office become internal to computers, and as computers are increasingly linked by communication networks, it becomes less necessary for office coworkers to be located in the same room, or in the same building. When a worker's primary interaction is with "the system" rather than with other people, she can do her work wherever she can get access to the system—in the office, while traveling, or even at home.

Some futurists have predicted that the availability of low-cost computing power and telecommunications will increase the number of Americans working at home. The dawn of the information age will find millions of people "telecommuting" from their "electronic cottages," that is, using computers and telecommunications to do office work in their homes.[2] At the present, there are only a few thousand Americans for whom working at home is a full-time substitute for working in the office, but the number is growing and many more might be so employed by the mid-1990s.

[1]Parts of this chapter draw on a contractor report prepared for OTA by Kathleen E. Christensen, New York University, *Impacts of Home-Based Work on Women and Their Families*, January 1985.

[2]The word telecommuting was probably coined by Jack Nilles, now at the University of Southern California, in the 1970s and reflected the interest at that time in working at home as a means of conserving automobile fuel and reducing urban air pollution. The term is not fully appropriate for those who are hired (or contracted) specifically for home-based work and might not otherwise commute to an office to do the same work. In any case, "telecommuting" is an awkward back construction since it means "commuting from afar" rather than "working at a distance." Other terms often used are homework, remote work, telework, or flexiplace. Blue Cross calls its home-based workers, cottage keyers, or telenauts. The home as a computerized workplace is sometimes called an electronic cottage or an electronic sweatshop.

THE CONTROVERSY OVER HOME-BASED OFFICE WORK

The term "home-based office work" describes three very different phenomena. The first is the practice of working occasionally or sporadically at home instead of at the office, when it suits the purposes of the worker. The primary work site is still the office, and the worker continues to be a fully participating member of the office staff while enjoying greater control over when and where, and under what conditions the work is done. The occasional home-based worker is most often a professional. This kind of home-based work is not controversial.

In other cases the residence is the primary work site. Some of these full-time home workers are entrepreneurs—people who have founded small businesses with headquarters in their homes. They may intend to move the business to separate quarters as soon as it can generate enough income to cover the overhead, or they may choose to keep their business at home no matter how successful it becomes. In any case, these owner-managers seek work from a number of clients and set their prices based on their perception of the value of their work and their competitive environment. These home-based businesses provide a variety of professional and clerical services from word processing to accounting to computer programming. This kind of home-based work is also, for the most part, noncontroversial.[3]

Finally, the residence can also be the principal work site for workers who are employed by a single organization, but seldom or never work in the central office. As employees, their

[3]Christensen found that women who developed word processing businesses in their home, seeking multiple clients rather than tied to one corporate client, thought of themselves as, and functioned as, professionals and businesswomen, in spite of the fact that the work they were doing would be called clerical work if done in an office, and the women had in fact previously been clerical workers. Christensen, op. cit.

wages are usually set by the employer. Most home workers in this category are clerical workers, usually performing data entry or word processing; in some cases however, the home may be the primary site for professional work such as computer programming.

Most of the workers in this last category are women. They may decide to work at home because they must combine work with other responsibilities such as care of young children or elderly relatives. Some other full-time home workers have physical disabilities or live far from commercial centers.

Those who are enthusiasts for home-based work usually discuss it in terms of the first two images, the privileged worker and the entrepreneur. Those who oppose it are likely to speak mostly of the last, the woman struggling to juggle two or more full-time responsibilities.

There are three important variables here, which relate to controversial positions on home-based office work. One is the extent to which the home replaces a separate office as the primary work site. Another is the degree to which the home-based worker functions as a separate unit providing services to the organization, rather than as an integral and participating member of the organization. The third variable is the degree of choice exercised by the worker, either in choosing a job that is home-based rather than office-based, or in allocating his or her time between two locations.

The controversy about home-based work can only be understood in the context of other social issues, including the long-range outlook for employment, the feminization of poverty, labor-management relations, protection for workers, the adequacy of child care sytems, and opportunities for the handicapped and the elderly. If we had full employment and ample social services, home-based work would probably not be controversial at all. The concern hinges on the question of whether, now or in the future, some workers are forced to work at home under undesirable conditions because the lack of certain social services deprives them of other options.

Home-based workers themselves are not divided over the issue; they would be unwilling to give it up. Many have demanded the privilege or worked hard to persuade employers to grant it. Some have accepted the risks that go with free-lance employment in order to work at home. Some have made the basic decision to stay at home while their children are young, and regard the opportunity to do paid work at home as a pleasant bonus, the icing on their cake. Others would much prefer to work away from home but have not been able to find any satisfactory alternative. Their choice is to work at home, or to settle for child care arrangements that they regard as unacceptable, or not work at all and become dependent on others.

Congressman Newt Gingrich of Georgia introduced a bill in the 97th and 98th Congresses (H.R. 2531, The Family Opportunity Act) that would have allowed a tax credit of 50 percent of the cost of computers bought primarily for "nonrecreational use in the home." One purpose of the bill, which has not been reintroduced in this session, was to encourage computer-mediated work at home.[4]

In contrast, the AFL-CIO has called for a ban on computer-mediated home-based work. The labor organization says that it is not possible to enforce health, wage and hour, and other worker protection measures in homes without invasion of workers' privacy. The unions are concerned that many home workers are paid under piece-rate systems and are deprived of benefits packages. They also claim that overhead costs are shifted from employer to employee, and that the threat of sending

[4] H.R. 2531 would amend the Internal Revenue code to allow an income tax credit for 50 percent of the expense of computers designed primarily for educational, professional, or other nonrecreational use in the home. It would limit the amount of such credit for a taxable year to $100 multiplied by the number of qualified members of the taxpayer's family. The bill was referred to the House Committee on Ways and Means and was not reported out. Computers used for work in the home are tax deductable, the bill called for a tax credit.

work out to be done at home could be used to discourage office workers from demanding rights and benefits or from joining unions.[5] The Service Employees International Union (SEIU) also supports the call for a ban by refusing to enter into collective bargaining with employers who use home workers, but is not completely opposed to home-based work if ways can be found to regulate it.

The implementation and enforcement of labor standards in home-based work is probably the central policy issue in this discussion. Those who call for a ban on home-based clerical work argue that such enforcement would be excessively costly or impossible, and that without it women (especially mothers), the elderly, new immigrants, and other disadvantaged minorities may be exploited. Those who favor home-based work argue that protective regulation should not become a reason to deprive workers of benefits that are often sought after, such as the privilege of choosing where they will do their work.

Historical Roots

Americans have a long tradition of working in the home to earn family income. Cottage industry did not entirely disappear with the development of factories. It is thought that about 10 million to 11 million Americans earn part of their income by working at home at a wide variety of craft, production, and service occupations.[6] This includes some farmers (although their number has been steadily decreasing) and many others who are only earning a little supplemental money at home, are part of the underground economy, or for other reasons are not counted in the labor force. The 1980 census counted about 1.2 million people in the labor force whose primary place of work was in their residence.[7]

[5]Judith Gregory, "The Future. Clerical Workers," a presentation for Nine to Five, National Association of Working Women, to the *National Executive Forum. Office Work Stations in the Home*, National Academy of Science, Washington, DC, Nov. 9-10, 1983, p. 9.

[6]Sarah Ban Breathnach, "Trends. Mothers and Others of Invention," *The Washington Post*, July 16, 1984, B5.

[7]According to unpublished analysis by Robert E. Kraut of Bell Communications Research, private communication of Dec. 20, 1984.

Home-based production work in a few industries, such as knitting of women's outerwear, was banned in 1938.[8] The Reagan Administration ended the prohibition on industrial home knitting in November 1984.[9] In addition, a bill has been introduced in the Senate to amend the Fair Labor Standards Act to lift the ban on sewing, knitting, and other industrial home work so long as the employer complies with minimum wage and maximum hour laws.[10] The controversy over the knitting ban began to focus attention on, and inflame, the emerging controversy over home-based automated office work, which is, of course, not restricted. The AFL-CIO and others assert that the conditions that brought about the ban in the 1930s can recur, that home-based office work can also be used in the future to exploit the unskilled, women, children, and immigrants.

In recent decades some kinds of office work —for example, typing and envelope stuffing— have been done at piece-rates in the homes of

[8]A 1930 publication of the U.S. Department of Labor provides background on the prohibition:

> The industries that use the home-work system vary . . . but they are alike in using, to quickly expand the labor force when a rush of work comes, the labor available in the home. Thus the industries need not provide factory space and pay rent and other overhead for this part of their production . . . The burden of expansion and production . . . is passed on to the home workers in the form of irregularity of employment and earnings. Inevitably questions arise as to the soundness and the social ethics of such a system of production. . . . From the standpoint of the public there is a clear case for regulation, if not the more drastic measure of prohibition, to set limits to the conditions that this highly competitive type of production imposes upon a group of workers who are, by the nature of the case, in poor position to protect themselves.
>
> Home workers are largely women, aided all too frequently by children. They are chiefly unskilled or semiskilled . . . (and) recruited largely in tenement neighborhoods, often from recent immigrants or other groups with little or no industrial experience. . . .

Emily C. Brown, *Industrial Home Work* (Washington, DC: U.S. Department of Labor, Women's Bureau, 1930).

[9]Regulations, pt. 530: Employment of Home Workers in Certain Industries. Title 29, pt. 530 of the Code of Federal Regulations. U.S. Department of Labor, Employment Standards Administration, Wage and Hour Division. White House Publication 1026. Revised March 1980. See also, S. 2145, a bill to amend the Fair Labor Standards Act of 1938 to facilitate industrial homework. . . . and H.R. 6103, a bill to amend the Fair Labor Standards Act of 1938 to provide that an employer who violates secs. 6 or 7 of that act shall be liable to the employee involved . . . These bills represent opposing sides of the issue of relaxing homework restrictions.

[10]"A bill to amend the Fair Labor Standards Act of 1938," S. 665, was introduced by Senator Orrin G. Hatch of Utah in March 1985 with eight cosponsors.

workers. These are usually women housebound with small children, or retired people. How much work is done in this way is unknown, much of it perhaps being part of the underground economy (that is, not reported to IRS), but it has provoked little comment and aroused little or no controversy. The tasks that can be done in this way are limited and poorly paid, and the number of workers willing to do such work is also limited. Home-based work has not been a viable option for most employers or employees, nor a threat to the mainstream clerical work force.

Two other categories of home-based office work have always been relatively common. The first includes the clerical and management aspects of home-based small businesses that most often involve crafts, personal services, and professional practices. In most communities, there are many such home-based commercial activities, even where they are officially forbidden by zoning laws and other local legislation. Another kind of home-based work is "overflow," work brought home to be done outside of regular office hours. An AT&T survey in 1982 concluded that in 16 percent of households there is at least one person who frequently brings work home—possibly as many as 30 percent of all employed people.[11]

Few people doing office work at home, in any of these categories, have until recently been using sophisticated technology. The AT&T survey found that most people bringing work home with them used only the telephone, pencil and paper, and perhaps a calculator. These, plus typewriters, are more than likely the most frequently used equipment for cottage industry offices as well.

Computers and telecommunication increase the viability of home-based work and make it possible for a significant portion of all office work to be done at home. The information that is to be processed or generated, the instructions for handling it, supervision and monitoring of the work, interaction between coworkers, and distribution of the output can now or at some future stage of technological development, all be done at a distance. In addition, American households are becoming equipped with computers that could be used for paid employment. By 1990, at least one-third of households may have a PC and some projections are much higher.[12]

Much of the interest in home-based work using computers arose, however, years before the technology was ready to allow it. In the early 1970s, the need for conservation of gasoline and the problem of growing air pollution and congestion evoked much talk about the potential benefits of decentralization of work. If or when these problems again become high national priorities, they will surely act as a powerful stimulus for interest in home-based office work.

[11]Robert E. Kraut (Bell Communications Research), "Telework: Cautious Pessimism," a presentation at the National Research Council's National Executive Forum. Office Workstations in the Home," Washington, DC, Nov. 10, 1983, p. 9 (manuscript, no date).

[12]About 15.8 percent of American households have a computer in 1985, according to an estimate supplied to OTA by Future Computing, Inc. (a division of McGraw Hill). This is based on a total installed base of 15.4 million in 1985, expected to rise to 38.8 million in 1990. They estimate that by 1990, 32.9 percent of households will contain a computer.

THE STATUS OF HOME-BASED OFFICE WORK

How Many Home-Based Office Workers Are There?

Estimates of the number of home-based office workers using electronic equipment at present range from 10,000 to 30,000. The most frequently used estimate is 15,000, the Bureau of Labor Statistics' projection.[13] But many of these estimates include those who only do cas-

[13]"Homebodies," *Forbes*, September-October 1984, p. 10. Joanne Tangorra, in an article, "Telecommuting," *Working Woman* 7.11.52-54, quoted in *Telecommuting*, Advanced Systems Laboratory, Wang Laboratories, Inc., educational brief, 1984, p. 6, says that the number of full-time home-based, computer-based workers is only 1,000.

ual or "overflow" work.[14] Probably there are only between 3,000 and 5,000 people who are doing office work, using microelectronic equipment, in their homes for outside employers or clients, and most of these began only in the last 4 years.

While there was much discussion of "telecommuting" during the oil crisis there was little or nothing in the literature discussing real experience or examples.[15] A survey in 1970 identified few home-based workers using computers.[16] But some corporations had already begun formal home-based work programs in the United States and in other countries. There are now at least 40 such programs in the United States. That could amount to only a few hundred people. But there may be at least 3,000 home-based workers in 200 companies that less formally allow employees to choose to work at home.[17] This does not include many people who work at home as contractors or free-lance workers.

How Many May There Be in the Future?

Some enthusiasts, such as Alvin Toffler say that there could be as many as 15 million home-based white-collar workers by 1990.[18] This is loosely based on the estimate that 15 million of *today's jobs* could be moved to remote locations.[19]

Others project 5 million to 18 million home-based workers (up to 18 percent of the white-collar work force) using computers by 1990.[20] One estimate is that 50 percent of all white-collar workers, or 26 million people, *could* do their work at home using computers.[21] There are similar estimates in other industrialized nations. For example, one organization has forecast that by 1990, 40 percent of people in Britain could be working at home.[22]

All of these highly unlikely estimates (some of them even presented as projections, or at least possibilities for the future) assume, explicitly or implicitly, that some driving trends will continue or that some existing constraints will be eased. Factors most often mentioned as encouraging the growth of home-based work are lower equipment costs, the growth of electronic mail systems, improved technology for linking the home and central office, rising energy costs, stable or decreasing communication costs, and renewed inflation (which tends to increase the demand for part-time workers or an externalized work force).

Some long-range social and demographic trends seem to make it likely that more people will be willing or eager to work in their homes in the future, or will see it as their only way to earn a necessary income. Married women increasingly want an independent income even when they choose the traditional role of housewife; in the absence of alternative provisions for child care they may be forced to combine work with family duties. The same choice or lack of choice may face people who must care for elderly relatives. Large numbers of

[14] Jack M. Nilles, University of Southern California, "An Overview of Office Workstations in the Home," presented at the National Executive Forum. Office Workstations in the Home, National Academy of Sciences, Washington, DC, Nov. 10, 1983.

[15] Ibid., pp. 1-2.

[16] Joanne H Pratt, "Home Teleworking: A Study of Its Pioneers," *Technological Forecasting and Social Change* 25, 1-4, 1984, p. 1.

[17] Patrick Honan, "Telecommuting, Will It Work For You?" *Computer Decisions*, June 15, 1984, p. 89.

[18] Quoted in Breathnach, op. cit., and elsewhere.

[19] An estimate by economist Elisabeth Allison of Data Resources, Inc., quoted by Judith Gregory, op. cit., p. 3, and *Business Week*, "If Home Is Where the Worker Is," May 3, 1982, p. 66.

[20] See for example, Lad Kuzela, "Office Old-Fashioned?" *Industry Week*, Oct. 19, 1984, p. 71, and Sally Jacobs, "Working at Home Electronically," *New England Business*, May 21, 1984, p. 15, for summaries of recent forecasts and projections. In the Kuzela article, Dr. Jack Nilles of the University of Southern California is quoted as saying that under different sets of conditions the number of telecommuters in California, by the year 2000, could range from 300,000 to 8 million.

[21] R.C. Harkness, *Technology Assessment of Telecommunications-Transportation Interactions*, Stanford Research Institute, Menlo Park, CA, 1977.

[22] *Business Equipment Trends 1983/1984*, compiled by Korn/Ferry International for Beta Exhibitions Ltd., quoted in B. C. Burrows, "Information Technology—Its Impacts on Property Development," *Long Range Planning*, vol. 17, No. 4, August 1984.

retired workers want or need a way to supplement retirement income on a part-time basis. Handicapped people seek the self-reliance that comes from an earned income. Many people simply like the idea of more flexibility in the use of their time, or wish to live in rural areas but are reluctant to spend large parts of the day commuting.

However, many observers are skeptical about the likelihood that home-based work will expand greatly.[23] The conventional office has proven to be a remarkably useful and stable institutional structure.[24] It has four valuable characteristics that cannot be matched by home-based work: the presence and cooperation of coworkers, its role in socializing the worker to the corporation and its unique culture, the prevalence of informal communication networks, and mechanisms for structuring the allocation of time. The office is also a major focus of social and recreational activities for many workers.

The central office provides economies of scale in capital equipment acquisition, communication and cooperation of coworkers, access to central files and reference material, and the supporting superstructure of superior/subordinate relationships.[25] Some of these benefits are lost or attenuated with dispersion of the work to other locations. If home-based work threatens to disrupt established corporate culture, employers are likely to choose instead to increase productivity by further automation within the office.[26]

[23]Margrethe Olson has surveyed corporations experimenting with work at home programs in 1983-84 and concludes that "... while there is continuing interest in the prospect, there are no significant trends toward shifting large numbers into their homes either part or full time." (Margrethe H. Olson, New York University, "Working at Home and Telematics: Myths and Realities," a presentation at the Office Automation Conference, Convention Center, Los Angeles, Feb. 20-22, 1984.)

[24]Robert E Kraut, Bell Communications Research, "Telework: Cautious Pessimism," a presentation at the National Research Council's National Executive Forum. Office Workstations in the Home, Washington, DC, Nov. 10, 1983, pp. 17-18.

[25]Steven S. Kawakami, Institute of Labor and Industrial Relations, University of Illinois, "Electronic Homework: Problems and Prospects From a Human Resources Perspective," September 1983, p. 14.

[26]Kraut, op. cit., p. 19.

There are other factors that may well retard the spread of home-based office work. Managers and supervisors sometimes oppose it, because it calls for entirely new techniques of supervision, instruction, and quality control. Home-based workers frequently report that they are resented by coworkers who do not have that privilege.[27] Many work-at-home arrangements depend heavily on telephone lines; if there is a significant increase in local telephone rates, home-based work may be less attractive to both employers and employees.[28] (In some cases, telephone costs are borne by the home worker.)

Finally, it is generally assumed that further development of information and communication technologies will tend to encourage home-based work. It is also possible however that technological development may make some of it superfluous. If the use of optical scanning devices eliminates the need for much of today's mass data entry, a large portion of the work now done at home may be eliminated.

Mechanisms for Home-Based Work

Work at home can be supported either by an organization or by independent, free-lance activity. The worker, in other words, may be an employee, or may be self-employed.

A corporation may have a formal program under which selected employees are offered the option, or employees may request home-based work (often under the condition that a supervisor also has the option of refusing to agree to it). Other corporations informally allow individual workers to negotiate the privilege of working at home, either full time or more often part time.

Most employed home-based workers have previously worked for the same employer onsite. But some corporations have set up programs to hire workers not otherwise available to them or able to work, e.g., handicapped workers, mothers with small children, or suburban housewives.

[27]Pratt, op. cit., p. 7; Jacobs, op. cit., p. 19.

[28]Honan, op. cit., p. 96.

Independent or self-employed home-based workers may work under contract for one or more organizations, or solicit piece work on an ad hoc basis. Often corporations shift employees to self-employed contractor status when they become home-based workers. However, if these workers contract with only one organization, they may in fact be employees in the eyes of the law, depending on how pay rates are set, and other details of the arrangement.[29]

Professionals are often operating as consultants, one-person firms, or part of very small businesses. Those who are employees, however, typically retain salary and benefits, whereas clerical home-based workers are usually shifted to part-time status or independent contractor status, and do not retain employee benefits. Most clerical workers who are first hired for home-based work are not given employee benefits.[30]

Whether workers are full or part time, they may not do their work in the traditional office hours of 9 to 5. The ability to control one's own work hours is often cited as a major benefit of working at home.[31] But the choice of work hours in practice is usually constrained. The workers sometimes find that they must work during the business hours of employers or clients in order to ask questions or receive instructions. More often, they must fit their work around family responsibilities, working during school hours, when another adult is at home to care for children, or when the children are asleep. It is common for them to work at night, often after a full day of child care, cooking, cleaning, and shopping.[32]

Some workers use dumb terminals connected to an employer's mainframe computer, usually by a ordinary telephone line and modem. An additional telephone line is often installed

Photo credit: Digital Equipment Corp.

A portable terminal can be connected via telephone lines to business computer systems

[29] A recent IRS ruling indicates that they are employees, at least for some purposes. See p. 38 below. There have also been cases under the National Labor Relations Board under which newspaper delivery truck drivers, for example, were held to be employees rather than independent contractors as a company had claimed, according to Dennis Chamot, Associate Director of the AFL-CIO Department for Professional Employees (personal communication, Jan. 8, 1985).

[30] Margrethe Olson studied work-at-home programs in 14 corporations in 1983. In eight programs the workers were permanent full-time employees (salaries plus benefits). All of these programs except one involved professional workers. The other six programs were for clerical workers. In four programs, they were permanent part-time workers earning hourly wages. One of these companies paid the workers no benefits, three prorated benefits. One program paid the part-time workers by output (piece rate) with no benefits. The sixth program used contract workers, paid hourly rates, but with no separate benefits package. Margrethe H. Olson, *Overview of Work-at-Home Trends in the United States,* New York University, Graduate School of Business Administration, Center for Research on Information Systems (New York: New York University, August 1983), p. 9.

The literature suggests that the disparity in arrangements for professional compared to clerical workers shown in Olson's data is probably typical of corporate programs.

[31] Olson found that about half of the workers in her study did, however, approximate a 9-to-5 schedule. The others tended to work early mornings or late evenings, but on a fairly regular schedule. These were most often professionals, working at home under informal arrangements rather than formal programs. Those in formal programs, i.e., clerical workers, who worked odd hours usually did so because of the need to work around family constraints. Olson, op. cit., p. 22.

[32] Kathleen E. Christensen, "Impacts of Home-Based Work on Women and Their Families," contractor report for OTA, January 1985.

in the home for this purpose. Sometimes a dedicated leased line is necessary for security. Other workers use personal computers or stand-alone word processors, dictating machines and printers.[33]

There have been problems with equipment in some programs, but by most accounts technological problems have been minimal.[34] The equipment may be owned and installed by the employer, and either lent or rented to the worker. The worker may own or lease her own equipment.[35] Blue Cross clerical workers in North Carolina, for example, pay their employer $2,400 yearly rental for use of their equipment.[36] On the other hand, an employer in the Netherlands pays home workers an extra 2,000 guilders per month to cover the costs of operating a terminal at home.[37]

What Work Can Be Done at Home?

One of the most likely kinds of office work to be done at home is professional work that involves only one person's creative activity (programming, writing reports) or contacts usually carried out by telephone (sales, brokering). A second kind is clerical activities that are unitized, repetitive, and routine.[38] Data entry and word processing can be monitored and measured electronically, computer checked for errors, and paid as piecework. Raw data and finished work can be physically transported between office and home in batches, or can be sent by telephone. Whether professional or clerical, this work usually does not require much face-to-face supervision or collaborative effort between coworkers in real time.

Supervisors are least likely to be able to work at home and there are now only a few firms where they do so. This may change in the future with the spread of electronic mail, computer conferencing, PBX, and other electronic tools that make possible cooperative document-handling and reduce the need for frequent interactions with coworkers.[39] However, the extent to which supervisors will be inclined and willing to replace face-to-face interaction and supervision with electronic communication remains to be seen.

Financial and computer service corporations have been most likely to experiment with work-at-home programs. Metropolitan Life, Control Data Corporation, National Bank of Chicago, Continental Illinois, Southern New England Telephone, Seybold, and Aetna Life and Casualty Company have started such programs, although some of these have been terminated or suspended.[40] Small new companies have also experimented with the scheme. Few or none of the programs have been found in old, traditional industries.

There is strong interest in work at home in other countries, but the movement has been strongest in the United States. In England, early enthusiastic projections of "electronic commuting" were not met, largely because of the high costs of telephone lines.[41] In France, there have been a number of experiments with working long distance from small neighborhood centers rather than homes. The national telecommunications authority, which sponsored these programs, made an explicit policy

[33] In Pratt's recent study of 59 home-based office workers, 57 percent of the equipment was employer-owned terminals communicating with mainframe computers in the office; 31 percent was stand-alone computers; and 12 percent was stand-alone word processors usually not equipped for communication. Pratt, op. cit., p. 5.

[34] However, according to Elizabeth Carlson, second vice president of personnel, as quoted by Honan, op. cit., p. 96, Continental Illinois curtailed its program in 1980 and again in 1981, "waiting for vendors to come out with usable equipment."

[35] In most of the formal corporate programs that Olson studied, the employer paid for installation of equipment and monthly telephone charges; in one program employees rented equipment from the company. Olson, op. cit., August 1983, p. 10.

[36] "If Home Is Where the Worker Is," *Business Week*, May 3, 1982, p. 66.

[37] Richard J. Long, "The Application of Microelectronics to the Office: Organizational and Human Implications," Nigel Percy (ed.), *The Management Implications of New Information Technology* (London: Croom Helm, 1984), p. 106.

[38] In one study of corporate pilot programs, it was found that they had targeted either clerical workers, with the objective of cutting overhead costs, or professional workers, in the interest of retaining valued workers who demanded the privilege of working at home. These were distinct objectives and quite different kinds of pilot programs; no corporations had both types. Olson, op. cit., 1983, p. 7.

[39] Olson, op. cit., August 1983, p. 7.

[40] Honan, op. cit.; Jacobs, op. cit., Wang Laboratories, op. cit.

[41] Ursula Huws, *The New Home Workers* (London. Low Pay Unit, pamphlet No. 28, 1984), pp. 14-15.

decision that home-based work would be too isolating. These experiments have generally not been successful and most of the workers dropped out.[42] However some pilot programs for handicapped workers are now underway. Sweden has also experimented with neighborhood work centers, and there is reported to be much interest, but little experience, with working at home.[43 44]

One multinational software company based in Britain, with subsidiary offices in Denmark, Holland, and the United States, is deliberately structured so that nearly all of its workers are based at home. These are computer professionals, and in Europe, 96 percent of them are women with small children, and 95 percent work entirely at home. In the United States, 70 percent of the company's employees are women, and 50 percent are fully home-based. The workers agree at the outset, they will steadily increase both their working hours and commitment to the company and career, as their children mature.[45]

[42]Ibid., p. 19.
[43]Ibid.
[44]Monica Elling, Swedish Center for Working Life, Stockholm, "Remote Work/Telecommuting," presentation at IFIP-Conference on "Women, Work, and Computerization," Riva del Sole, Italy, Sept. 17-21, 1984.

[45]Huws, op. cit.; and Marsha Johnston Fisher, "Firm Turns Telecommuting Into a Reality," *MIS*, Nov. 28, 1984.

PARTIES AT INTEREST

Employers

Employers who offer home-based work have at least one of four possible objectives: response to employee demands, social responsibility, access to an untapped labor pool, or cost cutting. The last is apt to be the critical factor for the future spread of home-based work.

Some corporations have begun home-based work programs, or allowed the option in individual cases, to hold on to particularly valued workers. Some allow workers on retirement to continue part-time work from their homes. Others such as Control Data Corporation and Metropolitan Life began programs in order to offer employment to handicapped workers.[46]

A few corporations are reported to be turning to home-based work as a way of recruiting otherwise unavailable but highly qualified workers, such as mothers of small children, or suburban housewives.[47] Critics say that they are trying to avoid hiring poorly educated urban minority workers.

[46]Honan, op. cit., pp. 88-91.
[47]Pratt, op. cit.

The strongest motivation for offering home-based work in the future is, however, likely to be the possibility of reducing costs. The employer saves money in terms of:

- floor space and associated overhead costs,
- equipment costs (in some situations),
- direct labor costs, and
- workers' benefits.

The office needs proportionately smaller facilities, with all of the reduced operating costs that entails, if many of the workers are at home. There workers pay for their own floor space, heating, cooling, and amenities; in some cases, they own and maintain the computer and other equipment. In effect, these costs are shifted to the workers

If the workers use terminals to communicate with the employer's central computer, the employer benefits by the more intensive use of the computer because workers often use it, and can even be required to use it, outside of peak hours. For example, in a pilot program run by the Army Materiel Development and Readiness Command, there was a 64 percent increase in computer usage without additional cost. Three home-based employees were shifted to second and third shifts. The percentage of work time that the remote employees spent on-line also increased by an average of 93 percent.[48]

Home-based clerical employees are often paid less than their peers in the office, although this is not always the case.[49] If the workers are paid piece-rates, the employer is not paying for set-up time, time spent in collecting or delivering work, coffee breaks, bathroom breaks, discussions with supervisors, chats with coworkers, or any of the other unproductive time that office work includes. The organization can define the work by task and pay only when it is satisfactorily completed.

The employer's biggest cost saving may come from flexibility—workers can be used when needed and not used when work is slow, without the difficulties of firing and rehiring or the expense of unemployment compensation. This is a great advantage for a company with a highly uneven workload. It means, however, that the worker does not have a steady income.[50]

Many home-based workers received no benefits—health insurance, sick leave, vacations, pensions, etc. Of 14 corporate programs studied in 1983, for example, the 6 designed for clerical workers shifted their status from full-time to permanent part-time workers, in which category, workers did not receive benefits.[51] Those classified as independent contractors are generally not eligible for unemployment insurance benefits when not working. Home-based employees and independent contractors studied by OTA for this project did not receive any employee benefits. Entrepreneurs had purchased their own health insurance and retirement plans.[52]

It has also been suggested that union-busting is, or will be, a motivation for some employers. At present, few office workers belong to unions, and home-based workers are likely to be even more difficult to organize than other office workers. The low pay for home-based clerical workers, especially piece-rates, could act over the long run to depress the pay of the main clerical work force. Critics argue that employers might use the threat of expanded homework programs to undermine attempts by office workers to organize.

In spite of seemingly significant benefits to the employer, many companies resist the concept of work at home. It involves a significant change in traditional techniques of management and supervision, and managers fear a loss of control over quality, quantity, and pacing of the product. The workers themselves sometimes complain of poor instruction and a lack of feedback from managers.[53]

Productivity

Almost without exception, studies show that home-based workers are more productive than those in the office. Estimates of the increased productivity of home-based workers range from Control Data Corporation's estimate of 15 to 25 percent to other estir⁻⁻tes of up to 60 percent[54] and even 80 percent[55] for some work-

[48]Mary T. McDavid, "The ALMSA Work-at-Home Prototype," presented at the National Executive Forum: Office Workstations in the Home, National Academy of Sciences, Washington, DC, Nov. 10, 1983.

[49]Continental Illinois, for example, paid at-home workers the same salaries paid to in-office workers, expecting that cost-reduction would result from reduced need for office space. Honan, op. cit., p. 96.

[50]*Business Week* reported in 1982, for example, that "Aetna plans to pay telecommuters by the project and to use them only for 'peak work,' leaving them without a regular salary. They will also be ineligible for health and pension benefits." Blue Cross home-based data enterers are excluded from benefits, which for office-based workers amount to $2,000 to $3,000. The company says that those at home earn "up to $3,000 a year more," but they also pay $2,400 rent for their terminals. "If Home Is Where the Worker Is," *Business Week*, May 2, 1982, p. 66.

[51]Olson, op. cit., August 1983, p. 11.

[52]Christensen, op. cit. Most of the home-based workers studied in depth were, except for those who were active entrepreneurs who owned their own business, regarded by their companies as independent contractors. Since they each worked only for one company, in most cases had been regular employees until they took maternity leave, and had been approached on the question of working at home in each case by the company rather than themselves soliciting home-based work, they probably should still be regarded as employees.

[53]Pratt, op. cit., p. 6.

[54]R.A. Manning, Control Data Corp., "Alternative Work Site Programs," a presentation to the National Research Council's National Executive Forum: Office Work Stations in the Home, Washington, DC, November 1983.

[55]In a study of about 1,000 home-based workers by Electronic Services Unlimited, reported in Jacobs, op. cit., p. 15.

ers.[56] In part, this is an artifact of measurement. With home-based workers, only actual working minutes are counted. In the office, there is a considerable amount of "wasted time" that is so fragmented that it is not noticed. However, many experts believe that much of this "wasted" time is in fact spent in informal help and support to other workers, or in the exercise of "invisible skills" beneficial to the company.[57]

Home-based workers who were interviewed for OTA said that they did not bill their employers for extra work they did in correcting mistakes. Some did not request payment for, or even report, hours that they put in on a project over and above the time that had been estimated as required, feeling that they should have been able to work faster—even though these estimates of required time had been made by the employer rather than by themselves. This kind of self-exploitation may be common among those for whom home-based work is new and regarded as a rare privilege, and should be taken into account in assessing the reports of high productivity.[58]

Workers themselves tend to attribute the increased productivity to their control over their schedule, their ability to work when they most feel like working. In part, the additional productivity probably results from the fact that home-based workers are carefully selected, highly motivated, and working in an environment chosen and designed by themselves.

Some observers argue that all of these effects are transitory and will disappear when the novelty of working at home is gone, and when less highly motivated or selected workers are involved. The cross-fertilization and mutual support that occurs in an office working group are valuable. Workers learn from each other on the job. When there is no chance to do this, productivity may suffer in the long run.

The Workers: Why Are They at Home?

Because the number of home-based workers is uncertain, their characteristics—age, gender, occupational status, etc.—cannot be described quantitatively with confidence. Certain groups are thought to be represented far out of proportion to their number in the total work force—women, single parents, the handicapped, and retirees.[59]

Professional home-based workers include both men and women; the clerical workers are overwhelmingly women, and the evidence indicates that most have one or more children under 6 years old.[60] This is true in other countries as well as in the United States. The typical home-based white-collar worker, then, is probably not a male professional, but a young mother doing clerical work.[61]

Most of the home-based clerical workers are women because: 1) most clerical workers are women, and 2) women are most likely to be responsible for care of children, the elderly,

[56] McDavid, op. cit. Nilles concludes that gains of 20 to 50 percent are common. (Nilles, op. cit., p. 3.) In one group, 67 percent of the workers perceived their own productivity, as well as the quality of their work, to have significantly increased. (Pratt, op. cit., p. 5.) In another study, workers reported their perceived increase in productivity to be 35 percent on the average, with the self-reported range from 5 to 100 percent.

[57] Invisible skills are important aspects of the job that are not specified in job descriptions but make the worker valuable to an organization; for example, a secretary chatting hospitably with important visitors, or a word processor showing coworkers features of the equipment that they have not yet discovered.

[58] Christensen notes that this response was typical for the *employed* home workers, but that it was not typical for entrepreneurs who had clear ideas about the value of their time and priced services to be competitive with similar businesses.

[59] An analysis based on the 1980 census suggests that of people regularly working at home (but not necessarily doing office work or using computers), 57 percent were women compared to 43 percent of those working outside the home. (Robert E. Kraut, in on-going analysis, communication of Dec. 20, 1984.)

[60] Among those who volunteered to be interviewed by OTA contractor Kathleen Christensen there were two groups, roughly equal in size. Those who were in effect employees (although called independent contractors they worked only for one organization, usually their employer before they took maternity leave) were all women in their thirties, married or with partners, and with small children. Those who were entrepreneurs, with their own companies and seeking multiple clients, were typically older, single, with no small children. An as-yet-unpublished survey of several hundred home-based workers confirms this finding.

[61] Most home-based women workers with children under 17 are clerical workers, according to a major survey: Kathleen E. Christensen, "National Survey on Women and Home-Based Work" *Family Circle*, Dec. 15, 1984 (publication of results in progress).

or the ill.[62] Women are probably also most likely to need additional income after retirement, because they live longer than men, and are less likely to have adequate pensions.

Most if not all home-based workers are now working at home by choice, in the sense that other jobs are available and no employers are known to require working at home as a condition of employment. In most cases, the demand for home-based work has so far come from the workers, not from employers, who are often reluctant or at least hesitant to provide this option. But this may already be changing, as organizations become aware of the cost-saving possibilities.[63]

"Choice" in any case has a wide range of meanings. In some cases, it means that other options are not available, or are less attractive to a worker for reasons over which she has little control—staying at home is necessary because of other responsibilities, because of social inhibitions (the traditional housewife's role), or because of physical disability. Often, however, the person has first decided that he/she wants to stay at home and care for a family; the opportunity to do paid work at home is a secondary choice that is not a critical factor in the first decision. Other people simply prefer a lifestyle that does not include going to an office, at least not at any preset times.

These people who have actively sought home-based work as part of a new lifestyle are more likely to be the professionals (including males) simply because professionals usually can exert more control over the conditions under which they earn a living. Corporations frequently report that they have formally or informally provided the option in order to retain valued employees.

Many of these professionals believe however that home-based work, especially if done full time or nearly full time, seriously prejudices their chance of promotion and advancement. They have consciously traded-off advancement for a preferred lifestyle.[64] Women managers especially tend to believe that this choice is particularly prejudicial to their careers; some have done it in preference to dropping out entirely when they became mothers, and in order to maintain their expertise and credentials until they could return to work.[65]

Those who look for home-based work reluctantly, because they must be at home, are more likely to be clerical workers.[66] They are less likely than professionals to be able to afford professional child care or specialized transportation for the handicapped. But even for these people, the opportunity to work at home may be cherished, in contrast to not working, or working under less desirable conditions.

It is therefore not surprising that overwhelmingly home-based workers are pleased with their situation. This must be kept in mind when evaluating the implications of home-based office work. Controversy over home-based work does not arise from the dissatisfaction of the current home-based workers themselves, but from the possibility of future exploitation.

The Benefits and Costs for Home-Based Workers?

How workers assess the relative benefits and costs to them of working at home undoubtedly depends on the degree to which they exercised free choice from a wide range of employment options.

All studies, and all journalistic accounts of home-based workers, indicate that most value the opportunity to control their own work hours. Many report that the quality of their leisure time is also improved because they can select and schedule recreational activities that

[62] While women constitute 80.5 percent of all clerical workers, they are even more dominant in clerical occupations most likely to include home-based work. For example, over 96 percent of typists are women, but less than 23 percent of shipping clerks. Kraut, op. cit., p. 5.

[63] The group of 13 "independent contractors" who worked only for one client included nine former employees of an insurance company, who had been offered work to be done at home when they applied for maternity leave. Four others were housewives who had each been asked to do work at home by friends or husbands who were the proprietors of small companies. Christensen, op. cit.

[64] Pratt, op. cit., p. 7. See also Breathnach, Honan, Jacobs, Olson, op. cit.

[65] Pratt, op. cit., p. 11. Also substantiated in Christensen, op. cit.

[66] For example, see Olson, op. cit., August 1983, p. 17.

are not otherwise available. Many of them find the home a congenial and comfortable working environment; this is not always the case for those who are combining work with child care in crowded living quarters. Many value highly, the additional time spent with their families, or the latitude to spend more daytime hours with family. The opportunity to care for children at home rather than have them cared for by others is the primary benefit for many people.

It is not always true, however, that working at home allows the worker to control when he or she works. The home-based worker indeed often has a double constraint, having to fit work around family needs and the times when the company computer is down, such as on Sundays. Thus, they may have as little control as office workers over when they work, and they may even lose some of what is usually considered family time.

Cost savings can be significant for some who give up work in an office. Workers have reported savings up to $200 per month for meals, $100 for gasoline, parking, and insurance; $100 for clothes and cleaning bills. Large costs of children's day care may be avoided.[67] Those who are entrepreneurs avoid the cost of outside office space and take tax deductions for the use of their home.

Eliminating the commute to work is for many a primary benefit. The average American worker now travels over 9 miles in each direction, often a 1- to 2-hour commute.[68] The time and the stress spent in commuting is often resented even more than the cost of gasoline, insurance, car maintenance, and parking.

These cost savings of working at home do not tell the whole story. There are also added costs, both direct and indirect. Some workers must lease or buy terminals. Most pay the telephone bills and some must pay for special dedicated telephone lines. Workers generally provide the furniture that they use in connection with the equipment. They pay higher electricity bills because of the equipment, and some report additional heating and cooling bills.[69]

Clerical home workers almost always earn less than their peers in the office, even within the same firm.[70] Sometimes the pay rate is technically the same, but those at home are shifted to part time or piece rates without fringe benefits. They usually work fewer hours than those in offices, either because work is not regularly available, because of their home-related duties, or by choice.

Part-time and piece-rate home-based workers usually report that their workload is very uneven.[71] (For employers, the flexibility of labor supply is a major benefit.) The lack of a regular income can be as much of a problem as is low pay; those who are dependent on income from home-based work may live balanced on the edge of financial disaster.

Health insurance coverage becomes a major problem for those converted to the status of independent contractor or part-time worker. The majority of home-based workers may be covered as dependents by the health insurance of spouses, but the separation from employee status leaves others to pay the high costs of individual coverage or be without protection.[72]

[67] Pratt, op. cit., p. 5.

[68] Motor Vehicles Manufacturers Association, *Facts and Figures*, Detroit, MI, 1981.

[69] Pratt, op. cit.; and Honan, op. cit., p. 97.

[70] See for example, Olson, op. cit., August 1983. Other case studies of home-based clerical work have consistently found that home-based workers make less than peers. However, some preliminary analysis by Robert Kraut at Bell Communications Research, shows higher hourly wages for home-based workers in a few clerical categories as compared to those not working at home.

Reduced income is typical of the larger category of all work at home as compared to work away from the home. According to the 1980 census, 10 percent of home-based workers are below the poverty line, compared to 6 percent of other workers. Male home-based workers have an average hourly wage of $6.77 compared to $8.20 for nonhome workers; women home-based workers have an hourly wage of $3.06 compared to $4.80 outside the home. In addition, home-based women workers average 30.6 hours work per week compared to 40.2 for those working away from home, 35 for male home-based workers, and 41.6 for other male workers. There may be several variables involved in this phenomena.

Pratt (op. cit.) also reported that many retired people found home-based work not worth their effort because of the low pay, even though many enjoyed having some work to occupy their time.

[71] Pratt, op. cit., p. 10.

[72] Among those interviewed by Christensen, independent contractors working for one client were covered under a hus-

While home-based workers have more control over their working environment than they would in most offices, in the sense that the decisions are their own, in fact, they often work under very undesirable conditions. It may not be possible to set aside space dedicated only to work. They may not know how to select, or perhaps cannot afford to buy, chairs and desks that accommodate the equipment and reduce muscular strain for the workers.[73] Poor lighting may cause eyestrain and headaches. It is possible that office automation equipment also introduces unrecognized hazards into the home.[74]

One intangible cost to the worker may be the social isolation of working at home. Saloman and Saloman point to the importance of social interaction at work, and studies that have shown that small, cohesive work groups are for most workers the most effective and satisfying work unit. For these workers, separation from the office work group may in the long run result in dissatisfaction and low motivation. For managers and professionals, the social role of the workplace may be less important; they rank achievement, advancement, and the work itself as the most important factors in work satisfaction. The Salomans hypothesize that for some of these workers, the shift to working at home may cause the individual's "motivators" to shift. He or she may become less concerned with achievement, status, and recognition, and more concerned with affiliation and emotional contentment within the family and community, which will become more important to the worker than his or her organization. If these needs for "belongingness" cannot be met within the immediate environment, then frustration and dissatisfaction will result.[75]

Home-based professionals whose salaries do not depend on the exact number of hours worked have remarked that minor illnesses, for which they would have stayed home from the office, now make them feel guilty—there is no ritual process of calling in to validate their reason for not working.

Distractions and interruptions by family members, normal household noise, salesmen and solicitors, friends who do not respect working hours at home and repeatedly call or visit, are sources of annoyance and stress for home-based workers.[76] Some people have reported giving up work at home because they could not resist the temptation to eat or drink too much. Men have reported that wives resented having them under foot all of the time.[77]

On the other side, some researchers have reported that both the loners and the gregarious types say that they can overcome these problems with time. Handicapped people report that they feel less isolated with work to do, even if their human contacts do not increase, and young mothers according to one survey said they were no more isolated than they would be if they were caring for children without paid office work to do. It appears to be the young, never married workers who are most likely to give up home-based work after they have tried it because they miss the social aspects of the office.[78]

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band's health insurance. Those who were entrepreneurs with, or seeking, multiple clients were mostly not married; they said that the high cost of health insurance (in one case, $1,400 per year) was one of their greatest concerns, and one or two had gone uncovered for long periods of time. Christensen, op. cit.

[73] *Telecommuting Review*, Dec. 31, 1984, cited a survey of computing furniture needs conducted by the Business Products Consulting Group, which found that only 25 percent of personal computer users, whether in the home or in the office, had specialized computer furniture, and many of them complained of flaws in design that caused discomfort. Overall 7 out of 10 PC users had complaints about the furniture used with the computers. The situation is likely to be worse in homes than in offices, since home furniture is often jerry-rigged to hold office equipment.

[74] If fire breaks out, there is a serious hazard to residents and to fire fighters from the highly toxic gases produced when the plastic casing of computers burns. Any special cabling that might be installed in homes could also involve fire hazards, according to discussions with insurance risk assessors.

[75] Ilan Saloman and Meera Saloman, "Telecommunicating: The Employee's Perspective," *Technological Forecasting and Social Change* 25, 15-28, 1984. The Salomans here are drawing on the work of N.D. Dunnette and others in *Work and Nonwork in the Year 2000*, Dunnette (ed.) (California: Brooks/Cole, 1973).

[76] Saloman and Saloman, op. cit., pp. 23-24.

[77] Nelson B. Phelps, "Mountain Bell Telephone Company, a Case Study," a presentation to the National Research Council National Executive Forum. Office Work Stations in the Home, Washington, DC, September 1983.

[78] Pratt, op. cit.

Again, those who found home-based work unpleasant or stressful, have so far either had the option of returning to the office or have found this alternative even less acceptable. Thus, studies of home-based workers almost always find the workers enthusiastic about this lifestyle.

Family Considerations

Advocates of home-based work stress the benefits to family life of returning the worker to the home. Little research has been done to determine the real effects on family life. Such indicators as there are point to generally positive effects, but with some caveats.[79] Mothers perceive several specific advantages for their children, in addition to the primary advantage of having a parent care for them, instead of strangers or a commercial facility. They believe it is good for their children to realize that "mothers can do more than cook . . . and take care of them." They want their children to see women performing a broader social role than that of housewife, however they themselves value that role. Some say that their children become more independent because they are not the only focus of mother's attention. They say also that their children become familiar with computers and what they can do.

On the other hand, some mothers report that their children get less time and attention, and that the mother gets impatient when she is under pressure to get work done.

For women struggling to earn an income and care for children at the same time, home-based work may be a golden opportunity, but it is not an unalloyed blessing. It involves significant stress, both physical and mental, and may create emotional strains within the family as well.[80] One expert says, "It appears that work at home cannot be called a 'good' solution to child care."[81]

Mothers working at home typically try to work when other adults are at home to care for the children or when the children are at school or asleep; they are not so much combining work and child care as interweaving them.[82] It is hard to find 40 such hours a week even when work is available and the income is wanted, and typically they work split shifts, often late at night. Those who must earn as much as possible because they and their children are dependent on their income, may therefore have little or no time for rest or recreation, like the cottage sweatshop workers of the turn of the century.

Those who regard this income as discretionary often have babysitters while they are working.[83] Since taking care of the children themselves is important to these women, the fact that they turn to baby sitters indicates two things: that doing paid work and taking care of children at the same time is difficult and stressful; and that it is important to them to have some other work, in addition to caring for a family, for reasons other than the marginal income. The second point is repeatedly confirmed by home-based working mothers, who say that they need something to occupy their minds or that paid work gives them pride

[79]Material in this section, unless otherwise noted, is drawn from Kathleen Christensen's study and chiefly from the responses of 14 mothers working at home, so that it is merely illustrative Her findings as discussed in this section are, however, in many cases confirmed by or congruent with the somewhat scanty and widely dispersed observations of other researchers about the family situation of home-based workers.

[80]Gregory, op. cit., discussing Cynthia Costello, "On the Front· Class, Gender, and Conflict in the Insurance Workplace," Ph.D. dissertation, University of Wisconsin, Dept. of Sociology, 1984. In one study, 50 percent of mothers working at home reported that they found it necessary to have a paid babysitter for part of the time in spite of their desire to combine work and child care. Also Margrethe Olson, *Remote Office Work: Implications for Individuals and Organizations*, CAIS No. 25, GBA No. 81-86 (CR), New York University, Graduate School of Business Administration (New York: New York University).

[81]Olson, op. cit., August 1983, p. 27.

[82]The 14 mothers interviewed by Kathleen Christensen, nearly all said the hours they could work were those in which the children were asleep, in school, being watched by the husband, or "playing by themselves and/or in a good mood." These women are in traditional two-parent households where the husband is the primary breadwinner.

[83]Six of the 14 mothers interviewed by Kathleen Christensen, all of whom were from traditional two parent households and said that they stayed at home to care for their children, relied on some form of paid child care while they worked. The mothers, whether or not they had child care, usually gave as their reason for working "to have something to do, so that my mind can keep working," or to show "that I can do something besides cleaning the house and being a housewife."

and self-respect (and respect from others) that is lacking otherwise.[84]

In the few cases where effects on the marriage, or other personal relationships, of home-based women workers have been studied, most husbands were said by their working wives to be supportive and helpful—sometimes because they welcomed the supplemental family income, sometimes because they recognized its psychological importance to the worker, sometimes for both reasons. A few husbands were said to have mixed feelings, perceiving that work sometimes interfered with housework; none were reported to be actively opposed.

Most of the women said, however, that their husbands helped no more with housework than they had before. The women had been, and still were, predominantly responsible for the household work, and a few spontaneously expressed dissatisfaction or resentment of this. Most were unable to draw boundaries between household and work responsibilities, and move back and forth between them during the day.

Even those home workers without children to care for often report significant stress resulting from the lack of separation between work and family responsibilities. Saloman and Saloman, in a paper on home-based work from the perspective of the sociology of work, point out that:

> Work and family life today are not only physically separate entities, but each also gives rise to distinctly different role behavior that may have little in common. It is not only that the two different environments require different behavior, but that they also offer the individual a chance to express different aspects of his or her personality.[85]

Sociologists define a "role" as a set of structural demands being placed on the individual in a given social position.[86] Role conflicts can result when the demands and expectations imposed by multiple roles operate at the same time. Working at home, the Salomans argue, can introduce identity conflict as it eliminates the sequential operation of the different roles related to home and work. For men, it has normally been "acceptable for work (to) interfere with family life"; at home, the reverse interference may happen more often. For women, who may have more social inhibitions to overcome in establishing a career role, the conflict may be particularly severe when the roles of mother, wife, housekeeper, employee, and career aspirant overlap in time and space.

These sociologists say that the trip between work and home is often a useful separation between two arenas of social interaction. Thus, eliminating the commute may be a cost as well as a benefit.

Effects on Society

Workers and employers are part of one society and the interests and concerns of each are part of the public interest. But society at large may have a general interest separate from the specific concerns of either party.

In this case, some of the costs that are ordinarily borne by employers or shared by employers and employees are shifted to workers—for example, in the case of independent contractors, social security taxes, health insurance, pensions, and the costs associated with periods when the workload falls below normal levels for long periods of time. For people who are not employed, those costs ultimately may be borne by the taxpayers. Thus, a strong trend toward farming out work to "independent contractors" who were previously, or would otherwise be, employees, also implies a shift of life-cyle costs from the employer to the general public.

[84]Ibid., citing D.T. Hall, "A Model of Coping With Role Conflict: The Role Behavior of College Educated Women," *Administrative Science Quarterly* 17 (4), 1972. See also J. Pleck, "The Work-Family Role System, *Social Problems* 24 (48), 1977.

[85]This was a theme that recurred repeatedly in the interviews conducted by Christensen.

[86]Ilan Saloman and Meira Saloman, op. cit., pp. 15-18, 21.

LEGAL AND REGULATORY BARRIERS TO HOME-BASED WORK

Zoning laws in some communities prohibit any paid employment in residential areas.[87] The Internal Revenue Service (IRS) has in recent years progressively restricted the income tax deductions that may be taken for home offices. It is not clear under what conditions home-based workers can claim deductions, especially if the workspace that they use is not entirely dedicated to work (many home-based workers use a corner of the dining room, bedroom, or living room). But when there is dedicated space, a recent IRS ruling says that the home office is to be treated as business property rather than residential property, and thus part of the proceeds of selling a house that includes a home office are not eligible for the standard exclusion from tax on the proceeds allowed to people who immediately buy another house, or who are over 55 when they sell the house.[88]

There have until recently been unresolved questions about the status of home-based "contractors" who contract with only one organization, especially, if they have previously been employees of that organization. The National Labor Relations Board has ruled, in similar situations, that such independent contractors are in fact employees. The tax code says that anyone who performs services for any person as a home worker, performing work according to specifications on materials furnished by the other person and required to return the finished product to that person, is an employee. This holds unless that person has a substantial investment in facilities used for the work, in which case, he or she may be an independent contractor.[89] The Internal Revenue Service has ruled specifically that computers with word processing capability are *not* "substantial investments" in that sense, and that home-based workers providing transcription services for one person or organization are employees at least for certain tax purposes.[90] The effects of these rulings on home-based clerical work are not yet fully apparent. It will open the door for home-based clerical workers, if they choose, to argue that they are employees, even if regarded by their client as contractors, and thus, entitled to certain worker benefits and safeguards.

Government work-at-home pilot programs have been frustrated or terminated because of regulatory requirements. The pilot program of the Army Material Development and Readiness Command wanted to use either direct lines or telephones with a modem to connect home-based workers to the central computer. The Army Communications Command determined that for the government to provide telephone service to a home violated a Federal statute;[91] but employees could not use their own telephones because another statute[92] placed some limitations on government acceptance of voluntary services from individuals.[93] The problem was solved by installing direct lines without voice capability; a legal opinion sanctioned occasional use of the employee's home phone to communicate with a supervisor.

This introduced a second problem: how to protect the government if personal property was damaged as a result of installing the communication lines or the use of government-owned equipment. This was solved by requiring employees to sign a "hold harmless" agreement with the government as a condition for participation.[94]

[87]Tammara H. Wolfgang, "Working at Home: The Growth of Cottage Industry," *The Futurist*, June 1984, p. 31.
[88]*Telecommuting Review*, Dec. 31, 1984, p. 7.
[89]Sec. 3121(d) (3) (C) of the Internal Revenue Code.

[90]Internal Revenue Service, Technical Advisory Memorandum 845 1004, Aug. 1, 1984. Index nos. 3121.04-00, 3306.05-00, 3401.04-00.
[91]Stat. 32 U.S.C. 1348.
[92]Rev. Stat. 3679, 31 U.S.C. 1342.
[93]McDavid, op. cit.
[94]That is, an agreement not to hold the government liable for accidental damages.

A third problem was the question of responsibility for injury to the employee while working at home. Workers' Compensation (U.S.C., title 5, sec. 8102) covers Federal employees on duty, but the question was how to prove that they were on duty when the accident occurred. The solution to this problem was a written work agreement stating hours to be worked each day; participants had to formally request changes to their designated work schedule and get a supervisor's approval. This of course eliminated one of the major benefits that workers typically see in working at home.

Finally, this program ended when government auditors ruled that there was a risk of fraud or abuse in spite of electronic monitoring of work done at home.

Some of these problems also appear in the private sector, for example, the problems with the installation of communication lines and questions related to the protection of home workers from work-related injury or illness. Installing an additional telephone line in a rented residence, for example, sometimes requires the permission of the owner. One study of home-based corporate employees found that half of them had no accident insurance, and most "assumed" that they were covered by Workers' Compensation.[95] It appears to be true that home workers are covered by Workers' Compensation if injured while working at home, and by the employer's insurance plan if injured at the same location while not working—if the worker is covered by employee benefits.[96] In either case, how the worker is to demonstrate whether or not he or she was actually working when injured, is so far unanswered.

[95]Pratt, op. cit., p. 8.
[96]Honan, op. cit., p. 91.

The more general question as to how Occupational Safety and Health rules apply to home-based workers is also unanswered. Laws pertaining to the use of VDTs in the office have been proposed in 13 States but it is not known how these will apply to home-based employees.[97]

A British document illustrates that these questions arise in other countries. Draft regulations proposed by the U.K. Health and Safety Commission in 1979 says that:

> Home workers, properly speaking, work for the person who puts out work to them in the sense that they contribute to products which he markets. For this reason, those who put out work to home workers bear the prime responsibility for ensuring that, so far as is reasonably practical, no risks to health and safety arise.[98]

In the next paragraph however, clerical workers are expressly excluded: "The Commission, particularly in the absence of evidence of risk to home workers from these processes . . . propose to exclude from these regulations all office type work undertaken in domestic premises." The document continues:

> It is important to reemphasize that any person requiring a home worker to utilize potentially hazardous processes in connection with clerical work is nonetheless bound by the requirement . . . to ensure that risk is controlled.

No further reasoning supporting the exclusion is given, nor are "potentially hazardous processes in connection with clerical work" specified or defined.

[97]Gregory, op. cit., p. 2.
[98]Health and Safety Commission, *Home Workers: Draft Regulations*, consultative document (issued by the Commission in compliance with its duty to consult under sec. 50(3) of the Health and Safety at Work, etc., Act, 1974, 1979, p. 1.

PUBLIC POLICY ISSUES

Encouragement or Prohibition of Home-Based Office Work

The primary public policy issue in home-based office work is whether the Federal Government should: 1) actively encourage it, 2) actively discourage or forbid it, or 3) take neither action.

Parties at interest include: employers, home-based workers, their families, other workers (especially clerical workers and working women with children), and unions. The issue also tends to engage people with an ideological position regarding home and family values, equity for women, and alternative life styles. Society in general has an interest, in that some potential costs may be shifted to the taxpayer when home-based workers are converted to the status of independent contractors.

Congress, and State governments, could take a number of steps to further encourage home-based work, although these are probably not necessary. These include:

- revising IRS rulings on independent contractors and relieving employers of some tax liabilities for them, for example, rewriting social security tax provisions;
- resolving the problems of applying workers' compensation to work performed in the home;
- persuading States to grant exemption from zoning and building codes for computer-mediated employment in residential buildings;
- providing significant tax incentives for equipment purchased for home-based work; i.e., a tax credit rather than deductions; and
- clarifying and expanding tax deductions allowed on home offices, especially providing large deductions when all or a significant portion of family income is earned in the home (this would benefit some home-owning workers).

If public policy is to discourage home-based office work—or more narrowly, home-based clerical work—the clearest option is to prohibit it, as was done for some other occupations in the 1930s. However, this would require very careful definition to limit the prohibition to those kinds of office work that are subject to exploitation. The prohibition would very likely be seen, even by some of those it was designed to protect, as discrimination against women (who would be mostly affected) or against certain occupational and income groups.

There are a few ways to discourage the spread of home-based work that are largely the converse of options for encouraging it:

- strong enforcement of the rules requiring organizations to treat independent contractors in some situations as employees, with full benefits;
- placing a special tax on income derived from services provided from homes, for both the employer and the employee; and
- high telephone rates for digitalized information transmitted between office and remote workers, which would run counter to present policies of deregulation.

Other government actions are possible that would both: 1) tend to discourage the spread of home-based clerical work, and 2) enhance the element of free choice for home-based work, thereby reducing the possibility that it will be used exploitatively. These actions are:

- developing subsidized, high-quality day care centers for children of working parents;
- providing larger tax deductions for expenses related to child care (or the care of elderly or infirm dependents); and
- requiring or providing further significant incentives for modifying transportation systems and office environments to facilitate employment of the handicapped, and providing positive inducements for employment of the handicapped.

Congress may choose not to take actions either to encourage or discourage home-based work. There are now few important legal or regulatory barriers to its growth; therefore the option of no-action will allow its spread. Eventually, home-based work is likely to grow since it offers benefits to both employers and many individual employees, while the costs that it imposes on some workers are generally considered acceptable in the absence of more desirable alternatives.

Controversy about home-based work is likely to become a major policy issue only if and when one of three conditions obtain:

- the number of home-based clerical workers becomes a significant fraction of all clerical workers, so that this becomes a factor in the competitive position of office workers in the job market and in negotiations with employers;

- cases of serious exploitation of home-based workers come to public notice through the media; and/or
- unions are highly successful in their attempt to organize white-collar workers.

Regulation of Home-Based Office Work

If, however, the Federal Government neither actively promotes nor prohibits home-based office work, then issues arise regarding its regulation to provide protections that are assured to other workers. In summary, these include wage and hour guarantees, assurance of safe and healthy working conditions, the right to negotiate collectively with employers, guarantee of equal opportunity, equitable pay, and equitable access to insurance, pensions, and other entitlements.

At present, managers and professionals are generally exempt from the Fair Labor Standards Act of 1938 (which covers such conditions of work as wages and hours) and managers, but not professionals, are exempt from the National Labor Relations Act (right to collective bargaining), whether they work in an office or at home. They are assumed to protect themselves individually by negotiation with employers, although some belong to unions or professional organizations that bargain collectively. They are however covered by the Equal Opportunity Act and other recent work-related legislation.

The chief concern in regulation of working at home therefore focuses on clerical workers. Predominantly female, nonunionized, and often bearing heavy responsibilities as mothers (increasingly, as single parents), they are particularly vulnerable to exploitation. Another growing concern is the vulnerability of new immigrants, of disadvantaged minorities, and of elderly workers to possible exploitation.

It is quite possible that States or local governments may impose regulations on home-based work, especially with regard to health and safety issues.

Questions with regard to regulation are:

- clarification of the application of existing regulations to home-based work (e.g., Workman's Compensation);
- what additional protection is needed for home-based workers? and
- what means can be devised for effective implementation and enforcement of regulations related to home-based work?

With regard to the last question, there are concerns that any attempts to implement and enforce regulation of home-based work may destroy the benefits for which it is valued (i.e., autonomy over work hours), or may lead to unacceptable violations of the privacy of workers and their families.

This—how existing labor standards can be implemented and enforced for home-based workers—is in fact, the critical policy issue most likely to confront the Congress in this area in the immediate future. It is the point on which opponents usually base their argument for an outright ban, since they maintain that real enforcement will be extremely costly, and in practice impossible. This is the problem that led to the ban on home-based work in some industries in the 1930s. However there has been little real examination of the possibilities and difficulties of enforcement today. It can be argued that the same difficulties would arise in enforcing a prohibition. It can also be argued that either a ban or regulation would be easier to enforce today than in the 1930s. Reporting requirements laid on businesses have proliferated, the rights of workers and the benefits they stand to gain by demanding those rights are larger, and people doing computer-mediated work are likely to be far better educated and more sophisticated in understanding to what protection they are entitled. The same technologies that make computer-mediated work at home possible, might be used to make it difficult to hide.

Chapter 8
Off-Shore Office Work

Contents

	Page
The Present and Future Status of Off-Shore Offices	211
How Off-Shore Offices Operate	214
Linkage Arrangements	214
Types of Data Processing	215
Examples of Off-Shore Offices	215
Factors in Moving Data Entry Off-Shore	216
Differing Views of Off-Shore Office Work	223
U.S. Off-Shore Companies	223
U.S. Labor Organizations	224
Foreign Government Officials	225
Economic Development Organizations	226
Public Policy Issues	227
Regulating or Prohibiting Off-Shore Offices	227
Regulation of Data	227
Encourage or Do Nothing About Off-Shore Office Work	230

Chapter 8

Off-Shore Office Work[1]

While the cost of electronic office equipment declines, the cost of employing Americans to perform routine office tasks is rising both per employee and in the aggregate. Some U.S. firms have established off-shore offices in order to take advantage of lower cost labor. Some of these offices involve manual clerical work such as coupon sorting. However, advances in information and communication technologies make it increasingly attractive to move data-entry operations off-shore. Data entry means converting information from "hard" or paper form into digital form so it can be stored electronically. This entry phase of data processing is commonly referred to as "keypunching," "keyboarding," or "keying."

High domestic labor costs could lead to an international division of labor in data processing. Data-entry clerks in Caribbean countries, for example, typically earn weekly wages that range from about $15 (U.S. equivalent) to approximately $60, while their counterparts in the United States may earn at least six times the latter figure per week. Even with transportation, communications, and other costs accounted for, total expenses for keypunching data off-shore may still not equal the cost of carrying out the process domestically.[2]

Several data-entry facilities are presently operating in the Caribbean region, and their number is expected to increase. Labor costs are low and the region is easily accessible and close to the United States. Transportation and communication networks are reasonably well developed, literacy rates are high, and there are favorable tax provisions for foreign investors. The Caribbean is only one region, however, in which off-shore offices could proliferate.

These operations can be simple to implement. The tools and raw materials are light, relatively inexpensive, and easy to transport. If full advantage is taken of communication technologies, distance and time become almost incidental factors when choosing sites at which to locate off-shore offices.

[1] This chapter draws heavily from an OTA contractor report: Christopher P. Astriab, *An Assessment of Off-Shore Office Work*, prepared for the U.S. Congress, Office of Technology Assessment, contract No. 533-0630, Feb. 28, 1985; and from an additional report from Consultant Anne Posthuma.

[2] Figures derived from Caribbean/Central American Action data (Washington, DC, 1982).

THE PRESENT AND FUTURE STATUS OF OFF-SHORE OFFICES

While off-shore offices have existed for the better part of two decades, the arrival of electronic communication and information technologies has set the stage for new and possibly rapid growth in the near future. The number of companies entering data at off-shore sites are still few, and the impact of the phenomenon on foreign and domestic employment and economic situations is at present insignificant.

Off-shore data processing facilities are predominantly located in the Caribbean region. Currently, there are at least 12 U.S. firms with data processing operations in the Caribbean. Barbados hosts seven such firms, while Jamaica hosts at least three, and St. Christopher-Nevis and Haiti each host one. In these four countries, approximately 2,300 workers are directly employed in off-shore offices. The largest such office in the region is a coupon-sorting operation that employs approximately 1,200 people in Haiti.

At least three off-shore offices in St. Vincent, Haiti, and Grenada closed down in recent years. Managerial and transportation problems were the causes; the ability of the employees to carry out the operations were apparently not in question.[3] In the case of Grenada, which hosted a firm for some 10 years, recent "unsettled conditions" there were cited as the cause.[4]

Other countries including India, Singapore, the People's Republic of China, and Ireland also host at least one data-entry firm each. Approximately 27 coupon-sorting operations are located in Mexico, one of the first countries to host off-shore offices. The total number of people employed by these firms is not known.

There are generally two types of firms involved in establishing off-shore offices. The first perform only their own clerical work offshore in order to reduce labor costs. The second group are vendors who have established off-shore offices to provide data processing or word processing services to clients in the United States.

All signs indicate that off-shore data entry could undergo rapid growth over the next 10 to 15 years. The vendors who provide these services are optimistic about the future of the industry:

> In 3 to 5 years we expect to have 300 to 500 people (keying) in different locations (in Jamaica). This is a large market, perhaps $50 billion by 1990.[5]
>
> The growth industry in Barbados has to be information services and data processing . . . As Barbadians acquire data processing skill, Barbados, with its investment in telecommunications, can develop software and other applications. The industry in Barbados . . . has tremendous opportunity to grow and evolve, especially given . . . the government's commitment to it.[6]
>
> For now, any softening of data-entry markets is being offset by explosive growth of data-base services. Such growing needs will give (data-entry firms) a big market to shoot at . . .[7]

In view of dramatic growth in data processing and expanding needs for digital data, these observations may be justified. There is considerable interest in establishing new data processing facilities abroad and some companies already in the business have cited expansion plans.

Several companies are now studying the possibility of setting up keying operations in the Caribbean. Barbados, St. Lucia, St. Kitts-Nevis, Dominica, Jamaica, Trinidad-Tobago, and Grenada are all possible sites for further growth.[8]

Firms already in the region may be expected to expand, but the scale of this expansion is uncertain. A firm in Jamaica that presently employs approximately 60 plans to expand to about 500 employees over the next several years. This growth—approximately 700 percent—is probably exceptional, however. The whole industry now employs about 500 people in Jamaica. The Jamaican Government encourages this industry, and Jamaica Investment Promotion, Ltd.—the government development agency—has reportedly secured contracts for another company that would require it to expand "significantly."[9]

While the industry has existed in the Caribbean for some time, investors are showing renewed interest since the passage of the Caribbean Basin Initiative Act by the U.S. Congress.[10] While no specific provisions in the act deal with data processing, the act does express the commitment of the U.S. Government to assist in the development of the region. Early signs of success in using satellites to trans-

[3]Donald Marsden, Coopers, and Lybrand, St. Kitts-Nevis. Personal interview, Miami, Dec. 7, 1984.

[4]Ibid.

[5]Mary Ramond, "Jamaica On the Move," *Business Week* special advertising section, Sept. 17, 1985. (Gary Bechtel, president of Telemar Data Systems, Fairfield, NJ, is quoted.)

[6]Mary Ramond, "Barbados - 1984," *Business Week*, special advertising section, Apr. 16, 1984.

[7]"The Instant Off-Shore Office," *Business Week*, Mar. 15, 1982, p. 136.

[8]Anecdotal information from various interviews, U.S. Department of Commerce, Caribbean Basin Business Information Center, and others.

[9]Audley Shaw, Director, North America, Jamaica National Investment Promotion, Ltd., New York, personal interview, New York, Jan. 14, 1985.

[10]Gary Bechtel, President, Telemar Data Systems, Fairfield, NJ, personal interview, and presentation given at the Miami Conference on the Caribbean "Off-Shore Key Punch Operations" square table discussion, Miami, Dec. 7, 1984.

mit data from the region are also attracting attention. Based on observations of people knowledgeable about the industry, it is probably safe to assume that at least 1,000 to 2,000 additional data-entry jobs could be created in the Caribbean region over the next decade.

In Mexico, the growth potential of data processing is high. An estimated annual growth rate of 10 percent has been cited, but competition from the Caribbean region is anticipated.[11]

In other areas of the world, growth is dependent on: 1) companies' willingness to establish operations at great distances from the United States, 2) the type of data they are dealing with (i.e., the lead time available for data-conversion work), and 3) the mode of operation being used (i.e., air transportation or electronic transmission). At the present time, the practice of flying hard copy to off-shore sites and returning the data on magnetic media is the predominant mode of operation. Only a few firms are using two-way satellite links to any extent, and the oldest has been operating for about 3 years. Unless satellites are used, it seems unlikely that time-sensitive work would be exported to areas such as the Far East or India. Air transport to these areas can be relatively slow and complicated, particularly if time is of the essence.

Wage rates in these areas, however, can be much lower than in the Caribbean. In the People's Republic of China, a figure of $2.00 per *week* for clerical workers was cited.[12] In India, the labor rate for keyers may be as little as one-tenth to one-fifteenth of the U.S. rate, which more than compensates for transport costs.[13] The president of one firm operating there estimates that it would cost approximately $65 to key 10,000 characters in the United States, while he can get the same job done in India for about $7 to $10, and the quality is higher.[14]

[11] Mollie Shields, Commercial Officer, U.S. Embassy, Mexico City, Mexico. Telexed response to inquiry.

[12] Posthuma, op. cit., p. 5.

[13] Nick Page, General Information Services, Philadelphia. Telephone interview, July 3, 1984.

[14] Ibid.

At least one U.S. firm keys data in Singapore, but this site may have been selected because the data is then relayed to the firm's office in Australia. Presumably, transmission costs also were an important factor. However, a World Bank report says that two-thirds of Singapore's total output is services and over 35 percent of these services were devoted to the production and distribution of information. The primary information sector in Singapore contributes over 24 percent of gross domestic products.[15] In the Far East, therefore, Singapore would be a promising site for expansion of data processing work.

As to the future of off-shore keying, there may be inherent limitations on growth. International telecommunications to link off-shore offices with the United States may not be available everywhere or may not have the tremendous growth in capacity that some expect. Not all "raw" information (i.e., hard copy) can be readily transmitted abroad for keying. Facsimile clarity is still a significant problem, particularly if operators must process large volumes of data. The use of facsimile equipment does not appear to be cost effective as yet. Facsimile transmitters may take as long as 6 minutes per page, ". . . far too long to let overseas operators compete for time-sensitive jobs," according to one firm.[16]

Advances in facsimile technology will, presumably, solve these problems. But the very fact that such advances are being made may drastically reduce the need to hire operators for many kinds of data-entry work.

Perhaps the most important technological consideration when assessing the future growth of the industry regards optical character readers (OCRs). As advances in the field permit the widespread use of scanners, and the use of machine-readable documents increases, the need for human intervention in data entry will be reduced considerably.

[15] World Bank, *World Development Report, 1982,* New York, 1982.

[16] "The Instant Off-Shore Office," p. 136.

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Most of the experts consulted on behalf of this study agreed that the arrival of cost efficient, highly capable optical scanners would mean the end of off-shore data-entry work. For example, an executive of one company believes that his firm will stay as long as the cost-effectiveness of satellite transmission is not outpaced by advanced technologies that could eliminate the need for a majority of data-entry jobs altogether: "To say that we'll be doing this for the rest of our lives is not accurate; but to say that we'll pull out in the near future is also not accurate."[17] Others in the industry agreed. It is thus reasonable to expect that off-shore keying may have an effective lifetime of only 15 to 20 years, but during that period it could grow rapidly and have a significant effect on U.S. clerical employment.

[17]Posthuma, op. cit., p. 18. (James Marston, vice president of data processing for American Airlines, is quoted.)

HOW OFF-SHORE OFFICES OPERATE

Linkage Arrangements

There are three principal methods of linking off-shore data-entry sites with data sources and end users in the United States. All three use some combination of air shipment or electronic transmission to move data back and forth between sites.

The least sophisticated approach is to ship information by air in both directions. Typically, paper documents, microfiche, magnetic tapes, cards or discs, or audio recordings are collected at one or more U.S. sites for packaging. In the case of paper documents some preliminary hand sorting may occur at this time. A major U.S. airline, for example, sorts ticket stubs according to station, flight number, and passenger class before shipping them abroad.

Documents are then packaged and shipped to the off-shore site via regular air freight or overnight courier services. On arrival at the host country airport, the packages are cleared through customs and delivered to the processing site by courier services or employees of the user firm. At the processing facility each keyer has a video display terminal that is typically linked to an onsite computer central processing unit. The information on the documents is keyed into the computer, the data is recorded on magnetic tapes, disks or cards, and shipped back to the United States, where the data can be stored, printed on paper, or fed into a computer program for analysis.

The second method of linking sites involves air shipping documents from the domestic point of origin to the processing site and then electronically transmitting the digitized data back to its source or to other end users. Typically, the data processing sites are linked via terrestrial telephone lines to satellite Earth stations. The use of this method is, of course, limited by the availability and proximity of earth stations, but permits shorter turnaround times. Where satellite communication facilities are not available it may be possible to use submarine cable links to the continental United States. Theoretically, the reverse of this process (i.e., transmitting data to the off-shore site and shipping hard documents back to the United States) is also possible, but OTA found no instances of such use.

Finally, electronic links may be used to transmit data in both directions. Documents are facsimilied in the United States and transmitted to the off-shore site, keypunched, and then retransmitted back to end users. Information that has already been digitized, but requires further processing or revision may also be sent abroad by simply "playing back" data on magnetic media and transmitting it from the United States to the off-shore site.

Two-way electronic links offer the shortest possible turnaround times, and may, in fact, be the only practical method of processing data off-shore when the ability to deliver it to end users within a very short time is essential. A major U.S. printing house that must process and deliver financial data to end users in as little as 15 hours is presently exploring the feasibility of establishing data processing facilities off-shore.

Types of Data Processing

The kinds of data processed off-shore and the types of processing they require are many and varied. Documents sent abroad for processing include manuscripts; legal documents; insurance or medical records; statistical data; financial statements; coupons for food and other products; order or subscription forms; business documents such as ledgers, payrolls and the like; ticket stubs; mailing lists; contest or sweepstakes entry forms; and audio recordings. In most cases, the documents are produced in large volumes on a relatively continuous basis, and their conversion to electronic form is essential to the end users.

Processing in many instances is limited to converting textual or tabular information on hard copy into digital form so it may be more readily reproduced, stored, manipulated, or analyzed. One company, for example, keys in mailing lists and contestant entry forms, while another concentrates on keying textual and financial data for a Fortune 500 client base.

Processing may also involve reformatting documents or revising and correcting texts that have already been proofread or edited and digitized in the United States. The printing firm noted previously may transmit to an off-shore site "rough" copy that had already been keyed. The off-shore facility would key in the necessary revisions to make copy ready for typesetting.[18] Another firm reformats financial data at its off-shore facility into standard forms for use in the United States.[19]

Examples of Off-Shore Offices

The following capsule descriptions exemplify the types of off-shore offices and the methods by which they operate.

[18]Keith Adams, R.R. Donnelly & Sons Co., Chicago. Personal interview, Miami, Dec. 5, 1984.

[19]Bechtel, op. cit.

Photo credit: Barbados Ministry of Finance and Planning

This office worker in Barbados is keying information from airline ticket stubs for a major U.S. airline; the keyed information is returned to the United States via satellite

- A California-based firm air-freights batches of paper copy to its keying facility in Singapore. From there, the keyed data is sent to its branch office in Australia via satellite. This allows the company to update the files of its Australian clients on a daily basis.
- A Texas businessman has an arrangement with students at Tsinghua University in the People's Republic of China to key in numerical and narrative information from surveys. Magnetic tapes containing the information are then flown to the United States for analysis.
- In Limerick, Ireland, a major U.S. market research firm keys magazine subscription information. The same firm has branches in Port-au-Prince, Haiti, and Chihuahua, Mexico, where product coupons are sorted and rebate lists are developed.
- A major U.S. international airline collects ticket stubs from its operating bases throughout the United States and flies them to its keying facility in Barbados. There, information on passenger class, point of embarkation, and destinations, etc., is keyed by a staff of almost 300. The revenue database is sent over private leased lines via satellite to its data processing office in the United States on a

daily basis. The company transmits about 2.25 million characters to the United States every month. Information on data-entry personnel efficiency is transmitted back to Barbados for analysis by managerial staff. The airline is now soliciting contract work in order to make its keying operation into a profit center.

- A New Jersey company has entered into a joint venture with a Jamaican firm to key financial data for approximately two dozen Fortune 500 clients. The data—about 50 percent textual and 50 percent tabular—is used for financial reports. The firm cited a document turnaround time of 1 to 2 weeks. It presently flies hard copy to the facility for keying, but anticipates using facsimile equipment in the United States to transmit information to Jamaica, and then return it to the United States via satellite. Approximately 60 people are employed in the firm. It expects to double its size sometime in 1985.
- A firm in Montego Bay, Jamaica keys in mailing lists for such companies as The Great American Sweepstakes and Publisher's Clearinghouse. The responses to mass mailings are flown to Jamaica and mailing lists on magnetic media are flown back to the United States.
- A small, Philadelphia-based firm operates a joint venture data-entry service that employs about 20 people in Madras, India. The company concentrates on keying in past records, and disk-to-disk conversion of data for clients shifting from one kind of computer system to another. It had originally used a Kurzweil optical scanner that translates printed characters into digital form for storage on magnetic media. It found that use of the machine was not cost effective, and also encountered technical problems regarding the capability of the machine to read accurately. It gave the machine to a university and now uses data-entry workers exclusively to key in information.

Factors in Moving Data Entry Off-Shore

Several general factors encourage American companies to establish off-shore offices:

- growth in information processing and increased need to convert information from hard copy to digital form;
- rising domestic labor costs and the availability of lower cost labor off-shore;
- the availability of good communication infrastructure;
- the existence of suitable office space, transportation facilities, electrical power, and other support infrastructure;
- the availability of measures that can be taken to ensure the security of information in transit;
- the general absence of regulatory impediments to the exportation or to the flow of data across international borders; and
- the existence of politically stable and economically attractive environments in other countries.

The Information Market

The director of one foreign government industrial development corporation says:

> In today's world, information resources have become abundant . . . and more efficient as a result of the progress stimulated by the new electronic technology. It seems fairly clear, to me at least, that as the U.S. economy continues its transformation from industrial activities toward information creation and distribution, that the demands for information services will continue.[20]

The need for rapid access to information helped to stimulate the creation of electronic data storage and retrieval systems. Their existence, in turn, has accelerated the speed at which information must be generated, and in-

[20]Fred Gollop, Chairman, Barbados Industrial Development Corp., Bridgetown, Barbados. Gollop moderated the "Off-shore Key Punch Operations" square table discussion at the Miami Conference on the Caribbean, Miami, Dec. 7, 1984.

creased the volume of data needed to enter into computerized information systems. The president of a U.S. firm, presently engaged in off-shore keying, notes that "... the history of the world, which is in writing, is about to be put into electronic databases throughout the world."[21]

The capability and need to generate information in large volumes and on a relatively continuous basis is essential for the move to off-shore data-entry operations. It is the strength of this growing information market that makes owners of off-shore keying operations enthusiastic about their future. In the absence of an expanding information market, the viability of off-shore operations would be doubtful. Attracting workers would be difficult if work were sporadic, and cost efficiency could decline rapidly, thus defeating the purpose of establishing such operations in the first place.

Domestic and Foreign Labor Costs

In the recent past, there has been a trend toward an international division of labor, in which labor intensive manufacturing work has moved to countries where wages are significantly lower than in the United States. This has allowed many American manufacturing firms to maintain their competitiveness in international markets. The exportation of data-entry work—one of the most labor intensive phases of data processing—is now occurring for the same reasons.

The hourly wage rate for keyers in other countries may range from one-fourth to as little as one-fifteenth of rates paid to U.S. keyers.[22] One U.S. firm reports that it was paying domestic keyers $9.50 per hour, whereas average hourly rates at its off-shore facility in Barbados are approximately $2.10.[23] This is a savings of 78 percent in labor costs alone. While companies use different methods of estimating their savings by moving off-shore, those questioned indicated that it is costing them about 75 percent less off-shore than it would in the United States to obtain a comparable level of labor output.

The availability of trained workers is a major consideration in choosing an off-shore site. Because the bulk of the work done at data-entry sites involves typing (typically, 60 to 90 percent of the employees of data-entry operations may be keyers), a pool of trained typists must be assembled. Companies located in Jamaica and Barbados report no apparent shortage of trained clerical workers; they invariably had more job applicants than positions.[24] Young women comprise about 99 percent of the workers. One firm reported that the average age of its keyers is 26.[25] Most of them have at least a secondary school education, while many have completed at least some post-secondary training.

A keying rate of 10,000 keystrokes per hour is cited as an industry standard.[26] Higher rates may be achieved if conversion is limited to keying tabular data on a numerical ten-key pad, while rates may average somewhat lower if text data is being keyed.

All companies surveyed indicated that a high literacy rate was a primary consideration. Literacy in English is strongly preferred to avoid the complications of crossing a language barrier, although language barriers may not be critical if keying is limited to numerical data.

However, other firms have experimented with using non-English speaking workers for keying text, and report excellent results. The workers do not need to understand words to key the right letters. Workers can learn to recognize up to 100 characters without any prior knowledge of them, and to respond by hitting the correct key. Because thousands of ideograms are used to write many Oriental languages, workers literate in these languages may be particularly adept at character recognition.

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[21] Bechtel, op. cit.
[22] Page, op. cit.
[23] Jordan, op. cit.
[24] Bechtel, op. cit.; and Jordan, op. cit.
[25] Jordan, op. cit.
[26] Bechtel, op. cit.

The ability to achieve high accuracy rates seems to be a direct result of employing low cost labor. In order to assure high standards of quality control, two or three keyers may be given the same information to key, on the theory that no two people will make the same error. After copy is "double-" or "triple-stroked," parity checks may be conducted to spot errors. The original copy is then checked in order to correct those errors.[27] It has been reported that by using this technique firms have been able to obtain very high accuracy rates even using non-English speaking keyers.

It would obviously be expensive to achieve quality control in this manner in the United States. Using the hourly wage comparison cited earlier as an example, copy triple-stroked for one hour in the United States would cost $28.50, while the same task off-shore would cost $6.30. This estimate is for Barbados, where wage rates are higher than those for most developing countries.

Some firms have noted that it is more difficult to find skilled managers locally than it is to find clerk-typists. However, this was usually overcome through programs to promote and train supervisory personnel, sometimes by sending them to the U.S. office for training.[28]

The size of available off-shore labor pools may be an important consideration for large operations, especially in countries with small populations, such as many of those in the Caribbean. U.S. off-shore offices in the Caribbean presently employ from 10 to as many as 1,200 personnel each. At least one firm chose to locate in Jamaica because keying operations companies already were absorbing most of the available labor pool in Barbados, and bidding for such labor "might get a little steep . . . particularly for a start-up company."[29]

In sum, countries most apt to attract U.S. firms to off-shore offices are those with low-wage rates and a highly literate, skilled labor force of a size sufficient to support proposed operations. The degree to which these characteristics are present promotes establishment of off-shore data conversion.

If English literacy is not critical, then virtually any developing country willing to provide the necessary infrastructure and having a large pool of unemployed people could host an off-shore data-entry operation.

Communication Technology

Advances in telecommunication, in particular, the advent of satellite communication, have encouraged the operation of off-shore offices Unlike manufacturing industries, which face high costs and pay a time penalty for transporting raw materials and products, the information industry may "ship" its raw materials and products thousands of miles in seconds when in electronic form.

International communications usually take place by satellite or by undersea cable. The use of satellites appears to predominate, but the use of international submarine cables cannot be discounted, and the desire for greater security and reliability of data transmissions may prompt some firms to maintain access to both.

A number of technologies are used to provide access to the international communication networks. Some firms have satellite earth stations on their own premises. Most, however gain access to common-use earth stations or to undersea cable terminals as subscribers to the local telephone system or by leasing dedicated lines. Firms transmitting large quantities of data generally find dedicated lines more economical since they can be designed to accommodate high-data transmission speeds. Thus, one criterion for locating off-shore data conversion facilities is the existence of a communication infrastructure with sufficient capacity to provide dedicated lines to large users.

Microwave transceivers are widely used for private line communications in the Caribbean where an extensive microwave system is already in place. It has been suggested that cellular telephony could also offer the capability of providing data links between off-shore

[27] Adams, op. cit.
[28] Becker, op. cit.; and Jordan, op. cit.
[29] Bechtel, op. cit.

offices and international communication terminals. Cellular telephony allows voice or data communications without the use of land lines. It could play a significant role in bringing the information age to Third World countries, allowing them to not only catch up, but perhaps also even surpass the phone networks that presently exist in the developed countries.[30] According to a representative of a U.S. cellular telephone company:

> Cellular will provide nationwide data network capability and needed mobile and fixed services to all segments of an emerging nation. It may well assume the role of the wireline system replacement in smaller cities and in isolated rural areas. Cellular could be utilized to remove isolation, encourage dispersal of industry and increase the efficiency of projects located far from the urban concentrations of industry.[31]

Costa Rica is expected to begin installation of a cellular system in early 1985, which will probably make it the first Third World country to use cellular technology as an integral part of its telecommunication systems. Installation of cellular systems in several countries could increase the options of firms looking for off-shore office sites.

Of importance to operators of many off-shore offices are the telecommunication regulations in the host country. In many developing countries, communication networks are owned and operated by the government in order to generate public revenue. In some cases, all phone equipment and services must be purchased or leased from the government, thus limiting users' options with regard to the availability, type, and capabilities of equipment.

A country's reputation for providing hook-up and maintenance service also deserves consideration. Clearly, it would not be desirable to establish an off-shore office where bureaucratic problems or lack of well-trained technical personnel caused significant delays in service, or impeded the timely and proper maintenance of the phone network.

Facilities, Transportation, and Electrical Power

By and large it does not appear that U.S. firms have had serious difficulties in locating facilities in which to set up shop, especially in the Caribbean. Many governments have developed industrial estates that rent or lease factory space at very low rates to foreign investors. In Jamaica, for example, the average rent for such space is a mere $.42 per square foot per month, or about $5 (U.S.) per square foot per year (1982 figures).[32] The leasing of space at off-shore sites is considerably cheaper than in the United States, and in some cases so much cheaper that leasing costs may be a minor consideration in the course of site selection.

Space may be leased or purchased outright from the private sector, depending on foreign ownership restrictions imposed by government. Or, it may be possible to expand existing locally owned data processing facilities, if, for example, a U.S. firm enters into a joint venture with an existing host country firm.

The quality of available facilities in developing countries may vary considerably. Some

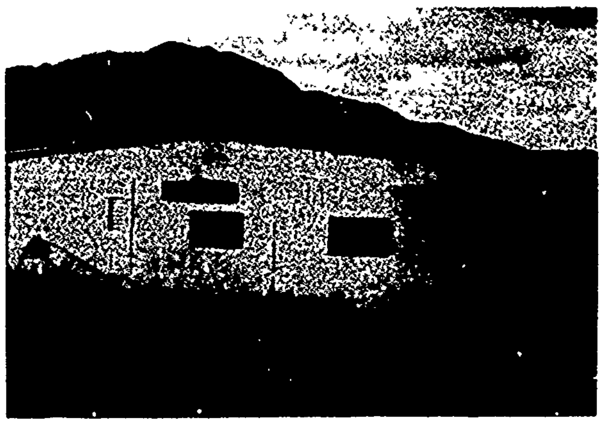

Photo credit: Ministry of Trade, Industry and Development, St. Christopher and Nevis

Off-shore data processing offices occupy a wide range of facilities from modern office buildings to converted factory shells. This one is in St. Christopher and Nevis

[30]Charles T. ..gel, *Application of Cellular Technology for Developing Countries*, presented at the Miami Conference on the Caribbean "Communications Infrastructures" squaretable discussion, Miami, December 1984.

[31]Ibid.

[32]Caribbean/Central American Action, op. cit.

office buildings may be on equal footing with those commonly found in the United States, while others may be simple corrugated metal or concrete block shells adaptable to many uses. One U.S. firm adapted such a shell for its data conversion operation in St. Kitts-Nevis. Another spent approximately $1 million (U.S.) to upgrade an existing office building in Barbados. Its facility is regarded by the company, the Barbados Government, and the company's competitors as a "showcase operation" equal to the best facilities in the United States.[33]

The availability of international air transportation may be essential if electronic linkage arrangements are not being used in both directions. Both regular air freight and overnight courier services are used. One reason for the proliferation of off-shore offices in the Caribbean is the availability of frequent, direct flights of relatively short duration to many of the islands from major cities in the United States. Time in transit from New York to Barbados, for example, is about 4½ hours. This is particularly attractive if time-sensitive documents are being dealt with. It also makes it easier to manage off-shore facilities, since U.S. personnel may get to the sites relatively quickly if necessary.

Companies generally indicate that availability and reliability of electrical power are not major concerns in their site selection. Some firms use on-site back-up electrical generators because power grids in some countries experience sporadic brownouts (i.e., voltage drops below specified levels) or blackouts. The cost of electrical power is not a major concern; in Jamaica for example electrical rates are comparable to those on the eastern seaboard of the United States.[34]

In general, facilities are less costly off-shore, although infrastructures in many countries lack the reliability and redundancy that is taken for granted in the United States. The growth of foreign investment in less developed countries has, in many cases, spurred government efforts to enhance their infrastructures with a view toward attracting still more foreign capital, technology, and expertise.

Security of Data Shipments and Transmissions

With large amounts of data being transferred across international boundaries, security of data shipments and transmissions is a concern, but has so far been a minor problem in off-shore sourcing. None of the firms interviewed for OTA identified any special measures that they take to ensure the security of shipments. Yet the loss or interception of documents containing sensitive information could conceivably cause serious damage, particularly if, for example, information on stock offerings or other financial information were made known prematurely, or if private, intracorporate communications are intercepted.

Interception of such shipments is not without its difficulties. One would need to know in advance about the nature and timing of shipments. If particularly sensitive documents are being shipped, air courier services may be used to ensure their safety. One courier firm in the Caribbean region indicated that its shipments are accompanied and monitored by their personnel on a continuous basis.[35] The companies shipping the information, as well as their clients, appear to be satisfied with its security.

Intercepting electronic data transmissions is another matter; it requires technical knowledge, and may not necessarily yield usable, understandable data because encryption can be used. Even if unscrambled transmissions were intercepted, strings of characters may not be useful unless one knows what to do with them.[36] In some industries such as airlines, much information is already shared, so the value of information transmitted may be negligible to another airline.

Nevertheless, wires *can* be tapped, and satellite transmissions *can* be picked up by parties other than the intended ones. Wiretapping

[33] Gollop, op. cit.
[34] Ibid.

[35] The firm referred to has operating bases in Miami, New York, and other cities in the United States and the Caribbean.
[36] Jordan, op. cit.

can be detected fairly easily because the amplitude of an electronic signal is attenuated when a third-party taps the line.[37] Identifying unintended recipients of satellite transmissions can be far more difficult. In either case, however, it would seem that a considerable amount of technical ingenuity would be required to not only intercept transmissions, but make them usable as well.

Rules and Regulations

At the present time, regulations of any sort that bear directly on the establishment or operation of off-shore data-entry services appear to be so few and/or minor that firms involved have expressed relatively little concern over them.

Laws that generally affect off-shore keying operations are those concerning telecommunications. Such laws often mandate the use of government-owned Post, Telephone, and Telegraph (PTT) networks and equipment, since the PTTs of developing nations typically generate revenues needed for other government functions. Firms report that these regulations have been more of an annoyance than a major obstacle to off-shore sourcing.

Foreign customs regulations also do not appear to have been a problem for data-entry operations. Many firms investing in developing countries are granted concessions including the privilege of importing raw materials and equipment duty free. The only notable complaints have to do with the difficulties in getting documents and other items cleared quickly through customs, especially on weekends, which can be a problem for firms keying time-sensitive documents. However, serious customs problems would probably spur authorities to make remedial actions to avoid losing sizable foreign investments.

U.S. telecommunications and customs regulations at present raise no obstacles to off-shore keying. Customs laws govern the importation of documents and magnetic recordings, but tariffs are extremely low or not levied at all.[38] U.S. companies keying their own business data (e.g., payroll, inventory, archives, etc.) may import these records duty free. These are classified under schedule 8, pt. 7 of the Tariff Schedules of the United States Annotated (TSUSA) (1981) as item 870.10—"records, diagrams and other data with regard to any business . . . operation conducted outside the United States, whether on paper, cards, photographs, blueprints, tapes or other media.[39]

Ordinarily, recorded magnetic tapes, cards, or discs are classified under TSUSA schedule 7, part 2, subpart G as item number 724.40—"recordings on magnetic tape or any medium other than wire."[40] A duty of 9¢ per square foot of recording surface is specified. Thus, a duty of only $9 would be payable for a recording on a standard 2,400 foot reel of ½ inch computer tape (which contains 100 square feet of recording surface). Even this duty may not be imposed if the recordings originated in a country that is beneficiary to the Generalized System of Preferences. Such countries may export most or all of their goods to the United States duty free. In any event, recorded media from data-entry operations are, by and large, regarded as returned U.S. goods and not subject to duties.[41]

While the physical characteristics of the media itself are not "advanced or improved" at keying operations, it can be argued that such media has an intangible good—information—added to it, and is, accordingly, increased in value. There has been sharp criticism in this regard, particularly by U.S. labor representatives. As one union spokesman says, "You may

[37]Hough, op. cit.

[38]John R. Gray, Chief, Classification and Value Division, U.S. Customs Bureau, Miami, personal interview, Miami, Dec. 6, 1984.

[39]*Tariff Schedules of the United States Annotat… 1980,* Washington, 1980, p. 774.

[40]Ibid.

[41]"The Instant Off-Shore Office," p. 136. Specifically, they are listed under TSUSA schedule B, pt. 1 as item number 800.00—"products of the United States when returned after having been exported, without having been advanced in value or improved in condition by any process of manufacture or other means while abroad."

be importing a $10 tape with $50,000 worth of information on it."[42]

Such claims do not appear to be exaggerations in view of the prodigious volume of data that can be recorded on a given amount of magnetic media. If recorded at maximum density (data density is dependent on the type of recording equipment used), a ½ inch wide nine-track computer tape can hold 6,250 bytes or characters of data per linear inch. A 2,400 foot reel of tape holds up to 94 megabytes (i.e., 94 million characters). To put this in perspective, a commercial directory listing the names, addresses, telephone numbers, chief executives, Standard Industrial Classification numbers, sales levels, and number of employees of the top 51,000 U.S. corporations comprises only about 30 million characters.[43] This equals approximately 1,500 pages of high-density text in very small print.

The president of a domestic data-input company has argued that duties should be payable at least on the labor value added to processed tapes and disks. The directory mentioned above, for instance, probably took at least 3,000 person-hours to key at 10,000 keystrokes per hour. Using the $2.30 per hour wage for Barbados, it would cost roughly $6,900 to enter all of the data in the directory. His concern stems from the fact that his firm has lost "millions of dollars in contracts to off-shore firms."[44]

Certain countries have erected tariff and nontariff barriers to regulate the content and operation of data banks, and designate the methods and routes by which data can be transferred across international borders. Where these regulations exist, they usually stem from governments' concerns over the privacy of their citizens, national security, perceived loss of cultural independence, and concern that unrestricted data transfers could lead to loss of control over economic development and growth.[45]

Off-shore data-entry operations have not been significantly affected by such laws because they have generally been established in the countries that have not enacted such laws. Many countries have not yet addressed the issues surrounding data and its transfer, and these countries tend to be less developed, have wage rates that are generally lower, and want the jobs, training, and capital that data-entry operations can provide. They view data entry as a basis for the development and advancement of computer and computer-related industries and capabilities.

Thus, data-entry firms presently operate in a very lenient regulatory environment. Developing host countries are not inclined to kill the proverbial "goose that laid the golden egg" by legislating against the data-entry industry. The benefits they obtain from it far outweigh any gains to be had by levying discriminatory taxes or imposing other restrictions. Undoubtedly, any moves in this direction would quickly cause firms to relocate to countries with more favorable business environments—of which there are many. U.S. laws impose virtually no burden on off-shore sourcing. Vigorous debate over regulatory matters can be expected to continue, however, as labor unions and domestic firms pressure authorities to extend tariff treatment to international trade in data and data processing services.

Political Stability and Investment Climate in Foreign Countries

The reason most frequently cited by U.S. firms in all sectors for not investing abroad is perhaps that they must deal with too many unknowns. Political stability of a foreign country and its policies regarding foreign, private investment are foremost concerns of U.S. businesses thinking about establishing off-shore enterprises.

[42]Dennis Chamott, Assistant Director, Professional Workers Division, AFL-CIO, Washington, DC, personal interview. Washington, DC, Dec. 17, 1984.

[43]The listing referred to is *Ward's Directory of 51,000 Largest U.S. Corporations*, vol. 1 (Petaluma, CA: Baldwin H. Ward Publications, 1984). The directory consists of "1,504 pages, 11" x 9¼" over 30 million computer data bytes."

[44]"The Instant Off-Shore Office," op. cit., p. 136.

[45]James R. Basche, Jr., *Regulating International Data Transmission. The Impact on Managing International Business*, Washington, DC 1984, p. 16.

Despite these problems, U.S. firms have found that the Third World presents an abundance of business opportunities for those willing to assume the attendant risks. Many developing countries recognize the advantages of permitting foreign investment to enhance private sector development. Not only does it expand their capital base, but it also provides new opportunities for host-country owned businesses, brings in foreign technology and expertise, and provides training for their people, which in many cases is their most abundant resource.

The host country's investment policies are also instrumental in attracting off-shore business. Specific investment incentives differ depending on the country, but various forms of tax relief and import duty exemptions are commonly used. The investment incentives provided by many developing countries are helpful to investors, and their existence is generally a good indicator of a country's need for such investment and recognition of its importance. Such incentives may, at the very least, provide an appearance of political stability and continuity, and an indication that foreign governments are aware of the need to create favorable business environments for investment by industrialized nations.

The U.S. Government and the governments of other countries have encouraged investment in developing nations by helping firms to locate business opportunities, guarding them against the effects of adverse political developments, and providing attractive business incentives. At least one American company notes that both United States and foreign government assistance was instrumental in the establishment of its data-entry operation in Jamaica. Of significant importance to the firm was assistance provided by the Overseas Private Investment Corporation (OPIC). OPIC is a self-sustaining, profit-making Federal agency (a component of the U.S. International Development Cooperation Agency, which also includes the Agency for International Development) whose mandate is to "mobilize and facilitate the participation of United States' private capital and skills in the economic and social development of less developed, friendly countries and areas." To do this, the agency provides political risk insurance, direct loans and loan guarantees, and other service, "All (of which) are designed to reduce the perceived stumbling blocks and risks associated with overseas investment."[46]

[46] *Overseas Private Investment Corporation*, corporate brochure, Washington, DC 1984, p. 1.

DIFFERING VIEWS OF OFF-SHORE OFFICE WORK

U.S. Off-Shore Companies

For the most part, U.S. companies cite savings in labor costs, as much as 75 percent, as their primary motivation for seeking off-shore sites for data processing.[47] None of the companies questioned thought that this trend would have a very significant detrimental impact on U.S. employment, and some suggested it would create many new marketing jobs in the United States.[48]

Some companies have found that productivity off-shore is often higher than in the United States, and standards of accuracy and employee conscientiousness are generally higher. One company had originally underestimated the capabilities of foreign workers, and anticipated a standard of performance 70 percent of that attainable in the United States. After only 1 year in operation, the company's foreign employees keyed *better* than its U.S. keyers who, on the average, had over 5 years seniority over their foreign counterparts.[49] At least two other companies confirmed the claim of higher productivity.[50] As noted earlier, high-

[47] Answers were in response to interviews conducted by the contractor primarily at the Miami Conference on the Caribbean, Miami, Dec. 3-7, 1984. Other interviews were carried out in New York and Washington in early 1985. Astriab, op. cit.

[48] Bechtel, op. cit.

[49] Jordan, op. cit.

[50] Bechtel, op. cit.; and Becker, op. cit.

er accuracy rates for converted data can also be obtained abroad because low-labor cost permits redundant keying.

Another argument raised in favor of off-shore data processing is that in some cases the work will not be done otherwise. One company official pointed out that his firm is doing massive archival work for several major customers. The customers had considered doing it in-house, but finding the work too costly, they postponed it until they could find a company like his to do it at an economical rate.[51]

U.S. Labor Organizations

Representatives of U.S. labor unions argue strongly against the movement of data-entry operations off-shore. While the AFL-CIO has not yet adopted an official position, their general opposition to moving any type of work off-shore is based largely on the following points:

- The creation of off-shore work represents a direct displacement of U.S. workers which is detrimental to our domestic employment situation, and does not always have a permanent, positive effect on the development of needy countries.
- Labor competition for jobs based on wage rate differentials is not fair or equitable, and is inherently exploitative of labor in less developed nations.
- Moving operations of any kind off-shore reduces effective control of our economy, and threatens our economic security.

U.S. labor organizations argue that for every job created off-shore, one is lost in this country. Exporting clerical work to low-wage countries is the latest phase in a trend that has been going on for a long time in U.S. manufacturing industries. While the number of people employed in off-shore offices has had, as yet, no discernable impact on U.S. labor, this should not preclude our taking steps to stop this trend.

[51]Bechtel, op. cit.

Further, it is argued, creating such work off-shore does not always have a permanent developmental impact on poorer countries, because companies always seek areas where wage rates are lower. As a country develops and its wage rates rise, companies located there may move to still less developed and less costly areas in which to operate.[52]

Union representatives argue that because our economy is becoming more heavily dependent on information and white-collar work, as opposed to manufacturing or blue-collar work, and as white-collar work becomes more automated, we could be "taking away the last large group of jobs that the economy is supposedly going to have available."[53]

Others argue that locating more and more jobs off-shore may jeopardize our economic security because: 1) investment in the economy is lost, and 2) off-shore operations exist in environments that cannot be controlled, thereby making the investments vulnerable to adverse political developments. The continued relocation of work out of this country is economically unsound because we are foregoing opportunities to create domestic jobs and new business enterprises.[54] Also, our dependence on foreign labor further diminishes the ability to function economically and independently, and, therefore, weakens the United States. There have been repeated nationalizations of U.S. investments abroad in recent years. Off-shore office work is particularly worthy of special consideration:

> What (we're) doing now with shipping jobs overseas (via the use of) electronic transmission . . . is making (companies) even more vulnerable. Work that they have to have for (their) company to function, they are placing outside the realm of their control. In terms of control, what do you do if you're not

[52]Chamot, op. cit. This argument is also presented in *The Electronic Sweatshop: The Use and Misuse of Work Stations in the Home*, a presentation given by Dennis Chamott and John L. Zalusky to the National Executive Forum: Office Work Stations in the Home, November 1983.

[53]Chamot, interview.

[54]Barbara Hutchinson, Director, Women's Bureau, AFL-CIO, Washington, DC, personal interview, Washington, DC, Nov. 19, 1984

duplicating that system here, and that system shuts down?"[55]

Off-shore offices would be very easy to shut down, because they tend not to be very large, do not have a major impact on host country economies, and are heavily dependent on vulnerable communication and transportation networks.

Foreign Government Officials

The direct impact of off-shore data entry on increased employment in developing countries may be significant and quite rapid. One company began interviewing prospective employees in Barbados in May 1983, commenced training on August 1, and began production in October of the same year. The operation presently employees 275 people, 80 of them managerial, technical, and supervisory personnel. This suggests that keying operations, especially larger ones, may provide significant job opportunities not only for clerical workers, but also for more highly trained workers. The same firm let approximately $1 million in contracts to local firms to refurbish its building. Thus, business opportunities and jobs may also be created in other economic sectors.

Reactions of foreign government officials to off-shore office work are very positive. Those countries that already host such operations are pleased with the results, while those that do not yet have such operations want them. In an informal survey, representatives from more than 20 Caribbean and Central American countries unanimously claimed that such investment projects would aid their economies and would be welcomed.[56]

Barbados has gone so far as to single out information services as a sector to receive major emphasis for development. At the other end of the spectrum, representatives of some countries know little about the phenomenon, but are eager to learn more about it.

The work is labor intensive, requires only a moderate capital outlay, and can generate employment rapidly. It is a "clean" industry, without the heavy equipment, large space requirements, and pollution often associated with other industrial enterprises. The industry provides, at the very least, rudimentary training in computer use—a rare opportunity for workers in less developed nations. Finally, it establishes a foundation on which further advancement in computer-related industries such as software development, technical services, and data transmission may grow. The Director of the Barbados Industrial Development Corporation (BIDC) elaborates:

> I know from experience in Barbados ... that we can offer a lower cost location (for the industry), and answer the needs of many industrial companies in the United States. I know too that the countries in the Caribbean can benefit from increased employment, and in the case of off-shore keypunch operations, th can be fairly rapid. And I also think we car benefit from technical education which would ultimately set us on the path to higher levels of technology in the computer services industry.[57]

Barbados has targeted information services as an industry group that is expected to have a major impact on the objectives of the Barbados Industrial Development Corporation and the Barbadian economy. According to its 1983-87 Development Plan:

> The Information Services industry can be expected to generate substantial employment in the short term ... linkages with the more technically proficient computer industry ... will be sought as a means of expanding the sector's contribution to the economy ... Local participation in the Information Services Industry can come about through the establishment of service bureaus to perform off-shore data processing for North American companies.[58]

[55] Ibid.

[56] Answers were in response to informal interviews conducted by the contractor at the Miami Conference on the Caribbean, Miami, Dec. 3-7, 1984. Representatives of approximately 20 Caribbean and Central American countries were queried. Astriab, op. cit.

[57] Gollop, op. cit.

[58] Barbados Industrial Development Corp., *Industrial Development Plan, 1983-1987,* Bridgetown, Barbados, 1983.

Development officials interviewed for OTA all agreed that foreign data-entry workers view their jobs and status in a considerably more positive light than their American counterparts. While keying in the United States is sometimes pictured as a low status, boring job, foreign workers often consider it a gateway to opportunities that did not formerly exist (as do many minority workers in the United States—see chapter 12).

Over-dependence of countries on information services is not seen as a problem at this point because the industry is presently so small. In addition, many developing nations opt for diversification of industrial development as a key ingredient of a more stable economy. They want to avoid heavy dependence on traditional industries such as tourism or agriculture, with their characteristic seasonal fluctuations in income and employment.

Economic Development Organizations

Development organizations are in essence the "middlemen" in regard to the development of off-shore office work. They view the expansion of the sector in the much larger context of economic development, are supportive of its growth, and reaffirm the arguments put forth by U.S. companies and foreign governments in favor of such growth. "The sheer number of jobs (off-shore data processing) creates is the main attraction of the industry in the view of developing countries," says one official of a private, nonprofit development organization.[59]

This development expert claims that negative reactions, if any, in developing countries usually come from the more educated sectors and the labor movement, or, as he put it: "people who are not worried about having a job."[60] Those citizens of developing countries who view U.S. investment as exploitative are those who are generally of higher economic status and are not in need of the job opportunities that result from such investment.

Some experts favor investment in developing country private sectors as opposed to just public-infrastructural development projects.[61] According to this argument, in many cases developmental aid programs have not achieved their intended purposes. For example, while good roads may indeed have been built, private businesses along those roads are necessary for the general advancement of the economy. While the wages paid to workers in these businesses may be extremely low by U.S. standards, this should not be considered exploitative.

Rebutting arguments from U.S. labor that the flow of clerical work out of the United States should be stopped, development organizations point to the great impetus of increased international economic interdependency and the disadvantages of impeding capital flows. "Business goes where business can be done," as one development organization official said, "The flow of capital cannot be stopped unless one wishes to control the economy, and this runs against the whole tradition of free trade."[62]

Answering U.S. labor's claim that wage competition is the only focus when selecting business sites, a development official countered that it has never been a case of just wage rates: "If that were the case, there wouldn't be a bit of work done but in China and India."[63] While this is, of course, an overstatement, higher profits are not the only motivation for many businesses off-shore. For some, it may simply be a matter of survival. Viewing the exploitation argument in a different light:

> You will certainly get cases of exploitation, but it is far more exploitative to say (that we will) keep those jobs here, and pay an unacceptably high level of wage hich will make our products unacceptable anywhere other than in our own economy. Plus, by doing so

[59] Gordon Hunt, Director, Investment Services, Caribbean/Central American Action, Washington, DC, personal interview, Washington, DC, Dec. 18, 1984. This claim was also affirmed by Gooch, op. cit.
[60] Ibid.

[61] Ibid.
[62] Ibid.
[63] Ibid.

we will 'starve' (the people in less developed countries).[64]

There has been massive legal and illegal immigration to the United States from the Caribbean. Many countries in the region have their second largest, and in some cases their largest population centers in the United States. Some see it in the best interest of the United States to create jobs for people in their own countries to stem this tide of immigration:

Do you employ those people in their own countries or do you employ them (in the United States)?, because that's where they're all coming. Do they come up here and work illegally for sweatshop wages . . . or do they stay in their *own* countries, where they would rather be to begin with if they could make a decent wage?[65]

[64]Ibid.

[65]Ibid.

PUBLIC POLICY ISSUES

Off-shore office work does not have a significant influence on the U.S. economy at present. Only a few dozen firms and a few thousand employees are involved. Nevertheless, it could grow. If domestic wage rates remain comparatively high and telecommunication and transportation costs continue to fall, market forces will encourage more firms to investigate the off-shore alternative. Growth could be quite rapid, at least in the short- to medium-term future.

In the long term, technological advances in input technology, especially optical scanning, are likely to undermine the cost advantages of off-shore data-entry work. Thus, off-shore offices are likely to be a temporary phenomenon, unless some other technological advances or economic conditions make it feasible to move other types of office work off-shore—for example, telephone reservations or order processing.

Assuming that it is temporary, the question remains how U.S. public policy should deal with off-shore offices. The alternatives include prohibiting, regulating, or encouraging it.

Regulating or Prohibiting Off-Shore Offices

Methods for limiting the growth of off-shore offices could include such government actions as:

- imposing regulation on the types of data that can be imported,
- imposing restrictions on the hardware and software used off-shore,
- using taxes to discourage off-shore work or encourage that work be done domestically, and/or
- imposing restrictions on the use of private telecommunication lines.

Regulation of Data

Many nations have imposed restrictions on transborder data flows for the purpose of protecting the privacy of their citizens, for example, prohibiting transmission of name-linked information to countries with less stringent privacy laws.

The United States has data protection laws designed to restrict the uses of name-linked data and assure access to the data by persons referenced in them. These laws do not, however, address the "front-end" issue of how or where information may be entered into electronic databases. Nor does U.S. law restrict the flow of data across international borders.

It is not clear that privacy protection is necessarily a good motivation for U.S. regulation of off-shore offices. Even if it were, the enactment of privacy protection laws governing transborder data flows would affect other industries, such as banking, and the internal operation of many multinational corporations, as well as off-shore keyers.

A more direct approach to discouraging establishment of off-shore offices is to simply designate data entry as a phase of processing that U.S. companies must, in virtually all circumstances, carry out within our own borders if the data is destined for eventual sale. This would, in effect, constitute a local content requirement.

Because such a requirement implies that the data being entered is a commodity, this type of restriction may not be applicable to certain types of data—e.g., revenue, personnel, payroll information, and the like—reserved for the exclusive use of a business, and not meant to be sold. "Buy national" requirements could fill this gap by mandating that off-shore data entry could not be resorted to unless domestic alternatives were unavailable. Brazil and Canada, for example, have imposed regulations that require certain phases of data processing to be conducted within their own borders.[66]

If viewed in a broad context, however, imposition of such regulations may serve to stimulate reciprocal actions by other countries. Thus, more harm could be done to the U.S. data processing industry than could be counter-balanced by benefits of restricting a particular phase of data processing to our own shores.

Restrictions on Hardware and Software

In lieu of limiting the kinds of data that could be entered off-shore or requiring that data entry be carried out domestically, requirements that U.S. equipment be used could be imposed. In essence, this would constitute another "buy national" requirement. This might effectively preclude the establishment of keying operations in some countries, since, as previously mentioned, foreign communications authorities often monopolize telecommunication equipment markets and require that *their* locally manufactured equipment be used. However, many countries do not even have a computer industry, and U.S. computers and modems are already usually the equipment of choice for off-shore firms.

Taxation Alternatives

In theory, duties could be imposed on the data that is keyed off-shore and subsequently imported into the United States by physical or electronic means; the data could be treated as a commodity or primary good imported for consumption. Alternatives might be to levy duties on the labor value added to data keyed off-shore, or to impose a trigger price tariff that would keep the price of off-shore keying above domestic levels.

In practice, however, levying any such tariffs would be fraught with difficulty. First, this shotgun approach to regulation would probably affect all data importers, of which off-shore keyers are a very small minority. In addition, a method for determining the value of data would have to be developed. Value might be related to proposed end use or might be based simply on the basis of the volume of data imported (e.g., a duty might be levied for every kilobyte—one thousand characters—of data). The latter seems inherently inequitable, since some kinds of data are much more valuable then others. The former seems nearly impossible to enforce, unless customs officials are going to play back and analyze every computer tape.

Imposing duties on data imported via telecommunication presents even more onerous technical and political problems. The sheer volume of transmissions to the United States and the many routes they may follow present logistical problems of inestimable proportions for monitoring. In the future, the increased use of direct satellite links between off-shore installations and domestic offices will make the imposition of border controls on data flows extremely difficult, if not impossible.[67]

In any case, it seems clear that on-site monitoring by government authorities and/or wiretapping on a grand scale would be necessary

[66] Joan E. Spero, "Barriers to International Information Flows," *Telecommunications,* November 1983, p. 68.

[67] Ibid.

to police electronic data flows. Even if this were technically feasible, it is doubtful that revenues accrued by a government could justify the efforts made to collect them.

Putting technical and economic considerations aside, moves toward monitoring data flows in the United States would undoubtedly encounter many political obstacles. The practice would cast a clear shadow of authoritarianism, and have a very inhibitive effect on business and communications in general. A far greater purpose than stifling a minor industry would obviously be in order if the practice were adopted. In sum, while the objective to curtailing off-shore keying could readily be attained through tariff legislation, a more tightly focused approach would seem more appropriate.

Restrictions on Dedicated Telecommunication Lines

Limiting the availability of leased private telecommunication lines to off-shore keying operations or prohibiting their use for this purpose would unquestionably deter the establishment of such operations, because it would directly effect one of the lifelines of the industry. Since leased lines appear to be the most cost effective way to transmit large volumes of data across international borders, off-shore keyers relying predominantly on telecommunication capabilities to operate would be acutely effected by any such restrictions.

Regulations of this sort could, of course, be applied only to the U.S. side of any communication link (e.g., the down-link from a satellite sending data to the United States, a terrestrial cable in U.S. territory, etc.), since the foreign ends of such links are out of American jurisdiction. Nonetheless, this strategy could be effective since the regulations could be applied specifically to off-shore data-entry firms without impinging on the rest of the data processing industry.

Restricting access to dedicated lines might be accomplished by specifying a limitation on the number of lines available to off-shore keyers in different regions. Implicit limitations might be achieved by imposing stiff tax penalties or surcharges on data-entry firms leasing such lines.

Several countries already use this strategy to protect their internal data processing industry and it is quite effective in curtailing undesired activities. In Japan, the Ministry of Posts and Telecommunications, through the international telecommunication authority, KDD, kept two large U.S. data processing firms out of the country's market by first denying them dedicated lines, and then restricting their use so that the firms could not market all of their services.[68] The Deutsche Bundepost in West Germany requires users of leased lines to use the public-data network. In 1982, the authority declared that it would permit the use of international leased lines only if some phase of data processing were conducted in Germany before data was transmitted out of the country.[69] Brazil has enacted many restrictions on the use of leased lines. For instance, firms may not use them to access databases located outside the country.[70]

Short of limiting access or prohibiting off-shore data-entry companies from using leased lines, legislation could require telecommunication carriers to impose usage-sensitive rates on these firms. A number of foreign governments have expressed interest in usage-sensitive rates, since they fear the loss of revenues that could result from reduced use of their public networks.[71] One international data processing service estimated that the introduction of usage-sensitive rates would raise its operating costs by 700 percent.[72] In the face of such cost increases, many off-shore data-entry firms would probably have to close up shop.

Regulations on leased lines could, therefore, offer a relatively "clean" approach toward discouraging off-shore keying; impeding other types of data flows could be avoided because restrictions could be tightly focused. To be

[68]Spero, op. cit., p. 68.
[69]Ibid.
[70]Ibid.
[71]Jussawalla and Cheah, op. cit., p. 292.
[72]Spero, op. cit., p. 68.

truly effective, however, such restrictions would probably have to go hand-in-hand with some form of customs regulations so that control could be extended over firms who import data recorded on magnetic media.

Encourage or Do Nothing About Off-Shore Office Work

Encouraging off-shore offices is discussed in the same section as a "do nothing alternative" because the current status of telecommunication and customs regulation already favor the growth of this industry. Inaction will undoubtedly assure the continued export of data processing work for so long as the marketplace provides the needed incentives.

Further encouragement might be achieved through increased activity of international development agencies. For example, the Overseas Private Investment Corporation could make more loans available and otherwise step up efforts to help U.S. firms find suitable locations and establish keying operations off-shore.

Chapter 9

The Automation of Federal Government Offices

Contents

	Page
Federal Procurement and Acquisition of Office Automation	234
The Three Phases of Federal Office Automation	234
Laws and Policies	235
The Federal Inventory of Office Automation	238
Acquisition Strategies and Problems	239
The Dilemma of Procurement Policy	241
What Will Office Automation Mean for Federal Office Productivity?	242
Evaluations of Productivity	242
Incentives	243
Implications for the Federal Work Force	244
Size of the Work Force	244
Changes in the Mix of Federal Jobs	246
Shifts Among Occupational Categories and Grade Levels	246
Unanswered Questions	250
Part-Time and Temporary Workers	251
Women in the Federal Work Force	252
Quality of Worklife	252
Labor Management Relations and Federal Unions	254
International Comparisons	255
Effects of Office Automation on Public Services	256
A Case Study of Expanding Responsibilities	256
Changes in the Nature of Delivered Services	258
Effects on Governance	258

Figures

Figure No.	*Page*
9-1. Paid Civilian Employment of the Federal Government, 1881-1983	245
9-2. Changes in the Distribution of Federal Employees by Occupation, 1975 and 1983	247
9-3. Change in Distribution of Federal Employees by Grade Levels, 1974-80	248
9-4. Distribution of Federal Employment by Grade Level, 1975 and 1983	249
9-5. Full-Time White-Collar Employment in the Federal Work Force by Grade Level and Sex, 1974-75 and 1983	253

Chapter 9

The Automation of Federal Government Offices

Automation of Federal Government offices is generally keeping pace with automation in the private sector. The effects are likely to be at least as significant in government offices as in corporate offices. But the forces that drive change are not the same, and the consequences will not necessarily be the same. Government is not business, although it is often argued that it should be business-like in its approach to delivering services.

Federal office automation is preceding on the reasonable assumption of significant benefits. Large investments of public resources are involved, and most Federal employees will be affected. Thus, a close look at the potential consequences of Federal office automation is merited.

The Federal Government is in effect the Nation's largest office. It occupies 2.6 billion square feet of office space; it has 332 accounting systems and over 100 payroll systems; and it employs about 1.7 million white-collar workers.[1]

Opinions vary widely as to how well and how rapidly the Federal office is being automated. One trade journal concluded that "government is pioneering some leading-edge office automation programs and in many respects is ahead of the private sector because the Reagan Administration is emphasizing automation in the effort to increase efficiency."[2] Some experts say with equal confidence that government offices are behind the state-of-the-art. Comparisons based on many case studies however indicate that while some large corporations are far ahead of Federal agencies in using information technologies, the government is at least keeping up with the private sector as a whole. Among major institutional sectors it has been the largest user of computer-based information systems.[3]

Some agencies are behind their closest private sector counterparts. For example, the Federal Reserve Board does not compare with leading financial institutions in terms of either advanced applications or the proportion of critical work that is automated. On the other hand, some agencies are at the frontier in specific office automation applications; International Revenue Service (IRS) is one example. Most agencies are in the mainstream in terms of penetration and in terms of advanced applications of hardware and software.[4]

Federal agencies were among the first institutions to adopt large computers. In the last few years, they have been adding small computers and word processors to augment their large-scale data processing. For the next few years, a major trend will be the linking of microprocessors, mainframe computers, and other devices into integrated office systems; and the networking arrangements that will connect office to office, headquarters to field

[1]It is in fact surprisingly difficult to ascertain how many white-collar Federal employees there are, or indeed how many Federal workers there are in all, at any one time. The Office of Personnel Management, the Bureau of Labor Statistics, and the Bureau of the Census all publish figures, but they are never the same figures. The total given varies widely depending on the time of year or month; or whether it is a monthly average or an estimate or a survey; or whether and how the count treats temporary workers, part-time workers, intermittent workers, postal workers, census takers, CIA and NSA workers, congressional employees, judicial-system employees, student interns, fellows, etc.; and on how many of the approximately 106 pay plans OMB chooses to count. All of these are traps for the unwary analyst.

[2]*Office Administration and Automation*, September 1984, p. 56.

[3]John Leslie King and Kenneth L. Kraemer, "Information Systems and Intergovernmental Relations," *Public Sector Performance*, Trudi C. Miller (ed.) (Baltimore: The Johns Hopkins University Press, 1984), p. 103.

[4]This judgment is based on materials supplied by Federal agencies and comparisons drawn from the literature and from OTA contractor case studies; and specifically, on the conclusions of an OTA contracted report by The Educational Fund for Individual Rights.

offices, and Federal agencies to external systems and databases.

This section looks briefly at the effects of office automation that can be detected now, and the effects to be expected over the next 15 years. After a discussion of Federal procurement and acquisition policies with regard to office automation, the rest of the chapter looks in succession at the following questions:

- Are there major problems in Federal acquisition of information technology?
- Will automation make Federal offices more efficient, or more productive?
- If so, can that benefit be translated into lower labor costs, and lower Federal budgets?
- What are the potential effects on the size and structure of the civil service, and what are the implications for recruitment, classification, and retention of Federal workers and for budgetary and personnel policies?
- What are the implications for career expectations and opportunities of Federal white-collar employees?
- How will automation affect the quality of their working environment?
- Will automation affect the relationship of government and citizens—will it change the availability or quality of government services?
- Could it affect the exercise of authority, accountability, responsibility, and the quality of decisionmaking?

FEDERAL PROCUREMENT AND ACQUISITION OF OFFICE AUTOMATION

It is the declared policy of the present Administration that information is an economic resource and should be managed efficiently. The emphasis has been on reducing the cost of information-handling rather than on increasing information services.

Federal agencies have had wide latitude in making decisions about office automation. The policy has been to keep governmentwide requirements and restrictions to a minimum. Critics charge that this has led to uncontrolled proliferation of small computers, and that the lack of compatibility among them is preventing the realization of expected benefits of automation. On the other hand, overly detailed and rigid specifications in procurement of major information systems, including local area networks, is said to preclude vendors from finding innovative ways to meet government needs, and to result in purchase of equipment that is already far behind the state-of-the-art when it is installed.

The Three Phases of Federal Office Automation

The adoption of mainframe computers in the late 1950s[5] led almost immediately to development of large centralized-computer centers. The Office of Management and Budget (OMB) and the General Services Administration (GSA) were soon given governmentwide authority over automatic data processing (ADP) policy and standards. During the 1960s and 1970s many of the major activities of government became dependent on computers for management functions such as planning, program control, financial and payroll operations, procurement control, auditing and inspection, and other government functions. The acquisition process was framed around centralized ADP

[5]The first general data processing computer, UNIVAC I, was acquired by the Bureau of the Census, in 1951.

and the communication functions that were developing in parallel.[6]

In the 1980s however the dominant theme in Federal office automation has become the spread of end-user computing. It is difficult to distinguish the effects of these two phases of computerization since decentralized computing does not replace, but is superimposed on, centralized computing. Now personal computers and word processors are often networked and part of an integrated system. Federal procurement policy, and accounting and inventory practices also blur distinctions between these two kinds of office automation.

Most Federal agencies now have word processing, spread-sheet packages, automated document transmission, and calendaring. The other most frequently used functions are electronic filing and computer graphics. Many agency headquarters communicate by computer with their field offices nationwide.[7]

Personal computers are being used more and more by managers and professionals as well as by support staff. The National Academy of Public Administration, in a 1983 report, assumed that this reduces the load factors and utilization rates of mainframe computers, and said that this cast "serious doubt on the future role of many of the large central computer service centers that have been built up . . . over the last 10 to 15 years."[8] But experts generally do not believe that ADP centers will be superseded by distributed processing. Rather, as small and large computers are linked, the ADP center will be the locus and guardian of the agency data to which all managers and professionals will increasingly have access and make contributions.

Some large Federal computers are, however, already obsolete or will soon become so.[9] "Obsolete," in this case, does not mean that they are no longer functioning, but merely that more cost-effective technology is available. The old systems require repeated patching and modification, maintenance costs are high, and spare parts sometimes not available. Older computers sometimes have limited on-line processing capacity because they were designed for 24-hour operation and not for the peaks caused by many end-users.

When these computers are replaced, databases often have to be converted, and new software packages developed or adopted. This is expensive. The incompatibility of equipment from many vendors is also causing problems.

Laws and Policies

The Paperwork Reduction Act of 1980, Public Law 96-511, was a milestone in government information management.[10] In addition to reducing the paperwork burden imposed on business by government, the act was aimed at improving efficiency and effectiveness in the use of information. It promulgated the concept of information resources management (IRM), meaning the integrated management of all basic information-handling activities and functions. The sections of the act dealing with information-resources management cover everything from conventional libraries to centralized ADP sytems, and have a direct effect on office automation.

The act required each agency to appoint an information-resources manager.[11] It charged

[6]International Data Corp., Procurement Information Management Service, "Federal Acquisition Strategies for Office Automation," research paper for Continuous Information Services Clients, March 1983.

[7]According to an office automation survey compiled by the Information Management Assistance division of the Office of Information Resources Management, General Services Administration, November 1984. Thirty-one departments and agencies responded to the survey.

[8]National Academy of Public Administration, *Revitalizing Federal Management: Managers and Their Overburdened Systems*, November 1983.

[9]The Grace Commission criticized the government for allowing its data processing systems, which in the early 1970s were state-of-the-art, to fall behind; according to the Commission about 60 percent of the government's then 17,200 computers were in need of replacement or significant upgrading. However, in a recent review of 100 "major systems," GSA concluded that only 5 percent are "totally supported by obsolete ADPE systems," and that obsolescence "is not as extensive as has been claimed." See *Assessing ADPE Obsolescence in Major Federal System*. U.S. General Services Administration, February 1985.

[10]The act built on the recommendations of the Commission on Federal Paperwork (1975-77).

[11]The act specified that these officials should be at the level of Assistant Secretary. Since the number of these positions

(continued)

OMB, assisted by GSA, with reviewing information resources management in each agency at least every 3 years. OMB has largely delegated this responsibility to GSA.[12] In practice, each agency conducts its own review, for which GSA provides a voluminous handbook or set of guidelines. The agency reviews are then reviewed by GSA.

OMB has stated two basic tenets that govern its approach to information-resources management:[13]

- Information is an economic resource and should be managed in the same way that other economic resources are managed.
- Information-resources management should entail the management of the total information life cycle from collection to dissemination.

OMB provides guidance on all matters of budget allocation and procurement in Federal agencies, but this guidance is not specific enough to materially affect the acquisition of office automation equipment.[14] GSA does provide guidance to agencies on this subject, although agencies still make their own basic decisions.

Twenty years ago, in 1965, the Brooks Act (Public Law 89-306) gave GSA sole authority to procure ADP systems.[15] Although this authority is premised on large-systems procurement it remains the basic authority for purchase of office automation equipment. If office equipment contains data processing components it must be bought under GSA standards and rules governing competitiveness in procurement. Procurements of microcomputers and word processors,[16] when under $300,000, are handled under a GSA schedule (Schedule C), which means that there are simplified procedures for competitive bids from already authorized vendors. When the total value of a procurement exceeds certain thresholds (for ADP equipment in general it is now $2.5 million) GSA usually issues to the agency a Delegation of Procurement Authority, based on information provided by the agency about the justification for the procurement. The agency then draws up specifications and goes through its own competitive bidding procedure. (GSA can withdraw this delegation or change the thresholds.) GSA acquisitions do not account for all, or even for the preponderance of, Federal-agency microcomputer acquisitions.

The Competition in Contracting Act[17] that took effect April 1, 1985, created simpler procedures for using GSA's ADP Schedule in microcomputer purchases under $300,000. GSA has an approved list of 45 microcomputers, available from 36 suppliers at special Federal rates. In addition, a GSA Computer Store carries 15 brands (not necessarily on the list); this is designed to encourage the selection by end users rather than leaving the choice to an agency's central-purchasing agent. GSA has published several attractive booklets of

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in each agency is limited by law, the responsibility was generally given to the Assistant Secretary for Administration or the equivalent. These are now referred to as Senior Designated Officials or SDO's, and there is typically an Office of Information Resources Management under them, with a director who acts as the IRM and represents the agency on the Interagency Committee on Information Resources Management. There is an Office of Information and Regulatory Affairs in OMB that coordinates OMB responsibilities for implementation of the Paperwork Reduction Act.

[12] Letter of delegation of June 13, 1983, and Temporary Regulation 10.

[13] Executive Office of the President, Office of Management and Budget, *Improving Government Information Resources Management*, March 1982, p. I, hereafter cited as *EOP/OMB 1.*

[14] OMB guidance on procurement (which comes from the "M" or management side of OMB, and specifically from the Office of Federal Procurement Policy or OFPP) is of course to be distinguished from OMB review of agency budget requests on the "B" side of OMB, which certainly does affect the level of office automation procurements.

[15] DOD computers and related devices were exempted if the equipment was "a mission critical computer resource." DOD has argued that if any office automation system is tied into a mission-critical computer resource system then it is also exempt from GSA procurement regulations. Statement of Undersecretary of Defense DeLauer on Mar. 4, 1983, according to International Data Corp., op. cit., p. 22. The question of whether this applies to word processors has been under review several times and the outcome is not clear.

[16] Word processors were not included under ADP equipment until late 1983 (SPMR Temporary Reg.F500, Oct. 25, 1983).

[17] Part of the Deficit Reduction Act of 1984. The CIC Act, aimed at increasing competitiveness in procurement, makes it more difficult to buy from a preselected sole source, but defines as competitive, awards that are made under a GSA Multi-Award Schedule Program such as the ADP program. An agency may also exclude a specific vendor in the interest of maintaining alternative sources.

advice to help agencies in buying and managing microcomputers.[18]

GSA also has responsibility for most of the many common-user telecommunication facilities used by Federal civil agencies. If an agency wants to make a major change in common-user services (e.g., Wide Area Telephone Service, or WATS, lines) to implement office automation communications, GSA must approve.[19]

The GSA authority under the Paperwork Reduction Act (and by delegation from OMB) was until recently exercised through two different services. The Automated Data and Telecommunications Service, which dealt with ADP equipment, and part of the National Archives and Record Service, which dealt with records management, micrographic, and word processing equipment, have been merged to create the Office of Information Resources Management.[20]

In April 1984, a number of policies and regulations related to information resources and technologies were consolidated in a Federal Information Resources Management Regulation (CFR Pt. 41, ch. 201). Amendments to the Paperwork Reduction Act have been introduced in Congress aimed at strengthening some aspects of the law.[21]

Other agencies have roles in office automation procurement. The Institute for Computer Science and Technology in the National Bureau of Standards develops standards for ADP and communications equipment, develops technical guidelines, and prepares a yearly forecast of developments in computer technology, including office automation.[22] The General Accounting Office (GAO) has general auditing power over all government expenditures and has repeatedly evaluated office automation acquisition programs.

The President's Private Sector Survey on Cost Control (the Grace Commission), which was highly critical of government management procedures, asked, "Can improvement of information systems create cost savings and efficiencies and facilitate managerial decisionmaking throughout the Federal Government?"[23] The report concluded that it could, and that this offered the "opportunity for savings and revenue of $15.2 billion over 3 years," an estimate that included both office-microelectronic equipment and large systems. The survey team said that the acquisition process was inadequate, characterized by excessive procedural steps, a confusing array of policies and directives, lack of qualified personnel, and deficient training and supervision. The survey team recommended stronger, centralized, governmentwide policies for information-technology acquisition and management, but not necessarily less discretion for the agencies, although it is not clear how both objectives can be preserved.

The Administration has stressed the importance of planning, and OMB, GSA, and the National Bureau of Standards together prepare a 5-year plan, updated every 2 years, together with guidelines to assist agencies in planning. A new OMB circular, 85-12, will provide agencies with further guidelines to be used in planning. Agency managers, however, often express a feeling of futility in doing long-range planning for information systems because their budgetary constraints are constantly changing. Nevertheless, the desire to link personal computers and word processors to mainframes and minicomputers, and to other devices, is pushing Federal agencies toward planning and coordination of equipment acquisition, probably more effectively than could be done by instituting government-wide requirements.

[18]Office of Information Resources Management, U.S. General Services Administration, *Managing End User Computing in the Federal Government*, June 1983, and *End User's Guide to Buying Small Computers*, August 1984.

[19]DOD manages its own procurements of communications technology.

[20]Another part of GSA's National Archives and Records Service became the independent National Archives and Records Administration.

[21]S. 2433 (amendments of 1984); H.R. 2718 (amendments of 1983); hearings were held in the House in April 1983 and in the Senate in April 1984.

[22]Recent budget cuts have abolished the planning office of ICST, leaving in doubt the question of whether these forecasts will be done in the future.

[23]The Executive Committee to carry out the survey was established by Executive Order 12369, June 30, 1982. See: President's Private Sector Survey on Cost Control, *Management Office Selected Issues*, vol. VIII, "Information Gap in the Federal Government," winter 1983.

The Federal Inventory of Office Automation

Expenditures for information technology for Federal agencies grew from about $10.4 billion in 1983 to $13.9 billion in fiscal year 1985, increasing 19 percent in the first year and 13 percent in the second.[24] This is a much larger growth than that for Federal expenditures as a whole. About a third of these expenditures are for defense-related agencies.

The government has been spending about 1.4 percent of its budget on information technology; this is perhaps somewhat less than the rate of spending by private corporations in the services and manufacturing sectors,[25] in spite of the greater intensivity of white-collar work in government (about 80 percent of the Federal work force are white-collar workers, compared to about 55 percent of the total civilian work force). The average length of time in service for Federal computers in 1982 was just under 7 years, and decreasing as old systems are replaced.

The purchase of equipment (capital investment) accounts for only about 19 percent of these expenditures, compared to 36 percent for commercial information services (ADP, etc.). The rest is for equipment leasing or rental and for personnel costs. Federal policy has generally been to encourage purchasing rather than leasing; it is more cost effective, and the proportion of systems that are leased has declined from 36 percent in 1970 to 12 percent at present.[26] But some procurement specialists question this strategy since leasing would make state-of-the-art technology more readily available.

In recent years, the largest absolute increases in expenditures for information technologies have been in the Department of Defense (DOD), the Department of Energy, and the Department of Health and Human Resources. But a number of small agencies that had lagged behind have had bigger percentage increases in order to catch up with the pace; for example, the Office of the U.S. Trade Representative (USTR), the Department of Justice, and the Securities and Exchange Commission.

DOD is by far the largest user of office automation among Federal agencies with about 67 percent of the stock. DOD however also has the largest share of all Federal white-collar workers (about 40 percent of them). One measure of the extent to which an agency has automated is the comparison between its share of total Federal office automation, and its share of the Federal white-collar work force. The ratio of DOD's share of automation to its share of the white-collar work force is a modest 1.68 compared to 8.24 for the Department of State, 3.41 for the Environmental Protection Agency, and 3.34 for the National Aeronautics and Space Administration.[27]

In 1982, the Federal Government had in its computer inventory about 13,667 major systems with over 20,000 central processing units. This inventory is not complete nor accurate.[28] Moreover, GSA will no longer attempt to list systems costing less than $50,000, and has recently discontinued its tracking of communications use and costs. It is therefore impossible to say how much office automation equipment the government owns. In early 1983, the General Service Administration said that "there are estimates" of 82,000 word proces-

[24]Office of Management and Budget, General Services Administration, and Department of Commerce, *A Five-Year Plan for Meeting the Automatic Data Processing and Telecommunications Needs of the Federal Government*, vol. 1, April 1984. Hereafter cited as *Five Year Plan, 1984*.

[25]Thomas G. Cody, "How Senior Execs View Info Technology," *Government Computer News*, July 1984, p. 64.

[26]In 1960, over 80 percent of computer systems used in the Federal Government were leased, by 1970 this had dropped to 36 percent, from 1977 to 1983 it was about 9 percent, and since then it is rising again, to 12 percent in 1984. *Five-Year Plan, 1984*, pp. 1-3.

[27]International Data Corp., op. cit. These percentages are for 1982-83; more recent figures are not available.

[28]GSA, *Automatic Data Processing Inventory, April 1984*. GSA guidelines require agencies to report all systems with a CPU but agencies nevertheless differ on their interpretations of the guidelines—e.g., some do not include word processing systems and some do. An on-line version of the inventory is being developed, but it will not include systems costing less than $50,000. GAO concluded in March 1985 that "GSA's data base of the government's inventory of computer equipment has been inaccurate for some time." (U.S. General Accounting Office, *Effective Management of Computer Leasing Needed to Reduce Government Costs*, IMTEC-85-3, Mar. 21, 1985, p. 111).

sors in government offices,[29] but these estimates were based only on old rules-of-thumb about government's share of computer purchases. Most agencies are not sure how many personal computers or small word processors they have. Accounting and inventory categories differ across agencies in how they categorize leasing arrangements, paced payments, etc.[30] Agency IRM officials nevertheless complain about surveys or audits aimed at clarifying these questions; audits are seen as a heavy burden that detracts from more productive work.

Much of the office automation equipment now being bought is low cost; decisions about personal computers are in this sense not much different from decisions about desks and typewriters. Over-elaborate regulations and controls could be needlessly costly. Organizations need the freedom to experiment in order to identify the most useful technology for them. However, monitoring and inventory could be done without affecting the range of choice.

Current procedures for inventory of office automation equipment make it difficult to assess the status, level of capital investment, and rate of investment. Projections of future office automation, future costs, and future benefits are therefore unreliable, and effects hard to measure. This is a problem for agency planners and decisionmakers trying to assess the cost-effectiveness of automation.

Acquisition Strategies and Problems

Within OMB and GSA guidelines each agency makes its own decision about office automation acquisition. OMB Circular A-109 requires every agency to have an acquisition strategy; some of these strategies have been widely criticized.[31] A series of GAO reports has faulted agencies for:[32]

- not complying with guidelines and regulations,
- not studying alternative methods of acquisition,
- leasing rather than purchasing,
- using vendor-specific programming language,
- not adequately analyzing agency mission and needs,
- failing to have a long-range plan,
- not consolidating individual small-volume orders,
- purchasing equipment in excess of need or likely use,
- failing to properly inventory equipment,
- lack of accountability in controlling equipment,
- failing to issue or enforce departmentwide policies,
- not separating short-term objectives from long-range plans,
- failure to use word processing to reduce the cost and size of the work force,
- faulty cost/benefit analysis,
- not realizing maximum productivity gains,
- underestimation of operating and maintenance costs, and
- use of untested technology.

[29] U.S. General Services Administration, Office of Information Resources Management, *Managing End User Computing in the Federal Government*, June 1983, p. 3.

[30] U.S. Office of Management and Budget, U.S. General Services Administration, and U.S. Department of Commerce, *A Five Year Plan: Meeting Automatic Data Processing and Telecommunications Needs of the Federal Government*, April 1983, pp. 121-146; National Bureau of Standards, *Future Information Processing Technology—1983*. Special Publication 500-103, pp. 177-179; International Data Corp., "Federal Acquisition Strategies for Office Automation," research paper for Continuous Information Services Clients," by the Procurement Information Management Service, March 1983, p. 32; and Dr. Richard Werling, "Applications of Information Technology in Government," July 1984, contractor report for the CIT Government Information Systems Assessment, OTA.

[31] For example, a National Academy of Public Administration panel (op. cit.) concluded that only a few agency leaders "are really aware of how swiftly change is being forced on their organizations as a result of rapid office automation." As a result, the panel said, acquisitions are often haphazard and poorly planned and fail to meet their objectives.

[32] See U.S. General Accounting Office reports CED-81-15, Oct. 23, 1980, AFMD-81-55, Apr. 21, 1981; HRD-81-74, Apr. 21, 1981; HRD-81-106, June 30, 1981, CED-82-113, Sept. 30, 1982, GGD-83-103, Sept. 1, 1983, IMTEC-84-11, May 25, 1984; and AFMD-82-54, Sept. 21, 1982.

Noncompatibility

Some of the most difficult decisions about acquisitions strategies involve the value of compatibility of small systems and devices. Some Federal executives insist that it is most important to get office equipment that is useful now; diversity will help the agencies determine what kinds of automation are most successful. Noncompatibility is a minor problem, they say; by the time it becomes cost-effective to tie systems together, it will be time to buy new up-to-date equipment. The experience and learning gained meanwhile will carry over.

This seems to be a minority position. The tying together is already going on, and for most agencies noncompatibility is certainly a problem. However, this problem may be an unavoidable cost of competitive procurement. Moreover, cumbersome attempts at coordination and control during the first few years of personal computers would almost certainly have greatly delayed the automation of Federal offices and put the government far behind the private sector in the pace of adoption.

Because the government is a major market for office automation, it is often urged to force the development of industry-wide standards, or to develop its own standards. Many experts think however that since the development of voluntary standards is proceeding, it would be preferable in the long run for government not to force this issue by intervening more strongly. There appears at present to be little pressure for such intervention.

Inappropriate Choices

Many day-to-day problems come about because of the selection of equipment by managers who do not understand the mechanics or flow of work in their own offices. The support staff is often not consulted, although they could bring to the decisionmaking valuable information that is otherwise not available. Formal description of work procedures often bears only nominal relationship to the real process of moving a form, a letter, or a report out the door. How smoothly the movement proceeds is affected by a myriad of details from how the office furniture is arranged, to what else has to be done at the same time. Hardware, software, or auxiliary furniture can improve this workflow or it can disrupt it, depending on characteristics that may appear unimportant or irrelevant to those who are not actually doing the work.

The Complexity of Options

The procurement of networking technologies involves much higher costs and longer-lived systems than the choice between stand alone devices. Mistakes are more serious. Even in procuring simple systems, the procurement options are becoming complex. To get a telephone system for a new office, the Federal executive must now choose between buying and leasing. If the budget only has operating funds, not capital investment funds, lease financing is necessary.[33]

Privatization

An agency's evaluation of its needs for computers and related equipment has also been complicated by confusion over Administration policy about contracting with private organizations for information-related services. OMB Circular A-76 requires the contracting out of services that can be performed more cheaply by the private sector. Many agencies have contracted for data entry or word processing to relieve the load on old systems and avoid the need for new systems. Some have become dependent on outside sources for training and support of office automation instead of developing the capabilities that they will need in the future.

Recent studies of productivity factors resulted in revision of A-76 to emphasize 14 major categories of services in contracting out. These include ADP, data entry and keypunch, audiovisual, and mail and file services. Agencies are now required to consider three options —internal performance, use of another government agency, and outside contractors. They

[33]Patrick J. Keogh, Chief of the Economic Analysis Branch of GSA. "Deregulation is Challenge to Procurement Officials," *Government Computer News,* November 1984.

are still encouraged to contract out as many services as possible, if those services would require more than 10 Federal employees.[34]

OMB recently reported that cost comparisons are now going against privatization in about half of the activities reviewed, a much higher percent than in the past. This has been advanced as an indicator that government is becoming more efficient in carrying out its activities.[35]

The Dilemma of Procurement Policy

In their own audits and reviews, agencies frequently identify problems such as those GAO listed above. For example, the Inspector General of a major agency[36] in a 1985 post-installation review of major systems listed a number of failures: no clarification over who has control over the project, no determination of total-user requirements, poor planning and design, lack of coordination between two user groups, and acquisitions occurring at field level, resulting in incompatibility. Mistakes of this kind can and should be avoided as better procedures are developed.

But at the same time, for larger systems, agency procurement procedures may be too elaborate and too rigid.[37] For advanced systems, including the computer networks that are becoming a high priority goal in most agencies, the procurement procedures often result in specifications that are precise, elaborate, and rigid. This creates major problems. The agency contracts officer finds himself caught in a tension between the agency or program officer's need to solve old problems or achieve new goals with advanced technology on the one hand, and on the other hand, customary professional procedures and the increasingly demanding safeguards and checks imposed by Congress to ensure fair competition.

To guard against violations of established safeguards, the contracts officer tends to insist on elaborate specifications before requesting bids. As a result, the development of the technology may outrun the procurement cycle, and equipment may be behind the state-of-the-art by the time it is installed. Vendors have no opportunity to propose alternative specifications that could provide more innovative ways of meeting agency needs.

Overspecification is particularly likely to occur with information technologies because contracting officers usually are not experts in the technology and are unable to rely on their own professional judgment about how detailed specifications must be. Contracting officers are themselves at severe risk if there are too many challenges to their actions on grounds of inadequate competition and this makes them even more cautious.[38]

An additional complication with competitiveness in regard to information-technology procurement is the desire for compatibility with existing equipment. If the procurement is decided on the grounds of compatibility, it may be faulted for noncompetitiveness; if greater competition results in procurements that require additional high expenditures to compensate for noncompatibility, the decision may also be faulted.

Overspecification, according to industry experts, can result in procurement specifications that reflect obsolete approaches to technical problems, or specifications that no vendor can exactly meet, although several vendors may have alternative approaches that would solve the technical problem, perhaps at less cost than is entailed in meeting the government specifications.

[34] Eric Fredell, "OMB Restricts Contracting Out in A-76 Revision," *Government Computer News*, November 1984.

[35] Myron Struck, "Workers Break Even in Cost Studies," *The Washington Post*, Apr. 11, 1985, A19.

[36] This was typical of audits and reviews shown to OTA by agencies; there is no intent here to single out a specific agency for criticism or otherwise, and the agency is therefore not identified.

[37] Based on discussions at workshops for Federal agency office automation specialists held by OTA in October 1984 and July 1985, and on many other written and spoken communications from Federal officials.

[38] Federal contracts officers have a warrant, giving them sign-off authority on contracts up to a specific dollar limit. If there are serious challenges to their decisions about competitive contracts they may not only get a poor performance evaluation, but can lose their warrant, or have their sign-off authority reduced, which would seriously damage their future career outlook.

In some cases, attempts to make procurements more competitive and to increase accountability result in procedures that seriously obstruct the accomplishment of agency responsibilities.

In spite of these problems, OTA concludes **that office automation, under Administration policies that give agency managers wide discretion in formulating acquisition policies, has kept pace with private sector office automation, and that the opportunity for increased productivity will not be unduly limited by procurement-related problems.**

WHAT WILL OFFICE AUTOMATION MEAN FOR FEDERAL OFFICE PRODUCTIVITY?

Nearly all observers agree that Federal office automation is increasing agency productivity. But because there is no agreement on the definition of productivity, this benefit is hard to measure and document.

Based on past experience and analogy with the private sector, the gain in productivity is probably far below that which is eventually possible. A mixture of old and new technology is rarely completely effective. Workers using the new technology must cope with existing paper-based data, through procedures built up around older work activities, coordinating with other offices that have not been automated, in a bureaucratic structure organized to fit the earlier patterns of workflow and task sequencing, and in a workplace environment that was not planned with the new technology in mind.

Moreover, the training that is given to workers using the new technology is clearly inadequate. Most of them are learning on their own, and from each other. This takes time to accomplish, and also cuts into the time that is spent in direct production of output, both for learners and teachers. Managers, too, are still struggling to learn new techniques for managing the automated office. (Federal training is also discussed in chapter 3.)

Evaluations of Productivity

The General Accounting Office estimated the cost of the government work force as $81 billion in 1980 and on that basis calculated a potential savings of $12 billion, or 15 percent, through the use of office automation.[39] It is not clear how this estimate was calculated, but the 15 percent estimate recurs frequently in agency projections of increased productivity.

The first round of agency reviews of their information-resources management, as required by the Paperwork Reduction Act, began in 1982. These reviews varied in scope and objective; some were designed to assess system performance, some evaluated the effectiveness of systems in direct support of specific program areas, and some concentrated on the effects on administrative responsibilities and budgets.[40]

The reviews were intended to address progress in reduction of the paperwork burden, improved delivery of services, elimination of activities that duplicate private sector sources, budget savings, improved productivity, improved technology, and improved management controls. But few cited specific productivity gains that could be quantified. These status reports illustrated why it is difficult if not impossible to specify, either in advance or in retrospect, the direct productivity benefits of office automation. First, information resources management goes beyond office automation

[39] As quoted by the U.S. General Services Administration, Office of Information Resources Management, *Managing End User Computing in the Federal Government.*

[40] OMB then targeted and monitored 66 of the reviews, being conducted by 26 agencies. Executive Office of the President, Office of Management and Budget, *Improving Government Information Resources Management: A Status Report,* March 1983. Hereafter cited as *EOP/OMB 2.* See also *EOP/OMB 1,* cited previously.

and some of the gains come from reorganization or increased management attention. Secondly, in most cases, automation is not a onetime, self-contained event and comparison of clear-cut before and after measurements are not possible.

Many agencies have provided OTA with system plans and evaluation reports in which they made estimates or projections of productivity gains from office automation. For example, a natural resource agency recounts cutting staff in one field office from 370 to 120 when much of the work was automated by a new computer system. There are also many estimates of future savings. A science-oriented agency estimates that 10 percent of the work hours of administrative personnel and 3 percent of those of its scientists[41] will be saved. Another agency expects time savings of 10 percent for administrative personnel and 20 percent for professionals, and the elimination of some technical positions. These estimates are persuasive in context, but they use so many different ways of estimating or aggregating that they cannot be evaluated or compared.

Although not called out as a criteria for evaluation in the status reports, there appear to be many cases where information technology has resulted, or can result, in services to the public that would not be possible without it.[42] But in the interest of reducing the Federal deficit, there has been more emphasis on attempts to reduce or constrain the growth of government services than on expanding them.

OMB, while specifying productivity as an evaluation criteria, has not defined it nor provided a metric for it. OMB says only that with the technology "the Federal Government should be able to utilize available resources in a more efficient and effective manner."[43] Productivity could mean more or better work performed or services delivered; it could mean doing the same work at less cost.

The Merlin Experiment

One example of productivity assessment is an Office of Personnel Management (OPM) evaluation of the General Service Administration's Merlin System, installed in GSA's Western Region in July 1983.[44] Merlin is composed of 84 personal computer workstations linked by a local area network and used by managerial, technical, and senior clerical employees. The OPM study was based on systematic measurement and evaluation of work before and after the installation. In 39 of the 47 categories of tasks studied, output increased "remarkably": OPM rated this "a strong overall improvement." The volume of output per employee hour went up in 14 of 19 categories. Cost per unit of output was reduced in 79 percent of the categories. In some categories it was possible to compare the same kinds of output with and without use of Merlin, in the same time period; 10 of the 17 categories showed improved unit time with Merlin. OPM also found a reduction in contract preparation time, improved time and project management, and a "marked reduction" in time spent in meetings, due to the system's communications capabilities. OPM's figures appear to indicate about a 1-percent cost saving for the organization as a whole (across about 4.4 person years spent in all tasks done by the organization).[45] No information is given about the cost of Merlin or its anticipated lifetime.

Incentives

In the private sector, increasing the output and/or the quality of the product should increase the organization's market share and ultimately its profits. This incentive does not

[41] Fifteen percent of the 20 percent of their time that the scientists spend on administrative duties.

[42] For example, the automation of the Occupational Safety and Health Administration's technical Data Center allows OSHA to respond yearly to several thousand inquiries by government agencies, workers and their unions, employers, public interest groups, and the general public.

[43] *EOP/OMB 1*, p. 12.

[44] U.S. General Services Administration, Office of Information Resources Management, *Merlin Improvements*, January 1985.

[45] App. D of the cited report gives "total time and total cost" for sample 1 (pre-Merlin) as 9,200.6 hours and $132,160.10 or $14.36 per hour; for sample 2 (post-Merlin) as 9,763.0 hours and $138,731.30 or $14.21 per hour.

operate in government. On the contrary, a government organization that performs its work at less cost typically finds its budget reduced for the following year, usually with no reward for the managers who achieved the cost reduction. Instead, if they have fewer employees they may lose status and find their chances of a higher grade level significantly prejudiced.[46] The always present possibility of across-the-board budget cuts encourages Federal executives to keep staff levels above the minimum that is necessary so that cuts can be absorbed without damaging their ability to get the work done.

New York City undertook to automate its municipal offices under a strong drive to reduce costs and increase government revenues,[47] and high level officials say that progress is being made toward these goals. The same pressures are operating within the Federal agencies, and there is every reason to anticipate that the results will be much the same. Productivity as measured by output and by labor costs is likely to increase; whether this is accompanied by improvement in the quality of government services is much more uncertain.

[46] For example, a 1980 U.S. General Accounting Office report concluded that productivity rates achieved by Federal payment centers varied by 600 percent, and added that the GAO auditors were told by payment center managers that there were strong disincentives against raising productivity, of the kind described here. GAO, *Improving the Productivity of Federal Payment Centers Could Save Millions*, FGMSD-80-13, Feb. 12, 1980.

[47] According to a case study of municipal office automation done for OTA; see app. B for a summary.

IMPLICATIONS FOR THE FEDERAL WORK FORCE

If office automation does increase productivity in Federal offices, it could allow Federal white collar employment to be reduced (or it could allow government services to be expanded without a proportionate increase in employment). Automation may also:

- change the nature of the work and the skill requirements of some jobs,
- effect the number of people needed in some job categories,
- create new jobs and occupations, and
- make other jobs obsolete.

Such effects would change the relative number of people needed in the major categories of Federal jobs—professional, administrative, technical, and clerical; and also affect the distribution of people at each grade level and salary level.[48] Such changes in the structure of the Federal work force, as well as the size of the work force, will strongly affect total labor costs and thus the cost of government.

These potential changes should be considered in work force projections, in planning, and in developing policies about personnel recruitment, rewarding and promoting, retention, and retirement. There is no indication that OPM, OMB, or other central agencies of government are studying the implications of such changes.

Since Federal offices have been using computers for about 20 years and have been rapidly automating over the last 5 to 10 years, indicators of such change should already be apparent with careful statistical analysis. This analysis has not been done on a systematic basis. However, OTA concludes that there are at least some general indicators that such changes are underway.

Size of the Work Force

If office automation is affecting Federal employment levels, then historical growth rates should be slowing or reversing. Growth of the Federal work force has in fact slowed, stabilized, and then been reversed over the past 15 years. It is not necessary to argue that office automation has been the cause of this decline. The volume of government employment

[48] In the Federal civil service, employees hold a grade level in one or the other of approximately 100 pay plans used by the executive branch. About two-thirds of them are covered by the largest pay plan, the General Schedule (GS). This has grade levels from 1 (the lowest) to 18. The employee's grade level determines the range of salaries that he or she can obtain.

depends strongly on the political philosophy of the Administration in power and of Congress about the scope of Federal Government responsibility and the services that government should provide. It is also strongly affected by population growth and economic expansion. However, given a political imperative to reduce the cost of government and hence to shrink Federal employment, it can be argued that office automation has at least allowed and facilitated a reduction of the work force.

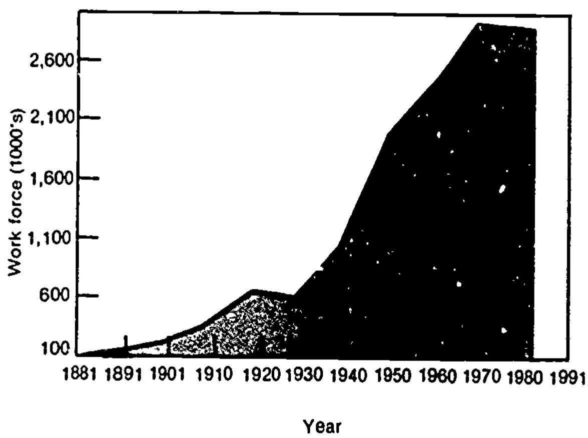
Federal employment has grown every decade of our history except the 1920s. (See figure 9-1.) It has not, however, kept pace with growth in population or in the economy.[49] Federal employment grew by 73 percent during the 1930s and the New Deal, 88 percent during the 1940s and world war, 23 percent in the 1950s, and 24 percent in the 1960s.[50] The growth in the 1960s was perhaps in part related to the Vietnam War, but it was characterized by increases in the number of postal workers and the number of general administrative, clerical, and office service workers in nondefense agencies.[51] Thus, it was probably related to the trend toward an information-intensive economy and to political initiatives such as the War on Poverty.

But from 1970 to 1980, Federal employment growth slowed; it grew only 2 percent in that decade.[52] During this period the Federal work force was—like the country's general labor force—becoming more thoroughly white-collar. The ratio of white-collar to blue-collar Federal workers changed from 2.9:1 in 1960, to 4:1 in 1980. Yet at the same time the growth of the Federal white-collar work force has also slowed; it grew more than 13 percent from 1960-65 and again from 1965-70, but only 7 percent from 1970-75 and 3 percent from 1975-80. This change was at least coincident with the speeding up of office automation, which began about 1974.

Every 2 years from 1960-74, the number of General Schedule and Merit Pay employees (about two-thirds of all Federal white-collar employment)[53] grew about 3 percent; from 1974-84, the average growth rate each 2 years was only 0.3 percent. This may also be an indicator that office automation was having an effect.

Such indicators do not of course establish a cause-and-effect relationship. Nevertheless, the cumulative evidence that automation of white-collar work can at least allow employ-

Figure 9-1.—Paid Civilian Employment of the Federal Government, 1881-1983



SOURCES Data from 1881-1960 based on U S Department of Commerce, Bureau of Census, *Historical Abstracts of the U.S. Colonial Times to 1970, Part II*, Series y 308-317 Washington, DC, 1975 Data from 1970-1983 based on U S Department of Commerce, Bureau of Census, *Statistical Abstracts of the United States*, N 523, Washington, DC, 1985

[49] Federal employment has steadily decreased relative to the size of the economy and the national population, from 3.7 percent of U.S. civilian employment in 1960, to 2.9 percent in 1982, and from 13.1 (executive branch) Federal workers per 1,000 population in 1960, to 12.2 in 1982. The Federal proportion of total public sector employees has declined from 33 percent in 1950 to under 18 percent in 1980 (U.S. Department of Commerce, *Statistical Abstracts*).

[50] Bureau of the Census, *Historical Statistics of the United States*, Part II. Series 308-317.

[51] Department of Defense employment increased 15 percent from 1960-70, but it was 43 percent of total Federal civilian employment in 1960 and only 41 percent in 1970. (Stat. Abstr. 1984, table 535.) But General Administrative Clerical, and Office Services increased 20 percent and postal workers increased by 26 percent.

[52] Stat. Abstr. 1984, table 535, p. 333.

[53] There are over 100 pay codes or schedules for Federal executive branch employees, although some cover only a handful of workers. A few, such as those used only for Foreign Service employees, the Tennessee Valley Authority, or the Veterans Administration, cover thousands of employees. However, the GS/GM pay codes cover about 67 percent of all white-collar workers, and a higher percentage of those who are administrative or clerical.

ment growth to be constrained or reversed while the amount of information-handling increases, is persuasive.

Changes in the Mix of Federal Jobs

There are now 8 percent fewer people in the jobs grouped under "General Administrative, Clerical, and Office Services" than there were in 1975.[54] A closer examination of this group, which contains about one-quarter of all Federal workers, also suggests that office automation is bringing about basic changes in Federal office work and in Federal jobs.

For example, four job titles within this grouping have disappeared since 1975[55]—cold-type composing machine operation, dictating machine transcription, electric bookkeeping machine operation, and calculating machine operation. Together they accounted for 8,500 jobs in 1975, although even then they were on the way to becoming obsolete jobs. In 1975, there were already 42,500 computer operators, specialists, and aides; that number has grown by 9,000.[56]

Some job titles have changed as the technology associated with them changed—for example, card punch operations has become data transcription. The number of people who presumably spend much of their time typing (now known as keyboarding) may have grown despite the spread of word processing. In 1975, there were over 7,146 dictating machine transcribers (a classification that does not now exist), 72,895 clerk-typists, and 62,373 secretaries. By 1983, there were 11,780 fewer clerk-typists but 29,100 more secretaries, a 7-percent overall increase. Secretaries, who have more diverse duties and make higher salaries than clerk-typists, now make up 60 percent of this group of workers, as compared to 44 percent in 1975.

Shifts Among Occupational Categories and Grade Levels

These changes in and among job classifications imply that there will also be changes in the shape of the Federal work force—the distribution among major occupational categories (professional, administrative, technical, and clerical) and across grade levels and salary levels. Such changes have occurred in the last decade, although undoubtedly many forces are operating to affect this trend. The distribution in terms of the major occupational categories is squaring up. The proportion of clerical workers is declining, and the proportions of technical, administrative, and professional workers have been growing (although the share made up by professionals is now beginning to shrink slightly). (See figure 9-2.)

Clerical Workers

In October 1983, about 25 percent of General Schedule (GS) employees were clerical workers. In 1975, more than 31 percent were clerical workers. The figures for both years exclude postal workers (who were removed from OPM's occupational survey between 1979 and 1981); with them included, more than 45 percent of white-collar employees were in the clerical grouping in 1975. Ninety percent of Federal clerical workers in 1983 were in grade levels 3 through 6, with another 3 percent in grades 1 and 2.[57]

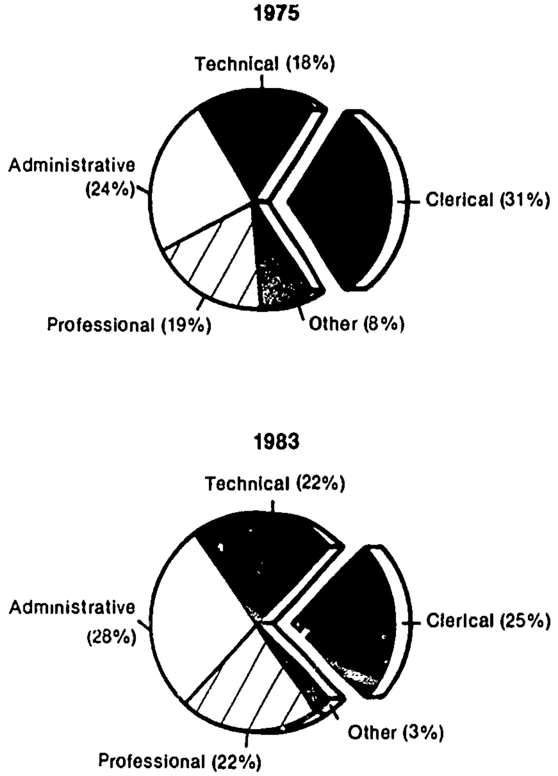
[54]U.S. Office of Personnel Management, *Federal Civilian Workforce Statistics: Occupations of Federal White-Collar and Blue-Collar Workers*, MW 56-18, Oct. 31, 1983, table E, and U.S. Civil Service Commission *Federal Civilian Manpower Statistics: Occupations of Federal White-Collar Workers*, SM 56-11, table F-1. Postal workers have been removed from the 1975 data to make it comparable to 1983 data.

[55]The only entirely new job title is equal opportunity specialist, although as noted the title of some job classifications (as identified by code number) has changed.

[56]The extent to which people displaced from eliminated jobs move into newly created jobs cannot be answered from this data However, it appears from OPM print-outs that most of the over 7,000 dictating machine transcribers were women, most of those in computer specialties are men.

[57]As a reference point, there were over 305,000 Federal clerical workers in grades 1-6 in October 1984. At the high end of the scale are secretaries and claims, payroll, legal, and travel clerks and statistical assistants; average grades for these job classifications are between 5 and 6 (roughly $16,000 to $17,000 in 1983) and there are about 110,000 people in such jobs. At the low end of the clerical scale are messengers, clerk-typists, mail and file clerks, and computer clerks, with average grades of 2-4 ($12,000 to $14,000). The breakdown of workers in each category by grade level is based on an OMB computer printout as of Mar. 31, 1983, while the total numbers for each category are for October 1983. This should not, however, cause any major misstatements.

Figure 9-2.—Changes in the Distribution of Federal Employees by Occupation, 1975 and 1983



SOURCES. 1975. U S. Civil Service Commission, *Federa. Jivilian Manpower Statistics Occupations of Federal White-Collar Workers*, Oct 31, 1974 and 1975, SM 56-11, Washington, DC. 1975, and 1983: U S Office of Personnel Management, *Federal Civilian Workforce Statistics Occupations of Federal White-Collar and Blue-Collar Workers*, Oct. 31, 1983, MW 56-18, Washington, DC, 1983

In internal Federal agency documents and in anecdotes told by Federal office automation managers, it is frequently said that government clerical workers, once trained in the use of office automation, are often hired away by private sector industries that offer higher wages. This is alleged to be true especially in field offices in some sections of the country. This disparity is largely at lower salary levels; 34 percent of Federal data processing workers made under $23,400 in 1983, compared to 22 percent of those in the private sector, according to figures derived by the Congressional Budget Office. However, 35 percent of Federal data processing specialists earned $35,400 or more, compared to 33 percent of those in the private sector.[58]

[58]U.S. Congressional Budget Office, *Reducing Grades of the General Schedule Work Force*, September 1984, p. 43.

Technical Workers

About 22 percent of GS employees in 1983 (nearly 332,000) were technical workers or paraprofessionals with such diverse titles as economics assistant, communications specialist, tax technician, and equal opportunity assistant—120 titles in all. In 1975, only 18 percent[59] of the Federal workers had technical ratings. This trend probably reflects the development of an information society in which scientific and technical information is a major factor in all economic activity.[60]

Administrative Workers

Another 28 percent of GS workers in 1983 (432,000), were classified as administrative, compared to 24 percent in 1975. Nearly 11 percent of all Federal white-collar workers are supervisors; just over 2 percent are called managers, or top-level executives. (The latter are usually in the professional rather than the administrative category.)[61] About 90 percent of administrative workers in 1983 were low and middle-level managers in grades 9 through 15, with nearly another 10 percent just below in grades 5 through 8.[62] Program managers, health systems administrators, and computer-systems administrators, for example, have average grade levels of 13 or over. Passport and visa examiners and social insurance claims examiners are at the lower end of the range and have grade levels under 9. Again, it is the administrative classifications with lowest grade levels that appear most likely to be reduced in numbers as some of their tasks are automated, if the experience of their closest counterparts in the private sector, insurance raters, and underwriters, can be generalized.

[59]U.S. Civil Service Commission, *Federal Civilian Manpower Statistics: Occupations of Federal White-Collar Workers*, Oct. 31, 1974 and 1975, SM 56-11, pp. viii and x. The 1975 figures have again been revised to exclude postal workers. See table B of the CSC publication.

[60]The grade levels for technical jobs vary widely (the 90 percent range is from GS 4-11) but the average grade is 7.14 (average salary $21,000 in 1983).

[61]U.S. Office of Personnel Management, *Federal Civilian Workforce Statistics: Occupations of Federal White-Collar and Blue-Collar Workers*, Oct. 31, 1983, MW 56-18, p. 8.

[62]The average grade for administrators is 10.9 (average salary $32,000 in 1983).

Professionals

Just over 22 percent of Federal workers were professionals in 1983, as compared to 19 percent in 1975. Again, this increased proportion is probably related to changes in American society and economy as well as to office automation. In 1983, 94 percent of professionals were in grade levels 9-15. Their average grade level was 11.7 with an average salary of $36,000. (In 1983-84, however, the proportion of professionals in the Federal work force was reduced slightly from that in 1980.)[63]

Changes In and Among Grade Levels

These changes have squared up the Federal structure, viewed in terms of occupational categories, so that their proportions, which in 1974 ranged from 18 to 31 percent, are now more nearly equal, from 22 to 28 percent, with administrative rather than clerical occupations as the largest group. Paralleling these shifts, the number of workers at each grade level has also changed. (See figure 9-3.) In 1974, 41.9 percent[64] of Federal workers were in the lower grades 1-6, where clerical workers are concentrated. By 1980, it was 38.6 percent. The percentage of workers in grades 7 and 8 remained much the same (11.4 percent in 1974, 11.5 percent in 1983). But the proportion in grades 9 through 14, where most of the professionals and supervisory administrative workers are concentrated, has grown from 45.1 to 49.4 percent.[65] (Congressional Budget Office (CBO), taking slightly different parameters, says that the percentage of people in middle-management grade levels 9 through 15 has grown from 33 to 37 percent since 1974.)[66]

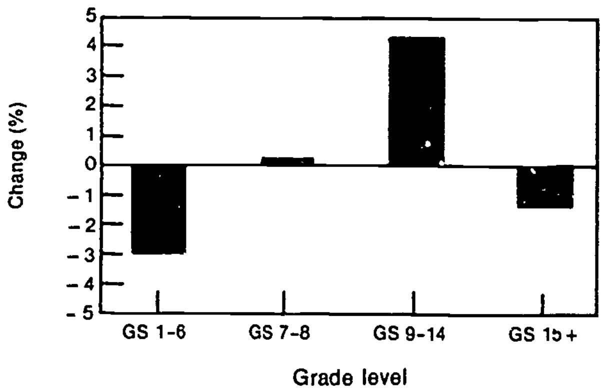
The establishment of the Senior Executive Service (SES) was intended to increase the retention of senior Federal executives by providing them with the opportunity for higher rewards (bonus pay) in return for some sacrifice in job security. It is generally agreed that it has not worked well; many SES people believe that they have been made more visible and therefore the particular target of reductions in force (RIFs) and salary caps or freezes, and most of the few bonuses have gone to a relative few of the highest ranking people.[67]

People tend to think of bureaucracies as shaped like a pyramid. The Federal work force is shaped more like a very flattened figure 8 or hour-glass. There are relatively few people in the lowest grades, a large bulge at grades 5 and 6, a narrow waist representing grades 7 through 10, another large bulge at grades 11 and 12, and a rapid drop-off in numbers in grades 13 through 15. The number of positions at grades 16 through 18 and in the Senior Executive Service (equivalent to grades 16 through 18) is limited by law and is less than 0.5 percent of all Federal jobs. (See figure 9-4.) The figure eight is getting squashed down, the bulges growing wider, and the top and bottom flattened.

[63]About 3 percent of Federal workers are usually classified as "other or unspecified," usually because their jobs are being reclassified during the counting period.

[64]The figure for both years excludes postal workers; if they are included for 1974, the percentage becomes 41.6 percent.

Figure 9-3.—Change In Distribution of Federal Employees by Grade Levels, 1974-80



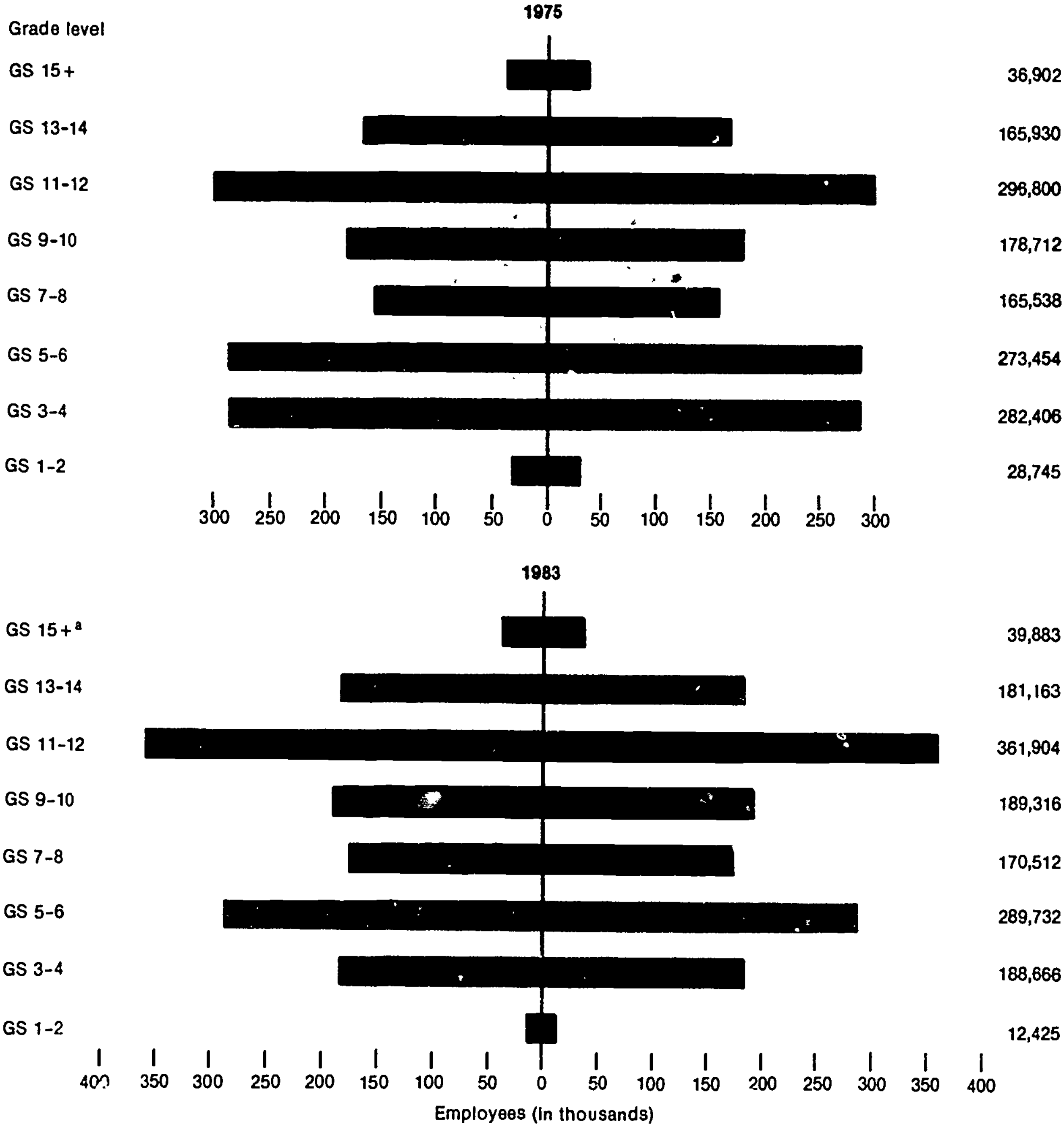
SOURCES: U.S. Civil Service Commission, *Federal Civilian Manpower Statistics: Occupations of Federal White-Collar Workers*, Oct. 31, 1974 and 1975, SM 56-11, Washington, DC, 1975; and U.S. Office of Personnel Management, *Federal Civilian Workforce Statistics. Occupations of Federal White-Collar and Blue-Collar Workers*, Oct 31, 1983, MW 56-18, Washington, DC, 1983.

[65]Figures supplied by OPM in advance of the 1984 analysis of Federal civilian work force statistics now in progress, and compared to OPM occupational statistics for 1974 and 1980, see previous cites.

[66]U.S. Congressional Budget Office, op. cit., p. x.

[67]Sar Levitan and Alexandra B. Noden, *Working for the Sovereign: Employee Relations in the Federal Government* (Baltimore: The Johns Hopkins University Press, 1983), pp. 94ff.

Figure 9-4.— Distribution of Federal Employment by Grade Level, 1975 and 1983



[a]The grades 16-18 excluded senior executive service employees

SOURCES 1975. U S Civil Service Commission, *Federal Civilian Manpower Statistics Occupations of Federal White-Collar Workers*, Oct. 31, 1974 and 1975, SM 56-11, Washington, DC, 1975, p 34 1983. U S Office of Personnel Management, *Federal Civilian Workforce Statistics Occupations of Federal White-Collar and Blue-Collar Workers*, Oct 31, 1983, MW 56-18, Washington, DC, 1983

Unanswered Questions

The Question of "Overgrading"

The average grade level for the civilian work force, not surprisingly in view of changes described above, increased from 8.03 to 8.51 between 1974 and 1983. As a result, salaries increased 4 percent (in equal dollars) and about 1.3 billion was added to payroll costs.[68] The President's Private Sector Survey on Cost Control, and others, have charged that the Civil Service is "overgraded," meaning that grades are too high in comparison with earlier levels and with the private sector.[69]

The Congressional Budget Office (CBO) concluded that the growth in the proportion of nonclerical jobs accounted for about two-thirds of the half-grade increase. They attributed most of the additional increase to promotions granted by some managers to compensate for repeated caps.[70] An earlier OPM analysis (1980) said that 60 percent of the half-grade rise was due to "changes in the occupational mix of the workforce," citing the disproportional decrease in the clerical work force.[71]

Neither the Private Sector Survey report, OPM, nor the Congressional Budget Office explicitly addressed the effect of the increasing professionalization of government work nor of the penetration of information technologies in the office. CBO did acknowledge "the changing character of governmental work" in identifying the factor of growth in nonclerical jobs,[72] but did not explicitly raise the question of how the declining proportion of clerical jobs might be related to office automation, nor did it point out that the Federal work force is far more thoroughly white collar than the private sector work force. CBO also pointed out that while the government has more middle- and top-ranked workers than the private sector, it also pays them much less; "Federal and private sector salary distributions were almost identical" in proportion going to people at those levels.

CBO noted that only 43 percent of Federal jobs were, at that time, below grade 11 compared with 61 percent in equivalent levels in the private sector. Again, it did not specifically note the greater proportion of white-collar work in the public sector.

Neither CBO, nor OPM in its own analysis, have given attention to the implications of office automation for future work force size, grade distribution, and payroll costs. Neither has systematically analyzed the forces behind the changing character of governmental work, nor acknowledged that these forces are likely to grow stronger in the future. There appears, in fact, to have been no major executive branch study of the possible effects of office automation on the Federal work force or labor costs. Considering the current emphasis on cutting the costs of government, the high priority given to increased productivity, and the strong trend toward procuring information technology to accomplish these goals, this is surprising.

Whether the potential increase in productivity because of office automation, and the consequential possibility of shrinking the size of the work force, will more than compensate for the need for more highly paid technical and professional workers is a question that should be studied thoroughly. To both reduce the clerical work force and artificially hold down average grade level and salary could mean that the government cannot attract and hold the people it needs for excellence.

The lack of systematic analysis and planning for changing work force needs makes some Federal workers anxious about their jobs. In discussions and workshops with Federal clerical employees concern is often expressed about what it may mean for job security and

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[68] U.S. Congressional Budget Office, op. cit.

[69] The Administration has proposed reducing the number of positions graded GS 11-15 by shifting 8 percent (about 40,000 jobs) to lower grades, this would be done over a period of 4 years, as vacancies occur. This would save $3.9 billion over a 5-year period. See U.S. Congressional Budget Office, op. cit., p. xi.

[70] R. Mark Musell, "Reducing Grades of the General Schedule Work Force," LRS84-12344 (Washington, DC: U.S. Congressional Budget Office, 1984).

[71] "Average Grade Trend 1974-1980," prepared by James Hall, Program Management Information Section, Work Force Information Division, U.S. Office of Personnel Management (manuscript, unpublished).

[72] Ibid, p. x.

the opportunity for promotion. Some of this concern may be unrealistic and exaggerated; it could be alleviated if officials could talk with their workers about current effects and the implications for the future. They cannot honestly do that at present because little or no information is available about the effect that office automation is now having on Federal employment.

How Jobs Are Classified

As discussed in chapter 4, office automation changes the nature of work and the skills requirements for many jobs. In both the private sector and the public sector, this leads to an expectation that job descriptions and personnel classification schemes will be revised.

OPM uses a point/factor rating system in assigning grade levels.[73] Brief definitions of the factors do not mention any consideration of equipment that is used in the work. The first and most heavily weighted factor is "knowledge required," defined as "the nature and extent of the information or facts that the worker must understand to do acceptable work." It is not clear whether more knowledge is required to operate a word processor than to operate a typewriter, or whether using a spread-sheet program takes more or less special knowledge than using a bookkeeping ledger. In some cases automation requires less knowledge about the process being carried out, in other cases it requires additional abstract thinking or ability at problem solving. It appears that Factor No. 1 could be interpreted so as to accommodate necessary technological skills, and thus jobs could be reevaluated and their grade level moved up or down, if their nature changes because of automation.

[73]The factors are:
1. knowledge required by position (1,850 points, 41 percent of maximum total),
2. supervisory control (650 points),
3. guidelines (and judgment needed to apply them) (650 points),
4. complexity of work (450 points),
5. scope and effect of work product (450 points),
6. personal contacts with nonsupervisors (220 points),
7. physical demands (50 points), and
8. work environment (50 points).

The point range for grades 1-6 is 190 to 1,350 points; for grade 9—1,855-2,100; for grade 15—4,055 and up The maximum total is 4,480 points.

Unless this is explicitly recognized, however, it is likely that there will be challenges to the factor evaluation system, especially if workers believe that they are mastering new skills not recognized and explicitly valued in their old job descriptions. Catherine Waelder, General Counsel of the National Federation of Federal Employees, has already said that "the factor system is new but its standards and values are old." She points out that if not continuously revised, the system will "fail to account for the ability needed to use developing technological resources essential in many professions. . . ."[74]

Part-Time and Temporary Workers

Government use of part-time and temporary workers is determined by many factors; it may or may not increase because of office automation. The Federal Employees Part-Time Career Act of 1978 was passed after several years of effort by members of the Senate and House of Representatives who were responding to urging of female constituents wanting to protect career opportunities in government while reserving time for at-home child care. Unions objected on the grounds that it would take jobs needed by over three million women actively seeking full-time employment who could not afford to support their families on part-time employment.[75]

The act required agencies to do feasibility studies, establish annual goals and timetables, and review and monitor part-time work opportunities. Part-time Federal employment did increase by almost 14,000 from 1979 to 1981, to a high of 57,184; but in 1981 in the strong effort to reduce Federal employment, part-time workers were laid off at a higher rate than full-time employees, and by 1984, the number of part-time workers had declined by roughly 2,000. In a 19[illegible] review of the Part-Time Career Act, GAO found that most agencies were not conforming to its requirements.[76]

[74]Statement in *Hearing on H.R. 4599, Federal Pay Equity Act of 1984*, op. cit., p. 248.

[75]William G. Whittaker, *Federal Legislative Interest in Alternative Patterns of Work: An Overview*, U.S. Congress, Library of Congress, Congressional Research Service, Mar. 31, 1980.

[76]U.S. General Accounting Office, *Part-Time Employment in the Federal Government*, July 12, 1982.

OPM is now again encouraging part-time and temporary employment on the grounds that it is cost-effective.[77] If office automation allows the work force to be reduced and kept lean, part-time and temporary workers are likely to be used to augment permanent staff when there is a short-term increase in the workload; thus temporary and part-time Federal employment is likely to increase as a long-term trend. Since the objective of part-time work is from an employer's perspective to allow rapid, flexible adaptation to changes in workload, the number of part-time workers will fluctuate widely.[78]

Women in the Federal Work Force

Several bills now before Congress deal with questions of pay equity and comparable worth in the Federal civil service. Comparisons of job content and skill requirements will be made more complex as office automation changes the nature of the work. While many clerical jobs have traditionally been considered "women's work," the degree of gender dominance differs significantly by grade level. (See figure 9-5.) In the occupational category of General Administrative, Clerical, and Office Services, women predominate at grade levels 1 through 9, and men at grade levels 10 through 15. In grades 2 through 6 the percentage of workers who are female varies from 78 to 90 percent.[79] In grades 7 through 9, the proportion of women ranges from 71 down to 61 percent, and at levels 10 through 15 the proportion decreases with each level, from 41 to 10.3 percent. Thus, while office services jobs are thought of as a group as "women's jobs," their grade level distribution is not much different from their distribution in the Federal work force as a whole for women. About 62 percent of female Federal employees are in grades 1 through 6, as compared to 20 percent of male employees. Only 10 percent of female Federal workers are in grades 14 and 15. As a result of their concentration in lower level jobs, women (who hold 46 percent of Federal General Schedule jobs) have an average salary that is 62 percent of men's average.[80]

It is estimated that three-quarters of the lowest ranking Federal jobs (by grade level) are predominantly women's jobs.[81] Since office automation is most likely to bring about reductions in lower level Federal jobs, women workers are those most likely to be made redundant. This could lead to a statistical improvement in the position of women in the Federal work force, as a group, since their average grade level should rise as a result. This statistical "improvement" should not obscure the fact that the job losses will be disproportionately suffered by women.

Quality of Worklife

Again, the case study of office automation in New York City[82] offers some possible indicators of present and future effects on a civil service work force. In automated municipal departments, new tasks were learned that cut across traditional occupational definitions, but there was little or no evidence of job upgrading in clerical and technical (paraprofessional) positions. Neither old or new job ladders provide a ready path for these workers to move up in the hierarchy of jobs, and some rungs of the job ladder have been removed by automation of intermediate tasks and responsibilities. In some jobs, abstract and conceptual knowledge is becoming more important than traditional skills, but this change has not been accompanied by an increase in pay scales. This

[77] Since January 1985 agencies have been allowed to keep temporary workers for up to 4 years; the previous limitation was 1 year.

[78] See ch. 2 for a general discussion of part-time and temporary work as related to office automation.

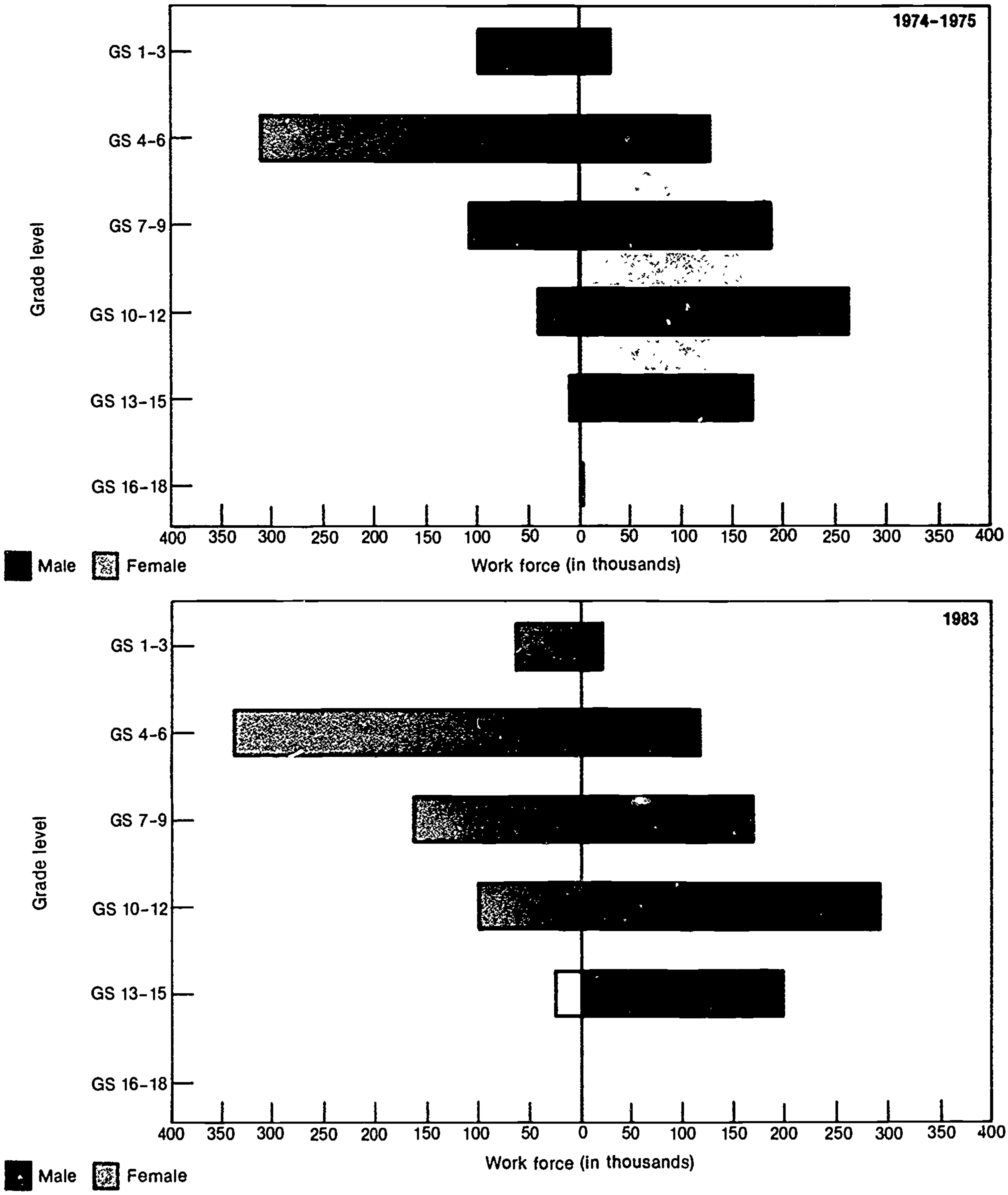
[79] Grade 1, which is held by fewer than 150 workers (many of them messengers) is only 66 percent female.

[80] In the Federal Wages Schedule (blue-collar workers) women are only 9 percent of the total, and their average wages are 79 percent of men's average. Among all FWS and GS workers (83 percent of all Federal workers) women are 38 percent of all employees and their average salary/wages are 68 percent of men's average. U.S. General Accounting Office, *Options for Conducting a Pay Equity Study of Federal Pay and Classification Systems,* GAO/GGD-85-37, Mar. 1, 1985.

[81] Statement of the Honorable Michael D. Barnes of Maryland, *Hearings on H.R. 4599, Federal Pay Equity Act of 1984,* before the Subcommittee on Compensation and Employee Benefits of the House Committee on the Post Office and Civil Service, 98th Cong., 2d sess., pt. I, Apr. 3-4, 1984.

[82] Greenbaum, Pullman, and Syzmanski, op. cit., ch. 1.

Figure 9-5.—Full-Time White-Collar Employment in the Federal Work Force by Grade Level and Sex, 1974-75 and 1983



SOURCES 1974-75. U.S. Civil Service Commission, *Federal Civilian Manpower Statistics Occupations of Federal White-Collar Workers,* Oct 31, 1974 and 1975, SM 56-11, Washington, DC, 1975. 1983. U S. Office of Personnel Management, *Federal Civilian Workforce Statistics Occupations of Federal White-Collar and Blue-Collar Workers,* Oct. 31, 1983, MW 56-18, Washington, DC, 1983.

is becoming a union issue and a political issue in the city.

The observations made on quality of work-life and the automated office environment in chapter 5 generally apply to the Federal office as well as to the private sector. Physical conditions are probably not as good in public sector offices as in many private sector offices. Turnover of facilities and office furniture is probably slower so that new technology is even more likely to be inserted into old settings. Furniture, lighting, and space layout is often inappropriate for microelectronic equipment now in use.

One issue likely to be controversial is the use of computer monitoring and pacing of work.[83] Federal labor law holds that applying work measurements and using these to evaluate employees are management prerogatives and need not be negotiated with unions representing Federal employees.[84] However, agency management can if they so choose bring the unions into discussion of work standards and measurement. Unions have attempted to raise the monitoring issue at some agencies but these attempts have been rebuffed as "non-negotiable" under the management rights clause. Arbitration rulings have upheld agency management when work monitoring was challenged, for example, in the Social Security Administration.

[83]See ch. 5, for a general discussion of computer monitoring of work.

[84]Civil Service Reform Act of 1978, Code of Federal Regulations, title V, sec. 7106 (a) (A) and (a) (B), "Management Rights."

The discussion in this section on work monitoring, where not otherwise cited, is drawn from an OTA contractor report, prepared by the Educational Fund for Individual Rights, Alan Westin, principal investigator, February 1985. The report is based on site visits and interviews in seven Federal agencies between 1982 and 1984, supplemented by a letter of inquiry to 78 Federal agencies, bureaus, and departments in September 1984 to which 44 agencies responded with letters and accompanying documentation. Follow-up telephone interviews were held with 12 agencies that reported significant activity related to work monitoring.

Labor Management Relations and Federal Unions

In the civil service, managers have less control over subordinates than in the private sector, because of civil service rules and protection. Managers themselves are subject to many of the same rules, regulations, and restrictions on wages and on bargaining as are their subordinates. Many Federal managers and professionals belong to professional associations that serve much the same functions as unions;[85] for Federal employees, this means lobbying Congress rather than bargaining for pay and benefits, since these are set by legislative action.[86]

Federal unions will not be able to mount effective resistance to reductions in employment as these become possible, but they may be expected to monitor changes in job content, job classifications, and compensation as a result of office automation. The position that the largest unions have taken and will take on such issues as stress, risks to health from CRT use,[87]

[85]These include the Federal Management Association, the Professional Management Association, and the Senior Executive Association (the latter open only to those in grades 16-18 and the Senior Executive Service).

[86]Until 1961, membership in unions by Federal workers was not recognized officially, and there was no provision for collective bargaining. However, about 13 percent of nonpostal workers and a much higher percent of postal and blue-collar workers had already joined. Between 1963 and 1969 the membership more than quadrupled, from 180,000 to 843,000. President Kennedy affirmed the right to join unions and a very limited right to collective bargaining in 1962 in Executive Order 10988, and the area for collective bargaining was slightly enlarged by the Civil Service Reform Act of 1978. But Federal unions are still generally precluded from bargaining about wages and fringe benefits, hiring, firing, work assignment, disciplinary actions, and contracting out. Levitan and Noden, op. cit.

Federal employees do not have a right to strike, and may be dismissed and subjected to felony charges if they do strike. The Supreme Court has upheld this ruling, saying that the employees' rights under the First Amendment and other Constitutional provisions must be balanced against the right of government to regulate the behavior and speech of its employees. The dismissal of the air controllers when they struck illegally is likely to discourage other strikes for some time. William B. Gould, *A Primer on American Labor Law* (Cambridge: MIT Press, 1982), p. 171.

Thirty-nine States have some form of legislation protecting the right of public employees to organize and bargain collectively. See William B. Gould, op. cit.

[87]Federal employees are not covered by the Occupational Safety and Health Act but agency heads are responsible for maintaining standards consistent with the act (Executive Or-

or access to training, will be important. Federal unions have already adopted guidelines or model contract provisions on VDTs, which they distribute to bargaining committees for use in agency negotiations. Their activism may increase in the future.

Federal white-collar workers are more likely to be represented by a union than are those in the private sector. About 54 percent of GS workers are covered, although only about one-third of those are dues-paying members.[88] In the national labor force, only 8.5 million white-collar workers, about 17 percent of the total, are members of unions.[89]

Those covered by Federal unions are predominantly women and predominantly in clerical categories. Although figures are not available, it is likely that Federal unions have had a net loss of members in the last several years.

International Comparisons

The International Labour Organization (ILO) says that in developed and developing countries' public sector employment:

> In respect of information processing, it is most likely that the over-all impact of computerization lies not so much in the threat of redundancies, but in future limits on growth in clerical and related employment.[90]

der 12196, Feb. 26, 1980); and Federal employees have the right to compensation for disability, death, or injuries sustained in performance of their work (Federal Employees Compensation Act, 5 USC sec. 8101 et seq.).

[88]About 61 percent of the Federal work force is represented by unions, but this includes 86 percent of Federal blue-collar workers. Dues paying membership is harder to determine; unions are not required to make these figures public. See Sar A. Levitan and Alexandra B. Noden, *Working for the Sovereign: Employee Relations in the Federal Government* (Baltimore: The Johns Hopkins University Press, 1983), pp. 15-20. Federal white-collar workers are chiefly represented by the American Federation of Government Employees (34 percent of those who are covered by union bargaining), the National Association of Government Employees (4 percent), the National Federation of Federal Employees (7 percent), and the National Treasury Employees Union (5 percent). The first two of these are part of the AFL-CIO; the other two are independent.

[89]Henry Levin, "Jobs: A Changing Workforce," *Chance*, vol. 16, October 1984, pp. 32-37.

[90]International Labour Organization, *The Effects of Structural Changes and Technological Progress on Employment in the Public Service*, Report III, Joint Committee on the Public Service, 3d sess. (Geneva: International Labour Organization, 1983), p. 30.

The ILO notes that this will have its most serious effects "on the prospects of women seeking to return to the work force and on school leavers."

Nearly all governments are trying to improve efficiency and hold down costs, the ILO notes, citing evidence that many advanced countries have made cuts in their public work force as a result of information technologies. For example, Canada had a net reduction of 12 percent in employment in government secretarial positions from 1975-80. Within that general category, the number of typists declined by 35 percent and the number of stenographers by 68 percent, while secretaries increased by 17 percent and operators of office-composing equipment increased by 97 percent.[91]

Evidence of employment effects in centrally planned developed nations are, according to ILO, unreported or ambiguous. In developing countries, wherever statistics are available, they often show a shortage of qualified computer personnel.[92]

A technology forecast done for the Federal Republic of Germany by a consulting firm suggested that if the government adopted a strategy of maximum use of information technology, 75 percent of all public sector office jobs could be standardized, and 38 percent automated.[93] The ILO recognizes, however, that "owing to cost, lack of planning, a desire to maintain existing work arrangements, or simply bureaucratic inertia such comprehensive plans will materialize only slowly," and a more likely scenario for most countries is the gradual introduction of components and systems that can later be linked, as the need arises.[94]

Rapid development of telecommunications technology has affected postal workers in many countries, although employment levels have not fallen dramatically. Rather, they have shown slower growth rates in recent years, and

[91]Ibid.

[92]ILO, op. cit., p. 28.

[93]J. Sleigh, et al., *The Manpower Implications of Microelectronic Technology* (London. Her Majesty's Stationery Office, 1979), pp. 77-79, cited in ILO, op. cit.

[94]ILO, op cit., p. 17.

in some countries staff reductions or hiring freezes occurred despite increases in the volume of mail traffic. As to the future, some governments expect reductions in postal, telegraph, and telephone occupations (which in most countries are all public service jobs) and some do nc+.[95]

[95]ILO, op. cit., p. 42.

EFFECTS OF OFFICE AUTOMATION ON PUBLIC SERVICES

Productivity increases do not necessarily lead to a reduction in labor force numbers or costs. Complementary or alternative objectives may be to increase the volume of products or services delivered, or to improve their quality. Or, increased productivity may merely mean coping with, instead of being overwhelmed by, an increasing workload.

Because our economy increasingly depends on information as a resource and a driver of growth, the office workload is inexorably increasing. The primary objective in office automation is sometimes merely to accommodate this increased workload.[96] One final meaning of increased productivity is the creation of entirely new information-related services for customers, clients, or constituents.

There has been rapid change in the global economy, and America's role in that economy, since the 1960s. There have also been significant changes—particularly during the 1970s—in the expectations that our citizens have about involvement in Federal decisionmaking, and the demands that they make on government agencies related to information about public resources and public expenditures. In allowing Federal agencies to meet these demands and to accommodate the increased workload, office automation quite possibly helped to avoid serious problems and disruptions that could have weakened the U.S. position of world leadership.

Many managers and professionals report that the quality of analysis, reports, and other forms of decision-related services is improved by office automation, which allows large databases to be collected, manipulated, analyzed, modeled, and systematically applied to policy formulation and decisionmaking. This improvement is more difficult to document and measure than other forms of increased productivity.

[96]Alan Porter, David Roessner, et al., Office Automation Outlook, 1985-2000, contractor report for OTA, February 1985.

It is also possible, however, that office automation may lead to a change in the nature of some government services and even to their deterioration. For example, services could become overly depersonalized and standardized, inflexible, and unresponsive to changing needs, if the technology itself is allowed to drive the design of the service or delivery mechanisms.

A Case Study of Expanding Responsibilities

The history of office automation in the Office of the U.S. Trade Representative is one illustration of office automation providing the means of meeting new challenges and avoiding disruptive overload in carrying out new government responsibilities.[97]

The Trade Act of 1974, authorizing U.S. participation in a new round of multilateral trade negotiations, elevated to cabinet status the position of Special Trade Representative and assigned that officer responsibility for representing the United States in the negotiations, and administration of the Trade Agreements Program under that and other existing acts.

[97]This section is drawn from an OTA contractor report, William Neufeld, *Office Automation in the Office of the U.S. Trade Representative*, February 1985. OTA is indebted to the Office of the U.S. Trade Representative for cooperation in allowing this study to be made and in facilitating the research by the contractor. The case study is also summarized in app. B.

The Office of the Special Trade Representative, which until 1972 had only about 30 employees, had grown to about 126 employees by 1980, when it became the Office of the U.S. Trade Representative. In 1980 it was assigned overall responsibility for formulating and coordinating foreign trade policy among all government agencies, representing the United States in all trade negotiations regarding the General Agreement on Tariffs and Trade (GATT), East-West trade, international investment, commodity agreements, the Organization for Economic Cooperation and Development, and the UN Conference on Trade and Development.[98] These developments reflected the growing importance of world trade in the U.S. economy.

During the 1960s, the small agency had needed more and more data to use in developing positions for multinational negotiations. There was no central database on trade volumes, tariff rates, exports and imports, etc. Data was kept or reported by many different agencies, in different forms, and categories. The Washington headquarters and the Geneva negotiating office relied on different sets of data collected from different sources, which made policy coordination difficult.

Planning to build a computerized trade database began in the late 1960s, but not until 1977 did an integrated database begin to function, serving many agencies and lodged for administrative purposes in a large computer system at the National Institutes of Health.[99] The development of the interagency trade database helped pave the way for office automation within USTR. It did not come about piecemeal but was systematically planned and implemented over a 5- or 6-year period, to mesh with the large computer system. It has so far cost only about $2 million (including about $1 million investment in hardware).

[98]The President in 1984 proposed to Congress the creation of a Department of International Trade and Industry, with USTR under the direct control of the Secretary of that Department.

[99]Renamed the Trade Policy Staff Committee Trade Net in 1984, the system provides a number of member agencies with data directly available through dial-out computer terminals.

Through a combination of central computer operations, personal computers, and standalone and shared-logic terminals the USTR staff now has the capabilities of word processing, spreadsheet analysis, on-line data management, graphics, correspondence control, internal electronic mail, telemail, facsimile, and telex. Users can access the general database, and also a "magazine" containing USTR schedules, recent trade and labor summaries, and economic news. They can call up trade data on bilateral trade balances, imports and exports, domestic and foreign trade actions, and GATT documents. They can communicate through their terminals with the members and staff of the Trade Policy Staff Committee (the nine agency committee that provides analyses and recommendations to the senior level Trade Policy Committee) and of its subcommittees, and can electronically transmit documents to them. They can communicate by telemail with the Geneva office, USTR ambassadors, and staff members on travel, and can use this method of transferring documents between Geneva and Washington. Hard copy original documents can also be facsimiled.

In interviews, nearly all professionals on the USTR staff and half of senior managers said that they use terminals extensively, for up to 75 percent of their working hours. Professionals who were interviewed say that they can complete a project in half the time it would take without their computers. They also reported that the increased productivity had allowed them to clear a backlog of work that always built up in the past. Senior staff reported that they could ask for work on shorter deadlines. Some members of the professional staff reported that because of electronic communication and transmission of documents, the time required for review and clearance of trade-policy positions has in many cases been cut in half.

At least in the perception of many professional staff members, the USTR has been able to take on a continually expanding workload, and maintain or improve the quality and pace of performance at the same time, because of information and communication technologies.

The staff has grown little if any during the 5 years in which office automation was implemented.[100]

Changes in the Nature of Delivered Services

Standardization and depersonalization of government services is a possible outcome of office automation. In the OTA case study of municipal agencies in New York City,[101] referred to earlier, an agency providing social services to disadvantaged clients reorganized the application and recordkeeping process so as to use standardized coded forms. When inaccurate or incomplete information is fed into the computers it can not be detected until late stages of the process, at which time the case has to be put on hold. Case workers say that some clients do not understand computerized forms and throw them away; others are intimidated by them and throw them away. Many of the municipal employees say that the quality of the services they deliver has been degraded.

The Federal Government also delivers some services directly to individuals and households; for example, social security checks. With office automation some element of personal attention to the difficulties or foibles of recipients may be lost. The less educated or sophisticated, and those with language limitations, are more likely to be unable to cope with formal, unfamiliar processes. Thus, as the delivery of government services is automated, special procedures may be needed to assure that the access that some people have to services, or the attention paid to their needs, is not inadvertently degraded.

[100]In 1980 after reorganization and expansion of responsibilities, the Office had 116 permanent full-time staff plus 10 Assistant U.S. Trade Representatives, or approximately 126 people. In 1984, it has 122 permanent staff members. But USTR has always used detailees from other agencies, and some consultants and part-time people. When this case study was done in 1984, the inclusion of such people brought the number of people working at USTR to 183; the number of such people on hand in 1980 could not be determined.

[101]This material is drawn from an OTA contractor report, *The Effects of Office Automation on the Public Sector Workforce—A Case Study*, prepared by the Labor Institute (Professor Joan Greenbaum, principal investigator), February 1985.

EFFECTS ON GOVERNANCE

Bureaucracy—a hierarchy of authority, specialization of functions, and formal channels of communication and command—is the basic structure of government as it is of all complex formal organizations. Bureaucracy is a valuable form of organization because it allows expertise to be harnessed, focused, and directed toward collective ends.

Bureaucracies serve both despotic and democratic societies. In a highly technologized society, it can be argued that democracy can exist only because bureaucracy provides a way of using experts without being ruled by experts. Policy can be made by political representatives, and implemented by the hierarchy of specialists under their control and oversight.

But as bureaucracy becomes larger and more complex, the specialization of functions at the lower ranks can become extreme—"rationalization" of tasks makes the work routine, monotonous, and finally mindless. The managers may spend increasing amounts of time correcting and coordinating, and little time doing anything productive. Some political theorists argue that in the electronic era, elaborate bureaucracies may be unnecessary. Information and communication technologies may offer a way to replace overly large and complex bureaucratic structures with more autonomous units assuming responsibility for an entire job.

This prescription would be hard to implement in government without some sacrifice of accountability. Those who want to transform bureaucracies into "democratic work groups" tend to see formal channels of communication and control as a byproduct of specialization of functions, or to imply that they are antithetical to participatory democracy. But formal communication channels are also a mechanism for achieving accountability, including accountability of bureaucrats to politically responsible policy makers. Within government, for example, communication typically moves through a series of nodes of authority.[102] The flow of information also involves in many cases a flow of authority. The presence of an authorizing signature on or with the information may give it force—that is, cause something to happen. It may create or make binding the acknowledgment of an obligation. At least it acknowledges the receipt of the information. The signature, in other words, expresses a personal responsibility or validation of the information or some action associated with or flowing from it. Finding a fully adequate electronic substitute for the handwritten signature, as an easily recognizable and widely accepted validation for the origin and receipt of messages, is only one aspect of the problem and probably a minor one.[103] Electronic sign off may merely replace the buckslip and the paper-based signature of authority and accountability.

But a signature is only one example of the set of procedures that in a government bureaucracy are designed to control and standardize behavior. The procedures usually include the designation of particular, formal channels of communication through which information (and authority) must flow. The flow is limited to these designated channels not only for the sake of efficiency and control, but to make it auditable in the future. These procedures not only guarantee control, for those at the top of the bureaucracy, but they also protect the general public; they are the means of making power lawful, of limiting its exercise within agreed on boundaries. Some political scientists fear that reliance on telecommunications both within and between organizations (e.g., electronic mail) makes it difficult to control or to monitor the flow of information and blurs the location of both authority and responsibility. For example, changes in a database may be made without an authorizing signature, or instructions may be transmitted to contractors by persons without adequate authority for fiscal commitments.

Thus, bureaucratic procedures, including formal channels of communication, are integral parts of the concepts of due process and accountability. But to the extent that information and communication technologies offer new opportunities—and perhaps new temptations —to ignore, evade, and erode those established channels, care must be taken that they do not diminish the accountability of government officials. The rules and established channels could persist, ossify, but be ignored.

The principle of accountability, carried to extremes, leads to inscribed, detailed, and inflexible rules for every process and procedure. Information technology may provide a healthy corrective, making information so generally available that bureaucratic authority is constantly challenged in a productive, rather than a disruptive, way. But when information is electronic rather than paper-based, it propagates more rapidly, is less closely identified with its source, is both more accessible and at the same time more opaque to the casual seeker. It may tend to be used less responsibly. The public could find itself less able than before to identify and hold responsible the propagator, or the user, of information.

On the other hand, as information becomes the subject of formal resources management, it is also possible for its use to become so encumbered with safeguards and procedures that access to it is reduced for both the public and the experts. None of these untoward consequences is inevitable. But the pervasiveness of new information technologies does mean that government information-handling is likely to change in unanticipated ways.

[102]The discussion here draws heavily on Ronald M. Lee. "Automating Red Tape: The Performative vs. Informative Roles of Bureaucratic Documents," *Office: Technology and People*, vol. 2 (The Netherlands: Elsevier Science Publishers B.V., 1984), pp. 187-204.

[103]Many organizations rely on the use of a combination of identification numbers or names and passwords to substitute for a signature. A few are developing techniques based on the concept of public key encryption, a mathematical technique developed in 1977 at the Massachusetts Institute of Technology (*EMMS*, vol. 9, No. 13, July 1, 1985). Many people deny the need for electronic signatures, on a practical basis, saying that messages sent by computer are no different from messages sent by telephone or telegraph.

Over a decade ago Kenneth Laudon pointed out[104] that information about a government organization affects that organization in four ways:

- it affects the organization's reputation with the public, with its primary constituents, and with its employees (and, although not mentioned by Laudon, with those who oversee the organization in Congress);
- it affects the organization's autonomy—the more public information there is about the organization's inner workings, the less independent the role it can play in formulating policy;
- the loss of full control over internal information tends to make an organization defensive and may lessen its own propensity to self-evaluation; and
- increased public information constrains the informal accommodations an organization can make with influential actors in its environment (congressional critics, interest groups, other agencies, etc.).

In short, when the flow of information within and from an organization becomes less controllable, the organization tends to react in ways that are sometimes desirable, from the standpoint of democratic responsiveness, and sometimes not desirable. It cannot be assumed a priori that information technology makes information management more efficient, from the viewpoint of organization managers; nor can the relationship between information management and effective performance of an agency's mission be fully anticipated.

Another major concern is the way in which information technology may be used either to increase government's collection and use of information about individual citizens, or to increase citizens' access to information about government. Abuse of the capability to collect, aggregate, and use information about citizens, to violate the citizen's privacy, or to make the citizen more visible to government and more susceptible to its control, has been a pervasive concern. These issues are being addressed in another OTA report, an assessment of government information systems.[105]

Many enthusiasts for information technology anticipate that it will greatly increase citizens' ability to know what government is doing and how, and to use that information to evaluate, influence, and participate in public decisionmaking. Four kinds of information about government are of primary interest to citizens, especially to citizens actively attempting to monitor or to participate in public decisions:[106]

- information about decisionmaking, policies, and practices internal to an agency—budgeting and programming priorities, planning, key appointments and assignments, the locus of authority for specific actions and decisions, the actions of specific officials, etc.;
- evaluations, reviews, status reports, and other policy-relevant information from actors external to the agency, such as administration officials, congressional oversight committees, etc.;
- intermediate and final outcomes of specific cases and decisions, especially individual client problems such as social security eligibility or income tax appeals, and other personal data; and
- information about the costs of agency decisions and actions to citizens—paperwork burden, personal records disclosure, inequities in application of regulations, etc.

Citizen access to the first two kinds of information has been widened by the Freedom of Information Act and other laws. Particularly when organized into public interest groups, citizens are generally able to obtain

[104] Kenneth Laudon, *Computers and Bureaucratic Reform* (New York: John Wiley & Sons, 1974).

[105] *Government Information Systems*, forthcoming from OTA's Communication and Information Technologies Program later in 1985.

[106] This analysis draws on that of Donald A. Marchand and Mark E. Tompkins of the University of South Carolina, presented before the panel on Information Control Policy at the Annual Conference of the American Society for Public Administration, Phoenix, AZ, 1974, and later published as "Information Management and Use in Public Organizations: Some Impacts on Citizen Participation," *State and Local Government Review*, September 1981, p. 103.

such information readily. Information technologies make it easier and less costly for an agency to supply such information when demanded by citizens. Some agencies are giving citizens direct access to such data through information systems.

The citizen has much less access to information about the status or progress of his or her individual dealings with government agencies as a client; for example, in appealing income tax decisions. Here the individual is dependent on the agency to give up information, and has no means, technological or otherwise, to access it directly. But the agency can use information technology to collect, or at least to aggregate, process, use, and disseminate information about the client. In this case, "the client's information-processing relationship with the public agency is likely to be one-sided. . . . the client must reveal information about himself to get services from the public organization."[107]

The thrust of this argument is that information technology improves the agency's ability to get or use information about the citizen as client, but does not improve the client's ability to know about the progress or outcome of his or her own case as it is handled by an agency. But even the first kind of benefit cannot always be assumed; that is, that agencies will have better data about clients. As already noted, New York City social services workers reported that many of their clients ignored, failed to understand, or were intimidated by standardized forms, and also that erroneous information fed into the automated system could not be caught and corrected until late in the process.[108] In this case, information technology may have degraded the client information going to the agency, without improving the citizen/client's control over it or access to it.

The fourth kind of information, about the direct and indirect costs of government action to the public, is diffuse and hard to make specific. Citizens have difficulty in figuring out exactly what a change in policy or procedures would cost them in taxes, additional paperwork, narrowing of options, or political power. The same is true in many cases for those who would benefit from government action. Thus, "the poor," the "disadvantaged," or the "small businessman" who are targets of government programs, may not even know that they are or would be affected.

Information technology could be of help to both citizens and government agencies in making this kind of data available.[109] Office automation could improve the ability of agencies to target the recipients of their services through conducting surveys and analyses, improved special census counts, and collection and analysis of information about clients as a group. It can be designed to improve the handling of client correspondence and to allow customized response to inquiries. However, information technology can also be implemented in such a way that relationships between government and constituents are further standardized and dehumanized, or information delivered to constituents becomes so highly technical and jargon-laden as to become useless to those who are not highly educated or even to those who are not specialists in fields such as contract law, taxes, or health delivery. Mechanisms such as forms for requesting information from, or delivering information to, a citizen are often designed for the convenience of the computer, or data processor, rather than for clarity to the citizen.

This creates a real possibility that information technology, unless used with care and judgment, could further increase the disadvantages confronting those who are already educationally and economically disadvantaged. The effects of information technology on the delivery of government services, and more importantly, on the quality and equity of governance, must be carefully monitored so that corrections can be made if needed.

[107] Marchand and Tompkins, op. cit., p. 106.

[108] *The Effects of Office Automation on the Public Sector Workforce—A Case Study*, op. cit. (OTA contractor report).

[109] This is not the conclusion of the authors cited above, Marchand and Tompkins, who conclude on the contrary that information technology is of little direct help to either the agency or "the citizen as victim." They argue that because information technology and the ability to access and use it is not equally available to all, it has distributive effects on the ability of citizens to use information about government to monitor and influence policy; current information policy has regressive distributive effects—it benefits the well-to-do more than the disadvantaged.

Chapter 10

Office Automation in State and Local Governments

Contents

State Government Office Automation: [illegible]

The Extent of Automation [illegible]

Perspectives on the Effects of [illegible]
  The Effects of Local Government [illegible]

Examples of Office Automation in [illegible] and Local [illegible]
  The State of South Carolina [illegible]
  New York City [illegible]

Unanswered Questions About Information Technology and [illegible]

Figure

Figure No. | Page
10-1. An Example of a Statewide Integrated Communication [illegible] for South Carolina . . . . [illegible]

Chapter 10

Office Automation in State and Local Governments

There are 50 State and about 78,200 local government units[1] in the United States. To make general statements about their activities is always difficult; one of the benefits of a Federal system is that the diversity of their approaches to problem-solving provides a living laboratory for public policy formulation.

The workload in State and local government has increased more rapidly in recent decades than that of the Federal Government. Between the end of World War II and 1980, State and local government employment increased steadily to a high of 13.3 million. It has since slightly declined, as pressure for increased administrative efficiency and cost reduction has grown. As a percent of total public sector employment, State government employment increased from 16.5 percent in 1950 to 23 percent in 1979; local government's share grew from 50 to 59 percent.[2] Federal budget cuts and the phase out of Federal grant programs could bring about a massive transfer of administrative responsibility from central to State and local levels of government. This provides a further strong incentive for seeking greater efficiency.

These governments are automating their offices at different paces and following different strategies, and the consequences will be different for each governmental unit. Much of the information now available comes from the limited number of case studies of individual jurisdictions. Many of these case studies have a narrow perspective, being focused on public administration criteria of cost-effectiveness. Relatively little literature is available as yet dealing with effects of office automation on governance policy, or political responsiveness.

[1]This includes about 3,000 counties, 19,000 municipalities, 17,000 townships, 15,000 school districts, and 26,000 special districts (when they are fiscally and administratively separate from other governmental units). At the beginning of World War II there were about 156,000 local government units, or 49 percent more. The big reduction was the elimination of over 93,000 school districts during the 1950s and 1960s, by consolidations.

[2]U.S. Department of Commerce, Bureau of the Census, *Public Employment in 1983,* GE83-No. 1.

STATE GOVERNMENT OFFICE AUTOMATION PLANNING AND PROCUREMENT

Some State governments have gone much further than others in computerizing their offices. Tax and finance operations, personnel records, and routine recordkeeping are however thoroughly automated in almost all States. It is common for a number of State agencies to share a data processing center, but there are usually several or many processing centers within a State government. In planning, procurement, management, and degree of control over information processing there is wide diversity. Some State governments have realized that computers represent the possibility of a fundamental change in the way public affairs are administered, and have established long-range plans and strategies for effective use of the technology. Other States have not gotten beyond treating office automation as merely the latest marginal improvement in office equipment. Some have let office automation happen to them, unplanned and incrementally, and are now struggling to rationalize these changes.

This is reflected in procurement strategies. Some States have governmentwide master plans for investment in information technologies while some expect planning to be done on an agency-by-agency basis as part of the budgetary process. Many States, after some floundering, have developed procurement controls and standards for large computer systems, only to be taken by surprise by the infiltration of small computers and word processors, which generally fall below the threshold cost that requires centralized procurement approval.

Minnesota, for example, has highly centralized planning and control of information systems, while in New York State the responsibility is almost completely decentralized. Other States fall along the continuum between these poles.[3] Most States do, however, have some central office or division that coordinates information-technology procurement, if not long-range planning. This office is usually within a department of administration or general services, or in the department of finance. Some States, however, give the responsibility for such coordination to a special commission. For example, in Florida, the Information Resources Commission, made up of the Governor and six major State officials, reviews agency information-technology plans. In Texas, the Automated Information Systems Advisory Panel, with a similar role, has both public and private sector members.

State and local governments are regarded as the largest single market for the microcomputer industry in the next few years.[4] During the early period of acquisition of government computer systems, States were concerned over their ability to maintain their control over public purchasing (especially physical specifications, terms, and conditions of price competition) because of the powerful market positions of a few firms. In this large but disaggregated and dispersed market, it was difficult for State governments to make effective demands regarding physical specifications of systems or to specify the terms and conditions under which they would do business with computer system vendors. The Council of State Governments warned in a 1975 report that:

> There are factors at work which defeat certain long-standing principles of public purchasing. . . . The effects of oligopoly are multiplying.[5]

This led the American Bar Association to develop a Model Procurement Code for State and Local Governments, which was published in 1979. Many States have since developed their own standard contracts and agreements. As State officials have become more knowledgeable and experienced with computer technology the problem has eased.

But more recently, stand-alone word processors and personal computers (PCs) have introduced a new element of uncertainty, since their cost is low enough that their purchase may not require centralized approval. It is common for State agencies and local governments to find that equipment from several different vendors have found their way into government offices with no central plan for—or even inventory of—their spread. For example, one State government report acknowledges that "thousands" of PCs have found their way into large organizations by the 'end-user end-around,' that is, users avoiding bureaucratic purchasing procedures by buying their PCs below required dollar review levels."[6]

At the State level as in large corporations, microcomputers and stand-alone word processors are almost always superimposed on an existing pattern of centralized computing. A

[3]Many of the examples in this section are taken from an OTA contractor report, *A Comparative Review of Information Technology Management Practices in State Government*, prepared by the Institute of Information Management, Technology, and Policy of the University of South Carolina, John C. Kresslein, research analyst, December 1984.

[4]J. Robert Ippolito (Director, Division of Electronic Data Processing, Florida Department of General Services), "Computer Technology Procurement: Can It Be Standardized for State and Local Governments?" *State and Local Government Review*, vol. 13, No. 3, September 1981, p. 85.

[5]The Council of State Governments, *State and Local Government Purchasing*, Lexington, Kentucky, 1975, p. 7.

[6]State of South Carolina, Division of Information Resource Management, *Personal Computers in State Government*, May 1984, p. 2.

report on personal computers in the government of South Carolina notes that this has caused a rethinking of management strategy:

> In 1979, when the Division of Information Resources Management began its original office automation efforts, the PC was not a viable end-user device for integration into the State's office system model. . . . However, we now see the computing landscape changing to a three level model in which: Level 1 is the corporate mainframe node; Level 2 is the departmental (mini)computer node; and Level 3 is the personal computer node. *These levels more closely match the organizational hierarchy.* At the time of this writing (1984) DIRM has begun efforts to provide management direction and support for the PC and is developing strategies to integrate the PC into its overall State Plan on Technology. (Emphasis added.)[7]

This State government anticipates, according to the report, that by the end of the decade there may be one PC for every State government office worker.

[7]Ibid See the case study on South Carolina government use of computers later in this chapter.

State office automation is not limited to computers in the State House or capital city; increasingly, it is including sophisticated systems to provide an interactive network between dispersed nodes of government services. At least two States, California and South Carolina, are planning digital "backbone" networks to link together centers of government activity around the State. Alaska has an audioconferencing network connecting 70 sites across the State and 17 full-time information offices that are also networked. Michigan has a distributed network throughout the capital complex, with a terminal in every senator's and representative's office.

State legislatures, as well as administrators, are using computers. Most States have electronic data processing systems for statute search and retrieval and reporting on the status of bills before the legislature.[8]

[8]Linda Schulte, "A Survey of Computerized Legislative Information Systems," *Law Library Journal*, vol. 72, winter 1979, pp. 99-129.

THE EXTENT OF AUTOMATION IN LOCAL GOVERNMENTS

By the mid-1970s most large counties and municipalities were also using computer systems for high-volume data processing.[9] By 1980 these governments had an average of 31 operating applications and as many as 30 under development, and were spending an average of $500,000 yearly for automated data processing. The systems tended to be used first and most pervasively for departments of finance. Recordkeeping and printing were other widely sought applications.[10] More recently, however, a large number of sophisticated applications have been developed for use by local governments, both in the processing of data for routine operations and in the analysis of information for broader purposes of management and planning.[11]

Larger governments usually bought or leased equipment and developed in-house technical staffs, often developing their own software. Others depended on contractual agreements for specific computer applications with a com-

[9]James N. Danziger, "The Use of Automated Information in Local Government," *American Behavioral Scientist*, vol. 22, No. 3, January-February 1979, pp. 363-392. A survey by the Urban Information Systems Research Group of the Public Policy Research Organization indicated that more than 90 percent of cities with populations of 50,000 and larger, and 90 percent of counties of over 100,000 people had computer systems, while less than half of those smaller had them. Kenneth L. Kraemer, William H. Dutton, and Alana Northrop, *The Management of Information Systems* (New York: Columbia University Press, 1981), p. 8.

[10]Robert E. Sellers, "Mini- and Microcomputers in Local Government. Their Application and Their Impact," *State and Local Government Review*, September 1981, p. 91.

[11]John Leslie King and Kenneth L. Kraemer, "Information Systems and Intergovernmental Relations," *Public Sector Performance. A Conceptual Turning Point*, Trudi C. Miller (ed.) (Baltimore. The Johns Hopkins University Press, 1984), pp. 102-130.

puter services/time-sharing company. In a few cases local governments acquired computer systems but hired a facility management concern to operate them, or two local governments (e.g., a city or county and a school system) developed a jointly owned and operated computer center.[12]

End-use computing is now spreading in the government agencies of large cities.[13] Public Technology, Inc., surveyed its member cities and counties with a population over 400,000 in 1983 and found that among the 50 respondents, 75 percent had microcomputers. By then, 93 percent had one or more minicomputers, and over half had mainframes. A similar survey in 1984 indicated that 77 percent of 84 cities responding (80 percent response) had microcomputers, and 87 percent planned to have them by 1984.[14] There are already hundreds of local government applications programs available for microcomputers.

But despite the low cost of small computers, most small local governments have not yet begun to use them. A survey in 1983 of 162 local governments within the State of South Carolina found that 81 percent were using computers of some kind, but this usually represented centralized computing, or large-volume data processing. While 3 of the 6 large cities were using microcomputers, only 3 of 27 counties, 1 of 12 medium size cities, and 6 of 53 small cities had acquired them.[15]

The International City Managers Association (ICMA) surveyed 5,808 cities of all sizes in 1982, and found that only 13.2 percent of them were using microcomputers, although about one-third planned to buy one or more during the next 2 years.[16] Most of those that had computers were using them for word processing and financial management.

Of the more than 19,000 U.S. municipalities, over three-quarters have populations of less than 6,000. These small towns or villages usually provide the same basic services as larger cities—utilities, fire and police protection, recreation, taxing functions, usually school systems, and often planning departments. In addition, they have many responsibilities under Federal programs, such as administering revenue sharing and block grants.[17] They too are trying to cut costs and increase productivity. In spite of this obvious need it appears that small local units, especially those in rural areas, are not rushing to computerize their offices.[18]

However, it is possible that the purchase of microcomputers by small governments has accelerated in the last 2 years beyond expectations. As late as 1982, lack of familiarity with computers was probably the major factor impeding their purchase by small cities; until recently there were likely to be few computer vendors in small towns and this market was not being aggressively pursued. This may have changed considerably by 1985.

[12]Sellers, op. cit., p. 93.

[13]See Special Symposium on Microcomputers in Local Government, *A Public Administration Review*, vol. 44, No. 1, January-February 1944, especially James R. Grieseemer, "Microelectronics and Local Government. New Economies and New Opportunities," p. 57.

[14]"C-TAC Survey Reveals Members' Information-Handling Resources," *Public Technology*, vol. 5, No. 11, November 1983. The 1984 data was reported in Joey P. George, "Who Does the Buying?" *Government Data Systems*, August-September 1985.

[15]State of South Carolina, *The South Carolina Local Government Survey of the Use of Computer and Communications Technology*, prepared by the Institute of Information Management, Technology, and Policy, University of South Carolina, 1983.

[16]Donald F. Norris and Vincent J. Webb, *Microcomputers: Baseline Data Report* (Washington, DC: International City Managers Association, July 1983), as reported in Donald F. Norris, "Computers and Small Local Governments," *Public Administration Review*, vol. 44, No. 1, January-February 1984, pp. 70ff.

[17]Sellers. op. cit., p. 91.

[18]Another survey in 1982 looked at cities and counties in seven Mountain and Plains States. Of 75 cities with populations of 2,500 to 50,000, 68 percent were using computers; of 75 counties under 100,000, 36 percent. Smaller communities were less likely to have computers than larger ones—41 percent of those with 5,000 or fewer people compared to 76 percent of those with more than 10,000 people. Those with city managers were much more likely to have computers than those with mayor/council governments, and metropolitan counties were more likely than rural counties to use them. About one-third of those who were already using computers, but only 16 percent of the nonusers, planned to buy more in the next 2 years. Over three-quarters of those that were using computers had a minicomputer or "bookkeeping system" and only 22 percent had microcomputers (7 percent of all the cities surveyed). Most were using their computer system for payroll and accounting, budgeting, and utility bills. Ninety percent had only one computer, and only 1 percent had as many as four. Norris, op. cit., 1984.

PERSPECTIVES ON THE EFFECTS OF PUBLIC OFFICE AUTOMATION

Early commentaries on State and local government use of computers tended to be theoretical rather than empirical, and often took one of three basic perspectives:[19]

- Information technology will rationalize not only operating procedures but the political/policy process.
- Adoption of information technology will be driven partly by "the technological imperative" and partly by the self-seeking actions of a technical elite, uncontrolled by humane values and unresponsive to public attitudes.
- Information technology is no different from other technology and other kinds of information resources, and will have no unique or discernible effects on government.

The first of these perspectives tended to be found in public administration literature, while the second tended to come from political scientists, perhaps reflecting the different relative values that the two disciplines place on efficiency and responsiveness.

Enthusiasts often saw automation as a way of achieving the goals of the old reform movement, and claimed that technology would increase productivity, cut costs, improve decisionmaking, allow better management control of operations, improve job satisfaction, and allow streamlined governments to offer more and better services. Critics feared that it would lessen the responsiveness of bureaucrats to citizens, put a technological elite in charge of the local political process, shift power from elected representatives to hired managers, deskill jobs, and greatly increase the costs of government.

The Effects of Local Government Automation

Some local governments were indeed taken aback by the costs of office automation because they had not anticipated that the life-cycle costs of the equipment, with the support and training required, would so far exceed investment costs. The first phase of computerization, at least, may not have reduced labor costs but rather stimulated the hiring of clerks because it required input of massive amounts of data.[20] There were widespread expectations of a shortage of trained personnel in local government.[21]

Other effects were mixed but generally favorable. In some jurisdictions administrative control was improved, and workers reported increased job satisfaction. There are indications in many cities that office automation tends to reinforce, rather than change, existing patterns of bureaucratic and political power.[22] Some social scientists make this point more strongly, concluding that computerization of local government has benefited those who already have broad power and control in the local hierarchy. They usually argue that

[19]Danziger, op. cit.

[20]K.L. Kraemer, J.N. Danziger, and J.L. King, "Local Government and Information Technology in the United States," *Local Government and Information Technology*, Informatics Studies No. 12, OECD, Paris, 1978.

[21]J.L. King, "Local Government Use of Information Technology: The Next Decade," *Public Administration Review*, vol. 42, No. 1, January-February 1982, p. 31.

[22]For example, a study of 42 cities from 1975 to 1979 found evidence for improved administrative control and operating performance, especially where computers were used for routine tasks, for example, tax recordkeeping and traffic-ticket processing. In applications, such as support of police detectives' investigations or planning and policy analysis, the results were mixed or marginal, or the evidence was ambiguous. Effects on job satisfaction and the office work environment were said to be beneficial, the researchers said that this was often an unplanned, unanticipated benefit.

The same survey concluded that there was some evidence that office automation reinforced existing patterns of bureaucratic power rather than changing them. In most cases, a trend toward centralized, professionalized management in local government seemed to be strengthened as a result of automation. The perspective of the research group in this case was clearly that of public administrators who placed high value on rationalizing government activities. They found that the most successful implementations of automation were "always linked with" the most advanced and sophisticated technology and a highly professionalized work force; the sociotechnical approach, emphasizing "user-friendly" equipment, human relationships, and worker involvement in planning and decisionmaking, often worked best from the perspective of individuals, but at the cost of some sacrifice of efficiency. "Evaluation of Information Technology in Local Governments, 1975-1979," a survey by the urban information systems research group of the Public Policy Research Organization, reported in Kraemer, et al., op. cit., pp. 27ff.

there is a need for explicit democratization of government computer strategies.[23]

Local governments collect and use information for two broad categories of activity—management of routine government operations, and planning and analysis.[24] Most of the information systems and applications in use are for operational purposes—management of government revenues, payrolls, etc. But local governments must collect and use information for scores of activities; two middle-size cities, in 1980, identified over 300 distinct operational information systems (not all then computerized).[25] This operational data, in summarized or aggregated form, is also useful for planning and management, especially status reporting, performance analysis, and compliance analysis.

Computer programs and models have been developed for these purposes, including, for example, fiscal impact analysis, land use, transportation analysis, urban development planning, and expenditure forecasting models. Many of these are in the public domain and others are readily and inexpensively available; but relatively few governments have used them, and these are primarily the larger municipalities. It may be that most local government organizations do not yet have the expertise required to use these tools, but it may also be that modeling does not fit the informal, pragmatic, personalized mode of decisionmaking characteristic of government close to the grass roots of democratic government.[26]

There are many examples of local governments using information and communications technologies in innovative ways that can be copied and adapted by other communities. For example, Jacksonville, FL, is using electronic printing and a local-area network to keep its city ordinances up to date. Amendments passed by the city council are immediately incorporated in the code, and supplements are printed four to six times yearly, whereas formerly the one supplement per year required 6 months and up to $50,000 to prepare. The Office of General Counsel reports that it has reduced costs by "eliminating the need for a large staff of editorial lawyers, printers, typesetters and other personnel." Boston has required its licensee for cable television to link with a coaxial cable network all public buildings, including municipal offices, schools, and fire and police buildings. The system provides electronic mail, and the city's 29 word processor systems will be part of the network. During the last municipal election a direct link was set up between the ballot counting at City Hall and local television and newspaper offices.[27]

San Diego developed a computer-based planning and management system to determine the most cost effective location for the city's service units in order to reduce travel to and from work sites. By reassigning crews and equipment among existing stations the city will realize an immediate net cost saving of over $445,000.[28] Fort Collins, CO, installed an automated information system for use by police officers that allowed it to eliminate one position in the Records Department, freed room for three additional workstations, and increased the reliability and integrity of criminal justice information.

The effect of the advent of personal computers in local government offices, even if it is now occurring more rapidly than was ex-

[23] James N. Danziger (University of California-Irvine), *Computers and Politics: High Technology in American Local Governments* (New York: Columbia University Press, November 1981).

[24] This analysis draws heavily on the conceptual framework provided by King and Kraemer, op. cit., see especially pp. 106-110.

[25] King and Kraemer, op. cit., p. 107.

[26] An analysis by Professors King and Kraemer of the University of California-Irvine concludes that in terms of producing improvements in performance, most attempts to use these models for planning and management have been "practical failures," because of several problems:

- Information collected for operational use is generally not aggregated at the appropriate level for, or organized for, planning and management purposes. Local governments collect relatively little data appropriate for assessment of output.
- Models must be fitted to the expected analyses, and this level of analytical competence is not always readily available.
- Behavioral and political constraints:
  - —Data useful for performance and compliance analysis often depends on self-evaluation by government officials and this affects their behavior in collecting/reporting the data—especially if it is to be used to evaluate performance.
  - —The assumptions used in constructing models may be unrealistic in a specific situation and location, given the diversity among American communities.
  - —Models tend to be used to rationalize or defend decisions already made for political or other reasons rather than to help make decisions.

(King and Kraemer, op. cit., p. 108.)

[27] Reported in "The Government Office," *Office Administration and Automation*, September 1984.

[28] Information provided by Public Technology, Inc., to OTA from a list of PTI's computer-technology award winners, November 1984.

pected in 1982, will not be apparent for some time, especially since they are likely to come into use without systematic planning, at a very uneven rate, and in many governments with little attention at the highest level of management.

EXAMPLES OF OFFICE AUTOMATION IN STATE AND LOCAL GOVERNMENT

In the absence of a large body of cross-jurisdictional comparisons, some brief case histories are presented as illustrative of what is taking place in government offices. They are not necessarily "typical," but they provide a picture of some of the possible outcomes of office automation for States and municipalities.

The State of South Carolina

South Carolina falls about midway among the 50 States in size (it ranked 24th in terms of population, in 1980) and in government revenue per capita (38th in 1980). Like other States, South Carolina began to acquire computer systems during the 1960s and 1970s. In 1981, South Carolina was spending as much as 6 percent of its operating budget for telecommunications, data processing, and office automation, but without any systematic plan, strategy, or control over these expenditures.[29] In buying equipment or services for data processing some State agencies had underestimated the costs by as much as 50 percent. In a decade, expenditures for managing data had more than tripled; and outlays for telecommunications in 1980 were 38 times greater than in 1960.[30]

The Governor, the State Budget and Control Board, and leaders of the State legislature agreed that something must be done. The time was right since the legislature was then working on a new Model Procurement Code. The consensus across branches of government was important, because power in this State government is particularly fragmented and diffuse. The heads of major State agencies are elected separately rather than appointed by the Governor, and therefore tend to have their own unique relationships with legislators as well as their own constituencies. The Governor consequently must often depend on powers of persuasion to initiate any change within the State bureaucracy.

With a powerful consensus among State leaders that some way must be found to cut the burgeoning costs of information management, it was possible to take action. The State administration began efforts to develop a comprehensive information resources management strategy. Key officials throughout government were interviewed, and State agencies were asked to develop productivity objectives. On this basis a preliminary State Plan on Technology was developed, and later a Master Plan. Agencies were asked to prepare their own 3-year plans for use of information technologies.

The Department of General Services was reorganized to create a new Director of Information Resource Management and a division by that name (DIRM) under the Budget and Control Board. Another important step was

[29]This section relies heavily on work done for agencies of the State (especially the Division of Information Resource Management of the State Budget and Control Board) by Donald A Marchand, John C. Kresslein, and others at the Institute of Information Management, Technology and Policy, College of Business Administration, University of South Carolina. Reports, to be referenced at points in this section as "South Carolina (number)," include:

1. *Information Resource Management: A Statewide Strategy*, April 1983.
2. *The South Carolina Local Government Survey of the Use of Computer and Communications Technology*, November 1983.
3. *Implementing Information Resource Management in State Government: The South Carolina Experience*, Research Report RR-84-1(K-84-8), May 1984.
4. *Personal Computers in State Government*, May 1984.
5. *A Manager's Guide for Implementing Information Resource Management (IRM) in a State Agency*, June 1984.
6. *Office Automation in the Office of the Governor*, January 1985.
7. *Initial Evaluation of Productivity Benefits Achieved From SOAPS*, Progress Report No. 2, July 1983.

However, neither specific State agencies, the Institute, the university, or the authors cited above are responsible for the interpretation and analysis in this section, which is solely that of OTA analysts.

[30]South Carolina (5), p. 5.

the creation of a new series of personnel classifications under the title Information Resource Management, to encourage the appointment of such specialists in each agency.

The State Plan, as it developed, encompassed office automation, telecommunications, and large-scale data processing technology. The backbone of the planned technology is to be a statewide microwave network for voice, data, and video transmission. (See figure 10-1.) This network, which is planned for completion in 1986, will cost an estimated $16 million, but is projected to save the State $100 million over the next 20 years. The State "did not set out initially to establish its own communication system," university consultants say, "but sought instead the most cost-effective alternative with the goal of controlling communication costs."[31] The planners sought and got bids from 25 private industry vendors but none could provide what was wanted.

Another aspect of the State Plan was a systematic approach to office automation (meaning, in the beginning, large-scale computer applications). An 18-month pilot project was begun in August 1981. Task forces and study groups were formed to consider procurement and standards, ergonomic issues, training needs, user perceptions, and contingency planning and security needs. The major objectives in office automation were:

- automation of formerly manual tasks to reduce manpower requirements,
- direct time-saving applications and work redistribution to reduce time and manpower requirements,
- time-saving applications providing opportunity to do additional work, and
- quality improvements in office products.

The first pilot project was purchase of three IBM 8100s and 100 peripherals for the Department of General Services in mid-1982. In the following year further advanced data processing applications were installed, and technical assistance was given to other State agencies. The Model Procurement Code passed by the legislature in 1981 provided strong inducements for agencies to comply with standards formulated by the Department of General Services' new DIRM. DIRM must oversee any procurement of over $2,500. The State would coordinate long-term contracts under which agencies would receive a significant discount on computer-related purchases. Office automation standards were developed in 1982 and subsequently revised.

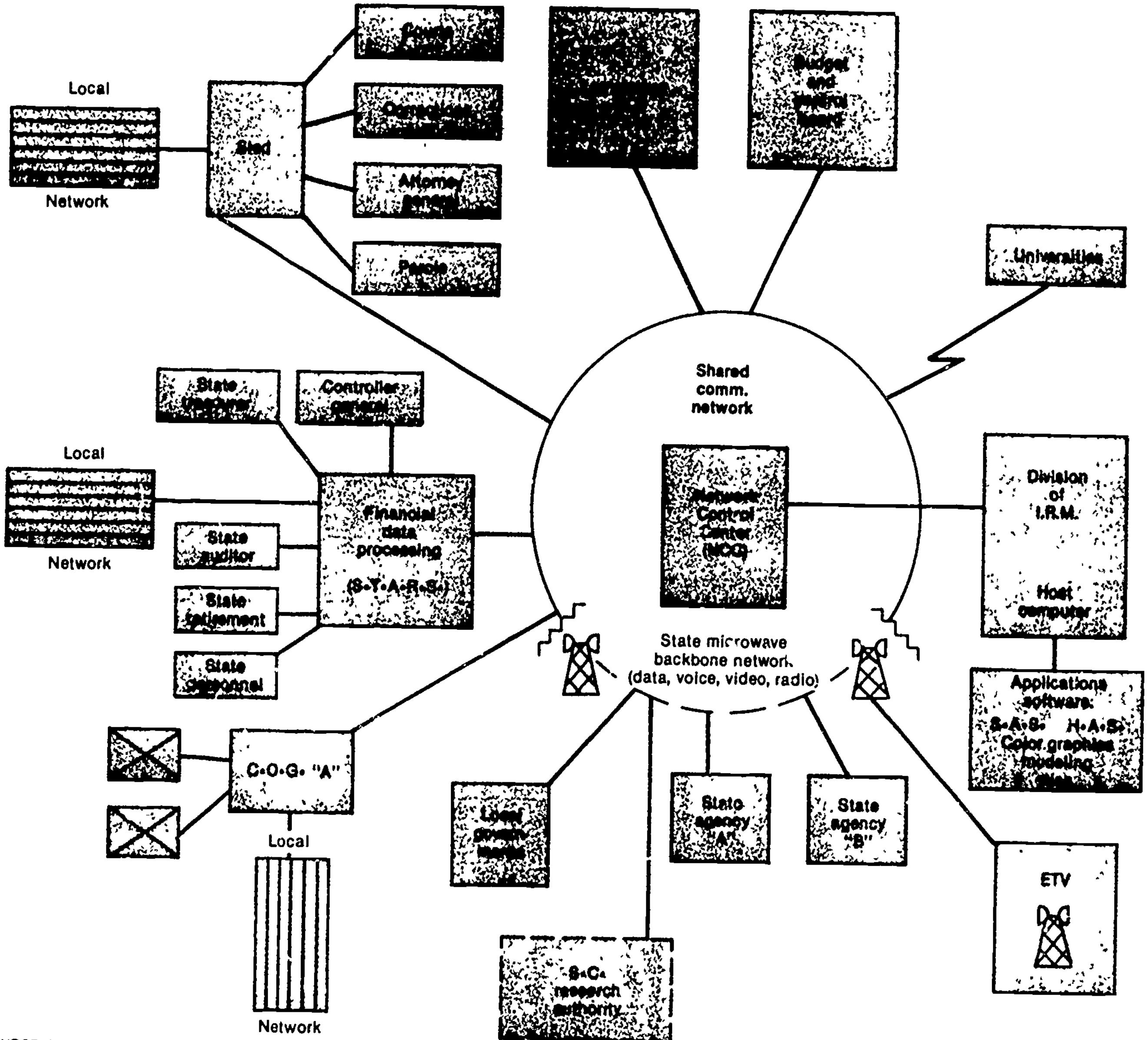
By September 1983, an electronic network linked the Governor's Office with nine critical agencies within the State House Complex—the office of the Executive Director of the State Budget and Control Board, the Health and Human Services Finance Commission, the Department of Agriculture, the Division of Human Resources Management, the Department of Social Services, the Office of the Secretary of State, the Department of Insurance, the Division of General Services, and the Division of Information Resource Management.

For automating the Governor's Office two minicomputers were linked to host computers at DIRM and the University of South Carolina; there are 22 workstations, 3 data processing terminals, 7 letter-quality printers, a line printer, and a data processing printer. A recent assessment concluded that the result was a 53 percent cumulative time saving in actual time to complete all tasks studied (approximately one-half person year), with an average time saving per task of 5.3 percent or approximately 112 person hours per year.[32] The improvement in time to complete each task was estimated to be about 86.5 percent. Three tasks that were done externally are now done internally (answering employment application letters, approximately 10 per day; preparing proclamations; preparing 200 news release envelopes, about twice each week) with an improvement in turnaround time of about 94 percent. Nine of twelve typewriters have been relinquished for redistribution to other offices.

[31] South Carolina (4), p. 15.

[32] South Carolina (6). The specific tasks studied were property management certification, grant report, audit report, grant award letters and forms, consolidated vouchers (math calculations), updating office personnel lists, preparing governor's schedule, repetitive letters, commission letters, educational statistical report.

Figure 10-1.—An Example of a Statewide Integrated Communication Network for South Carolina



SOURCE Donald A Marchand and John C Kresslein, "Implementing Information Resource Management in State Government The South Carolina Experience," Research Report RR-84-1, University of South Carolina, Columbia, SC, 1984.

282

283

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More qualitatively, the assessment found that the successful adoption of the Governor's Education Improvement Act in 1984 was "partially achieved through the efficient and effective use of the office automation capabilities" that were used for creating the text, completing 100 major revisions, preparing the related speech by the Governor with 18 major revisions, and performing mass mailings to constituents, related to the act. The Governor's Executive Assistant was quoted as saying that without office automation capabilities the act would not have been adopted in that fiscal year, or would have contained a lesser program content. The assessment concluded that:

> ... (O)ffice automation is indeed initially more costly than conventional or semiautomated techniques. It also is extremely difficult to precisely measure the quantitative productivity improvements and equally as difficult ... to determine the return on investment ... However, ... (automation resulted) in the capability to produce and distribute information faster and more accurately and to make more accurate and timely decisions ... Indeed, the ... technologies helped improve the level of service and the relationship of the Office of the Governor to the citizens of this State.[33]

The Legislative Services Group also automated (with 200 word processing terminals connected to a mainframe) and terminals were put in the offices of legislators. Through the system, legislators can access and track bills and amendments and search the State Code of Laws. Word processing, data processing, key-word search, and calendaring are also provided.

Automating State offices was not accomplished without significant problems. Those identified at an early stage of the process were those found in nearly every large organization —functions beyond word processing tended to be underused because people had not been taught how to use them; there was sometimes a mismatch between capabilities provided and those needed; and distribution of terminals was sometimes not appropriate so that people queued to use them in some places while other terminals were idle. But four-fifths of the clerical staff and over half of managers and professionals said that the new systems had improved not only their productivity but their attitudes toward their work.[34]

By 1983 it was clear that personal computers were rapidly being added to State offices. Their prices often fell below the threshold at which there is central oversight. There was concern about the potential lack of compliance with office automation standards, which could cause compatibility problems later, yet the flexibility that PCs offer pointed them to becoming the "primary office automation workstation," university consultants said.[35]

A survey of 10 agencies in early 1984 showed at least 500 microcomputers in use, and that number was likely to double during fiscal year 1985. The Comptroller General's Office was using two personal computers to design a financial reporting system to be used by small State agencies.[36] Several agencies reported that there was a high demand for personal computers, and staff members were dissatisfied and frustrated by the necessity for sharing them. No local area networks (LANS) were yet in place in these agencies and use of shared hard disks was just beginning. But the two State universities were planning campus-wide networks and four of the agencies were interested in developing them.

The State now requires personal computers to be bought under a term contract, so that all agencies enjoy the volume discount and guarantees of support negotiated by the State. It is officially anticipated that by the end of the 1980s there may be one microcomputer for every State white-collar worker. DIRM has purchased software packages for PCs that provide "English-language-like query capability" and facilitate the downloading of data from mainframes to PCs. PCs and mainframes will be linked using leased or dial-up lines to allow

[33]South Carolina (6), p. 2.

[34]South Carolina (7).

[35]South Carolina (7), p. 26.

[36]South Carolina (4).

end-users controlled, preauthorized access to central government databases.

Several State agencies and institutions (e.g., the Department of Mental Retardation, the Tax Commission, a State technical college, and the State university medical school) are systematically developing their own long-range, information-resource management plans.

Throughout the process of automating government offices, this State government has used university experts to monitor and report on progress and problems in achieving its stated objectives. A broader assessment from the perspective of effects on delivery of government services, governmental responsiveness to citizens, and on the locus and exercise of governmental power is to be undertaken but is not now available.

New York City

The Mayor's Office of Operations in New York City cooperated with OTA in studying the effects of public sector office automation by encouraging and facilitating a case study by The Labor Institute of automation in three municipal departments—the Department of Finance, the Department of General Services, and the Human Resources Administration.[37]

New York City has for several years been under intense pressure to reduce government operating costs and increase revenues. Major reorganizations aimed at increasing productivity took place in city government departments both before and during office automation. The case study focused on the consequences of automation for the clerical, managerial, and professional work force, and on their perceptions of how it affected both them and the services that they deliver to the public.

Many of the workers who contributed their insights to this study said that in spite of some early misgivings, they like office automation. However, there is at the same time a high level of disatisfaction. Some—both clericals and professionals—felt that their jobs had been degraded, and their own interest in the job eroded.

Most said that their own productivity had increased; and some said that the quality, quantity, and timeliness of services delivered by their work units had improved. But in other cases, services have been depersonalized, standardized, and routinized; accountability of individuals, if not of the government as a whole, has been decreased.

The clerical workers in the three departments are group clerks, office aides, office associates, technical support aides, and word processor operators. The clerical work that has been automated was all done manually until 1982, but now requires personal computers, word processors, Automated Forms Systems, and other systems.[38] For example, at the Bureau of Child Support (in HRA) a clerical work unit formerly typed between 400 and 600 letters each week. Now a clerk enters a code to select forms to be sent to a client from nine forms that are generated by an automated system. Clerks at the Income Maintenance Center once hunted for paper files on particular clients as they were needed by eligibility specialists; now the files are called up on a cathode ray tube (CRT) and the needed data is printed out. Personal computers are used in the Real Property Transfer Tax Unit of the Department of Finance to call up information on property sales history and determine the market value of property. Word processors are used for tax billing, as well as for generating reports, mailings, memoranda, and other documents in all of the departments. In one department the most proficient typists were removed from their old work units and placed in a central production unit.

[37] *Effects of Office Automation on the Public Sector Work force: A Case Study of New York City*, done under an OTA contract by The Labor Institute (New York); Joan Greenbaum, principal investigator, with Cydney Pullman and Sharon Szymanski, February 1985.

[38] Twenty-eight clerical workers took part in workshops and group interviews for this case study. They are predominantly women, and predominantly black and Hispanic. Most have completed high school and a few have completed college; they have worked for the city from 2 to 10 years, and have been using computerized office systems for at least a year. The clerical workers spent most of their 7-hour workdays using the systems, and usually have two 20-minute breaks, in addition to 1 hour for lunch.

One goal of city government is reduction of the clerical work force and this has been occurring. Managers report that the objective is to reduce the clerical work force about 15 to 20 percent through attrition. The effects of office automation cannot always be clearly separated from the effects of reorganization that either preceded or accompanied it, but much of that reorganization was itself for the purpose of making better use of the new technology. One work unit manager reported that the automated systems have already resulted in a 15 to 20 percent reduction in clerical staff over 3 years.

Clerical workers said that when automation began, they were fearful of losing their jobs and afraid that they could not learn the new systems. Minimal formal training was provided by vendors. Most of the workers learned from coworkers, and then taught others. Now the workers generally approve of the automation, saying that it freed them from tedious manual work and allowed them to learn new skills, and that they can now produce better quality work, at a faster rate. They also say, however, that they still need more and better training and that they are not being adequately compensated for what they perceive as their newly learned and higher level skills.

Because the new systems can handle a larger volume of work in a shorter period of time, most of the workers work more steadily and take fewer breaks.[39] Those doing data entry in many cases say that their control over their work has decreased because it is paced by the machine. However, those in one kind of decentralized word processing pool ("clusters") now have relatively more variety in what they are keyboarding and also have to prioritize it, so that they feel they have more control over their work.[40]

[39]Their union, AFSCME, has negotiated two 20-minute breaks for VDT users in some work units, but the workers say that they do not always take them because they are too busy. Some, however, say that they take informal breaks when necessary to relieve eyestrain and back discomfort.

[40]In two word processing units, one a pool and one a cluster, some similar effects were found, including rotation of jobs and prioritization of work; but for different reasons. The cluster is a smaller unit where management encourages worker involvement in everything from selecting equipment to organizing the work. In the word processing pool the increased control that the workers have is due to a virtual lack of supervision. As a result, workers must work as a team to coordinate and [illegible]nize the unit's work.

Most of the New York City clerical workers say that even though they like the new systems, they also suffer from increased stress. They report increased eyestrain, backaches, and headaches. Many of the new systems have been installed in old offices with unsuitable furniture and lighting, and poor ventilation; excessive noise from printers, and wires or cables stretched haphazardly around the floor, add to the risks to health and comfort.

Almost all of the clerical workers do more work than before automation. Some say that they now have a better understanding of "the whole picture," that is, what the agency does and how. The sharing of information and cooperative learning that has occurred has generally increased the interaction between coworkers. But frequently this interaction is forced; it is an attempt to overcome problems caused by lack of supervisory coordination, lack of formal training, and problems with the equipment. The only way that work gets done is by the workers going into a huddle and finding some way to get around the problem. The workers overwhelmingly say that they have more interest in their work now, although as they fully master the new process some anticipate that it will become boring.

In New York's city government, paraprofessionals, who have less formal training than professionals, can perform some of the work of professionals and assist them in other tasks. Some paraprofessionals are now using computers and related devices, although usually less intensively than the clerical workers. Typically, they may review computerized files or scan data for 2 or 3 hours a day interspersed with other duties and activities.[41] For example, in the Bureau of Child Support (HRA) preassignment investigators are now reviewing forms, generated by computers, to track down information about absent parents who are evading child support payments. In the Income Maintenance Office (also HRA) eligibility specialists use computers to review client

[41]Nine paraprofessionals participated or were interviewed for this case study. They were predominantly black and Hispanic women between the ages of 30 and 50, all high-school graduates, most with some college training. They had worked for the city from 5 to more than 15 years and are now using automated data-entry and or data-retrieval systems in their work.

files for recertification of public assistance eligibility.

The eligibility specialists also have extensive direct contact with clients by telephone; they help them with emergencies such as evictions, fires, or illness. These paraprofessionals rate the work they do with computers for about 10 hours a week as the most satisfactory of their tasks. They report that their productivity has increased and the quality of the output improved after automation. The workload has also increased; because more information is available they are now required to submit more reports, and their deadlines are tighter. Although many feel that they have a better sense of "the whole picture" and more control over their work, many feel that they are overworked, undercompensated, and that the quality of services delivery has not necessarily improved.

The preassignment investigators in the Bureau of Child Support also rate their reviewing of files by computer as the most satisfying of their tasks. They have almost no direct contact with clients, using forms almost exclusively in processing cases. But while they find reviewing these forms more satisfying than their other major task of sending out form letters, automation has not, in their opinion, improved the quality of the services.

The paraprofessional workers also complain of eyestrain, backpain, and headaches, even though they spend much less time in front of CRTs than do the clerical workers.[42]

Professionals in these three city departments vary widely in the extent to which they use computers or other forms of office automation, but their jobs have also been strongly affected.[43] For example, in the Department of General Services, analysts in the Commissioner's Office of Management and Analysis use Wang VS terminals or IBMs linked to a mainframe computer for data input or inquiry, or word processing. Tax auditors in the Tax Examinations Unit use IBM PCs for data inquiry and input, and caseworkers in the Bureau of Child Support use IV Phase terminals for similar purposes.

Before automation, tax auditors in the Real Property Transfer Tax unit handled all aspects of a tax audit. Particular cases and case follow-up were assigned to one auditor. As automation is being introduced, this unit, with a staff of seven, is being merged into the much larger Examinations Unit, which now handles eight kinds of municipal taxes. This represents the beginning of a larger reorganization in which all tax auditors in the unit will be trained to handle all eight types of taxes. Auditors acknowledge that the computer generates more information, quicker, and thus provides more control over the status of each case. Yet the auditors are dissatisfied with the overall process. With the reorganization of the work unit, the tax audit procedure has become fragmented and more clericalized. Some of the auditors are frustrated with what they perceive as a decreasing need for their professional training and judgment.

Analysts in the Office of Management Planning and Analysis say that the improved quantity, quality, and accessibility of data has resulted in improved services from their office. Unlike other employees participating in the case study they do not see an increase in work because of computers. Rather, the computers have changed their perceptions of their jobs. The expansion in the amount, speed, and wider range of reliable information has given the analysts more varied and creative possibilities for solving problems. They feel that their influence has increased as they go beyond identifying problems and become more involved in working out solutions.

But caseworkers in the Bureau of Child support think that the services provided by their unit have definitely not been improved by Automated Forms Service. Some of their clients, they report, ignore all standardized forms, others are intimidated by computerized forms and will not respond to them. The caseworkers say that the data fed into the sys-

[42]Seven of the nine paraprofessionals who contributed directly to this case study have had to get stronger eyeglass prescriptions since they began using a VDT.

[43]Fifteen professionals participated in workshops and interviews. They included 9 men and 6 women (80 percent were white), and their ages ranged from 20 to 40, with the average in the mid-20s. All have college degrees and the majority some graduate-school training. A few have worked for the city more than 15 years, but most less than 4 years.

tem is often inaccurate, and that, thanks to automation, errors are not caught until late in the progress of a case, which must then be held up until the errors can be corrected. Also the system has generated increasing numbers of small procedures that not only increase the amount of work but also the chance for errors.

These caseworkers, before the automated forms service was adopted, wrote or typed numerous letters. They no longer perform such clerical duties,[44] but paradoxically their position is being deprofessionalized. Since they are no longer solely responsible for deciding what letters to send out, their control over a case throughout its history is not as complete. Their job title is being changed from "caseworker" to "eligibility specialist." A college degree is no longer required, and the new job title does not have the range of possible grade levels that went with the old title, so that opportunities for promotion are decreased. This job degradation was not caused by office automation, but office automation was used to foster an ongoing process.

The professionals as a group have mixed perceptions about other effects of automation on their work. They generally report that interactions with coworkers increased, with sharing of ideas about uses of the systems. They continue to pace their own work to suit themselves and the needs of a particular project, as professionals generally can. Some report an increase in "petty" supervision, apparently because supervisors can review more drafts of reports and more easily ask for changes. Some see the increased use of data (because more is available) as an increase in their workload, while others perceive this in terms of more options for solving problems. Most think that their ability to perceive "the whole picture" of their agency's work is enhanced; yet some say this is marred by increased uncertainty as to the long-range effects of computerization on government.

Both caseworkers and auditors, however, feel that they have lost some control over their work, because it has been fragmented. Caseworkers, by being relieved of clerical aspects of their work have also been relieved of knowledge about its progress and outcome. Crucial steps are taken by other people who do not know the whole story. Auditors do not always complete an audit they have initiated, as it may be passed on to others. Both the caseworkers and these auditors say that their overall job interest has decreased.

Managers, those top-level administrators who set broad policies and exercise overall responsibility for their execution, have also been affected by office automation, although they may or may not use any microelectronic devices themselves.[45] Some of the top-level managers in these departments use word processors for memos, notes, drafting materials, etc. Some use electronic mail and messaging. Most also use database inquiry from time to time; a few reported using spreadsheeting, graphics, list files, and typesetting functions. These managers used a computer from 2 or 3 hours a week to as many as 15 hours. Most they had learned by watching others use the systems, but a few had taken courses.

Buying microcomputers for managers to use was said to be much harder to justify "to the city" than buying large systems for clerical use. Most of the purchases were approved on an experimental basis. But all of the managers said that computers increased the speed and improved the quality of their work, and allowed them to do new kinds of work. Almost all also said that computers increase the amount of work to be done.

The managers, however, were more concerned about the effect of office automation on their departments than on their own work habits. Some were eager to use office automation to reduce the work force and their operat-

[44]Their work was rationalized and restructured to relieve them of some of the paperwork, prior to automation. The clerical workers who took over the paper work became overloaded, and Automated Forms Service was brought in to relieve this problem.

[45]Seven managers were interviewed in-depth; they include a department commissioner, an assistant commissioner, a deputy general counsel, and the directors of four major offices within departments. They included 4 men and 3 women, between the ages of 28 and 50, who have worked for the city between 1 and 15 years. Their own use of computers varied from "none," to working (at home) for several years on a computer.

ing costs. Others felt that the combination of civil service rules and union resistance would keep that from happening in the near future, but that other changes set in motion by automation would nevertheless have major impacts on the delivery of government services. Said the Commissioner of a large municipal department:

> Since the city civil service ensures that jobs and people stay, I feel that this offers us room to experiment with using computer tools for new uses. I see the line between clerical and managerial workers blending. A clerical worker is not just a clerk and a manager is not just a manager.

UNANSWERED QUESTIONS ABOUT INFORMATION TECHNOLOGY AND GOVERNANCE

In all public sector offices, office automation is increasingly tied to and part of larger information systems, and the effects on quality of governance must be considered as a whole. In State and local governments this is particularly important because this is the level of government most likely to impact directly on individuals and households on a daily basis. To the extent that this assessment has considered public sector offices, it has been directed almost entirely to the effects of office automation on government itself, its productivity, effectiveness, and efficiency. There has been only peripheral attention to the ultimate effects on the constituents and clients of government offices.

A study of 42 cities, in the first phase of office automation from 1975 to 1979, found improved administrative control and operating performance, increased job satisfaction, and improvements in the offices as working environments.[46] The survey also produced evidence that office automation reinforced existing patterns of bureaucratic power, and in most cases, this meant a trend toward centralized, professionalized management at the expense of the power of elected officials. This was one of very few cross-jurisdictional studies and also one of even fewer that looked at effects on power relationships within government.

[46] "Evaluation of Information Technology in Local Governments, 1975-1979," a survey of the urban information systems research group of the Public Policy Research Organization, reported in Kraemer, et al., op. cit., pp. 27ff.

To date, the sparse and fragmented literature on government office automation and on the broader topic of government information systems, and the case studies reviewed above, suggest some further questions that should be thoroughly studied. If information and communication technologies can, as now appears highly probable, increase the efficiency of State and local governments and decrease their operating costs, what can be done to help the citizens of small as well as large governmental units enjoy these benefits? How can office automation be implemented and managed so that it improves, rather than degrades, the work life of civil servants and thus attracts to government service capable and dedicated people? Can office automation improve the effectiveness and responsiveness of government, as well as its efficiency?

Several aspects of governance on which office automation has a direct bearing were beyond the scope of this assessment, but are particularly worth further consideration. One is the ability of governments to gather essential information needed to carry out their responsibilities effectively. A second is the ability of citizens to know and understand what their governments are doing—i.e., access to information. A third is the ability of citizens to withhold some personal information from government—i.e., civil liberties. Finally, there are questions about how information technologies affect the nature and the equitable distribution of government services.

This assessment, although it did not address the question directly, nevertheless indicates that office automation can improve the quality as well as the quantity of information available to government decisionmakers and planners. It can also make it easier for the representative branches of governments to exercise oversight over executive agencies, and for all branches of government to increase their analytical and planning capabilities.

However, all improvements in the ability of government to gather, integrate, and use information also increase the danger that this information can be misused. Questions of confidentiality and civil liberties arise at the local and State level as well as at the National level.

Office automation could also be used to allow government offices to be more effective and efficient in responding positively to requests for information about government activities. The prevailing Federal policy of information resources management, which is now being adopted by many States, is based on the principle that information is an economic resource and is to be managed accordingly. In itself this principle is not hostile to the objective of increased public access to information, but it does not necessarily include that objective. Some States are, however, making concerted and systematic attempts to give the public access to government information by means of public information systems. They are confronting technological, economic, and legal problems in doing so, and have so far had mixed results.

There are disturbing hints, although as yet only hints, that government office automation can change the nature of government services in ways that are not completely desirable. For example, it may standardize and depersonalize the way in which some services are delivered. To the extent that depersonalization or standardization reduces the likelihood of discrimination, favoritism, arbitrariness, or corruption, it is good. To the extent that it makes government less humane, less sensitive to individual needs, and particularly to the needs of the handicapped, the poor, and the ignorant, it is not good. To the extent that it results in people and their personal needs and problems being regarded as interchangeable, manipulable statistics, it is a deterioration in civil life.

These questions, as already noted go beyond the scope of this assessment. Some of them, especially those related to citizens' access to public information and to the protection of privacy, security, and civil liberties, will be addressed in a forthcoming OTA assessment of government information systems. All of these questions should however be the subject of serious scrutiny by citizens, scholars, and decisionmakers at State and local levels.

Chapter 11

Office Automation in Small Business

Contents

	Page
The Importance of Small Businesses	283
Factors Affecting the Use of Office Automation in Small Businesses	284
Extent of Office Automation in the Small Business Sector	286
What are the Problems?	287
Capital	287
Software	288
Time	289
Training	289
Security	289
Vendor Responses	290
Future Impacts of Office Automation on Small Businesses	290
The Market for Business Services	291
Productivity	291
Competitiveness and Scale	292
Employment and Skills	292
Policy Options	293

Table

Table No.	*Page*
11-1. Percent of Firms Using Personal Computers by Size of Business, 1983 v. 1985	286

Chapter 11

Office Automation in Small Business

Small businesses play a vital role in our economy, and technological changes could affect that role. Small businesses are often a vehicle for basic innovations; they create new jobs; they serve small, local, and specialized markets not otherwise served; and they employ marginal resources that larger companies cannot utilize effectively. This chapter provides some general background and a summary of the limited information currently known about the effects of office automation on small businesses.

The first phase of office automation required relatively large capital investments and much specialized expertise, and was chiefly implemented in large organizations. The availability of small computers and software packages designed for small-scale operation is recent. Manufacturers and vendors are now emphasizing this market. But very small firms, and in particular beginning entrepreneurs, are often uncertain and apprehensive about taking the first steps toward automating their offices. They would like to know more about the experience similar small businesses have had with automation, but may find that it is difficult to get objective, disinterested information. Researchers and experts in the Nation's business schools and universities could help to develop a body of information to fill this need. Few researchers have studied the effects on small business. This chapter can provide a starting place for more detailed assessments and discussions.

Purchases of office automation equipment by small businesses are rapidly increasing as the prices of the equipment come down and as this market becomes a major focus of vendors. Computer systems have been used for several years by entrepreneurs and consultants working out of their homes, but the hardware and software used for this purpose were hardly differentiated from that sold for amateur, recreational, and educational use in the home market. Now small computers and specially designed software packages are coming into use by very small firms such as farms, restaurants, mom and pop stores, and entrepreneurial sellers of business services, as well as for the larger category of small business, firms with up to 500 employees. They are being used for many applications, including accounting functions, networking with peers, and research.

There have been few or no studies on the impact of office automation technologies on employment, job content, productivity, or survivability of the small business or beginning entrepreneurs. Because of the importance of the small business in the U.S. economy, the extent of adoption of automated office equipment in that sector and the problems faced in implementation of automated systems by small businesses merit special attention.

THE IMPORTANCE OF SMALL BUSINESSES

Organizations with 100 to 500 employees, although considered small businesses in law and regulations, tend to have a well-developed organization structure, formal procedures, and company policies much like those of midsized organizations. Over 99 percent of all firms, in the United States, fall within this category. While such firms might not be able to use a mainframe computer, they are likely to be able to mobilize the assets and acquire the expertise to proceed rationally and systematically toward some form of office automation if they choose to do so. But with personal computers, organizations with fewer than 100 employees can automate. Even very small firms, such as a family business or a new venture by one or a few people new to entrepreneurship, can automate many of their office procedures by using, for example, word processing, spreadsheets, and automated mailing procedures.

Such organizations are often the incubators of new industries, new products, and new services. Their problems are often different in kind from those of larger firms. Relatively little is known about the factors that determine their survivability and growth. For that reason, the focus of this chapter is the question of what is known about the potential effects of office automation on independent firms having fewer than 100 employees.[1] Unless otherwise stated, the term "small business" in the rest of this chapter means firms having 100 or fewer employees and the term "very small business" is usually applied to those with 20 or fewer workers.

Such small businesses are a major part of the American economy, accounting for over 34 percent of the U.S. labor force, and 32 percent of sales.[2] These figures do not include self-employed workers, who constituted 10 percent of the work force in 1982, making the very small business share of total employment even higher than indicated in most studies.[3] They are a particularly important part of many industries, such as agriculture, construction, wholesale and retail trade, and business and personal services.

[1]The Small Business Administration has two definitions of a small business including those with fewer than 100 employees and those with fewer than 500 employees. The latter category includes 99.7 percent of total firms in the United States. An establishment is a business located at one physical site, an enterprise is a business consisting of one or more establishments, and the word "firm" refers to all establishments under the same ownership or control.

[2]Executive Office of the President, *The State of Small Business: A Report of the President* (Washington, DC: U.S. Government Printing Office, March 1984), p. 73.

[3]"Job Generation," *Economic Policy in the Eighties: The Small Business Factor* (Washington, DC: Small Business Administration, June 1984), p. 6.

Nonagricultural self-employment increased by more than 45 percent between 1970 and 1983. Eugene H. Becker, "Self-Employed Workers: An Update to 1983," *Monthly Labor Review*, July 1984, pp. 14-18.

All of the net increase in jobs (984,000) between 1980 and 1982 was attributable to firms with fewer than 19 employees.[4] These small businesses produced a total of 2,650,000 new jobs, more than offsetting the 1,666,000 jobs lost by larger businesses.[5]

Small businesses train beginning workers in needed skills, providing two out of three workers with their first jobs in the private sector; larger firms reap the rewards of this training through increased productivity due to the availability of trained workers. Small businesses also account for almost half of women's jobs and provide jobs for the elderly and those wishing to work part-time or intermittently. In addition, small firms are said to be more innovative than large firms and they offer services considered too differentiated or too small in market potential to be pursued by large firms.

This is, therefore, an important segment of the U.S. economy. Should Government policies aid small business in their efforts to use new technologies such as office automation? Can the private sector be encouraged to help? Or will office automation tend to change or diminish the role that small business plays in the economy?

[4]*The State of Small Business: A Report of the President*, op. cit., pp. 26-27. The 1985 edition of the same report did not update these figures.

[5]*The State of Small Business: A Report of the President*, 1985, p. 2. But many small business firms start up and many others go out of business each year. In addition, firms are constantly moving in and out of this classification due to expansion, contraction, and purchase by larger firms. This dynamism of the small business sector is thought by many analysts to be a useful indicator of overall business cycles; these cycles are felt by small business 3 to 6 months before they affect large businesses.

FACTORS AFFECTING THE USE OF OFFICE AUTOMATION IN SMALL BUSINESSES

The factors affecting the use of office automation technologies in small businesses center around the price and availability of equipment, the growth needs of the firm, and the available labor or skills. The declining price of microelectronic equipment is making it more feasible for small businesses to purchase. Access to capital, however, is often still a problem. Even a few thousand dollars in capital investment can be significant. High interest rates limit the ability of very small firms, and especially new businesses, to invest in capital equipment, and the bankers' interest in lending small amounts is minimal. Many small firms simply do not feel the need for computerization yet, although that situation seems to be changing rapidly.

The targeting of the small business market by manufacturers and retailers has no doubt influenced many to purchase and caused most at least to consider the technologies. The interest of the vendors is evident from the increase in advertising aimed at small businesses and the number of small business seminars offered by vendors and retail outlets.

The retail computer store has been the most common method or site of purchase because vendors have been unwilling to develop a sales staff to deal with small businesses. Thus, the sales effort has been largely passive. The vendors now are dealing with that problem by means of seminars oriented to small business owners and new entrepreneurs, attracting a target audience with which their sales forces can deal more efficiently.

The dynamics of the firm and of the industry of which it is a member affect a firm's need for and use of automated office equipment. A business that is growing rather than stagnating is likely to use it to service more clients or provide faster response to clients. A growing firm is also more likely to have the capital or credit to purchase new equipment. Struggling firms sometimes expect that office automation will allow them to compete more successfully with larger firms. For example, a small travel agency may find that the addition of a computerized reservation system is necessary for it to survive and compete.[6]

[6]Judith Kamm and Aaron Nurck, "The Organizational Implications of Implementing Technology in Small Businesses" (Department of Management, Bentley College, Waltham, MA), *4th Annual Bentley College Small Business Resource Center Research Conference*, spring 1984.

Businesses of less than 100 employees make up over 45 percent of the miscellaneous business service industry, and an even larger proportion of another seven industries expected to grow rapidly in the next decade.[7] The miscellaneous business services, the finance, insurance and real estate industry, and professional services (health and legal), are already heavily impacted by office automation. Personal services, such as beauty shops, drycleaning establishments and repair services are likely to be less affected by office automation.

The availability of people to use the equipment will also influence the decision to automate. More highly trained, specialized personnel such as systems analysts and programmers may be needed if the office's activities are in any way highly specialized or nontraditional, and only a few specialized very small businesses are likely to have such people, unless they are themselves the owners/entrepreneurs. The higher cost to the small firm of pension plans and other benefits, the costs of recruiting and hiring these workers, and the small scale of operations and markets put smaller businesses at a disadvantage. Once they have automated their operations, however, they are less likely to be able to employ unskilled neighborhood labor, untrained new or occasional workers, or family employees.

The proliferation of incubator facilities that provide computer and telecommunications equipment on a shared basis to small firms or beginning firms will provide many of them with their first opportunity to use such equipment. Builders are developing "smart buildings" prewired for computer and communications networks, and are renovating older buildings and furnishing them with electronic equipment for lease to small business/entrepreneurs. Such facilities will provide small businesses with the benefits of office automation at an affordable cost. The number of incubator facilities in the United States doubled in

[7]Bruce Phillips and Kim Beverly, "Employment Projections in Large and Small Business-Dominated Industries, 1982-1995," draft memorandum, Small Business Administration, Jan. 4, 1985.

the last year and shows signs of continued increase. They are attracting private investment capital as well as private-public partnerships, and with a two-thirds survival rate for the small businesses using these facilities, appear to be successful.[8]

[8]"Business Incubators Are Doubling in Number Each Year," *Wall Street Journal*, Nov. 14, 1985, p. 1.

EXTENT OF OFFICE AUTOMATION IN THE SMALL BUSINESS SECTOR

The lowering of prices has allowed small businesses to begin heavy purchasing of automated office equipment, as evidenced by several marketing studies.

Although, more large firms use computers than small ones, small firms are increasing their purchases steadily. Comparison of a 1983 Dun's 5000 survey[9] and a 1985[10] survey show the increases. (See table 11-1.) The increases in purchases for small firms were 60 to 70 percent during this short period. In fact, firms purchased more than twice as many computers during this time as they had predicted they would in the 1983 survey.

Small firms responding to the 1983 survey used their computers mostly for accounting while the largest firms used them for financial analysis and forecasts. By 1985, the use of financial analysis/spreadsheets had decreased overall and the "other category" had increased from 8.5 to 78.0 percent, indicating heavier usage of specialized applications.[11] This confirms the need for specialized software and specialized personnel in the small business if they are to use computerized systems effectively. All of the surveys studied indicated that small businesses are conservative in their choice of systems and the use to which they are put, which is mainly word processing and accounting functions. Larger firms are apt to be more interested in state-of-the-art equipment and more innovative applications than are small firms.

[9]Joseph Duncan, "Business Bets on Microcomputers," *D&B Looks at Business*, August 1983, p. 45.

[10]*Dun & Bradstreet Looks at Business*, vol. 3, No. 3 (New York: Dun & Bradstreet Corp., May/June 1985).

[11]Ibid., p. 4.

Table 11-1.—Percent of Firms Using Personal Computers by Size of Business, 1983 v. 1985

Size of business (number of employees)	1983	1985
1-19	14.5%	23.9%
20-99	22.4	36.3
100-499	27.3	47.2
500-999	44.5	71.8
1,000 or more	65.7	85.4
All firms	31.9	46.1

SOURCE: Joseph W. Duncan, "Dun's 5,000 Survey Shows Dramatic Increase in Use of Personal Computers," *Dun & Bradstreet Looks at Business*, vol 3, No 3, May/June 1985

In 1980, *Inc.* magazine surveyed its readers and found 48 percent of the respondents then using minicomputers and microcomputers or small business computer systems;[12] 22 percent were using word processors.[13] Only 4 years later, 57 percent owned/leased microcomputers and 28 percent owned/leased minicomputers.[14] The median number of employees of these companies was less than 25. Personal computers are used most often by management, followed closely by engineers, clerical and middle management; the most common use is word processing, followed by accounting/bookkeeping, file/list maintenance, and records/schedules. Further automation of tasks was planned by 72 percent of the respondents within the next 2 years.

The small business market for communications equipment is also increasing rapidly. It was over $3 billion in 1983.[15] The cost of tele-

[12]*Inc. Office Technology I* (Boston, MA: United Marine Publishing Co., Inc., 1980).

[13]*Inc. Office Technology II* (Boston, MA: United Marine Publishing Co., Inc., 1980).

[14]"*Inc.* Personal Computers" (Boston, MA: *Inc.* Publishing Co., Inc., 1984), and "*Inc.* Minicomputers" (Boston, MA: *Inc.* Publishing Co., Inc., 1984).

[15]Frost & Sullivan, "The Small Business Communications Equipment Market Report," A1254/D-1, winter 1983/84.

phone services is high on their list of problems, according to testimony before the Committee on Small Business in 1984.[16] Small businesses are faced with much more complex choices now in the selection of telephone and other communications services, which intensifies the cost problem.

Most businesses (66.7 percent) used their computers as stand alone workstations, according to the Dun & Bradstreet 1983 survey. Larger firms were more likely to use personal computers in telecommunications link-ups. Very small firms often used their microcomputers to replace a Telex or Twix communications service and were comparatively strong in their use of commercial databases.

It is evident from surveys, advertising efforts by vendors, and retail sales activities, that small businesses are purchasing automated office equipment in increasing amounts. Some are purchasing out of genuine need to improve their productivity and others are purchasing because the competition is doing so.

[16] "Impact of Changes in the Telecommunications Industry on Small Business," Hearing Before the Special Task Force on the Impact of Telephone Costs, U.S. Congress, Washington, DC, June 26, 1984, p. 405.

WHAT ARE THE PROBLEMS?

The very small business is faced with a myriad of problems when considering office automation. Included among these are:

- Capital—Even though the prices of equipment have decreased tremendously over the past few years, this may still be an expensive undertaking for the very small firm whose access to capital is limited.
- Time—A large investment of time is required to evaluate, purchase, and learn to operate new systems.
- Expertise—Small businesses often lack the expertise and the financial capability to hire technology experts for evaluation, implementation, and maintenance of automated office systems.
- Training—Small businesses often lack the time and expertise to train operators of the new equipment. In addition, the cost of training is usually overlooked when planning the purchase of new office technology equipment. The result is neglect of the training function and underutilization of the equipment.
- Repair services—Equipment is often purchased at retail outlets and the follow-up services are not available in a timely manner.
- Software—Much packaged software is available for small businesses but it may not be entirely suitable to a firm's specific needs.
- Security—Lack of knowledge about computer security and little control over shared information systems are a problem that the small business will have to deal with in the future as proprietary and private information becomes more accessible to all employees through computerized systems.

Capital

The capital needed to purchase hardware may actually be the lowest cost involved in converting to automated office equipment. Once it is purchased and installed, the owner/manager needs someone to turn to for help when it does not work and the vendor may or may not provide good support. The implementation costs, which include training and temporarily lowered productivity, are often unexpected. The five U.S. industries that are dominated by small businesses—services; retail and wholesale trade; construction; finance; insurance and real estate; and agricultural services have capitalization rates much lower than industries dominated by large businesses.[17]

[17] Bernevia McCalip, et al., "The Sensitivity of Small Businesses to Interest Rate: A Cross Sectional View," Congressional Research Service, U.S. Congress, Library of Congress, Washington, DC, May 26, 1982.

Photo credit. Hewlett-Packard Co.

A small business owner/manager seeking productivity through automation

This ratio will have to change if smaller businesses are to automate their offices.

The switch to computers can be a costly and frustrating experience for a small business. A company selling cheerleaders' supplies leased a computer system that would accept phone-in orders, check customer credit limits, figure shipping charges, adjust inventory, print an invoice, add the order to accounts receivable, and update inventory when supplies arrived. Within 6 months, orders were piled up from high schools ready to begin the football season, angry customers canceled orders, and attorneys general in three States were pressuring the owner to deliver the goods. What had happened? Like many businesses, this company had purchased hardware first and then purchased software from an independent supplier. The owner hired, then fired a computer expert who was unfamiliar with the business operation; neglected to solve poor inventory control problems present before the computer system was implemented; and failed to become involved in the switchover. The owner blamed the equipment vendor and the software supplier and they blamed the business owner. The equipment has been reclaimed by the vendor and the owner is suing them.[18]

Software

The problems and costs of choosing suitable software are even more significant than those involved in choosing the hardware. Larger firms often have software designed specifically for their use. In these companies, programmers can spend 60 percent of their time doing maintenance on programs.[19] This is not feasible for the small business manager. Small firms must make do with packaged software that often does not work well for them, and the developer is unavailable to them for consultation. A survey by the U.S. Chamber of Commerce in 1984 found that half of the respondents felt the need for more information than was found in their software manuals, 39 percent found the manuals hard to understand, and 23 percent complained of not having enough written instruction.[20] General Business Services, a firm that provides consulting services to 50,000 small business clients through franchised counselors, notes that many of the client firms are purchasing microcomputers, but only a small percentage of them are using their equipment fully. The effective use of the equipment depends on the motivation of the users and on improvement and availability of helping aids such as teaching diskettes, trained consultants, and user friendly languages.

A small cleaning services firm bought a computer when a 15-year-old bookkeeping machine broke down. The owner was convinced by a salesperson that a computer would only cost $2,000 more than a new bookkeeping machine. However, he then had to spend $8,000 for customized software. He later learned that the

[18] Dennis Kneale, "Garbage Out: The Wrong Equipment in the Wrong Hands Can Turn the Computer Dream Into a Nightmare," *The Wall Street Journal*, May 20, 1985, p. 83C.

[19] David Thompson, "Small Business Buyers in the Retail Computer Market," *Desktop Computing*, May 1983, pp. 58-61.

[20] "Small Computers Market Study," *Nation's Business*, U.S. Chamber of Commerce, September 1984.

system was too small to track all 6,000 of his customers; two employees trained on the machine never got it working; and a second expert said fixing the system would take an additional $8,000 in programming and equipment. The owner now stores the computer in an upstairs corner since he could not find a charity to accept it. He is aware of his mistakes—trying to computerize before it was necessary, buying hardware before software, failing to get written guarantees, and failure to plan for training cost. He feels he should have hired a consultant for a second opinion before purchasing the system.[21]

Time

Time is a major problem. An owner/manager with a 50- to 80-hour workweek will find it difficult to invest the extensive time required to investigate office automation equipment and then learn how to operate it. The lack of time to learn the system could quickly cause discouragement. The equipment is then neither properly nor fully utilized. And he or she often lacks the knowledge needed to evaluate whether automated equipment is really needed. The pressure to be competitive or to purchase because peers are doing so may influence a business owner to buy equipment without the analysis of needs, benefits, and costs that should precede such a purchase.

Training

Training of personnel is another problem faced by the very small business. The manager must not only know how to use automated office equipment, but often must also train employees. Alternatively, he or she must hire trainers or pay for commercial courses; hire new already trained people; or depend on self-teaching software. As the costs of software and training can be twice that of the hardware, this is a significant problem. Salvate's respondents[22] indicated that lack of trained personnel was a problem for them. This may, however, only be a short-term problem, diminishing as existing employees are trained, as more and more new workers are already familiar with computers from school courses, and as there is more and more self-teaching software. At present, however, it is a significant barrier to automation for very small firms.

Bradley Schiller explores the role of small business in training workers and concludes that this may be the most important function of small business.[23] The economy benefits by having a large pool of trained workers available. The advantage to the beginning worker is the opportunity to gain marketable skills, under close supervision, in a variety of activities—all of which are generally denied to them in larger businesses. Schiller points out that 67 percent of male workers obtain their first steady job with firms of fewer than 100 employees.

Small businesses now provide a valuable service to the economy and to other businesses by training new entrants to the labor force in specific skills and in general business skills. Only the successful adoption of office automation technologies will enable them to continue this function. However, there are costs to the small business employer. According to Schiller, there is a general exodus of employees from small firms to larger firms (300,000 in the past 9 years), where they obtain an average of 23 percent in wage increases in the first year. High turnover can be very costly to the small firm. The productivity of new workers is often less than wages paid and the small business may not keep the employee long enough for the increased productivity to pay off.

Security

As small businesses become more aware that information is a primary resource they will necessarily be more concerned about computer

[21] Kneale, op. cit., p. 84C.

[22] James Salvate, "Microcomputer Survey," School of Business Administration, California State University, Long Beach, CA, 1984.

[23] Bradley R. Schiller, *Human Capital Transfer From Small to Large Business* (Washington, DC. Small Business Administration, July 1982).

security. Not only could their information be accessed by competitors but it could be distorted or destroyed, deliberately or accidentally, by insiders. The Small Business Computer Crime Prevention Act (S. 1920), which became effective October 1, 1984, provides for educational assistance to small businesses in the area of computer security.[24] Specifically, it provides that the Small Business Administration should, through its extensive network of counselors to small business, provide the computer security education that small businesses lack and may need.

Hearings held in March 1984 emphasized the problems that the small business has with computer security—lack of divisions and specialized employees (one employee could have access to all company information), the high cost of purchasing specialized computer security systems, lack of knowledge/education about the problems, and little control over the information systems used because of leased communication lines, time-sharing computers, or packaged software. Even basic security measures such as audit trails are not enforced in many small firms and separating employee duties is difficult.

[24] *Small Business Computer Crime Prevention Act* (S. 1920), Hearing Before the Committee on Small Business, U.S. Senate, Mar. 7, 1984.

Leslie Ball, founder of the Association of Computing Machinery's Special Interest Group on Security (SIGSAC), testified to Congress that small business membership and seminar attendance in that group was extremely low, indicating that the growing awareness of the problems of protecting information is not reaching this group.

Vendor Responses

The vendors are aware of the problems faced by the smaller business in adapting to office automation technologies. Available but not fully utilized yet, are systems and components that address these problems, such as:

- software with a 30-minute learning time;
- modular systems that can grow with the business;
- self-diagnostic systems;
- use of natural languages for easier retrieval of data;
- customer hotlines for quick, accessible help; and
- expert systems that simplify managerial tasks.[25]

[25] David Cushing, "Vendor Watch: Perspective on Small Business Automation," *Venture*, November 1984, pp. 123-158.

FUTURE IMPACTS OF OFFICE AUTOMATION ON SMALL BUSINESSES

The impacts of office automation will depend on the overall growth of the economy, the growth stage of the firm, and the growth stage of the industry of which it is a part. It will affect the demand for certain kinds of business services, the extension of their markets, and the employment levels and skills needed.

Small business is a heterogeneous category including very small to medium-size firms, low and high technology firms, professional and unskilled services. Within firms under 100 employees, there may be a very big difference in the effect of office automation on a three employee owner-managed business and a firm of 50 employees. Some jobs are similar such as that of a secretary, and some functions are similar such as payroll. But compared to larger businesses, small firms have less uniformity by occupation and more multifunction personnel. Some small business firms, both high and low technology, are dynamic and growth oriented. Some are not. The difference may depend on entrepreneurship, location, and demographics more than on technology.[26] However, the use of available technologies will eventually affect their competitiveness.

The Market for Business Services

Forty-three percent of small businesses are involved in providing services to other businesses. This industry is projected by the Bureau of Labor Statistics to develop the most new jobs between 1982 and 1995, growing at a rate of 3.9 percent per year.[27] Although these rates are high compared to other industries, they are low compared to past years, when business services employment grew at a rate of 7 percent per year.

The use of office automation equipment will allow firms to perform services such as graphics, printing, and forms generation in-house. Electronic publishing systems can cut printing and documentation costs by up to 50 percent.[28] These trends could decrease the demand for these services from small businesses.[29] On the other hand, office automation technologies could also facilitate the entrance of small businesses into national and international markets.

Productivity

Most businesses that have automated office functions feel that they have become more productive, often by decreasing time spent on word processing. Small professional offices may gain productivity by adding clerical chores to the professional job, thereby eliminating clerical jobs. Examples of this include legal offices that use a computerized database from which the lawyer can develop simple wills and other legal papers without benefit of clerical help, and small advertising firms that can computerize all client presentation formats, allowing professionals to compose these without clerical help. Conceivably, professional firms could also go in the opposite direction, having the clerical help develop the basic computerized will or presentation, allowing the professional to spend more time on exceptional work.

Nonprofessional offices may find greater productivity in upgrading clerical skills to include some management functions, such as information gathering and organizing, in order to decrease the need for professionals. The small farmer, though reluctant to switch to computers, is finding that the use of computers will aid in generating the cash flow statements and business plans that banks are now demanding.[30]

The use of a microcomputer for administrative information processing such as accounting/billing forces the manager to develop more organized work habits that will improve efficiency and lower recordkeeping costs. It could also increase effectiveness by permitting more communication with customers and potential customers and a faster response time to customers' needs without a comparable increase in the time and labor required. Income taxes and other Federal paperwork that require a great deal of time could be accomplished with much less stress and time with the aid of a computerized system.

Loss of control of information is a significant problem for the growing business; the use of a computer can alleviate this by allowing the owner/manager to control all records.

Effective use of the equipment purchased will depend on the motivation of the users and on improvement and availability of helping aids such as teaching diskettes and of trained consultants. However, in the effort to minimize costs, the use of trained consultants is most likely to be deferred or eliminated thus reducing the effectiveness of the automation.

[26] Peter Drucker, "Business Innovation: Our Entrepreneurial Economy," *Current*, May 1984, pp. 14-18. See also, Bruce Phillips, *The Marketing of Small Business by Big Business* (Washington, DC. U.S. Small Business Administration, August 1983).

[27] Valerie Personick, "The Job Outlook Through 1995: Industry Output and Employment Projected," *Monthly Labor Review*, vol. 106, No. 11, November 1983, pp. 24-36.

[28] Maureen Nevin Duffy, "Publishing an 'Inside Job' With Today's Technology," *MIS*, Nov. 21, 1984, p. 42.

[29] Carol Anderson, "SME Word Processing Department," *SME News*, winter 1985.

[30] "Computers. How Ya Gonna Sell 'Em Down on the Farm?" *Business Week*, Feb. 18, 1985, p. 144.

The use of office automation technologies could aid small businesses in becoming more efficient and effective. However, there is some risk that firms may overburden themselves with debt to make this capital investment, overestimating the benefits or underestimating the time it will take to realize them.

Competitiveness and Scale

A special value of small businesses is that they can serve small, specialized and widely dispersed markets that, in general, large firms would have to aggregate and standardize or ignore in the name of economies of scale. Advanced information technologies may perturb these special niches. They have allowed the financial service industries, for example, to diversify products, tailor them to special needs, and offer them nationwide (e.g., special investment funds); and conversely, by aggregating markets on a greater scale, to offer more standardized products (e.g., mail order life insurance policies with rates determined only by age, and requiring no medical examination). These offerings can intrude on specialized niches formerly filled by small businesses. On the other hand, real estate firms, formerly small and highly localized businesses, have in some cases gone nationwide. Information and communication technologies, by nullifying the barrier of distance and time, can also allow very specialized (and formerly very small) firms to operate in larger markets. To do so, however, will demand a high level of entrepreneurial and management skill that is always difficult to muster in a new or very small business.

Employment and Skills

A general increase in overall economic activity could increase the demand for services, allowing small businesses to expand and/or encouraging the formation of new businesses. The Bureau of Labor Statistics predicts that the miscellaneous service sector, which has a large share of small businesses, will provide a large proportion of the new job opportunities over the next 15 years.[31] Many of these service industries, such as hotels, restaurants, educational and medical services are labor intensive and, although already automated to some degree, may not be as heavily impacted by automation as business services.

The Salvate microcomputer survey[32] indicated however that 11 percent of the small firms surveyed were able to eliminate employees because of the use of a microcomputer and 59 percent expected to cut back on employment needs in the future. A U.S. Chamber of Commerce survey[33] also showed staff reductions in 11 percent of the respondents' firms and 63 percent reported more efficient use of staff. A 1985 survey by the same organization showed that 16.5 percent of respondents plan to reduce hiring in the future because of automation. Since small business is the largest employment growth area, this could have significant impact on employment opportunities if it is representative of all small firms.

Drennan notes that less skilled labor which used to be concentrated in manufacturing is now concentrated in the service sector.[34] He predicts slower growth in clerical jobs in offices, including the business service industry, which is predominantly small businesses.

In the near future, higher level skills than are currently required may be needed by small businesses who wish to automate. However, in the long run, less skilled labor may be needed as people become familiar with computer equipment in grade/high school and as the equipment becomes more user friendly.

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[31] "Employment Projections for 1995" (Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 2197, March 1984), p. 31.

[32] Salvate, op. cit.

[33] U.S. Chamber of Commerce, op. cit.

[34] Matthew P. Drennan, *Conservation of Human Resources* (Washington, DC: U.S. Department of Labor Report, January 1983).

POLICY OPTIONS

The public interest in the health of small business is well established; a strong small business sector prevents overconcentration of economic power and wealth and provides opportunity for the exercise of initiative, innovativeness, independence, and challenge to obsolete industries and firms. Small businesses have also played a major economic role in job creation; training and testing of new workers; serving small, specialized, or dispersed markets; and productively utilizing resources that would otherwise be wasted. As small firms are faced with technological change that may bring about structural changes in their economic environment, the related public policy questions are:

- Will office automation make larger firms more efficient and allow them to participate in small and dispersed markets, putting small business at a further disadvantage? Or can small businesses also use office automation to become more productive and increasingly able to compete with larger firms, in local or in larger markets?
- To the extent that small businesses adopt office automation, will their important role in creation of new jobs diminish?
- If small businesses do not adopt office automation, will the economic and social benefit that they have provided by training new workers be diminished?

Only if they remain productive and competitive can small businesses continue to create new jobs, train first-time employees, serve specialized markets, and utilize marginal resources. In the future, this is likely to require them to participate in economy-wide changes in basic technologies—viable small businesses that did not adopt the telephone, the typewriter, electric lighting, and motor vehicles would be difficult to find. Thus, small businesses sooner or later will have to use computers and probably some other office automation.

Congress may therefore wish to consider actions to encourage and assist small businesses with efforts to automate. These actions need not involve major programs or large expenditures since they would be directed only at reducing the problems encountered by very small or beginning firms that have themselves made the decision and taken steps toward improving their productivity. Congress might, for example, urge the Small Business Administration to expand its instructional and counseling services to small entrepreneurs who are considering the use of office automation equipment for the first time. SBA could also provide initial training for employees of very small firms at low cost, or provide a telephone advice and information service to supplement the often inadequate support services available to small computer users through computer stores and vendors. It could provide incentives for banks to provide small low-interest loans for the purchase of computers, software, and maintenance and support.

Chapter 12

Office Automation and Differentially Affected Groups: Working Women and Minorities

Contents

Page

Section 1: Women in the Workplace 298
The History of Women and Work in the Office 298
Current and Future Labor Force Participation of Women 300

Section 2: Office Work and Minorities 302

Tables

Table No. *Page*

12-1. Minority Employment in Administrative Support Occupations, 1950-80 303
12-2. Minority Employment in Selected Occupations as a Percent of Total Employment, 1972 Compared to 1981 304

Chapter 12

Office Automation and Differentially Affected Groups: Working Women and Minorities

This chapter gives closer attention to two overlapping groups within society who have an especially strong stake in the long-range impacts of office automation—working women and workers belonging to racial and ethnic minorities. A number of issues are now actively before Congress related to employment and economic equity for women and minority groups. This assessment is not primarily directed at exploring these complex clusters of issues. The assessment nevertheless reveals obvious relationships between office automation, as a broad technological, economic and social trend, and the special concerns of working women and minorities, which have been noted throughout the report. This chapter is intended only to provide some general background on these themes in the hope of contributing to future, more detailed assessments of the effect of technological change on these issue areas.

Many of the trends discussed throughout this report will affect women office workers as compared to male office workers either differently or to a different degree, because men and women tend to be concentrated in different occupations, jobs, and industries, and at different levels of organizational hierarchies. Economic, social, and legal conditions of long standing, largely unrelated to technology, have a bearing on how technology effects the life of specific groups within the larger society.

With office automation there will be fewer jobs in some occupational categories and more in others; those now held predominantly by women are most likely to decrease in number, and those that women increasingly aspire to hold will change in less predictable ways. The possibility of working at home tends to have a different meaning for men and women because their family roles tend to be, at present, very different.

Congress now has before it a number of bills dealing with pay equity and comparable worth. These issues are not directly tied to office automation, but because automation will affect both the number and nature of office jobs and the skills they require, any attempts to compare jobs within a specific formal job classification or the demands of jobs across formal classifications must take such changes into account. The resolution of these issues will of course be determined by many other factors besides judgments about the comparability of jobs. Legal and regulatory pressures as well as economic, behavioral, and attitudinal factors and explicit management decisions affect how jobs are designed, how they are filled, and how they are compensated.

Section 1 of this chapter provides some background on the history of women's position in office work, summarizes their present white-collar occupational status, briefly discusses the evidence for pay inequity in white-collar jobs—particularly those directly tied to computer-related work—and highlights the relationship between these issues and the potential effects of office automation. The potential effects of office automation on minorities and their relatively recent entrance into these positions is explored in section 2.

SECTION 1: WOMEN IN THE WORKPLACE

The History of Women and Work in the Office

In the early 19th century men performed clerical work in offices as an apprenticeship in business. This was the first step on a career ladder that led to management positions. The tremendous expansion in commerce in the mid-19th century and the accompanying expansion in paperwork required a great expansion in the office work force. Many businesses grew in scale after the Civil War from small firms with a few clerks and office boys into large corporations with national and international interests. Organizations were restructured into functional divisions and clerical work tended to be broken down into specialized tasks requiring an increase in supervisory positions.

The first significant recorded use of women in an office in the United States occurred during the Civil War when, in spite of great opposition, the U.S. Treasurer General, Francis Elias Spinner, hired women clerks to alleviate a severe shortage of available male labor.[1] By 1880, offices were being mechanized with typewriters and telephones. Organizations (sometimes unwittingly) began to recruit women for de-skilled clerical jobs while the men retained the management/administrative jobs.[2] For example, "The Bowery Savings Bank of New York installed its first typewriter in 1894—without realizing that only females had been trained to use the new-fangled contraption. So the bank promptly hired its first women. . . ."[3] Although the new technology, typewriters, did not cause the expansion in office work that brought about the recruitment of women, it did facilitate the movement of women into office work, in that typing was not prelabeled as "men's work" and therefore unsuitable for women.[4]

[1]Margery Davies, *Woman's Place Is at the Typewriter* (Philadelphia, PA: Temple University Press, 1982).
[2]Joan Scott, "The Mechanization of Women's Work," *Scientific American*, vol. 24, No. 3, pp. 167-185.
[3]Sidney Feldman, "Women in Banking: An Overview of an Underutilized Resource," *The Bankers Magazine*, vol. 166, March-April 1983, p. 70.
[4]Davies, op. cit.

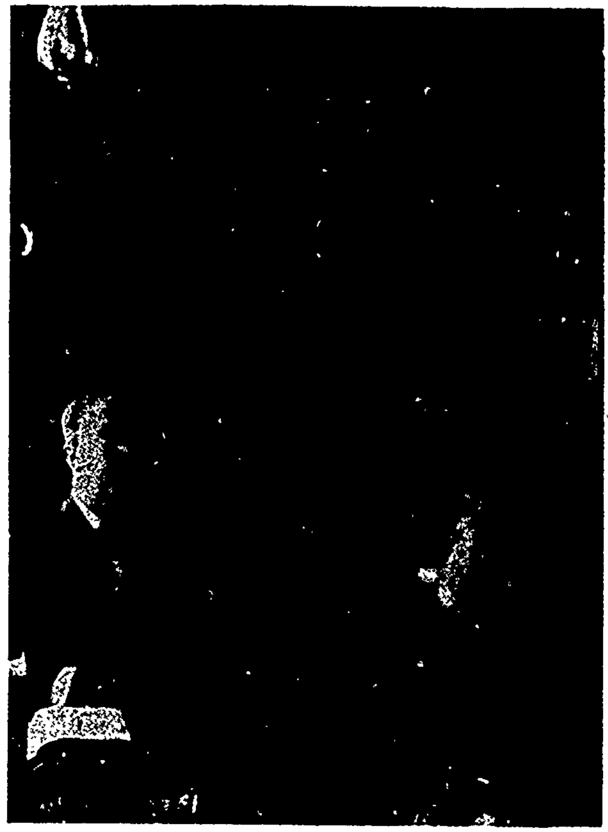


Photo credit: Library of Congress

Women were not accepted wholeheartedly into the labor force. There was strong opposition from young men who felt they would be losing opportunities because women worked for less pay. Many people felt that women would lose their femininity if allowed to work in offices and would then be unsuitable wives and mothers. Proponents argued that office work did not denigrate women but rather provided them with training that would make them better household managers, and also argued that the office would benefit from women's "higher moral code."[5]

When the U.S. economy was mainly agricultural, women were an equal and important part of the economic team maintaining a family farm. In addition, single working-age wom-

[5]Davies, op. cit., ch. 5.

en were often expected to earn some income from at-home work such as sewing, knitting, and preparation of food for sale. When women left the farm to work, it was as domestic workers and later as factory workers. For women, this meant higher wages and increased economic independence over work at home. However, their wages were still quite low and working conditions poor.

When office work became available to women, there was a large pool of women to seek these jobs, which were easier, cleaner, and had more status than factory jobs. Small farm employment declined from three-fourths of the labor force in 1820 to one-half in 1880. During this period many small family farms were barely able to make a living or went out of business, requiring their daughters to seek employment elsewhere.[6] The same thing was happening to many small family businesses that had used the unpaid labor of the owners' daughters.

In the first half of the 20th century, educational levels were increasing significantly, with many more women than men completing high school. Since literacy was required for office work, women gradually became the preferred sex for clerical employment in expanding businesses. Commercial business schools became common in the 1850s to fill the needs for clerks trained in office skills. They offered arithmetic, bookkeeping, penmanship, stenography and by 1880, typewriting. By 1890, they enrolled 80,000 students (for comparison, grades 1 through 12 enrolled 298,000 at that time).[7]

Until late in the 19th century, these students had been almost entirely men, but with the restructuring of businesses and office work and the cutting off of the career ladder from clerk to manager, men instead sought training in business management in the universities, whose now proliferating business schools did not admit women.

The opportunity to work in offices brought women into the labor market in steadily increasing numbers after 1890. In 1890, 17.4 percent of women aged 20 to 64 were in the labor force; by 1920, 22.9 percent and by 1940, 29.4 percent.[8]

In 1984, the participation rate for women aged 20 to 64 was 64.1 percent. Historically nonwhite women participated in full-time work in greater numbers than white women, but were limited to fewer occupations. Their rate in 1890 (for the same age group) was 39.3 percent and is currently 65 percent. Work force participation for men is about 75 percent.

The burgeoning of office work influenced women's increased participation, but other factors were also powerful. Birth rates had been declining throughout American history; whether this was a cause or an effect of women's growing participation in the work force is a matter for some debate. Birthrates declined in the period 1890-1947, reaching historic lows during the 1930s. The birthrate increased rapidly during the 1950s, the baby boom years. These periods were paralleled and reflected in labor force participation rates for women of childbearing years, which increased steadily between 1890 and 1947, and decreased for 20- to 35-year-old women in the 1950s.[9]

During this century, the acceptance of married women in the labor force slowly increased. In 1900, less than 2 percent of married women were employed, and employers often fired working women who married and did not voluntarily leave. But from 1920 to 1940 their participation rate doubled, from 9.7 to 20 percent.[10]

Women's participation rates in past decades did not increase at the same pace for all age groups. Women went to work in great numbers during World War II. Women whose children were past early childhood tended to stay in the labor force after the war, while the par-

[6]Davies, op. cit., ch. 4.

[7]Janice Weiss, "Educating for Clerical Work: The Nineteenth Century Private Commercial School," *Journal of History*, spring 1981, p. 407.

[8]James Smith and Michael Ward, "Women's Wages and Work in the Twentieth Century" (The Rand Corp.), October 1984.

[9]Ibid. p. 5.

[10]Ibid. pp. 7-9.

ticipation of younger women dropped considerably in the late 1940s.[11]

Discrimination kept the majority of women working in offices in clerical positions until recent times. In 1919, Civil Service examinations covered 260 occupations, but for nearly 60 percent of those occupations, the examinations were not open to women.[12] As recently as the 1960s positions were advertised in newspapers as "male" and "female."

Current and Future Labor Force Participation of Women

In 1984, 53 percent of all women aged 16 or older were in the labor force in the United States, totaling nearly 44 percent of the civilian work force.[13] Between 1972 and 1982, women accounted for 68 percent of the 14 million increase in employment in white-collar occupations. For those women born in 1951 to 1955 (now 30 to 34 years old) the participation rate is now 66.7, a considerable increase over earlier cohorts.[14] As older women, who were raised, educated, and socialized when the traditional nonemployed housewife was the norm, decline in numbers, the overall participation rate can be expected to rise. Moreover, the birth rate is likely to remain low, and there has been a dramatic increase recently in continued labor force participation of women during childbearing years, including continued participation by mothers of young children.

The available work force in 2000 will consist predominantly (75 percent) of people already in the work force in 1985. Today, 80 percent of the clerical work force is female, and 30 percent of working women are clerical workers. That gender segregation in clerical jobs has, over the long range, been increasing in spite of changing social attitudes and public policy objectives. Women continue to cluster in traditionally female occupations, constituting 80 percent of all administrative support workers compared to only 32 percent of managers, administrators, and executives in 1983.[15] These higher level jobs account for only 7 percent of all jobs held by women, even though they include many members of the traditional female occupations of registered nurse, health technician, elementary school teacher, librarian, and social worker. Where women are in management positions, they are mostly in the lowest rungs of management.[16]

A report on Microelectronics and Working Women for the National Research Council notes that although there has not been widespread labor displacement of women by means of layoffs, there has been lack of growth in occupations that have been their main source of employment.[17] In the United States, employment growth in the clerical occupations shows a lag behind increases in the volume of business in insurance, banking, and other offices where women have been so highly concentrated. A Canadian study confirms that jobs such as secretaries, filing and other office clerks, bank tellers, keypunch operators, telephone operators, mail handlers, and the supervisory personnel for these positions are among the slower growing occupations.[18] OTA's analysis (chapter 2) points to a long-range decline in jobs held predominantly by women. Already employment declines have occurred in the heavily automated insurance industry in keypunch operators, bookkeepers, file clerks, mail handlers, and typists.[19]

[11] Women's household burdens decreased during the early 20th century because of fewer children and because of the introduction of labor-saving devices for the home. There is still debate, however, as to whether or not this provided housewives with extra free time; there were also fewer women per household, the family servant disappeared, and new tasks appeared.

[12] Davies, op. cit., app. table 5.

[13] *Employment and Earnings* (Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, January 1985), p. 156.

[14] Smith, op. cit., p. 8.

[15] *Facts on Women Workers* (Washington, DC: U.S. Department of Labor, Office of the Secretary, Women's Bureau, 1984).

[16] *Time of Change: 1983 Handbook on Women Workers* (Washington DC: U.S. Department of Labor, Office of the Secretary, Women's Bureau, 1983), Bulletin 298, pp. 52-53.

[17] Diane Werneke, "Microelectronics and Working Women: A Literature Summary," Committee on Women's Employment and Related Social Issues (Washington, DC: National Academy of Sciences, 1984), prepared for the National Research Council.

[18] Werneke, op. cit.

[19] Eileen Appelbaum, "The Impact of Technology on Skill Requirements and Occupational Structure in the Insurance Industry, 1960-1990" (Philadelphia, PA: Temple University, Apr. 1, 1984).

Future employment opportunities for women, although dependent on growth of total demand in the economy, may be more dependent on the opportunity for increasing their skills, work experience and upward job mobility, which would allow them to take advantage of changing job requirements. However, these opportunities may not materialize. In the insurance industry, as overall female employment has increased in all job categories, the professional jobs into which they have moved have frequently been changed to lower pay levels to reflect lower skill levels.[20]

New jobs are emerging in the computer and technical specialist occupations, especially for engineers, computer analysts, and paraprofessional computer technicians, positions in which relatively few women are employed. According to the Bureau of Labor Statistics, computer specialist jobs increased from 275,000 in 1972 to 585,000 in 1980. Women increased their share of these jobs from 17 percent in 1972 to 26 percent in 1980. However, women were more likely to be programmers than systems analysts (a higher level, higher paid position).[21]

Whether it cuts off career ladders, eliminates unskilled clerical work, or requires more or different training and skills, office automation will change the nature and skill requirements of traditional office occupations and jobs.[22] Whether or not these changes will be reflected in changes in job title, job classification, and compensation levels remains to be seen. Historically, "women's" jobs have paid less than "men's" jobs. The figures comparing men's and women's average salaries are well known, as are the many discussions of the reasons for the differences. The reasons usually offered include differences in education and experience, occupational and industry choices, job mobility and number of hours worked. However, men who go into "female" lines of work earn more than women in those fields. Female full-time, year-round clerical workers had a median income of $10,997 in 1980 while male clerical workers had a median income of $18,247. A similar differential is found in all occupations.[23]

Pursuing a career in the computer industry does not automatically alter traditional relationships. There were compelling reasons to expect to find relatively little male-female disparity in computer-related occupations, especially programming. The occupations are new, women have been involved in the field from the beginning, there has been a steady sellers' market, and the growth of the industry coincided with implementation of affirmative action and equal employment regulations. However, women are paid less than men in every computer specialization, in every industry, and at every organizational level.[24]

The possibility of a general decline in compensation associated with de-skilling of work and enhanced interchangeability of workers (generally in conjunction with anticipated job polarization) is also of concern to some researchers. While these conditions have been noted in specific organizations, particularly those in office-oriented industries, the counter trend toward job enlargement in both office-oriented industries and general offices may provide some offset. Another uncertainty is the effect of large-scale shifts in the structure of the economy, together with changes in labor supply, on the wage structure (holding job content constant).

Some observers express concern about undercompensation for skills that may not be

[20] Barbara Baran, "Insurance Industry and Trade Strategies," draft report prepared for the Office of Technology Assessment, September 1984, p. 6.

[21] Carol Boyd Leon, "Occupational Winners and Losers, 1972-80," *Monthly Labor Review*, June 1982, p. 22.

[22] Arbeidsnotat fra forskningsprammet "Teknologiens betydning for kvinners arbeidsliv" (Working Paper From the Research Program "Technology and Women's Work") *Journal for Social Research*, vol. 23, 1982, pp. 519-534; Roslyn Feldberg and Evelyn Glenn, "Technology and Work Degradation: Effects of Office Automation on Women Clerical Workers," *Machina Ex Dea*, Joan Rothschild (ed.) (New York: Pergamon Press, 1983), p. 72; and Baran, op. cit., p. 136.

[23] "American Women: Three Decades of Change" (Hearings before the U.S. Congress, Joint Economic Committee, Washington, DC, Nov. 9, 1983), Testimony of Lewis Kincannon, Bureau of the Census, p. 26.

[24] Philip Kraft, "Computers and the Automation of Work," State University of New York at Binghamton and Center for Survey Research, University of Massachusetts, 1984.

captured in formal job descriptions but are nevertheless essential. Automation may de-skill some jobs, but it may also involve a change from manually intensive work to mentally intensive work that requires closer attention and increased responsibility for accuracy. Increased knowledge about the operations of the whole organization may be required to ensure accuracy of data input. These "invisible skills" become apparent only when they are not performed well.[25]

As office automation changes tasks and jobs, blurring the distinctions between "men's" and "women's" work and between clerical and professional work, the opportunity is available to objectively evaluate jobs, their skill requirements, and compensation. Major changes in the occupational mix and in job content are likely to bring about pressure for new pay structures. In economic theory, individual pay is a function of the contribution of the individual to the organization's output; hence, pay generally increases with productivity. In a competitive market wages are also influenced by supply and demand. For example, an abundance of teenage candidates for fast food-service work in the recent past may be one reason why the pay is low. That situation is changing now with the decrease in the number of young workers entering the labor force. But in practice, other factors confound pay structures so that there may not be a direct relationship between the pay and the supply of workers. If fast food restaurants in the future were faced with raising pay rates to attract needed workers, they could further automate their tasks and insist on more self-service by customers. It is evident from the experience in other consumer service industries, for example banking, that we are becoming more and more a self-service society. This could also be the case in offices as professionals perform their own typing and graphics tasks and clients input information directly into computers, receive output directly into their own computers, and print the information themselves.

The effect of information and communication technologies on the nature of work, on job classifications, and on compensation structures is thus far broader than the issue of pay equity and comparable worth for women, but it will have a direct and immediate relationship on those discussions.

[25]Joan Greenbaum, Cydney Pullman, and Sharon Szymanski, The Labor Institute, "The Impact of Office Automation on the Municipal Workforce of New York City: A Case Study," contract report for the Office of Technology Assessment, April 1985.

SECTION 2: OFFICE WORK AND MINORITIES

Black workers account for 10.2 percent[26] of the clerical work force, which is comparable to the black share of the labor force and the population. Hispanic Americans account for 5 percent of this occupational category.[27] For minority women, especially, the movement into clerical jobs has in fact represented an important channel of upward social mobility.[28] (See table 12-1.) They began moving into office work in significant numbers only in the 1950s. Black women increased their share of clerical jobs by 163 percent between 1950 and 1960. Women of Hispanic origin increased their share by 333 percent,[29] now making up about 4 percent of the clerical work force.

[26]*Employment and Earnings* (Washington, DC. U.S. Department of Labor, Bureau of Labor Statistics, January 1985), p. 177.

[27]The Hispanic category includes black and white Hispanics, so the true number of black clerical workers is difficult to ascertain.

[28]See: Diane Nilsen Westcott, "Blacks in the 1970s. Did They Scale the Job Ladder?" *Monthly Labor Review*, June 1982; Center for the Study of Social Policy, "A Dream Deferred: The Economic Status of Black Americans," July 1983; and Thierry Noyelle, "The New Technology and the New Economy: Implications for Equal Opportunity," work in progress, Columbia University, New York, February 1985.

[29]*U.S. Census of Population for 1950. Occupational Characteristics*, Special Report P-E No. 1B, p. 1B-31, and *U.S. Census of Population, 1960: Occupational Characteristics* (Washington, DC. U.S. Department of Commerce, Bureau of the Census, p. 23).

Table 12-1.—Minority Employment in Administrative Support Occupations, 1950-80

Year	Total	White Male (%)	White Female (%)	Black Male (%)	Black Female (%)	Other Male (%)	Other Female (%)
1950	6,864,600	2,476,710 (36.1)	4,187,820 (61.0)	109,740 (2.1)	75,060 (1.1)	5,580 (0.08)	9,690 (0.14)
1960	9,617,874	2,821,463 (29.3)	6,048,678 (63.3)	184,823 (1.9)	197,263 (2.1)	22,504 (0.23)	41,998 (0.44)
						Hispanic Male (%)	Hispanic Female (%)
1970	13,748,260	3,258,901 (23.7)	9,346,947 (68.0)	330,492 (2.4)	691 097 (5.0)	144,309 (1.1)	297,136 (2.2)
1980	16,851,398	3,235,744 (19.2)	11,325,716 (67.2)	435,365 (2.6)	1,200,516 (7.1)	234,132 (1.4)	595,461 (3.5)

SOURCE Data are derived from the U S Department of Commerce, Bureau of the Census, *U S Census for 1950-1980*, Washington, DC.

Between 1960 and 1976 the proportion of minority women workers employed as domestics dropped from 35 to 9 percent, while the percentage employed in clerical work increased from 9 to 26 percent, and the percentage in professional and technical jobs rose from 7 to 14 percent. Half of all minority women were in the work force in 1976, compared to 47 percent of white women. The movement of black and Hispanic women into office occupations has thus occurred almost entirely within the last 30 years and has aided many of them to move into the middle class.

By 1980, over 29 percent of employed black women held clerical jobs, and 14 percent held professional jobs. The wages of all minority women relative to white women rose from 70 percent in 1960 to 94 percent in 1976.[30] But between 1976 and 1980 their income slipped to 86 percent of that of white women. In 1976, black female clerical workers' wages were 107 percent of that of white female clerical workers, but it slipped to 97 percent in 1980.[31] One reason for the higher level in 1976 is thought to be that black women had been in these jobs longer and thus had higher pay levels because of seniority. After 1976, higher paid, educated black women may have been moving out of clerical work and into supervisory, management, and professional jobs as these options opened up for them.

Black and Hispanic males also increased their share of clerical jobs considerably between 1950 and 1960. Black males held a larger share of clerical positions in the 1950 census than did black females. The balance changed however by the time of the 1960 census, when black women slightly outnumbered black men in clerical jobs; they have increased this gap steadily since 1960.

During the 1970s, minority workers made significant gains in moving into white-collar occupations and in advancing within these occupations. Their share of professional jobs such as credit and collection managers and office managers increased tremendously as did their share of clerical jobs such as bill and account collectors, secretaries, and statistical clerks. The jobs that showed the largest growth for minorities between 1972 and 1981 are shown in table 12-2. Many of these positions are, however, still at the lower end of the scale and thus most likely to be affected by job displacement from office automation; the black workers also tend to have least seniority since these jobs became open to them only in recent years.

Because of a growing economy and the active interest in social change in the United States, employment opportunities for minorities have seen noteworthy improvements in the last two decades. However, black workers still have significantly higher unemployment

[30] "Minority Women Workers. A Statistical Overview," *Manual on Pay Equity: Raising Wages for Women's Work*, Joy Ann Grune (ed.), Committee on Pay Equity, November 1981, pp. 31-34.

[31] Westcott, op. cit., p. 37.

Table 12-2.—Minority Employment in Selected Occupations as a Percent of Total Employment, 1972 Compared to 1981

Occupation	Minority employment (%) 1972	1981
Computer specialists	5.5	9.4
Bank officials and managers	2.6	5.5
Credit and collection managers	1.4	4.4
Office managers	1.0	4.0
Bank tellers	4.9	7.6
Billing clerks	6.7	10.5
Bookkeepers	3.6	6.3
Collectors, bill and account	5.0	10.8
File clerks	18.0	22.9
Secretaries	5.2	7.2
Statistical clerks	8.4	15.1
Typists	12.0	17.8

SOURCE U S Department of Labor, Bureau of Labor Statistics, *Current Population Survey A Databook*, vol 1, Washington, DC, 1982, pp 651-667

rates than whites and also higher rates of involuntary part-time work. Both of these trends could be intensified by the use of office automation. The changing nature of skills required for beginning and mid-level jobs and the changing nature of job training (see chapter 3) will also have an effect on the future employment levels of minorities in offices, unless their access to training is increased. Minority workers will have to find ways to obtain the more formalized and more off-the-job training required to fill positions in the office.

Another problem for the minority workers is the strong trend in the last decade for offices to move from the central city to the suburbs, and for business and industries to grow in the South and Southwest and shrink in the Northeast. Because 55 percent of black Americans live in central cities, as compared to 24 percent of whites, and only about 22 percent of blacks live in the suburbs, the movement of offices from central cities to suburbs decreases their opportunity for office employment. Government employment in central cities, which has been a significant source of employment for minority workers, is likely to stabilize and may well decline. The shift of office work to the Southwest tends to further decrease the access of black women to office jobs, although it increases opportunities for Hispanics.

The greater instability of worklife for minorities and their concentration in the lower level clerical jobs indicates that their efforts to better their status may be more difficult in the future than it has been in the past decade. The availability to them of training and education and the continued growth of the U.S. economy is of the highest importance if minorities are to maintain and increase the progress they have made.

Appendixes

Appendix A

The Technology of Office Automation

Business is now faced with the problem of controlling 400 billion documents, a number that is increasing at the rate of 72 billion per year.[1] Fortunately, technology is providing the means of electronically storing billions of characters on a single device and moving data at the rate of millions of characters per second. This appendix describes the technologies that are in use in offices, those that may be applied in offices during the remainder of this century, and how they may affect office operations.

Information is ephemeral. It must be available when and where it is needed; too late, it may be useless. The goal in applying information technology is to deliver information to the end user on time and at the lowest possible cost. Information technology eliminates distance as a significant factor in determining the degree of operational control that managers can exert over operations. It reduces the time required to analyze large volumes of data and makes the resulting information available to those who need it for decisionmaking.

Overview of Appendix

This appendix describes the technologies for information processing and telecommunication in the office. First, a taxonomy of the functions of the office is presented, followed by a description of relationships between the functions and the technologies that are now available or could be available in the future. Following that is a more detailed description of the technologies and the options for employing them.

A Systemic View of the Office

The following functions comprise the set of major office activities:

- data gathering,
- data organization and storage,
- data access and retrieval,
- data processing, and
- communication of results.

[1] C E White, C "USTA and AT&T," *Telecommunications*, April 1985, p. 44.

Data Gathering

Information flows into an office from the internal accounting systems of the organization, customers and prospective customers, government agencies, suppliers, trade groups, and other sources. Intraorganizational data flows constitute a significant portion of the total. Data, once received, must be put into a form suitable for processing. Some has to be transcribed from one medium to another. For example, an order that is received by telephone has to be recorded on an order form. On the other hand, automatic readers in supermarkets capture all the data needed for inventory control as a byproduct of the checkout procedure.

Traditionally, the process of transcribing data from one medium to another has constituted a significant portion of the work. Large numbers of people worked at typewriters transcribing manuscript and at keypunch machines transcribing information from documents to punched cards. Modern technology is reducing the need for transcription. Professionals now create text that clericals edit and format rather than transcribe. Scanners are included in materials-handling systems to capture data in a form processable by machine.

Data Organization and Storage

Data is useful only if it is organized in a way that makes it identifiable and accessible. Offices have used multipart forms and files housed in cabinets for organizing and storing data. Modern technologies for data storage and organization range from large-scale computers that are capable of handling hundreds of millions of records, as in the case of the Social Security Administration, to small data bases containing a few dozen records that are stored on personal computers. Copying machines reduce the need for multipart forms because additional copies can be made on demand. Telecommunication lets responsibility for organizing and storing data be assigned to those responsible for gathering it. Or all of an organization's data can be gathered in one central location. In either case, all who require access can have it immediately regardless of their physical location.

A shared database reduces the problems of keeping multiple copies of data synchronized. But not all data in an office is meant to be shared. Much consists of working documents useful only to specific individuals.

Data Access and Retrieval

The third function provided by an office is data access and retrieval. Implicit in this function is making all who may need data aware of its existence and denying access to it by others. In a paper based office, one of the means of assuring awareness of data is to provide potential users with "information" copies of documents. Others who need data must then seek out one of the existing copies and its accessibility to those not authorized to have it is implicitly limited. On the other hand, errors in data are often discovered after documents have been distributed, and corrective information has to be sent to all who have copies so that all are operating from a common base of information. This goal is difficult to attain.

Paper-based files may be less than satisfactory because of the time that it takes to move physical documents from point to point. Advanced technologies do not constrain the accessibility of data to those in a specific geographic area and thus reduce some of the limits on office operations.

It is most efficient to access only those data of interest. In the past, the user had to obtain one or more documents and sort through them for specific data of interest. With the aid of modern technology, the user can identify and retrieve specific data elements that are needed.

Data Processing

The tools for data analysis range from hand-drawn graphs depicting relationships between and among data elements through programs run on the most powerful computers. Nonnumeric data is assembled in tabular formats for study and analysis.

The speed at which humans can process data is limited regardless of whether they are performing numerical calculations, preparing charts and tables, or creating text. It is unreasonable to expect an individual to even attempt some computations. But modern information technology provides powerful tools, ranging from systems that will retrieve and order data to user specifications, to those that routinely prepare reports representing thousands of individual data items. The trend is to reduce the need for professional data processing personnel by providing users with easy to use tools having great analytical power.

In addition to automating traditional data reduction and reporting tasks, modern technology puts new capabilities in the hands of users. Word processors make it easy to alter text and combine or refine documents. Computer-based models can be used to explore the consequences of decision alternatives. These range in complexity from comparatively simple spread sheets to econometric and process simulation models that involve the interaction of hundreds of variables. Decision-support systems can provide insight into the consistency or interaction of judgments made by the decisionmaker.

Experience over the last 30 years shows that users constantly find new and previously unforeseen ways to employ this technology effectively. As the number of users has increased, the technology has evolved to require decreasing degrees of technical sophistication from the user. Innovative applications will thus continue to emerge.

Communication of the Results

Another function of an office is the delivery of information. Traditionally, it has been delivered either orally or in hard copy. Preparation of hard copy requires considerable effort, and transporting it requires time. Orally transmitted information is ephemeral and difficult to capture; transcription is required if an enduring record is to be created.

Modern technology lets the user specify the format in which information is delivered. It can be presented for viewing on a display screen but can be easily replicated. Telecommunication has largely neutralized distance as a factor. Many users can work from a common database eliminating the problem of inconsistent data.

Users and Providers

The trend in applications of advanced technology in the office is toward direct involvement of the user with minimal technical training. The technologies to support these systems comprise two relatively distinct classes. The first consists of centralized data processing equipment that is used to prepare printed reports as well as provide for direct user interaction through terminal devices. The second includes a variety of stand alone devices, microcomputers and word processors that are under the direct control of the end users.

The user seeks a functional capability rather than a specific technology. From this perspective, the terminal tied to a central computing facility can be the functional equivalent of a personal computer. However, from the systems point of view of managing the information resources of an organization, the alternative technologies can have quite different implications. For example, in an office served by a centralized facility, both the reporting needs of the organization and the needs of users for selective access can be supported from a common, shared database. On the other hand, coordinating the activities of users of personal computers who each define and structure data resources differently, may present a considerable problem for management.

Complicating this problem is the fact that the technology is not neatly divided into centralized processors and individual workstations. There are hybrids of these technologies. Microcomputers can be linked to central facilities to retrieve data that can then be processed at the user's location. Alternatively, networks of microcomputers permit the sharing and interchange of information. Thus, one of the effects of the emerging technologies is that the functional characteristics of an office system can be defined almost independently of the technologies used to implement those functions. Furthermore, while the end product of a system may be achieved through alternative means, the internal structure of a system can have significant implications for the operations of an organization, its employees, and its management.

Technology consists of tools and the knowledge of how to use them. Computers and telecommunication networks are virtually valueless to those who do not have a clear understanding of how they fit into the office environment and the benefits that can be derived from them. Systems put in place without such understanding have often failed to meet the needs of users. These failures represent a waste of significant resources and, in many cases, result in the creation of barriers to future introductions of technology.

Equipment Providers

The providers of technologies for the office come from three distinct heritages. First, there are the suppliers of the kinds of equipment that have been in offices for decades—typewriters, calculators, copying machines, etc. They have traditionally assumed a comparatively rigid division of tasks among office workers. Secretaries type; professionals use paper and pencil. They are accustomed to selling to office managers who buy equipment as though it were standardized, like paper clips and forms.

Computer manufacturers comprise the second class of equipment suppliers. They are most comfortable dealing with professional technicians and have had little contact with other office workers. While programmers and analysts were interposed between the computers and the end users, sellers of computer systems did not find it necessary to structure their products to be understandable by nontechnical people. Technicians were assumed to know the strengths and limitations of the equipment and to take the steps necessary to ensure its operability and the integrity of the work it supported. Data processors, for example, know the importance of creating backup copies of data; office managers often do not.

The third group of providers of technology to the office are telecommunication specialists. Their traditional role was to place telephones where needed and keep them in repair. Organizations with significant communication requirements worked with the providers of telephone service to establish private networks when such steps were economically justified. Data communication facilities were generally separate from voice services. Additional circuits were obtained for facsimile and video transmission as required.

The divestiture by AT&T of its operating companies and the emergence of a variety of competitors has complicated the job of the telecommunications manager. There has also been a marked increase in data traffic and in requirements that voice, data, and other traffic share telecommunication facilities. This has required that telecommunication mangers become heavily involved in the design, development, and operation of information processing systems. They must now work closely with technologies that are often unfamiliar.

In the past, the office manager, telecommunication manager, and data processing manager have been able to operate more or less independently. Each had a constituency of users able to maintain a marked level of distinction between the three classes of support services. Now there is a need for greater interaction, a need that will increase with time.

Equipment and service providers from each of the three sectors have moved into areas served by the others. Computer manufacturers offer word processing systems; some word processors now have the same capabilities as small to midrange computer systems. All offer telecommunications equipment, and telecommunication providers are beginning to offer processing services. From the point of view of the user, this competition is probably beneficial, but each kind of provider may have difficulty in understanding the nuances of new markets. For example, the firm that has been successful in providing word processing equipment may not grasp all of the operational ramifications of expanding its line to include capabilities normally associated with data processing.

The Merger of Telecommunication and Information Processing

In 1956, AT&T, in a consent decree, agreed that it would not build data processing machines for sale on the open market. In the mid-1970s, it offered for sale a terminal that had some processing capabilities; and the question of whether that violated the 1956 consent decree led to an inquiry by the Federal Communications Commission, called Computer Enquiry II. One of the purposes of this proceeding was to establish a line of demarcation between telecommunication and data processing equipment and services. The final report sidestepped the issue; it failed to differentiate between telecommunication and data processing, but defined a set of basic telephone services that could be offered by AT&T and enhanced services that could be offered through an arm's length subsidiary. This put to rest the assertion that telecommunication and data processing services and equipment could be differentiated. The interaction of the two technologies has changed the fundamental character of both.

One result is the ability to deliver information processing services directly to the end user through a variety of system configurations. Terminals can be connected to a central processing facility through either the conventional switched telephone network (dial-up service) or through a dedicated network "owned"[2] by the user organization. In this configuration, all processing takes place at the central site. A variation of this substitutes computers for the terminals so that some of the processing is done at the user location and some at the central location.

Alternatively, a communication network may include only small computers under the direct control of end users, using the network facilities to access data wherever it is located. Processing functions are controlled by the end users with, possibly, some coordination activities being the responsibility of a central data processing function.

Telecommunication facilities can be designed so that they perform processing functions as well as provide a conduit for moving information. For example, the network can convert codes used by one type of equipment to a format usable by another so that the two can exchange data. Network switches can route data between locations on the basis of address information that constitutes part of the message. They can also combine information from a number of incoming messages into another that is sent to a specified destination.

Advanced telecommunication equipment available for offices can select the lowest cost alternative for routing each call, with some calls routed over one of the public long distance services and others over the organization's private network. Some equipment can combine voice with data traffic on a common internal network. Computers that comprise an office local area network function as the switches for the network while at the same time providing its data processing capabilities.

Broad Trends in Telecommunication and Information Processing Technologies

The foundation of new office technologies is the integrated circuit. The equivalent of hundreds of thousands of transistors can be built on a silicon wafer with an area of a fraction of an inch. Although many argue that the limits of silicon-based chip technology are being approached, the component density of chips can continue to increase at least in the short run. Alternative technologies are likely to become a factor in the market in the 1990s. Gallium arsenide, for example, offers potential advantages in speed relative to silicon oxide technology, and may provide a foundation for new materials that are more optimal than silicon for microelectronic circuits. Chips that have circuit components distributed in three dimensions rather than two are likely to be on the market in the relatively near term, with improved performance to price ratios relative to those now available.

Increasing the number of components that can be built into a single integrated circuit, by reducing the physical size of a circuit increases its speed

[2] An "owned" network, more often than not, will make use of circuits that are leased from a common carrier and dedicated for the use of the lessee. In some cases, organizations will build and operate their own telecommunication facilities that may include such diverse components as ground stations for use with satellite transponders, microwave towers, and fiber optic cable. The balance between leased and owned facilities is struck by each organization to be consistent with the cost schedules for the alternatives and other, noneconomic consideration (e.g., the organization makes the judgment that it does not want the problem of operating a satellite Earth station).

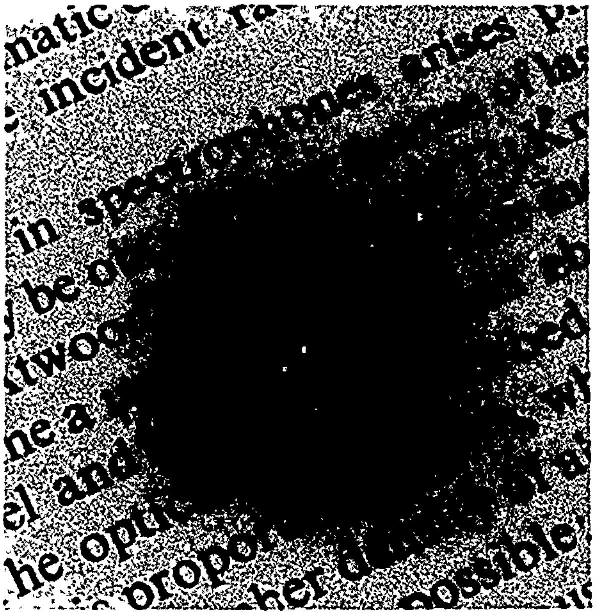


Photo credit: Bell Labs

One of the continuing trends over the last several decades has been the reduction in the size of the microprocessor. This shows a very large-scale integrated memory management chip.

and hence the computational power of devices. As production volumes grow, the prices of chips fall. Generally, this is translated into increased performance to cost ratios for equipment. Fewer chips are required for end-user devices, again lowering the cost to build them and reducing the cost of maintenance.

Thus, the cost of office equipment will continue to decrease, but they will not go to zero; the bottoming of prices is likely in the next few years. Beyond that, the benefits of technological improvements are likely to be in the form of improved performance at relatively stable prices.[3]

Optics[4] may provide an alternative to electronics as the basis for the operations of computing and communication devices. Already, fiber optic conductors are being deployed widely in telecommunication networks. They offer advantages over copper wire, microwave and coaxial cable technologies in the form of reduced physical size, elimination of interference between messages carried over conductors in a common cable, and increased security (because fiber optic circuits are more difficult to tap). The use of optical devices in switching and storage devices is still a subject of basic research and is not likely to be a significant factor in the market in the near term. Such devices, if perfected, could offer advantages over microelectronics in that they could be less susceptible to electrical and magnetic fields generated by office machinery. In addition, since they would not emit electromagnetic radiation that can be detected and decoded, they would provide more data security.

Because the prices of computer components are expected to continue to decrease, it is possible that functions now performed by software may be built into the hardware. For example, one of the most popular spread-sheet programs is now built into a portable lap-top computer and operates as if it had been loaded as a diskette. On larger systems, complex programs such as language processors, database systems and communication processors may be included in machine hardware.

A logical extension of this concept is the development of limited function machines dedicated to a specific task or a narrowly defined set of related tasks. Familiar examples of dedicated devices include stand-alone word processors and hand-held calculators.

But running counter to the trend of building increased capabilities into the hardware is the recent emergence of reduced instruction set computers (RISC).[5] These computers have 50 or so instructions in their repertoire rather than the well over 100 found in conventional machines. By processing a few types of instructions very quickly, RISCs can in theory outperform those with more complex instruction sets. A greater burden is placed on software designers to optimize their designs in light of the attributes of the machines. RISCs have gained some degree of commercial acceptance, because tests have shown that in some applications they can outperform conventional computers. However, all of the reasons for this improved performance are not fully understood. Changes in conventional computers that would use some of the coding techniques and architectural features found in RISCs may yield significant improvements in their performance.

[3] This statement has to be taken with a grain of salt. In the early 1970s a calculator with four functions, memory, and square root sold for something over $100. In the last year, a major manufacturer of electronic equipment gave away such a calculator as part of a promotional campaign. This adds some credibility to the argument that equipment could become a "throw-away" provided at no cost to the user who buys some package of services.

[4] Computers and communication devices can be built of components that manipulate light waves just as microelectronic devices and conventional communication network components manipulate electrical currents.

[5] "RISCs—Reduced Instruction Set Computers—Make Leap," *Systems and Software*, December 1984, pp. 81 ff.

The users of office automation are less interested in the nuances of the technologies used to implement systems than they are on the functional characteristics of those systems. Just as most automobiles are bought to provide transportation, not as a hobby for the amateur mechanic, most users of office systems want specific tasks performed and care little about the inner workings of the computer. Designs of newer office systems are generally moving in the direction of insulating the user from the specifics of the underlying technologies.

Many of the application programs now commonly used in offices are accompanied by thick jargon-laden manuals purporting to inform the user how to obtain the promised benefits from a package. Some of the newer systems, on the other hand, are self explanatory and are accompanied by minimal amounts of paper documents. In the long run, information processing systems will, like the automobile, evolve to the point where the user can operate them with only minimal understanding of their underlying technical structure.

As the capabilities of applications and hence their complexity increase, total development costs for office systems have tended to rise. However, emphasis is moving from systems tailored to meet needs of specific organizations to those having sufficient generality to meet diverse needs. Because these generalized capabilities can be sold in volume and development costs can be spread over large user communities, their price should fall.

These tendencies toward lower priced microelectronic circuitry and systems designed to minimize requirement for technical expertise, together with the merger of telecommunication and information processing imply:

- a broad and increasing choice among technological options for accomplishing information-handling objectives;
- a strong movement toward distributed data access and data handling, usually superimposed on rather than superceding centralized automatic data processing;
- more and more capture of data at the point of origin, with decreasing need for repeat keyboarding and centralized data entry; and
- unlimited capability for communication, between devices, between organizations, and between locations.

Managers will have the freedom to define organizational policies and objectives with more alternatives for implementing them. This creates a greater need for analysis to make good selections. Both for the designer and user of office systems there may have to be a significant rethinking of the way an office operates if the potential benefits of the technologies are to be realized.

Trends in Specific Technologies

From a functional perspective, information processing and telecommunication technologies can be grouped into five broad categories: 1) processors, 2) input technologies, 3) storage, 4) communication, and 5) software. Trends in each of these areas will be discussed in the sections that follow.

Processors

The Microcomputer.—The microcomputer that is becoming ubiquitous in many offices is the smallest of computers, followed by, in increasing order of size, minicomputers, mainframes and supercomputers. These constitute a continuum of capabilities, with considerable overlaps at the boundaries between classes. A large microcomputer may have roughly the same capacity as a small minicomputer.

Conceptually, given enough time, any computer can perform all of the computational tasks that can be envisioned. They all operate on the same principles. Realistically, however, large computers are necessary to perform tasks that require the manipulation of large databases and extensive computations. A large computer can also simultaneously support many small tasks each of which could be handled alone by a smaller computer. Thus, one alternative for offices is to provide all processing support from one or more large computers with many terminals.

Generally, microcomputers are designed to be used by a single individual and to perform one task at a time. In 1985, a microcomputer for use in the office can be purchased without a printer for $1,500 to $3,500. A printer, depending on the quality of the output desired, can be bought for an additional $300 to $2,000.

Microcomputers capable of supporting multiple tasks and several users simultaneously are coming on the market. Programs that allow two or more programs to be active simultaneously are available. Networking microcomputers has become possible using programs and hardware components purchased off the shelf. A variety of generalized spread-sheet, word processing, accounting and utility packages are available from both computer manufacturers and third-party suppliers. Thus, office workers will have under their direct control computer power that until very recently was found only in corporate data centers. At present they need to develop the expertise to modify existing procedures and design new ones to take full advantage of the available capabilities. But this could lead to a significant redistribution of function and power between data processing groups and end users.

Stand-Alone Word Processors.—Stand-alone word processors are microcomputers whose hardware and software configuration has been optimized for word processing. As other software, such as data management and spreadsheet programs, are made available for them, the dedicated word processor becomes indistinguishable from a general purpose microcomputer. But as yet, with a few exceptions, the manufacturers of word processors have not significantly broadened the application packages for these machines.

Electronic Typewriters.—Electronic typewriters have limited word processing capabilities built into the circuitry of the machine. The repertoire of the machine is fixed and the purchaser does not have the option of either expanding or modifying the capabilities.

Integrated Office Workstations.—Integrated office workstations are now being developed that combine a personal computer, telephone, and modem in one desk-top device, providing a voice, text, and data terminal that can communicate with other computers. First generation versions are now coming on the market. Whether this market will develop probably depends on how integrated workstations compare in price with enhanced versions of conventional personal computers. The end that is sought through integrated workstations is usually to allow files and documents in preparation to be shared and passed between coworkers, or between professionals and support personnel. However, some designers speak of the need for a "multifunctional electronic office automation system compact enough to fit into a relatively small office area" and including in one unit an electronic typewriter, personal computer, word processor, laser printer, copier, electronic mailer, filer, telephone, modem, and facsimile machine.[6] Many users are likely to create their own integrated workstations through add-ons, modifications, and software packages. Ultimately integration will come about in a different way; it will result from the fact that almost all information will routinely be available in digitized form.

[6]John Vacca, "Key to Automated Systems Lies in Miniaturization," *The Office*, February 1985, p. 66.

Minicomputers.—Minicomputers trace their lineage to the requirements of scientists for low cost computers for laboratories. They were the earliest means of providing end-user computing. However, they were delivered with little if any software, and it was the responsibility of the users to do whatever was required to get useful work out of them.

Minicomputers have, however, evolved to achieve many of the characteristics of mainframes. They support large amounts of data storage and permit multiple users simultaneous access. Often, minicomputer installations are run by a data processing manager supported by a small group of programmers. The principle advantage of minicomputers is that they offer the midsize organization considerable power at a cost significantly below that of a mainframe. Generalized applications for accounting, inventory control, and other applications are available to avoid the cost of developing custom software. The equipment is self diagnosing so that much of the required maintenance can be handled by replacing failed components from an inventory of spares.

Most minicomputers offer office-oriented software such as word processing and can support networks of terminals in addition to supporting conventional data processing services. Some are in direct competition with the shared-logic[7] systems sold by the office machine manufacturers. Some firms that entered the market as office machine providers have expanded their product lines to include shared-logic systems with a significant range of data processing capabilities. Some of these systems fit at the top of the range of microcomputers while others can be classed with minicomputers. However, all computers that offer users the opportunity to share resources, whether they are labeled shared-logic word processors or general purpose minicomputers, create new problems for managers who must allocate the shared resources among competing demands and at the same time protect the integrity of the organization's data.[8]

Mainframe or Large-Scale Computers.—Mainframe or large-scale computers are normally associated with data centers and/or data processing departments. They are capable of supporting a large number of users simultaneously, providing them access to large databases and libraries of com-

[7]A shared-logic word processor uses a central computer to support a number of word-processing terminals. Many are, in reality, minicomputers that are limited only by the software that is available to support them.

[8]The problems of resource allocation and system integrity exist in the microcomputer/stand-alone word processor environment as well. But, they change in substance and magnitude in shared resource systems.

puter programs. Although these computers are capable of supporting routine office operations such as word processing and small database systems, they are not much used for such limited applications.

Where processing capabilities are distributed among many devices in an information processing network, large-scale computers may function primarily as repositories for data and programs that are to be shared throughout the organization. Data and programs can then be communicated from the mainframe to a small computer for processing. Drawing from databases stored on mainframe computers ensures that all users will have a common base of information, but new problems of coordinating data input and updating activities are created. Generally, office work does not challenge the computational capabilities of mainframe computers, but as applications that include voice and pattern recognition become available, greater processing capabilities may be required.

Supercomputers.—Supercomputers are very high performance machines with capabilities approaching 100 million instructions per second. These systems are being delivered to universities, government agencies, and a few private companies who have particularly intense computational requirements. Machines in this class as yet so far exceed the requirements of the office that they are not found in conventional data processing centers.

The laws of physics limit the computational speeds of conventional computers. Therefore, the supercomputers are structured to perform many operations in parallel rather than sequentially. Problems must be described in terms that make it possible to take advantage of parallel processing. Descriptions of office operations with this in mind have not been accomplished. Potential office applications for supercomputers that come immediately to mind include the processing of voice input by pattern recognition.

The range of processor capabilities now available more than covers the range of office needs. Moreover, technological developments are likely to proceed at a pace sufficiently rapid to stay ahead of the ability of office applications to challenge them. More importantly, users of office automation will be able to acquire processing capabilities appropriate to their needs and as those needs increase, expand those capabilities incrementally. Even the smallest users are likely to be able to enjoy the benefits of the technologies.

Data Capture Devices

The Keyboard.—The keyboard is likely to remain the dominant data input device at least through the remainder of this century, augmented by the mouse, wand, touchscreen and other devices for specialized tasks.[9] But this assumption, while it is perhaps the most obvious one, can certainly be questioned. In fact, the most important question about office automation, from the standpoint of effects on future employment, may well be the outlook for input technology, especially optical character recognition.

OCR.—State-of-the-art optical character recognition (OCR) devices can now read typed, printed, and some hand-printed material in a limited number of fonts.[10] Some OCR equipment can automatically feed about 75 pages into the reading device; recognize characters in 23 different fonts, whether in 10 or 12 pitch or proportionately spaced; read the material into the computer's memory at the rate of one page every 15 seconds; and format the text. The claimed error rate is one per 300,000 characters. Such systems are now being offered for prices under $12,000.

OCR can already input a typed document into word processing 40 to 50 times faster than a typist can rekeyboard it.[11] It can capture data from order forms, application blanks, ticket stubs, etc. Publishers are beginning to instruct authors to use specific fonts on their typewriters or computer printers to avoid the need for retyping. Banks are now introducing Automatic Teller Machines that will accept, read, and cash a check.

Within a decade OCR may be able to read all standard fonts, and have some capability to recognize, isolate, and read or copy specific bits of information. It will be much more difficult to de-

[9]The mouse is a palm-sized device, used with some computers, that when moved over a table surface positions a cross-hair curser on the VDT, using mechanical, mechanical analog, opto-mechanical, optical, and hybrid sensors. Touch-sensitive screens allow direct positioning of a cursor on a screen through touch; one approach surrounds the screen with infrared light-emitting diodes and sensors, the other places a resistive or capacitative layer on the screen that acts as a pressure-sensitive switch. While these kinds of input are swifter than keyboarding instructions, they have limited uses in most offices.

[10]With OCR, a page is scanned with light. White, or background, portions reflect the light and inked portions absorb it. The resulting image is recognized, digitalized, and fed into a circuit. There are two approaches to character recognition—matrix matching (the character is gridded and compared to templates) and shape analysis (features of the character are abstracted and used for identification). The latter is most useful where characters are less predictable, as with handwriting.

[11]E. Polizzano, *The Office*, February 1985, p. 75.

velop OCR devices that can read handwritten material except in very limited, constrained form.

During this early stage of office automation, some offices are using OCR to deal with the problem of incompatibility of equipment. Advanced OCR systems can take the hard copy printout from one computer or word processor and forward it into incompatible systems without rekeyboarding.[12] In another current application, time-sensitive forms for reporting hours worked are marked by the worker with a felt tip pen, collected or "batched" and fed into a scanner, which checks them for length and completeness, flags errors, accepts only data thus checked, and stores it for further processing. OCR systems are now being used for processing subscriptions, proxy cards, surveys, orders, sales call reports, piecework payroll data, utility meter-reading, tax bills, and tax payments.

OCR print elements are readily available now for office printers. If OCR reading capability becomes a standard component or add-on to standard office computers, printed and typed documents coming from outside the organization can be entered without rekeyboarding. The possibility of transferring information from one medium to another (e.g., from a printed page to a computerized data bank) without a second keyboarding, or capturing data at the point of origin (directly from a ticket agent in the field, from a customer's order, or from business correspondence) rather than sending it to the receiver's central ADP unit could greatly reduce the volume of secondary data entry that is now done. If OCR can be improved so that it can read handwriting, the potential for labor-saving is even greater.

Optical character recognition technology has not been widely introduced into offices in the past because of relatively poor performance and high costs. Software has been a particular bottleneck. But performance is now rapidly improving.

In principle, combining OCR with facsimile technology (FAX, or electronic transmission of images from hard copy to hard copy) is attractive since OCR involves substantial data compression. This would allow FAX transmission to consist of intermixed ASCII code and digitized image bits. For this purpose, OCR will have to handle graphics, which it cannot do yet.

With the present rate of OCR development, by the end of this decade today's volume of manual data entry could be reduced by a significant amount, with a much greater reduction by the end of the century. The amount of data that is collected and used is of course steadily increasing, and likely to increase still more if the cost of data-handling decreases. Nevertheless, since more and more of the data will be digitized from the beginning, or can be captured with only one keyboarding at one point early in its processing, the amount of manual data entry to be done is likely to decline steadily.

OCR is a technology for translating hard copy into machine readable form. But as time goes by more and more data will be digitized from the beginning, and be translated into hard copy only when a paper version is needed.

Machines can read a variety of formats to capture information. Optical wands can read bar codes and alphanumeric characters printed in suitable formats. The scanner used in supermarket checkout lines and wand readers used in retail stores to gather inventory data are examples. Mark sense document readers have been used in a wide variety of applications for years. In some applications, the IRS Form 1040 EZ, for example, computers can read manually printed characters. Cash registers and a variety of machines can be connected to computers so that data capture becomes a byproduct of operations such as recording the details of a sale.

Speech Recognition Input Technology.—Speech Recognition Input Technology (SR) could in theory mean that data need not be keyboarded even once. This technology is however likely to develop much more slowly than OCR.[13] State-of-the-art, commercially available SR technology can recognize from several hundred to 5,000 different words, spoken by a single individual for whom the device has been programmed. However, for most SR systems the words must be spoken clearly and with a pause between them, and there is still an unacceptably high error rate. Vocabularies are still too limited to be very useful.

Speech recognition has been used in some environments with limited success. For example, baggage clerks at airports speak flight numbers for routing baggage through automated baggage handling equipment.

[12]Polizzano, Ibid., p. 75.

[13]Speech creates variations in air pressure that are transduced into electrical signals that are then broken down into their component frequencies. In the processing system, words have to be time-aligned to compensate for the variations in their length when they are spoken. When a machine is "trained" for one speaker, he or she creates word templates to which the SR system matches words. In another approach the system extracts consonant and vowel features and recognizes invariant relationships among them. This is aimed at allowing the system to accept voice input from any speaker, but at present it is difficult to reduce the error rate below 10 percent. Continuous speech recognition is also complicated by the fact that the acoustic properties of a word are modified by adjacent words and by its place in a sentence.

IBM and Kurzweil have demonstrated voice-activated typewriters that may represent steps on the road to viable machines for use in the office. It is conceivable that a commercially viable voice-activated typewriter will be marketed by the middle of the 1990s.

A few SR developers are now claiming to offer continuous speech recognition—that is, recognition of speech at a normal pace and rhythm, without artificial pauses; and the ability to accept voice signals from people for whom the equipment is not specially programmed. A vendor recently announced a possible breakthrough in SR technology—a digital filter chip integrated circuit that, when used in sets, is said to allow something approaching the sound processing capability of the human ear. It is to be combined eventually with artificial intelligence techniques to allow software to deal with such peculiarities of the English language as homophones (words that sound alike, such as "to," "two," and "too").[14]

If SR is improved so that it can recognize up to 10,000 or 15,000 words of continuous speech, from multiple speakers, it can be used to put data into a computer for memory or processing, thus automating many office functions—taking dictation for correspondence, dictating rough drafts of documents, accepting commands to the computer, recording observations as a worker reports on other activities, keeping minutes of meetings, and perhaps most importantly accepting customer's orders, complaints, or inquiries over a telephone. If it can eventually be combined with speech synthesis output technology, the computer might provide many basic customer services without human intervention or with very little human backup—for example, taking airplane or theatre reservations over the telephone.

Even by more conservative expectations, SR could make some of today's data-entry work unnecessary by the end of this decade. It is conceivable that OCR and SR together could displace a significant amount of data keyboarding during the 1990s.

A related technology, voice identification, may have some special uses in offices; for example, providing security for facilities or computers by identification of authorized users.

In general, technology will diminish the distinction between information that is machine processible and that which is not. The number of cases will increase where users will be willing to accept information displayed on a screen in lieu of having it printed on paper. Many people will find that using a computer keyboard or alternative data-entry device gives them more flexibility and is preferable to the traditional pad and pencil.

Storage

Conventional Storage Media.—From the time of the first computers, there was a very strong dichotomy between machine processable data and data that could be easily read and used by people. Punched cards, magnetic tape and disks and punched paper tape not readable by people were, and continue to be, the data-storage media. The computers that could read them were not readily accessible to users. This has changed to an extent as terminals and personal computers have become readily available.

Paper is a "people medium." Together with microfilm it is the primary means of creating a permanent record and a primary way of transferring information between people, and also the primary means used by computers to convey their output to users. Paper and microfilm are not media that have been usable by computers for storing data for further processing.

The media used for storing data should support the delivery of data to the user's location. Therefore, a key element that distinguishes alternative data-storage media is the degree of portability it offers. A large capacity magnetic disk is permanently attached to a computer. If the data is to be transferred to another site, it must be transcribed to another medium. Magnetic tape and portable disks can be shipped without transcription, but are not efficient if only a limited amount of data is to be moved. Punched cards, on the other hand, are very efficient for moving limited amounts of data, especially if it can be put in the standard 80 character format.

Traditional data processing installations have always stored large amounts of data primarily on magnetic disk and tape. These media support databases that contain millions of pages of data. Disks are available in two broad classes. The first, capable of holding hundreds of millions of characters on a single unit, are the so called "hard" disks that are permanently attached to a computer. The large capacity disk with a system that permits the sharing of resources can put immense amounts of data within reach of the users on demand. A single large capacity disk drive can store well over half a trillion characters. Even the magnetic disks used with

[14]Kurweil Applied Intelligence, Inc.—a description of the new chip, KSC 2408, appeared in *Technology Watch*, vol. 5, Nos. 1&2, November-December 1984; and *Fortune*, Jan. 7, 1985.

microcomputers and the smallest minicomputers have on-line storage capacity that can approach 100 million characters.

The great volume of information that can be stored on one large-capacity disk creates some problems. A large number of people within an organization may need to access the data at one time. Getting access to a specific bit of data may be slow. If the data is stored on or in a limited number of physical locations, the problem of contending for access will always arise. There may be technological ways to provide multiple access paths to the same surface (whether that be a disk, tape, or other object), but as will be discussed later, optical disks designed for small computers may make it practical to provide multiple copies of databases.

This however creates other problems. With many copies of the database there is no way for an organization, or user, to make sure that all copies are identical, or are properly updated and corrected. This can also raise legal, ethical, and psychological problems—e.g., questions about the ownership of information and willingness to share it. Choices about data-storage mechanisms will be a matter of costs and management priorities.

Floppy disks are generally used with microcomputers and have capacities that range in the hundreds of thousands of characters. These offer the advantages of low cost and high portability; they can even be sent through the mails. Three sizes of floppy disks are used with office systems—3.5 inches, 5.25 inches and 8 inches in diameter. The last are most often used with stand-alone word processors, the first and second by microcomputers. The 3.5 inch disk is just entering the market but may become the medium of choice. It is packaged in a hard case that protects it from inadvertent damage, and its capacity of about a half million characters far exceeds 360,000 character capacity of the most popular 5.25 inch floppy disks.

The portability of floppy disks can be in part illusory. Virtually every word processor using eight inch disks uses a disk-storage format that is incompatible with all others. The same is true for 5.25 inch disks that are used on microcomputers supported by the CP/M 80[15] operating system. If data and programs are to be transferred on disks between machines that use incompatible formats, a conversion process is required. There are businesses that specialize in offering conversion services in many major metropolitan areas. On the other hand, floppy disk compatibility does exist among office microcomputers that follow the DOS format used, for example, by the IBM/PC, and this format is becoming an industry standard for office microcomputers.

The storage medium used determines to an extent the degree of control managers have over the data resources. Permanently mounted (fixed) disks, can be reached only through a computer to which access can be tightly controlled. Magnetic tapes are stored in a controllable central facility. The task of controlling access to data stored on floppy disks is much more difficult.

In spite of talk of the paperless office, paper could be widely used as a medium for storing data in some future automated offices. For decades, the punched card has been valuable as a turn-around document, for example, inventory cards and checks printed on punched card that could be machine processed. Today, the punched card has disappeared from many applications. But technology is now available that can read data that is printed in a variety of formats. Packages can be imprinted with a machine readable bar code and credit cards with numbers in a scannable type font. In addition, standard fonts used by typewriters can be read by optical character readers.

Therefore the printed page can be used as an external storage device for data that will be processed by computers, because the cost of converting the printed image to the electrical signals processed by a machine is becoming relatively small. Operationally, however, devices that read printed pages are not likely to replace the magnetic disks and tapes that are used to store data since the character reading devices are much too slow for anything but capturing data inputs for office systems. Processing will continue to be performed using an electrical representation of the data, but much of the data may be captured initially by scanning.

From time-to-time there is heightened interest in the use of microform (microfilm or microfiche) technology in the office. It is often used for storing information where large volumes must be archived for an extended period. Financial institutions routinely microfilm all checks. Computer manufacturers distribute infrequently used documentation on microfiche. There are some systems that facilitate the retrieval of information from microform files by coupling a computer to the reading device. Microform systems have been proposed that would have information recorded as conventional images in one portion and as a machine processable hologram in another.

[15]An operating system is a program for a computer that performs many of the overhead functions required to manage the machine. Among the services it provides are those needed to move data and programs between external storage and the main memory of the computer for processing.

Optical disk technology may provide a viable means for on-line retrieval and processing of the types of records that would now be stored in a microform retrieval device coupled to a computer. If so, microform may be permanently relegated to the task of preserving large volumes of infrequently accessed records.

Optical Disk Storage.—Optical disk storage can potentially provide 25 times the per-disk capacity of magnetic disks, at one-thirtieth of the cost. The equivalent of 250,000 typed pages can be stored on one disk.[16] A read-only disk already available in the United States carries the equivalent of 100,000 typewritten pages on a 4.7 inch diameter disk. A number of optical disks, making up a very large database, can be stacked and sorted and accessed like platters in a jukebox.

Optical disk storage is still in the development phase, but the development is moving rapidly and reaching the market faster than expected even a year ago. It is likely to have a major effect within this decade. Diode lasers are used for "writing" data on optical disks in digital form. The disks may be "read-only," which means that users cannot change them; or they may be "write-once," meaning that users can record but not wipe clean; or they may be erasable. Read-only disks are useful mostly for archiving.

At least 30 American companies are working on development of optical disks, but it was generally believed until recently that the Japanese held the lead in development of erasables. In March 1985, 3M Corporation announced that it would immediately begin producing (in small quantities) 5¼ inch erasable laser disks that will store the equivalent of 250,000 pages, the capacity of 25 magnetic hard disks of the same size.[17] They are designed for microcomputers, and will allow data to be moved and changed or erased just as on magnetic disks. This will let personal computers perform many tasks that until now could only be done on a minicomputer or mainframe.

Because optical disks have such a large capacity it becomes reasonable to use them for storing images as well as alphabetic and numerical data. This capability will make it possible to organize, process, and present data more effectively than is possible when image and textual data must be stored separately.

[16]In early 1985 a draft of this report said, correctly, that the best commercially available optical disk (read only) stored 1 billion bytes or the equivalent of 40,000 pages By June that statement was incorrect. This is an example of how rapidly events are moving in this field

[17]Brian Dumaine, "Here Comes the Erasable Laser Disc," *Fortune*, Mar. 4, 1985, p. 100.

Image Processing.—Image processing capability will be readily available as part of, or an add-on to, small business computers in the near future; it is already available from some vendors. It will allow drawings, photographs, maps, and other forms of graphic information to be scanned, stored, incorporated into databases, copied, or rearranged. It will allow parts of these images to be removed, added to, switched to a new location, or otherwise modified. Image processing has many uses in a general office, such as in presentations and facilities planning, and it will be very important in some specialized offices such as those in the real estate industry, marketing, and advertising. It should be noted that for the unscrupulous, image processing can be a tool for counterfeiting, misrepresentation, and fraud.

Special-Purpose Terminals.—With falling hardware prices, it is reasonable to expect the development of special purpose terminals. Some are already used, for example, to gather inventory data through either a hand held keyboard or an optical wand. Pocket-sized terminals with a key pad and small display screen, that can be easily connected to a telephone, may become available soon.

Portable computers that maintain memories when the power is turned off can be used to gather data to be transferred at a later time to another computer, either directly or over the telephone lines. In this way, a traveler can, while on an airplane, create a document to be transferred to the main office system for further processing and archiving.

Personal Storage Devices.—Machine-readable and updatable data storage devices exist that can be personally carried or attached to an article in transit. Included among these are the familiar credit card magnetic stripe technology[18] and the "smart" card that contains a microprocessor and memory.[19]

[18]The fare card used on the Washington, DC, subway system provides one example of what can be done with magnetic stripe technology. When the card is purchased, the purchase value is recorded on the stripe. Then, whenever the user enters the system, the station of origin is recorded. At the destination, the fare is computed based on the recorded data and the value of the card decremented appropriately. Similar cards could be used to capture and store data for office applications where very low data volumes are involved and the connection of computers by telephone is unwarranted.

[19]A Canadian company has designed a hospital information system around the smart card. When the patient enters the hospital, a card is created. Then the card moves with the patient and as each service and product is dispensed, the memory of the card is updated using a device built into a microcomputer. When the patient is discharged, the data that has been captured during the hospital stay is retrieved and a bill is prepared. It is conceivable that the "smart" card, originally designed for executing financial transactions, could find significant application as a data capture and storage medium in a number of office applications that range from systems for providing security to those that require capturing transaction data.

Communication

In the present context, communication includes all technologies that are used to transmit data between people, people and computers, and computers.

Telecommunication Networks.—The backbone of office telecommunication is the switched telephone network. It was designed to handle voice communication passing between individuals, and still functions primarily in this mode. However, data comprises a growing portion of the traffic.

For many organizations, the switched telephone network consists of two relatively distinct parts. First is the conventional and ubiquitous interorganizational component, the dial telephone service. No operator intervention is required even for many international calls. Credit card calls can be initiated using the 10 key TouchTone™, and some pay stations are now being equipped with devices for reading billing information from the magnetic stripe on the back of a credit card.

The repertoire of services available from the switched telephone network will expand over the remainder of the century unless legal or regulatory constraints are imposed. Simple services such as call waiting, call forwarding and three party conferencing are already offered in many areas. Some code conversion services offerings by local operating telephone companies were recently approved that would translate the signals from one type of computer or terminal to a format understandable by another. Such services will be valuable to offices that until now had to provide code translation through their own systems. Not all businesses are prepared to deal with the code conversion problem and the detailed technical questions of interchange.

The future is likely to see such services as voice message storage offered through the switched telephone network. Virtually all telephone traffic, including voice, will be transmitted digitally. Organizations will no longer have to maintain separate networks for voice and data communication. It will also be technologically possible to deliver processing services through the network, including the routing of messages based on their information content. For example, the interchange of financial transactions (now accomplished by financial institutions) could be a service of the switched telephone network, and this could include data processing such as the accumulation and reduction of transaction data and following the enroute status of shipments.

The opportunity for offering an increasingly large variety of telecommunication services through the switched telephone network derives from the fact that much of the switching capacity now in place is provided through computers. Eventually, all switching will be done by computers. Already, much of the traffic between major switching centers is transmitted digitally; and customers are able to subscribe to on-site digital transmission services. They are then able to mix digitized voice and data traffic. Much attention is now being given worldwide to the concept of an integrated service digital network (ISDN) that would make digital transmission of all data, voice, video, and facsimile traffic universally possible over a common network.

For some years, long distance telecommunication services have been offered by competing providers. However, since the divestiture by AT&T of its operating companies in 1984, the choices have become significantly more complex. Organizations now have the option of using either the switched telephone service or operating their own telecommunication networks. Most often, a private network is assembled using circuits and support facilities leased from telecommunication providers, some combination of the local telephone company, and one or more providers of long distance services. However, some organizations choose to build and operate telecommunication networks that include privately owned facilities as well as capacity leased from common carriers. Alternatives include leasing of transponders on satellites, the building of microwave systems and the construction of conventional telephone circuits. One problem is that large users of telecommunication services often find it in their interest to by-pass public utilities, depriving them of significant revenues.

A variety of providers offer business telecommunication services. Third-party operators either build facilities or lease them from another carrier and use them to offer services to those who cannot justify developing private networks. Packet switching is used to obtain the high rates of utilization that are needed to justify third-party networks. Messages are broken into data packets that are individually routed to their destination and reassembled to constitute the original message. Network operators can bill users on the basis of traffic volume rather than time and distance, because the packet switching technique levels the load across the available network facilities rather than allowing it to concentrate on the paths between points with the highest volumes of traffic flow.

Many localities are wired for cable television, and many of the newer systems are capable of two-way communication. Because television requires a broad channel, cable systems can handle large data volumes. In some areas, such as New York, cable operators find it profitable to make some of their capacity available for transmitting voice and data.

In congested areas, not all telecommunication options are available. For example, in New York City it has become very difficult to build private microwave facilities because buildings often obstruct the proposed path for the signals and facilities already in place cause electromagnetic interference that cannot be neutralized. Routing communication to a central antenna "farm" located in an area relatively free of these obstructions (the teleport concept) provides one alternative for neutralizing this problem. In some cities the cable tunnels beneath the streets are so congested that there is no room to run additional cables. Fiber optic circuits provide potential relief from this problem because they provide substantial increases in capacity in significantly less space than conventional cables.

Mobile Communications.—For local communications, offices also have the option of using mobile telephone services. The most common are the "beeper" services available in many areas. A person is alerted to a call by an audible tone generated in response to a signal sent by the service operator and received by a carried device. Some devices can visually display a message, eliminating the need to telephone the office for information.

Telephones in cars have been available for years, but the technology severely limited the number that could be used within a geographic area. A new technology, cellular radio, has eliminated this limitation on the number of mobile telephones. In addition, the quality of the service with the cellular system is significantly better. Companies requiring constant telephonic communication with people in the field can now have such service at relatively affordable rates. In the future, cellular radio may also provide an alternative for delivering fixed point telecommunication services to rural and remote sites more economically than is possible with conventional telephone lines. Potentially, this technology could also permit the transmission of data to and from mobile terminals, but not all of the problems posed by this application have yet been resolved.[20]

PBX and Local Networks.—Managers of offices are now faced with complex telecommunication choices. A few years ago, arranging for telecommunication services required only a call to the local telephone company and everything was taken care of. Today users can tailor services to their needs and shop for providers who can offer the required services most economically. However, the user organization has to devote more resources to analyzing the costs and benefits of alternative telecommunication services. To an extent, the settlement of the antitrust suit negotiated between AT&T and the Department of Justice has led to this increase in complexity. However, even without the divestiture, advances in technology were increasing the options available to users.

Adding to the telecommunication options available to managers are other technologies available for in-office communication. At the lowest level are electronic replacements for the 1920s plug switchboard to permit intraoffice communication as well as connection with the external network. Modern private branch exchanges (PBXs) can provide a variety of services, including the ability to forward calls from one office to another and to automatically transfer calls to another number once a predefined number of rings have gone unanswered. PBXs can be programmed to record voice messages and to select from the alternative services available the most economical routing for each call as it is placed. Some provide for the sharing of internal telecommunication circuits for both data and voice, giving the user organization the benefit of a shared internal network.

Another alternative for use within an organization is a variety of local area network (LAN) technologies. These provide high-speed data communication for a variety of office machines, including data-storage devices,[21] printers, word processors, gateways to external telecommunication networks and professional workstations. Several technol-

[20]Cellular radio operates using a number of low-power transceivers, computers are used to assign traffic to the one of many antennas that is best able to communicate with the mobile unit. As the mobile unit moves from cell to cell, traffic is handed from one antenna to another. This handoff procedure could introduce discontinuities in the signal that offer no problems for voice communication but could present problems for data transmissions.

[21]Most often disks that can be used to store data of interest to a number of individuals and/or organizational elements and shared by a number of workstations.

ogies for implementing LANs are in use;[22] and this diversity of incompatible technologies using a variety of LAN architectures may present problems. But most LANs include the ability to carry on communications over the switched telephone network, so that the switched network becomes a common facility over which dissimilar LANs are able to communicate.

To an extent, modern PBX and LAN technologies are competitive. Both provide the ability to switch data at relatively high speed between office machines. On the other hand, LANs will be useful for voice transmission only to the extent that the telephone instruments that are connected to them can send and receive signals in a digital format.

An interesting variant in telecommunication lies somewhere between the public switched network and intra-office communications facilities; this is the smart building with which some realtors are experimenting. These buildings are wired for telecommunications and data processing services so that multiple tenants can use technologies available in the past only to large organizations. A smart building may provide outlets that permit all tenants to connect terminals to a common word or data processing facility. Other outlets may be used for telephone connections to a common PBX that routes calls within the building or complex without using the public switched telephone network, or routes external calls using the most economical service. High-cost facilities like laser printers and reprographic facilities can be shared.

Once digital information has to be transmitted more than a quarter mile over conventional telephone circuits, an instrument called a modulator/demodulator (modem) is required, to convert digital signals used by the computers to or from an analog signal that can be handled by the switched telephone network.[23] Commonly available modems are capable of transmitting or receiving 30 or 120 characters per second over the standard switched telephone network. Modems capable of handling 240 characters per second are becoming widely available. Speeds of 480 and 960 characters per second can be achieved by some premium instruments.

Higher speeds require the use of circuits that are dedicated to a specific customer. These may be leased from a common carrier or built as a private venture. Commonly, these lines are rated at 19.6 and 56 Kb.[24] The highest capacity lines are called T1 carriers and are rated at 1.544 Mb.[25] Satellite transponders have capacities on the order of 6 Mb.

Interactive communication that involves people usually will not challenge the capacity of a circuit capable of handling 30 characters per second. Higher speed circuits are needed only when large amounts of data are to be transferred directly between computers.

However, there are technologies for multiplexing many signals over a common line. Thus, many slow-speed conversations can be combined to take advantage of the economies attainable when high-speed circuits are used. A company with offices in two major cities may find it useful to provide one high-speed circuit between the two points. Some of the private lines can use the capabilities of a PBX to connect with any number in the remote city through the local switched telephone network, thus bypassing the long distance dial-up network and its toll charges. This reduces the revenues to the long-distance carriers, and, indirectly, revenues to the local-operating companies.

Communication Terminals.—The most ubiquitous communication terminal in the office is the telephone, basically an instrument for accomplishing voice communication between two people. However, computers have been programmed to accept the tones created by a TouchTone™ telephone and respond to them using computer generated voice. When a customer enters the long string of numbers required to use long-distance services provided by other than AT&T, the data (access code and number dialed) is received and processed by a computer. Telephone bill paying also uses the common telephone as a data terminal.

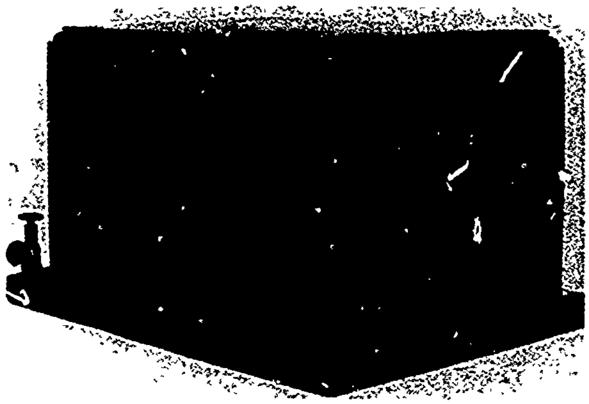
The telephone is suddenly a rapidly evolving instrument. Display screens are being added that let the user view a number from an electronic directory before instructing the telephone to dial it automatically. Telephone handsets are being added to data terminals so that the user can communicate voice and data interchangeably over a common circuit. When coupled with the PBX, the office telephone becomes a versatile, multifunction commu-

[22] Alternative transmission techniques include broadband and baseband signaling. The technologies for managing traffic include token-ring passing and collision detection and retransmission in the event of a collision between messages.

[23] Actually, a digital signal can only be transmitted a few hundred feet without a modem. However, limited distance modems, low cost models with limited capabilities, can be used for distances under a quarter mile.

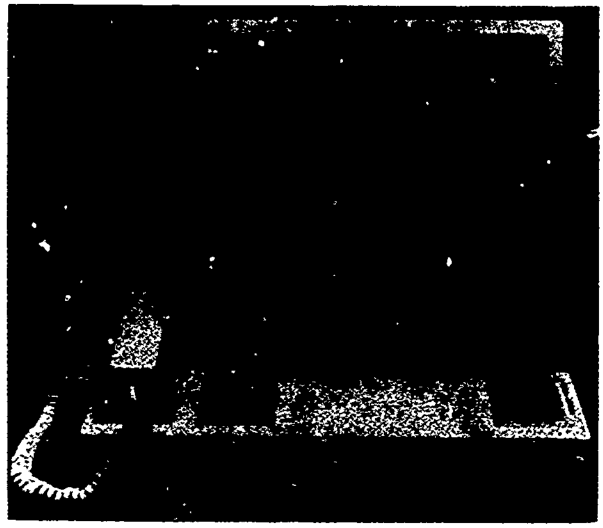
[24] Kb is kilobits per second or 1,000 bits per second. A character transmitted at these speeds normally requires the transmission of eight bits.

[25] Mb is millions of bits per second.

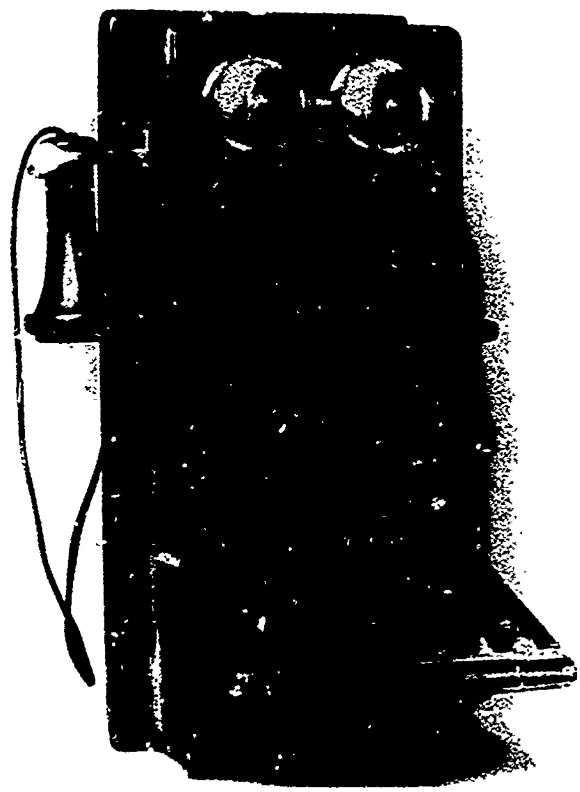


Photos: Courtesy of Bell Labs

In 1877, the first commercial telephone was leased to a Boston banker. The round, camera-like opening on this box instrument served as transmitter and receiver.



By the 1980s, the telephone and display monitor were integrated. This terminal can access files from other computers and perform a full range of telephone management and message functions.



This example of a 1907 Magneto wall set was in use from the late 1890s through the 1930s.

nication instrument for the office. AT&T divestiture has forced businesses to decide whether to buy or lease the telephones in their offices. The increased variety of options has forced decision-makers to carefully match service requirements with alternative capabilities.

People now communicate with computers, and computers communicate with computers. It will become more and more common for computers in one organization routinely to interchange information with computers of another with little human intervention. For example, a computer can determine that an inventory level has fallen too low and send a replenishment order to the supplier's machine. Alternatively, payments can be queued in a computer that is instructed to contact the computer in a financial institution and order the funds transferred at the optimal time for the debtor organization.

The most common way for an individual to communicate with a computer is by means of a terminal that uses a typewriter keyboard for entry and either an electronic display or a printer for output. The terminal, in its simplest form, captures input from the keyboard, transmits it over the telecommunication line, receives data from the computer, and displays it either on paper or a screen. This kind of terminal has no processing capabilities. With these "dumb" terminals, the user depends on a central system for all computational support.

Increasingly, however, the terminals used to communicate with computers will have significant processing capabilities in their own right. Some will have printers attached to them directly, but in the office, printing will increasingly be done by printers shared among the terminals that comprise a network.

Teleconferencing.—Information processing and telecommunication technologies can be used to substitute, at least in part, for face-to-face meetings of individuals. Two broad classes of teleconferencing are computer conferencing and videoconferencing, both insensitive to distance. A computer conference is also insensitive to time, in that people participate independently on their own schedules.

A computer conference is conducted by providing all of the conferees access through their terminals to a distant computer on which are recorded their contributions to the conference and from which they are able to retrieve the comments of the other participants. The conference may take place over an extended period, and each individual contributes at times that are personally convenient. Conferees sometimes are allowed to make their contributions anonymously or using a pseudonym, in order to encourage them to be more frank than they would be in a face-to-face meeting. Computer conferencing permits the users to ponder their thoughts rather than react to the dynamics of the group. This can be either an advantage or a disadvantage; the body language and other forms of nonverbal communication that occur in a face-to-face meeting are absent.

Videoconferencing permits conferees at widely separated locations to both see and hear one another via a television link. Several levels of videoconferencing are now available. One provides only for the transmission of stop frame pictures where the image seen by the viewers changes only every several seconds rather than continuously. At the high end of the spectrum is full-motion color video transmission that provides a level of quality at least as good as commercial broadcast television. As one moves to higher quality of service, however, costs increase markedly.

Some corporations and at least one common carrier have installed videoconferencing facilities. At best, success as measured by market growth has been marginal. Although this technology has been heralded for some time as a way of reducing travel costs, it has not been well accepted. Some people may like travel because it is a break in the day-to-day routine.

Display and Printing

The primary means of presenting information to users is by means of a display screen. The standard display screen now in use is the cathode ray tube, a specialized version of the television picture tube. There has been considerable controversy regarding whether prolonged exposure to the radiation from cathode ray tubes has long-term implications for the health of the user. (See chapter 5.) The question may well become mute as new display technologies become available that are more attractive, take up less room, and do not depend on high-energy beams[26] to generate the display. Liquid crystal displays are used on most of the lap computers now and plasma displays appear to be just over the horizon. A by-product of this display technology will be the flat screen that can hang on the wall, taking up no more room than a photograph or painting.

Display technology has improved so that it is possible to create finely defined images on a terminal screen. Color displays can cost three times the price of a monochrome monitor; some specialized office users find the benefits worth the additional cost.

Electronic Document Preparation.—The printing of documents may increasingly take place only at the last step in the document creation process. Documents will be created and transmitted from point-to-point electronically because of the delays incurred in sending paper.

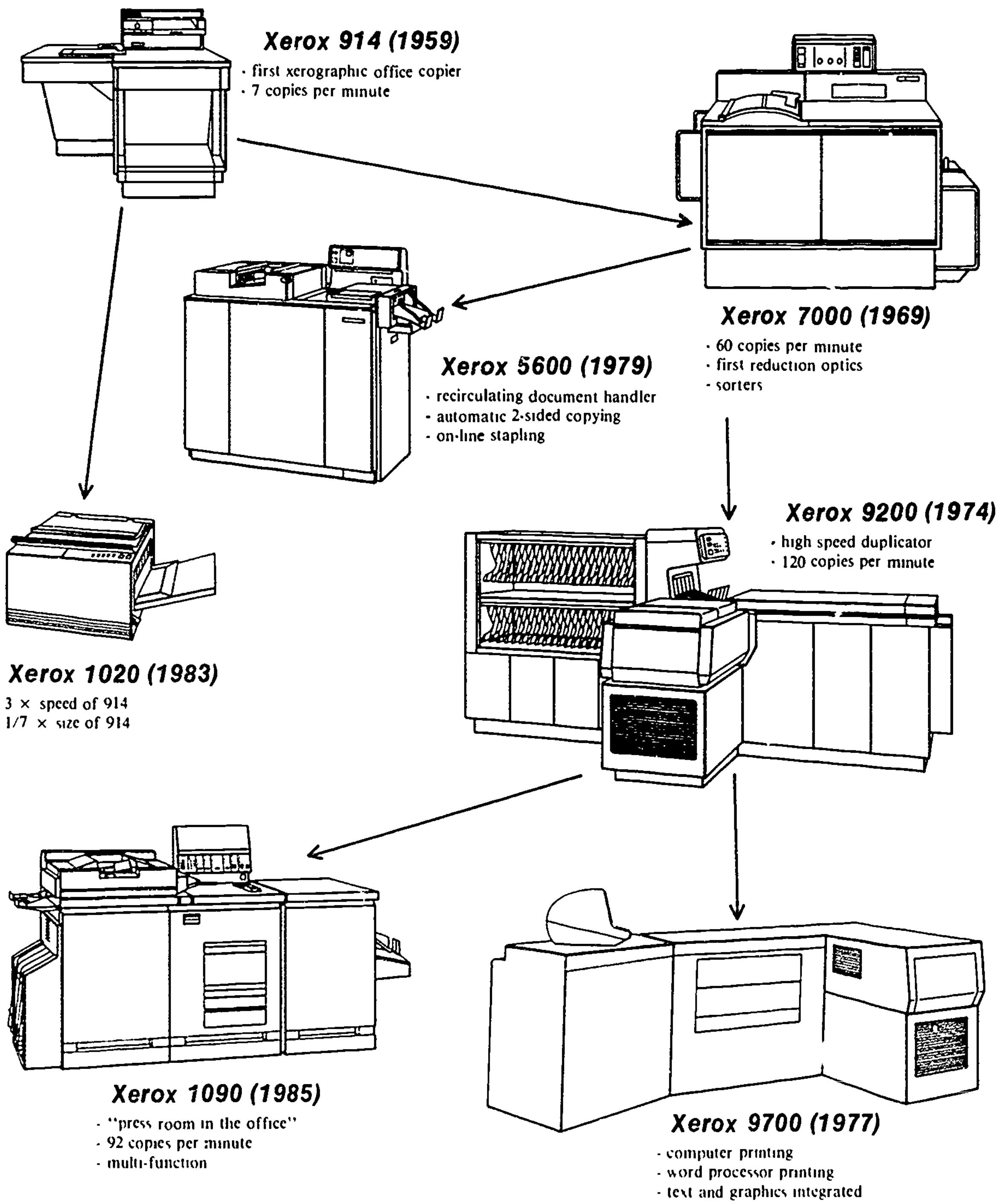
The trend is toward rapid convergence of printing, copying, and typesetting technology. They may also incorporate color sensing and image processing in designing and modifying output.

Multibin, multicolor, jetspray and laser printers are already becoming common in offices and are likely to increase in capability and decrease in costs for several years. Reprography (copying) technology is also becoming more sophisticated; print quality is improving and speed is increasing. Some of the capabilities already in the market or likely to be available soon are the ability to store and

[26]The display on a cathode-ray tube is created by a stream of high-speed electrons that strike a phosphor on the face of the screen and cause it to luminesce. At least some of the electrons continue past the face of the tube for some distance before losing their energy. It is the electrons that continue past the screen face that give rise to concerns about radiation hazard from cathode-ray-tube displays.

25 Years of Xerography in the Office

The use of xerographic technology to aid in office communication began with a slow-speed copier - the Xerox 914 Now 25 years later, xerography is used in (1) desk-top copiers, (2) multi-function machines that incorporate enlargement, reduction, and 2 sided copying into stapled sets, and (3) electronic printers that merge text, graphics, and scanned input.



Credit Xerox Corp

use form overlays, to assemble a composite image with parts taken from many sources, and to automatically size an image to fit the space available.

As these technologies improve, it is likely that many organizations will do their printing of forms and documents as they are needed. The cost savings that are possible by reducing the warehousing of documents is large, and this is augmented by savings from reduced waste (no stocks of unused documents and obsolete forms to be disposed of), and reduction of labor time spent in ordering, unpacking, storing, etc. An additional benefit of on-demand printing is the ability to provide only those sections of a document or report that a specific user needs.

Documents that are electronically stored and transmitted will be complete with diagrams and illustrations properly inserted in the text. A major company has already demonstrated a printing device that will combine pictures that have been stored in a digital format with text on a single page. Optical storage, because of its large capacity, will be a key element in making this possible. Relatively small offices will be able to create documents that will give the impression of having been typeset.

Software

Software, broadly defined, includes all of the procedures, documents and computer programs for office computer technologies. This discussion focuses primarily on computer programs. Much attention has been directed toward software packages for microcomputers, but as has been pointed out, the combination of terminals and telecommunication capabilities has made it possible for office workers to interact directly with centrally operated computers. Therefore, the software that runs on larger machines is of as much interest to the office worker as that which runs on the smaller computers.

Software technology consists of two components. The more obvious is the ability to implement and operate computer programs that perform the operations necessary to produce the results needed by the end users. Second, and less obvious, is the knowledge needed to design the computer programs and related procedures. This requires the involvement of the user in the design of information processing and telecommunication systems, or full benefits of the technologies will not be realized.

Much of the software being developed today is designed to minimize the technical knowledge required of the users. At the same time, systems are coming that will be able to accommodate comparatively unstructured demands. The need for most users to develop programming skills or use the services of a trained programmer is diminishing.

Early applications of advanced technologies were for highly structured procedures such as payroll, general-ledger accounting and the processing of financial transactions. They were operated by highly trained specialists and did not have to be designed to be used directly by large numbers of technologically unsophisticated people. As the capabilities of applications software to accommodate comparatively unstructured demands for information have increased, much of the focus has shifted to the organization of data and the means of making it accessible to large and diverse user communities. To date, designers of automated systems have viewed applications in the light of the traditional computers that execute programs one step at a time, sequentially. Not all of the machines of the future will execute processes sequentially. Newer architectures now being developed to meet the needs of the scientific community for unheard of volumes of computations emphasize parallel processing to achieve these capabilities. Supercomputers are not used in today's offices, but for some industries they may be the business machines of tomorrow. At some point there will have to be a reexamination of the techniques used to design office-oriented systems to make it possible to realize some of the benefits of parallel processing.

During the early 1970s, much attention was given to the concept of an integrated management information system (MIS) that would meet all of the needs for information of an organization. Some organizations undertook the development of such systems; none were particularly successful. But information systems to meet the more limited objectives of specific organizational elements have been quite successful. These range from complex systems designed to serve large numbers of users to personal-information systems for individuals.

One of the challenges for software and system engineering is to establish effective mechanisms for interchanging information between automated systems while preserving the integrity and security of all of the involved data, processing, and communication resources.

Some tools to aid systems engineers already exist. Structured approaches to system design that emphasize the analysis of functional relationships have been in use for some time. Rapid prototyping is a newer concept that is meeting with a measure of success. In this technique, demonstrations that show the intended user samples of system output and the procedures used for entering data are developed. The rapid prototype does not include implementation of the internal processes that will comprise the system. It presents only the facade that can be evaluated by the user in light of the requirements the proposed system is intended to meet, just as a wind-tunnel model is used as a tool for defining the external shape of an aircraft.

Two classes of software are used with modern computers. The first, support software, creates an operating environment that provides functions of value to all users, including resource scheduling and input/output services. The second, end-user software, includes application programs for specific users, ranging from spread-sheet processors run on a microcomputer to complex, tailored analytical programs that require the services of a very large mainframe.

Support Software.—Support software, in this context, includes language processors, utility programs, database systems and other software resources that are shared by all users of a computer system.[27] The software creates an environment within which a computer user operates. To an extent, a common operating system is created for computers that are, in reality, quite different from one another.

On large systems that are shared by multiple users, operating systems manage the resources on the computer, scheduling them for use by specific applications.[28] An application is permitted to become active on a computer system once it has moved to the front of the line and all of the data it requires can be made available to it. The operating system on a computer shared among multiple users also keeps the various users from interfering with one another. On smaller systems that only support a single user at a time, the operating system lets the user move easily from one application to another and relieves him/her of some of the routine tasks that would otherwise be required. For example, a user can establish a series of commands to perform often repeated multistep tasks, and they will be executed automatically under the control of the operating system.

All operating systems, regardless of the size of the computer, provide input and output services for all applications. The operating system takes the data that is used by an application and translates it into a form suitable for driving the physical input and output devices.

Generally, the computer manufacturer designs and implements the operating system.[29] In the past, each manufacturer used a proprietary system, and this made it difficult for users to move from one brand of equipment to another. Today the trend is to standardize operating systems. For the microcomputers most commonly found in offices, MS-DOS is a defacto standard, although competitors exist and some are in relatively widespread use (e.g., CP/M). The UNIX operating system developed by Bell Labs is becoming a competing standard, available on a spectrum of hardware ranging from microcomputers to large-scale mainframes. However, although UNIX is the focus of substantial attention it is not as yet an established standard, and in fact may never become one. Competing systems are likely to continue to be a significant factor in the industry at least into the 1990s.

Standardization of operating systems would offer the user several potential benefits. The first is portability of application programs. An application written to an operating system standard, in theory, can be run on any computer for which that operating system is available with little or no modification. In this sense, the operating system can mask differences among machines from users, and competing computers take on the attributes of commodities not differentiable from one another in the eyes of the users. Second, third-party suppliers of generalized software will tend to prepare products for use with a standard or widely accepted operating system in order to have the largest possible base of potential customers. Thus, using a system for which a standard operating system is available ensures the user of a large and varied supply of software packages from which to choose. This availability of generalized packages, in turn, tends to reduce the need for expensive development of software tailored to needs of a specific organization.

Programming languages, or, more precisely, processors[30] for programming languages, are another

[27]One could argue that the generalized packages such as word processor and spreadsheet programs so widely used on microcomputers should be included in the category of support software. However, for the purposes of this analysis, because they are oriented to use by individuals on personal computers, not to be shared by a number of users of a shared computer system, these types of programs will be discussed as end-user software.

[28]Some installations may determine that all short jobs will run before long ones. Others may determine that some work, regardless of the demands it places on computer resources, will receive a higher priority than all others.

[29]In the early days of microcomputers, some third-parties created operating systems that were offered in competition with those created by the manufacturer. This practice is not widespread, but competing operating systems are still available for some of the most popular microcomputers.

[30]Language processors accept computer programs written by users and translate them into a form that is understandable as a set of instructions to a computer.

set of support software. COBOL and FORTRAN have been the two languages used most heavily for management information systems. BASIC is the language most widely available on microcomputers, but the common BASIC interpreter that is supplied with most microcomputers is not suited for very large application systems.

From time to time, new languages appear and receive some degree of acceptance before disappearing. ALGOL was one of these. It made some headway in Europe in the 1960s but was not accepted in the United States. The current crop of computer languages includes ADA, C, and PASCAL, among others. Whether they will be able to demonstrate real staying power remains to be determined.

In order to use programming languages of this type, the user must develop a degree of technical skill. First, the syntax or rules of the language must be mastered. Second, skill must be developed in describing a task at the fine level of detail that must be specified in a computer program. Most casual users of computers are more concerned with their tasks in the office than with developing the skills required to write computer programs. Rather, when the need to develop a program materializes, office workers turn to professional computer technicians.

The tendency today is to minimize the need for any user to develop computer programs. The general assumption is that most of the needs of end users, office workers in particular, can be met by program packages available on the open market. At the time it announced a major new product, one of the major producers of microcomputers made no language processor available; in fact, computers developed by suppliers of office machines are often delivered without a language processor.

The computer languages used for application systems continue to evolve, and languages available in the future, whether or not they have familiar names like COBOL, will be different from those available today. Software engineers have recognized some of the limitations of existing language structures and are developing new ones to overcome the deficiency. One approach is the development of object-oriented languages that focus on the manipulation of processes and the entities manipulated by those processes rather than the definition of procedures.[31]

As this evolution continues, it is possible that comparatively few people will be engaged in the task of application programming as it is understood today. Rather, the language capabilities may evolve to the point where it is no longer reasonable to make a distinction between the language that is used to describe a process to a computer and the application program that is delivering information to the end user.

Support software also includes a variety of programs that are really applications, but fill needs for such a large portion of the user community that they are properly included under the heading of support software. Within this group are housekeeping programs that are used to create copies of files, prepare diskettes for use, and check copies to see that they are accurate. Some utilities also permit modification of existing data; for example, a utility could be used to change all occurrences of the word "green" to "blue." Others permit the user to select from a database some records that meet specified criteria.

Database management systems also fit in the category of generalized support software. These software systems are used to organize, store, and access data so that it can be shared among many applications. This concept makes it possible to manage data as a corporate resource and decouple specific applications from the databases that they use. The difficulty of modifying both application programs and the databases is thus markedly reduced. Changes in the data bases do not necessarily require corresponding changes in the applications that use them nor do changes in applications necessarily demand changes in the databases.

Some database management systems are designed to be used in conjunction with a generalized programming language such as COBOL. Hence, they are of value only to those with programming skills. Others provide the end user with a generalized query language that can be used to specify the criteria to be met by data retrieved in response to an inquiry. These query languages in general do not have the versatility that is found in general-purpose programming languages, but they let a user have access to data without the intervention of a programmer. Many of the data-management systems sold for microcomputers follow the model of the query languages used with generalized database management systems initially developed for mainframes.

End-User Software.—End-user software consists of the application programs that deliver information to users. With mainframe and minicomputers, end-user software consisted of a relatively well defined class of programs designed to meet the needs of a user community. Such applications still exist

[31]See a series of articles in the May 1985, issue of *Byte Magazine*, p. 151, discussing Small Talk, an object-oriented language developed by the Xerox Corp.

and the development of new application systems will continue, but the class of end-user software is no longer so precisely defined. Now a variety of generalized application packages such as Lotus 1-2-3® meet the needs of broad classes of users.

The development of software to meet the needs of specific users is expensive. The user organization not only incurs the cost of developing the software, but must also maintain it. Maintenance includes correcting errors as they are discovered and making modifications to operational programs as requirements change. A mature data processing organization is likely to devote as much as 80 percent of its programming resources to the maintenance of operational applications, leaving only 20 percent for the development of new applications. Many organizations are discovering that their requirements for data processing services are not as unique as they once thought, and are turning to packaged application programs. This trend is most clearly evident at the low end of the hardware spectrum where thousands of programs are being marketed.

There are two broad classes of generalized end-user application programs. One consists of modeling or decision aids oriented to fairly narrow categories of problems; the other includes applications of general interest.

Application systems designed to run on computers of all sizes have been developed for sets of problems to which a common methodology can be applied, such as packages for econometricians,[32] engineering specialties, statisticians, accounting, inventory control, and system-management packages. These applications are not designed for nonspecialists; users are expected to understand the underlying disciplinary concepts on which they are based. The command structures are oriented to the jargon of the professional. For the person not trained in the discipline, they are not "user friendly."

The second class of generalized user applications consists of programs designed to meet needs common to most offices, such as data processing, spreadsheet, and graphics packages. "Thought processors" facilitate the creation of outlines and, thus, help the user organize ideas. "Desk organizers" let the user make notes or maintain a calendar and an automated telephone index. Programs that let users create personal databases, make inquiries against the data, and prepare summary reports are also available.

These programs are designed to be used by people with limited understanding of the technologies. Many are menu driven; the user only has to select an operation from a list on the screen. Most cannot be operated without sometime referring to voluminous, usually poorly written manuals or documentation; but the number that require only simple documentation is growing. For some of the more popular programs, dozens of texts explaining their operation to the user have been written and are widely available in bookstores.[33]

Some packages, because of their popularity, have become de facto standards of a sort. For example, word processors and spreadsheet programs will sometimes note that they are able to accept data from one or more other widely used spreadsheet programs.

Series of spreadsheets and word processing programs are available, designed so that their command structure is consistent, thus minimizing the learning time required to use each program. Also, the programs in a series are designed to facilitate the passage of data between them, e.g., a table from a spreadsheet is easily included in a document being prepared using the word processor.

Integrated, multifunction programs are also being marketed. While some of these have been reasonably well accepted in the market, each one of these programs has both its strong points and weaknesses. For example, the spreadsheet capabilities may be powerful but the word-processing functions weak. Often, integrated packages require complex command structures that are difficult to learn. There is some question whether it is more advisable to acquire a number of single-function programs that can pass data between and among themselves or to obtain a single, integrated multifunction package.

Instructions and owners' manuals, which the industry persists in calling by the intimidating name "*documentation*," have been a major hurdle for beginning computer users; they are often incomprehensible to the novice. But competition for the small computer software market will sooner or later force software vendors to concentrate on ease of use, and to emphasize usability, training, customer service, and software maintenance in order to build and keep a share of the market.

[32]Econometric programs, for example, include procedures for estimating the parameters of an econometric model, access to data useful in building economic models, and the means for exercising models once they have been built.

[33]Another explanation for the popularity of the texts for some programs is that they are being used in lieu of manuals by those with pirated copies of the software.

The management information system concept that has been developing over the last two decades is already evolving into the broader conceptual framework of information resources management, a field that seeks to understand the overall requirements of an organization for information and to provide the means for meeting them. Decision-support applications will comprise an important element within information resources management. These applications will range from comparatively simple models such as pro forma financial statements in the spread-sheet format to comprehensive models of both the internal operations of an organization and its interactions with the environment. Models for marketing and production management are already in use and will become increasingly commonplace even for small firms.

Much attention is now being given to expert systems. Some expert systems are being used, but they are generally rudimentary; and the ability of expert systems to deal with some of the more complex problems faced by knowledge workers may be slow to materialize.

Expert systems attempt to capture the problem-solving knowledge and methodologies used by people who have demonstrated abilities significantly above those of the large majority of the professionals working in a specific area. Specialized technicians, called knowledge engineers, interview experts and attempt to define in a format processable by computers, a series of rules of thumb that will emulate the experts. Users are then asked to provide the parameters of a problem, and the expert system returns an analysis that is intended to approximate the results that would be arrived at by the experts whose knowledge was used to structure the decision rules. In theory, if there is a sufficient gap between the abilities of top experts and the journeymen who would use the systems, expert systems should significantly improve the performance of the journeymen.

To date, expert systems have found some application in law, medicine, and insurance underwriting. Development work in other areas, including the management of emergency preparedness and financial services, is underway. The results of these efforts have so far been limited, but they offer considerable promise. An understanding of the process of building expert systems is developing and the computational power required to support them is available to many organizations.

Summary

System designers and users are only minimally constrained by the information processing and telecommunication technologies that are available. A wide variety of telecommunication services is also available. Capacity can be added in relatively small incremental steps so that users are not faced with unused capacity for extended periods.

Management can impose a strongly centralized structure or substantial decentralization of decisionmaking can be allowed. Regardless of the strategy, technicians have considerable latitude in implementing system designs that are optimal from the technical point of view while supporting whatever management philosophy is in place. For example, a centralized processing system can serve a decentralized decisionmaking structure as well as one that is highly centralized.

The processing and telecommunication technologies that are now available to the office put significant amounts of processing power in the hands of office workers and managers. The equipment used to deliver processing services ranges over a broad spectrum of capabilities, creating for office managers a wide range of options for configuring systems and designing the flow of work within an office. As the applications of the technologies become more widespread and the experience with them increases, they will have significant effects on virtually all aspects of office operations and the ways in which office workers interact with other elements of their own organizations and the outside environment.

Appendix B
OTA Case Studies

In support of OTA's study of office automation, several case studies were performed to supplement the many found in the management literature. In choosing contractors to perform these studies, consideration was given to the researchers' scholarly qualifications, their access to the proposed study organization, and the relevance of the study to the needs of the OTA staff. Those needs involved information on the impacts of office automation on organizational structure, job content, skill levels, training and employment levels. In addition, it was desirable that the studies illustrate a variety of office settings. Special efforts were made to consult workers at all levels of each organization, because their perspectives were neglected in many of the case studies examined.

The case studies summarized here were set in five types of offices—a small Federal Government agency, the Office of the U.S Trade Representative (USTR); "XYZ Company," the corporate headquarters of a manufacturer of a consumer product; the production, planning and control department of "Aircraft Instruments Plant," a manufacturer; an international division of a large commercial bank ("Commercial Bank"); and three agencies of the New York City municipal government—the Human Resources Administration (HRA), the Department of Finance (DF), and the Department of General Services (DGS).

Office Automation in a Manufacturing Setting[1]

Introduction and Background

This case study examines the effects of computer-based technology on one of the most common "offices" in American industry—those that handle ordering, inventory, scheduling, coordination, and control in the manufacturing facilities of private industry. According to one estimate, the people working in factory offices make up 10 percent of the clerical work force in the United States. Clerks take orders for a variety of products, break the products down into their component parts, then order parts from a vendor or have them built on site. As components wend their way through the factory, expeditors and production control clerks track their progress and position them for final assembly. Finally, still other office workers make sure the components meet the appropriate quality standards and ship them to customers.

For the last 15 years, companies have used a variety of data-entry and computer-printout techniques to create an "after the fact" tracking system. Today, the lowered prices of computer terminals and the greater sophistication of software makes possible "real time" scheduling and inventory systems. Usually known by the generic term of "MRP" (for "Materials Requirements Planning" or "Manufacturing Resources Planning"), such systems integrate the various functions of the industrial office and automatically track components on the shop floor as products are produced; coordinating the entire production process.

The focus of this study was production of gyroscopes, that contain over a thousand components, involving 14 different levels of assembly. This was the first product to go "on-line." With accurate information on the product structure and how long it takes to either manufacture or purchase each component, one can work back from the "due date" of the customer order to determine what components to order, how many, and when. The MRP system can also schedule production by matching customer orders to plant capacity and provide feedback on the work-in-progress. This information system can be extended to the purchasing, marketing, and finance departments.

The study of the MRP II system implementation at the Aircraft Instruments Plant illustrates some of the dangers that ignoring the organizational dimension of technological change can produce. It reflects how the demands of a new technological system can conflict with traditional management practices and style. It also demonstrates how worker involvement in and commitment to the new technology is crucial to success and how new technical systems, far from making traditional work skills obsolete, can make certain skills and expertise more important than ever before.

The study site is at a medium-sized factory, known here as the "Aircraft Instruments Plant." At the time of the study, the MRP II system was being implemented. This was both a disadvantage and an advantage for the case study; the implementation process was observed as it took place.

[1]This section is based on research performed for OTA by Leslie Schneider, Robert Howard, and Frank Emspack, Harvard University.

But the full impacts are not yet known, although participants in the study did speculate on what those impacts will be.

This plant is part of the Aerospace Business Group of a major American corporation. Of a work force of approximately 1,300, some 500 are managerial and professional personnel. The rest are production and clerical workers represented by a local union belonging to a large AFL-CIO international. The plant manufactures a wide variety of high-technology products such as aircraft instruments, engine sensors, displays and monitoring systems, incorporating some 55,000 different parts. Much of the work is under contract to the Department of Defense, and military specifications require high quality, strict cost control, and extensive documentation and recordkeeping.

Methodology

The study was based on 75 hours of interviews with approximately 30 employees, conducted in December 1984 and January 1985. Those interviewed included a broad cross-section of managers, systems designers, supervisors, clerks, shop floor workers, and union officials. However, the study focuses on the experiences of the clerical workers in the plant's "Production Support" department, in particular, production planning and control supervisors, clerks, and expeditors. This study looked not only at the technology, but also at the production planning and control, the general manufacturing process, the concept and philosophy of MRP, and labor-management relations.

Organizational Structure

The plant has five basic product lines: gyroscopes heat sensors, electromechanical sensing and display devices, electronic sensing and display devices, and flow meters. It also has four "contributing areas"—machine shop, coil shop printed circuit boards, and silk screen. These areas supply the five production areas with parts and components that are not purchased from outside vendors. There are seven functional areas—finance, marketing, purchasing, engineering, manufacturing, information systems, and employee relations. The first product to go on line with the MRP II system was a gyroscope. The Production Support Office that handles the gyroscope performs two functions—production planning and production control—and consists of a production support manager, two supervisors, and five clerks and expeditors. These clerks and expeditors are "graded salary" personnel and receive a yearly salary rather than an hourly wage, but are members of the union. There is also a Production Support Office for the contributing areas with its own managers, supervisors, schedulers, expeditors, and clerks. Finally, there are people in the shop itself who interface with these production support personnel—primarily, the shop supervisor, dispatchers, and gyro analysts.

Many of the senior salaried workers at the Aircraft Instruments Plant were hired in the years immediately following the Second World War and because of union seniority rules, are now concentrated in the highest job classifications, including the graded salary positions of the Production Support Office. Because of the long tenure of many workers, there has been little incentive to invest in explicit documentation of work procedures and practices. As this generation retires, the plant risks losing important job skills that have not been passed on to younger workers. Systematizing and formalizing work practices in order to counter this loss was a major objective for the automated inventory control system.

The Old System

For the last 15 years, the Plant used a computerized Inventory Management System (IMS) run out of a centralized corporate computer center in another city. Keypunched paper orders were batch processed monthly to break the orders down into component parts. This monthly "profile report" updated all material on hand, on order, and on the shop floor, and identified shortages. The Production Planning clerks then put out "order action reports" to Purchasing for outside vendors and to contributing areas for in-house "make" parts. In general, this process took a month. In addition, documents were generated setting aside parts for the manufacture of particular products and listing shortages of parts required to fill current customer orders. Supervisors and expeditors in Production Control followed these orders on the shortage lists into, through, and out of the plant. Other Product Support personnel schedule and coordinate the work of the contributing areas.

The above is a description of the *formal* production planning and control process. Along with the formal rules, a system of informal negotiations was necessary to accomplish production goals. The process was rife with irregularities and conflicting priorities, some resulting from technical limitations of the IMS system. The once-a-month report quickly became out of date. Accumulated inaccuracies were difficult to eliminate. As a result, Production Support personnel often did not know whether the data on the profile report were accurate and spent much time tracking down inaccuracies. The plant had a number of parallel recordkeeping systems that could not communicate with each other and that were often in conflict. The organization of work also caused irregularities because of the multiplicity of smaller competing suborganizations each with its own managerial hierarchies, priorities, and goals. In order for these various units to work together, considerable informal negotiation was required. Effectively performing one's job might mean doing favors for other departments in hopes of return favors or putting pressure on someone, but not so much pressure as to make an enemy. This kind of informal negotiation served to smooth the production process and iron out conflicts, but the inefficiencies were obvious and their elimination was one of the goals of the new system.

Implementing the System

While the managers recognize that organizational issues and workers' attitudes are the key to the ultimate success of the new system, the tendency has been to concentrate on the narrow technical details of getting the system installed; organizational issues have been left for later, and often either ignored or mishandled.

When the plan for an MRP II system was approved in 1983, a Core Team was created to select a vendor and oversee implementation. The Core Team had representatives from all major functional areas but the two organizations most directly concerned with employee attitudes—Employee Relations and the local union—played only a marginal role. In order to justify the major investment, the Core Team had to produce a cost/benefit study. Estimating the costs of the new system was relatively straightforward—one-time purchasing costs plus yearly maintenance and servicing fees and labor costs.[2] The benefits were considerably more difficult to estimate. These would include savings on labor costs, control over data processing operations, reducing inventory, and speeding up the movement of inventory.

The implementation began with an intensive review of the gyroscope production process. Changes were planned in the production process, systematizing shop procedures to correspond to the logic of MRP. The systems designers began writing the applications software when the hardware arrived in April 1984.

The MRP II system is an elaborate simulation of the gyroscope production work process. Managers say that increased access to information is its greatest benefit. However, the computer is not as yet programmed to correspond to the complexities of the actual work. For example, the system refuses to release orders if there are missing components. Production could begin without those components if the MRP system were programmed to handle such exceptions. Much night and weekend time that could be used for certain processes is lost because the system is closed down. Since there is no easy way to record a product moving backward in the assembly process for "reworking," which happens frequently with such a complex product, the MRP often does not know where the product is.

The problems in the gyroscope division during the first weeks of implementation had to do with rigidities created by the shift from an informal production planning and control system to a highly formal system. With the MRP system, each time one level of assembly for a product is completed, the new subassembly goes back to the locked stockroom, where its new status is fed into the computer. There is no general floor stock; every single component is accounted for, "mortgaged" to a specific order number and under strict control. However, amidst the pressures of preparing the gyroscope division for implementation of MRP, cataloguing general purpose floor stock received a low priority. When the newly functioning MRP II system began releasing its first components many of these parts (yet to be entered into the computer or even properly organized in the stockroom) were left out. In addition, supervisors were still responsible during implementation for meeting their normal monthly production quotas, an impossible situation for them.

Employment Impacts

In order to justify this major investment, the Core Team produced a cost/benefit study. The team projected that one-tenth of the plant's total work force (130) people could be laid off over a 5-year period. With attrition, the overall reduction could approach nearly 20 percent of the current work force. These potential savings have not occurred as yet but are expected when the system is operating more smoothly.

[2] The team estimated the MRP II would cost $2 million for the initial investment (80 percent was for hardware) and $1.7 million in expenses over 3 years Maintenance and service would amount to $600,000. the remainder would be training and labor costs.

Job Content, Skills

The problems experienced during the implementation illustrate that instead of eliminating the need for traditional product knowledge, MRP makes that knowledge more necessary, to ensure that the MRP simulation is as accurate as possible. Supervisors have to have sufficient familiarity with the product to know when to ask that the MRP system be manually altered. Product knowledge is especially important for the supervisors of Production Planning and Control, the people with the authority to manually release orders. This shift of authority from the shop floor to the Production Support Office has led some production employees to see MRP as a threat to their own control, exacerbated by their perception that the people in Production Support do not know how to perform their job effectively.

Knowledge of the system is also necessary for effective use of the MRP. Production Support personnel need to know how and when to perform end-runs around the system. For example, parts for a specific order are released in lots of ten. If only eight parts of a component are available, the system will not release the order until two more arrive. The current lot size must be manually changed to 8 and the next lot size to 10 in order to begin production.

The system has substantially increased the time that Production Support personnel spend actually working at computer terminals, by as much as 300 percent; they enter their own data, gather information and perform transactions (e.g., releasing parts onto the shop floor). The need for accuracy in data entry becomes very important. This, and the need to identify and handle exceptions demand constant alertness and can be extremely stressful. In addition, there are not enough terminals to handle the work to be done and lighting and other environmental conditions are poor.

The management is operating under two basic assumptions—that MRP II will require significantly fewer people to oversee production planning and control and that because of the centrality of MRP to the plant organization, those people who work on the system must be management personnel. Many of the new supervisors occupying newly created positions are young with almost no experience in production planning and control. They have often confronted problems that they do not have the expertise to handle. Unofficially, some experienced employees are still performing the tasks.

One example of shifting work roles is that of the production control clerk in the contributing areas. This position formerly involved planning; ordering materials; sending it out to the shop floor; and seeing that it was properly machined, inspected, and put back into stock. The more accurate and up-to-date information provided by MRP makes it unnecessary for the production control clerk to spend a great deal of time on the shop floor. Many of their traditional tasks have disappeared—some into the computer system, others taken over by the new supervisors in the Production Support Office and by shop coordinators. What is left are clerical tasks that are repetitious and, some say, pointless.

When graded salary personnel work with the new system, it is usually at their supervisors' discretion and only to perform the lowest level clerical tasks. The managers claim that this is temporary and that eventually some additional tasks will be delegated to graded salary personnel. The union, however, sees this division of labor between supervisory and union personnel as a contradiction of the work organization model presented by the management. This change in the balance of responsibilities puts the union workers most at risk if the predicted labor savings are achieved.

Training

From the beginning, the MRP training process encountered serious problems. The Core Team's recommendation that a manager be hired and given full-time responsibility for training on the MRP project was rejected by top management as too costly. Preoccupation with getting the system working resulted in the neglect of training. On the surface, the quantity of training provided to managers and workers seemed considerable. Some managers, supervisors, and hourly personnel attended a week-long MRP training course at the nearby factory of the system vendor. The training for most of the affected work force was a 10-week, 40-hour, in-plant course developed by the Core Team and the Information Systems Department, which proved far from adequate. Some key workers did not receive training until well after MRP was implemented. The vendor training course was criticized, especially the videotapes, as boring and a waste of time. Workers were not taught how to use the paperwork that comes out of the system, and did not understand the logic of the system.

Managers believed that workers did not understand what production control itself was. Workers from the Production Support Department tended to see things differently. They felt they understood how the work process really functioned, but were being asked to learn a highly formalized system radically different from what was actually happening.

The superficial training has come back to haunt the Core Team. The system designers have had to play a support role that takes valuable resources and time away from implementation of the MRP system in new product lines.

Conclusions

The final organization of work within the MRP II system is not yet determined. It is still too early to know whether a work organization based on a small group of relatively young, new supervisors can effectively oversee production planning and control at the plant. The promise of increased decisionmaking for graded salary workers has so far remained unfulfilled, because of managerial decisions about how technology is used. There may be a conflict to management as to whether to entrust responsibility for working the system to bargaining unit workers or to reserve it within management.

This case study illustrates the fact that technological change is a social process, in which organizational choices that shape not only the effects on people and organizations but the effectiveness of the technology itself. Managerial choices were a major obstacle to the successful implementation of MRP II; and as MRP II was put into operation, management did not address a variety of sharp contradictions between the new system and traditional work practices, job categories, and plant incentive systems.

The management staff feel that these problems will be resolved in time. The problems are not unique, but represent some of the most common problems that organizations experience when implementing new office technologies. Their resolution depends far less on narrow technical factors than on the social processes by which technological change is managed and negotiated.

Office Automation in the Corporate Headquarters of a Consumer Product Manufacturer[3]

Introduction and Background

This is a case study of the successful implementation of an office automation system. It suggests that choices in managing technological change can lead to positive outcomes for both employees and for the organizations, if that is a priority in the planning and implementation process.

The research site is the national corporate headquarters for Company XYZ, a major manufacturer of a consumer product. In addition to the headquarters office, the company includes four manufacturing plants located throughout the country. There are approximately 300 employees in the corporate headquarters and approximately 1,000 employees overall. The company is a wholly owned subsidiary of a larger corporation. The study focused on four departments within the corporate headquarters—marketing research, planning, the controller's office, and product development.

Only one of the four manufacturing plants is unionized, the pay is high compared to similar companies, and there is a high degree of career mobility in this company. The company literature stresses the importance of treating employees well and giving them the freedom, opportunity, and rewards to perform effectively. A second theme is the importance of open communications. Productivity is viewed in terms of a total system, embracing employees, equipment, information and materials. There is a strong emphasis on innovation, risk taking and experimentation, and state-of-the-art knowledge and technology. There is also, peculiarly, a strong emphasis on punctuality, with all employees, including the president, clocking in every morning. Bonuses are linked to both sales volume and return on assets, providing an obvious incentive for improved performance for the company as well as for the individual salaried employees.

It is clear from interviews and personnel data, company brochures and policies, that the corporate headquarters work force is highly educated, well-paid, and largely professional. Except for its formalistic policies on punctuality, the company closely resembles the "organic" (i.e., nonmechanistic) model of organizations that management theorists have touted for years.

Methodology

Semistructured interviews were supplemented by researchers' informal observations and archival information. Interview data were collected from—2 executive managers, 1 manager from personnel, 3 managers from technical departments, 2 key people involved in the implementation process, 4 department heads, 8 individuals outside the focal work groups who were links in the process and 20 employees from focal departments. Where possi-

[3]This section is based on research performed for OTA by Tora Bikson, Don Mankin, and Cathleen Stasz of The Rand Corp.

ble, respondents were selected for participation on the basis of formal position in the organization chart. Others were identified during the data-collection process.

The interview format used with all respondents required 1 to 2 hours to complete. Field notes taken during research visits were used to construct case reports for each department and for organizational personnel; these then became the basis for subsequent examination. Preliminary research findings were reported to the participants in feedback seminars in order to confirm descriptive information, validate conclusions, and generate discussion of issues this organization faces as the technological innovation continues.

Implementation

In 1980, Company XYZ acquired a new chief executive officer who saw a critical role for information systems which permit a business to collect, store, structure, share, and manipulate information about previous experiences in order to learn from them and improve business performance.

The segment of the consumer product industry in which XYZ operates is highly competitive, with many strong players. In 1980, XYZ, holding fourth place among its competitors, was facing major profit-and-loss difficulties; it needed to increase market share and cut costs. This impetus led to an investment in computer technology. The goal was to replace old batch-oriented information systems and manual technology with flexible cutting-edge electronic tools and concurrently, according to management, to give users a renewed sense of power, insight, and enthusiasm about their tasks.

A high-level organizational manager (now a Vice President) was named to lead the planning effort and put together an implementation team. He chose employees who had substantial business experience and a strong sense of strategy, and who, like himself, were not systems professionals but were comfortable with information technology. In addition, he recruited for the team an employee from another firm with recent systems implementation experience. The five-person team produced a business systems plan by first studying the work of the firm's many departments to determine what information needs they had; this task required substantial input from department employees. Then the team investigated the kinds of technology that might fill these needs, relying heavily on technical advice from an outside consulting firm.

Looking back, the former head of the team emphasizes the importance both of employee participation and technical expertise in the planning. A direct knowledge of business tasks was critical. On the other hand, comparing technologies and assessing their ability to handle the needs required computer system professionals.

The year-long planning effort yielded an approved plan and those who developed it were charged with its implementation. Executive management was highly committed and provided solid budgetary support that was apportioned as follows:

- 10 percent—hardware,
- 10 percent—software,
- 30 percent—software development, modification,
- 40 percent—implementation, and
- 10 percent—training.

The process operated on a project-by-project basis, with the plan partitioned into relatively independent parts. Each project required its own specific plan and justification. The plan established a very general blueprint and performance criteria for system development but was indeterminate with respect to order of projects and details of their enactment. Projects originate either from user groups or from the technical consultant's perception of a need. The consulting firm operates a centralized computing facility, the use of which provides this mid-size firm with more computing resources than it could support on its own.

The major architectures include a remote mainframe owned by the consultant firm, another large computer system on which time is rented, and a small number of personal computers. The acquisition of personal computers at this point is unsystematic and there is no formal responsibility for their support. They are purchased by employee request. Although the company does not want to discourage personal computer use, there are concerns about data security. Only a few people have more than read-only access to corporate databases. Analysts can download data from the larger systems and upload data that they have entered onsite. There are a variety of systems available for use through time-sharing that provide several programming languages (including a variety of applications software and a fairly high-level matrix-structured language suitable for flexible data manipulation, analysis, and reporting).

In addition to these major applications, word processing is handled by a small centralized department doing internal and external correspondence for various departments. Electronic mail is used primarily for external communications to subsidiary companies. For a variety of reasons, it has not been fully implemented within XYZ—drawbacks were found in two systems pilot-tested, most employees do not have their own terminals, and it is seen as hindering personal communications, which is an essential element of XYZ's corporate culture. The company does, however, use Voice Mail Exchange (VMX) to better manage telephone communications. Primary VMX communication occurs between sales representatives in the field and the Sales Planning department in the home office.

The Users

On average, employees had been using computers for at least 3 years at the time of the interviews. Across the four departments, five employees had their own workstations; the remainder shared workstations with two or more others, and often found getting computer time to be a problem. In most departments workstation allocation reflected task demands. In one department, however, status was also a factor. Actual time spent working on the computer was extremely variable across the four groups. Since few people use the computer all day, it seems reasonable that workstations be shared, but the tradeoff of cost v. access has not been wholly resolved.

The users in most departments have a range of options for guiding and modifying the systems they employ. There is considerable choice about how to use the advanced tools, left largely to user initiative. Some employees envision a split between "haves" and "have nots," based on differential aptitude for information technology.

Users across the four departments were generally enthusiastic about the capabilities of the computer systems, although some had specific complaints such as poor graphics capability and difficulty moving between databases. Other complaints concerned the databases themselves—the data were sometimes inaccurate or unavailable. The disadvantages cited by users have more to do with lack of systems integration than with individual systems. The integration problem had been expected as more applications were implemented and accessed by users.

Job Content, Skills

No trends were observed toward mechanization of work or toward de-skilling of jobs. Most users reported increased variety, challenge, creativity, and responsibility. Time savings were universally reported for individuals and for groups. For example, some vital procedures requiring nearly a day when done manually now require only 1 hour and are less likely to contain errors. Most employees use the time gained to take on new tasks and responsibilities. On occasion, groups have also widened or redefined their missions as a result of computer use. In terms of bottom-line measures, XYZ has succeeded in increasing its market share and cutting total costs per unit output, even though labor costs are higher.

Reported changes in work were generally consistent across all groups. There was increased control over work. Work demands increased for some and decreased for others, depending on the work group. Rather than create repetitive data-entry jobs, the company chose to distribute database updating tasks among the employees using the databases. This has caused some dissatisfaction. There were two important between-group differences. One was a change in management style in one department—a manager apparently was spending most of his time on-line and less time in typical management activities. Opinion was mixed as to whether this change was good or bad. Another difference was the degree to which users had invented new ways of doing their work. Many reported that they adapted or modified the technology to suit their needs, although most of what they reported was more appropriately categorized as a new task.

Most changes in communications resulted from tool sharing and interactions with others in the department, rather than increased communication with people outside their department. Few employees used computer-based communications, and no one reported that this took the place of other forms of communication. Because of the strong emphasis on face-to-face interaction, many believe that electronic communications systems are unnecessary and possibly detrimental to intraorganizational behavior.

Formal job changes were reported in three of the four groups, but only at the clerk level. Two clerks believed their recent promotions and pay increases were due to increased responsibilities and special assignments resulting from their computer use. The clerks' job descriptions in one department were being updated at the time of the interview, explicitly because of the new computer-related higher level skills and responsibilities. The clerk position in another department has now been upgraded from an hourly to an exempt one.

While the majority of users found satisfaction and a sense of accomplishment, others were bored, less motivated, and working below their abilities.

Among the reasons cited were increased expectations about what the technology could do and, therefore, frustration when expectations were not met. Another user felt "locked to the terminal" when trying to meet end-of-period or other deadlines.

Training

Despite the fact that training was a mixed-bag of formal and ad hoc procedures, most users were well satisfied with it. For most employees, learning about the computer system is part of doing the job. Learning beyond the minimum required for this purpose is voluntary.

Training varies by department. In R&D, the tasks are so specialized that general purpose introductory and intermediate courses are of little help, so training proceeds on an individual basis with the help of peers. Peer learning also characterized the Planning Department, where only one person uses the system. Formal classes are offered by the system vendor. The consultant firm and the Business Systems Department both provide training and technical support for users on major mainframe applications. The amount of time required for users to learn their systems varied widely by department. In R&D it took 2 to 3 months; in Planning, some applications could be used in just a few days; sales forecasting took about 6 months to master.

Users mentioned a variety of formal help mechanisms, including documentation, local technical staff, a telephone hot-line, a users' group, and online help. Some means of assistance, however, were not entirely reliable. Employees had problems finding some of the manuals they needed, and some applications were not well documented.

Informal support was crucial to most users. The learner must find someone who is willing and able to teach and then find a time when they are both free. Self-taught "experts" among the employees performed voluntary support service. While they seemed to enjoy the teaching role, they believe that learning support could be more effectively provided if some resources within the department were formally allocated for that purpose. A resource center was one suggestion.

Conclusions

In Company XYZ, a conscious attempt was made not only to remove the constraints on innovation, but to encourage it. They view computers as tools needed by competent and motivated people to perform their jobs effectively. The technology is mission focused, user driven, and can be guided, modified, and manipulated by users. It is designed for change as users acquire greater expertise. The organization had a conscious strategy for implementation that had been carefully planned, staffed, and budgeted. They attempted to balance centralized and decentralized decisionmaking. The implementation project was characterized by a great deal of user involvement that promoted a feeling of "ownership" among employees. The system continues to change and individuals keep finding new ways of working with it. There is no "post implementation" period. Rather than minimizing the change, the organization has learned to manage it.

Computer-Mediated Work in Commercial Banking[4]

Introduction and Background

The influences that affect the implementation of automated office systems can be environmental or institutional. In this study of the automation of one group in the international department of a major Commercial Bank, the original reasons for deciding to implement the system were environmental—the desire to improve world-wide communications in the International Department (ID) and to become more competitive by offering more or better services. The factors that contributed to the success of the implementation were institutional, the most important being the visible and unwavering support of top management. Key actors were involved from the beginning and provided their backing. Users were involved in the feasibility study and in the actual implementation.

These factors, while critical, are not sufficient for success. If unwise technical decisions are made or based on inaccurate technical information, the implementation is likely to be compromised. While it is felt at Commercial Bank that the original implementation was a success, there have been some problems. For example, they were not able to "close more deals," which was one of the goals; the number of functions available on the system was reduced after the pilot project was completed to reduce costs; communications, especially overseas, have been a problem because of low-speed lines and lack of sufficient equipment; and at certain times, the system is heavily loaded which affects performance and user satisfaction.

[4]This section is based on research performed for OTA by Jon Turner. New York University.

Commercial Bank has over $40 billion in total assets and employs some 8,000 people, worldwide. Since 1977, equity has grown by more than $1 billion, largely through high earnings performance achieved by taking advantage of capital market opportunities.

There has been an intense effort to control noninterest expense. Over the past 6 years, operating expense has increased at an average annual rate of 11 percent, compared to 16 percent for a composite of the nine largest U.S. commercial banks. Several tactics have put downward pressure on expenses, among them, the application of technology in labor intensive areas and internal expense budgeting.

The International Department (ID) is one of three groups that make up the banking function. As part of the ID, the Asia/Pacific Group, which was the focus of this study, provides commercial banking services and has well over 60 percent of its staff located in field offices in Asia and the Far East.

Most of the 800 information systems personnel in the bank were part of the Technology Department (TD), which developed and maintained most of the bank's computer application systems and ran the data centers. TD was the builder of large, transaction processing systems and was viewed by many as being slow and not responsive.

Almost all of the Asia/Pacific Group's communication, among the field offices and between the New York and field offices, took place over an international TELEX System, because of the need for a hard copy record of the communication on both ends and because time differences restricted the time available for telephone conversations during the normal business day. Long (15-20 page) loan proposals had to be sent between Tokyo, Hong Kong, New York, and London several times during their preparation. Preparation of TELEX messages was time consuming for the principal and the secretary, inefficient, and error prone. It discouraged sending messages.

The possibility of using computer and communication technologies to overcome the communications problem in ID was of interest to the head of the Asia/Pacific Group, who realized that poor communications was compromising his people's performance and his ability to control them.

Implementation

Initially it was thought that communicating word processors in each location could handle the job, but this approach was too limited. The Office Information System (OIS) was then planned. It was intended to be integrated, providing a variety of functions, for example, electronic mail, coupled with text editing to deliver information directly to people in the field.

The concern over controlling expenses meant that the pilot had to be tied to clear-cut goals. It was to be a means for increasing revenue and a catalyst for behavioral change, to improve communications, and to be financially justifiable in terms of cost savings. Specific goals in customer service were same day response to 30 percent of customer Money Transfer Inquiries from field locations and elimination of all routine customer inquiries from the field to the New York division Customer Service Officer. Other goals included building a database to assist in identifying customer needs, developing and monitoring market plans, and permitting broader product requirements' assessments across units. Finally, the OIS pilot test was to reduce the amount of time marketing personnel spent on administrative matters by 15 percent, eliminate 25 percent of the problem solving workload of the New York based Customer Service Officer (permitting more time to be spent in customer contact) and reduce secretarial workload.

Planning for OIS began in the spring of 1982. Equipment was installed in New York during the summer and in the field during the winter of 1983. Evaluation continued into the beginning of 1984.

An employee was hired to implement the OIS who had experience in implementing a similar system for another financial institution. The bank also retained a consultant. A two-stage pilot test gave ample opportunity to debug and configure the system. A member of the Asia/Pacific Group was the full-time user representative on the implementation team.

Equipment.—The OIS included word processing, electronic mail, document processing, desk management with calendar, and calculation abilities, and forms development in one integrated package. The system is connected to a time sharing system and to the bank's mainframe computers. A 72 line statistical multiplexor (STAT MUX) tied to a microwave link is used to connect the equipment between New York City offices. Terminal transmission speeds are 9,600 baud at the headquarters office, 2,400 baud at another NYC location, and 1,200 baud on the overseas and dial-up links. The system can access the time sharing system, transactions for each customer, commercial loans, historical records, financial asset inventories, and all other banking databases.

Methodology

This study focused on the individual worker, although some conclusions were drawn about work group, departmental, and organizational processes. Semistructured interviews, memoranda, and observation were the primary method of data gathering. Respondents were selected from all levels of the department studied, ranging from clerical to department head, based on the participation in the implementation and on their position in the organization. For purposes of verification, at least two subjects were selected from each work group and from each organizational role. They included workers who had been in the field at the time of implementation.

An open ended interview selection process was used, adding personnel to the list as their roles were identified. The senior personnel were interviewed last to permit the identification of critical policy issues.

The Users

One of the goals of the system designers was that everyone would prepare, send, and receive their own messages. Officers would read their mail first thing in the morning and prepare their own replies. They may check the system 3 to 4 times additionally during the day. The system is used heavily by personnel when traveling to field locations. However, the lack of enough terminals in overseas offices limits access to the system. The speed of the lines and the need for certain operations offices in New York to be open in order to use on-line files also restricts the usefulness in the field offices.

Secretaries make extensive use of word processing and electronic mail. Large documents are prepared off-line, proofed, corrected, and then transmitted over OIS. The low-speed lines restrict use of the system interactively.

In New York, most employees in Asia/Pacific have their own terminals which, along with the higher speed lines, encourages use. Employees do much of their own document preparation. Officers and support staff make extensive use of the connections to other systems, directly accessing the Money Transfer, Cash Connector, and Historical Research systems. An active officer in New York might be continuously logged in to the system, receiving 10-15 messages per day and transmitting 7-10. Meetings may take place around a terminal while scrolling through a document or list. Some officers use OIS to access the time sharing system where they execute analytic procedures and route the output back to the terminal or printer. A spread-sheet function is used for preparing plans and can be downloaded to a personal computer and back into OIS.

Job Content and Productivity

The content of secretaries' jobs has clearly improved. Previously, up to 40 TELEXs per day would be sent, which meant spending 2 to 3 hours in a TELEX room and many more hours in preparation. Now principals send most of their own messages. Because not all offices have OIS, some TELEXs are still sent, but this is much easier with the OIS. The secretaries' typing load has been reduced and now consists mainly of larger manuscripts. This has freed them for other activities that includes some customer contact and some research. The word processing software helps them to create more "professional" looking work. Some secretaries feel that the total amount of paper has decreased; however, many principals do not agree with this.

The secretaries feel that they have acquired new skills and that they are more productive. New career paths have opened up for some secretaries who showed unusual interest in or skill with the system. Some were promoted to system "expert," providing consultation and teaching to others in the group. Some were transferred to the Information Management Systems group where they are pursuing a systems career. Management appears not to have anticipated the change in work mix for the secretaries. Each secretary has been left on his/her own to work this out.

Some managers feel that the system helps them establish priorities in their work or that they are more aware of what is going on in overseas offices. Because information is easier to transmit, more is sent. Principals feel more productive because the number of telephone calls and memos has decreased, messages sent on the system tend to be brief, there is less time wasted in telephone tag, and more reports are distributed over the system. The Monthly Profitability System used in planning, formerly took several days to distribute. Now it is distributed instantly by electronic mail. Although more useful information is being communicated, the number of trivial messages has also increased. Communications tend to be among peers rather than flowing up and down the hierarchy. For certain people, the system has served as an excuse not to get out into the field. There is some concern that management will see everything through the machine and will not benefit from exposure to the field offices and customers.

In times of great pressure or emergency, workers at Commercial Bank tend to revert to their old methods of doing work. They pick up the phone to relay messages or they may not read their electronic mail for several days.

The effectiveness of the organization as a whole seems to have increased because of the increased access to the various databases such as historical records and customer transactions.

Training

The original concept for training was one-on-one training. Often an on-site person in each office was designated as the "expert" in that office, received special training, and became a "friendly" source of information. While there was some "cultural" resistance to using the system in the field at the more senior levels, this was a short-term phenomenon and disappeared when the "boss" began using it.

Special care was taken to have documentation prepared and to provide training sessions on the equipment. The training was staggered to accommodate new users over time. A good portion of the staff were trained by their colleagues, rather than in the formal training sessions. The simplicity of the system and its self-help features made it easy for many of the staff to learn on their own.

Organization

Although there have been no major changes in structure or social support, the system has facilitated social interaction among levels. Since the secretaries were the first trained on the system, they later aided in teaching senior officers. This served to break down social barriers between levels, particularly in the field offices.

The system also permits more time/place flexibility in performing work as managers can do their work from home or hotel rooms and do not have to spend as much time on the telephone. Formerly, all information was sent to New York for entry into the systems. Some of the data entry is now done in the field, which better distributes the workload and makes the system more current. Also, field personnel communicate directly with operations to resolve some problems rather than going through the Customer Service Officer in New York.

Conclusions

Employees at Commercial Bank feel that there has been an increase in individual productivity and more communication with customers. Although this improvement is difficult to quantify, a 1 day turn-around on approvals for certain proposals has made the bank more responsive to customers. Marketing personnel have not reduced the time they spend on administrative matters and Customer Service Officers still handle most of the contact with the field. In the New York offices, the number of secretaries has decreased from 11 to 7. Labor savings figures were not available for the field offices.

OIS will not be fully cost justified on the basis of electronic mail alone. One of the most important benefits of the system is access to the various application systems such as money transfer, commercial loan, and collections. The full potential has not yet been realized. The use of leased lines and satellite communications could increase bandwidth and make the system much more usable in the field. Local processors in major regions would reduce traffic on the relatively slow transoceanic links. The real payoffs will occur when the system is used as a single interface to all written material and this has not yet occurred, possibly because of the costs involved. This is an example of the conflict between controlling operating expenses and taking advantage of office automation to improve operations.

Development, Implementation, and Impact of Office Automation at the Office of the United States Trade Representative[5]

Introduction and Background

Office automation at the Office of the United States Trade Representative (USTR) has established extensive system capabilities in a relatively small agency with wide ranging policy responsibilities. The ratio of terminals to employees is almost one-to-two, an achievement that is not common at this early stage of development.

This case study reviews the brief 25-year history of the office, its role in international trade

[5]This section based on research performed for OTA by William Neufeld, consultant, Washington, DC.

policy, early efforts to automate a number of functions to aid in carrying out its responsibilities, and how these early efforts served as the beginning of the present automation system.

USTR is a small agency with a permanent staff of 122 in 1984 and a total staff including contractors and part-time personnel of 183. Assisting the USTR with his responsibilities for trade negotiations are three Deputy U.S. Trade Representatives who also hold the rank of ambassador, two in Washington and one in Geneva, Switzerland. There are also assistant representatives in trade policy, industrial and energy policy, international investment policy, agriculture and commodities, General Agreement on Trade and Tariffs (GATT) affairs, and for several specific areas of the world.

Three events contributed significantly to development of office automation—commitment by the United States to a new round of multilateral negotiations and the need for a method to handle large volumes of trade data and material, the failure of the Department of Commerce to assume a leading role in the creation of a centralized trade database, and the introduction of microcomputers into the workplace. Computer technology suggested to USTR that a database could be developed specifically for international trade, from data that existed in files of many different agencies with responsibility or interest in international trade. A consolidated base of accurate information was greatly needed.

Initial efforts by USTR to centralize trade data used contracted computer and programming time. A plan was outlined utilizing the hardware and programming capability of the Central Intelligence Agency (CIA), including the development of communications capability between the USTR Washington and Geneva offices by high-speed data link. The program was eventually transferred to the Department of Commerce computer facility and to a computer system at the National Institutes of Health.

In 1977, USTR formally proposed development of a centralized computer system for the trade community to eliminate duplication of effort. It would require each agency to contribute data to an information pool. A major goal was to give trade professionals direct access via computer terminals to the data. The system became known as the Trade Policy Information System (TPIS). The NIH, Division of Computer Research and Technology was chosen as the main computer support facility because many agencies already used the system and it w - cost effective. By 1979, the data system was working and in 1984, it was renamed, Trade Policy Staff Committee (TPSC) TradeNet. Office automation followed development of the large system.

Methodology

Personal interviews were conducted with 37 people, including 10 senior staff, 15 professional staff, and 13 secretarial staff members. (Secretarial staff at the agency currently number 46, including 3 confidential secretaries.) Four of the ten senior staff interviewed had terminals on their desks; the others did not have direct access to computer terminals. All but three of the professionals interviewed had computer terminals at their desks.

Terminals had been available to most of those interviewed for 1½ to 2 years. Few USTR staff used the system directly before that. Office automation is a recent development, and work patterns, habits, expectations, and performance are still changing. In spite of this it was difficult for some respondents to recall how they worked previously, and conversely, difficult for senior staff to notice significant change because they have not participated as fully.

Implementation

The computerized trade database has become a major component of the tools used at USTR and was the forerunner of the office automation system that eventually developed. The interagency trade database and some additional electronic capabilities evolved over the course of 15 years. Introduction of a more fully integrated and comprehensive office automation system took place in only 5 years.

There was as much planning and consideration on the part of the Computer Group and senior management as time and budget allowed. The first features to be developed were systems for sending messages between offices electronically and for keeping track of incoming mail to assure timely response. This system, although not unique, was ahead of many other such programs in government. Since most of the agencies participating in the shared data network had some terminals allowing direct access to the computer facility, an electronic mail system was introduced in 1980 using the existing elements of the TradeNet system. It allows users to send and receive messages and completed documents, and enables members of the Trade Policy Staff Committees to transmit unclassified documents. The system serves nine agencies, including the Office of Management and Budget; Departments of Agriculture, Commerce, Interior, Justice, Labor, State, and Treasury; and the International Trade Commission. A telemail system is available for communication 24 hours per day between Washington, Geneva, USTR Ambassadors, and staff members on travel. It is also possible to use this system to transfer documents into the word processing systems in Washington and Geneva.

USTR had only begun to purchase terminals for those outside the computer operations group in 1980 and electronic mail was not available to all staff. To use the electronic mail or database systems, it was necessary to use one of the few terminals available through the computer operations group. To encourage users to sign on to the system frequently despite the inconvenience, a calendar was published electronically of daily meetings and events held at USTR. The International Trade Commission added a calendar showing trade decisions being considered by the Commission each week. A system designed to keep track of the increasingly large amount of correspondence directed to the agency was developed at the same time.

By 1980, the agency had acquired a computer to do data manipulations and communicate with the NIH system, and a minicomputer with capability of supporting 128 users. A needs study recommended that the ultimate configuration be a combination of stand-alone units and shared logic terminals that would use the same software, be linked through telecommunications, could access electronic mail and files, and could share common resources such as printers. Terminals were placed in only a few offices at first, but as professionals gained experience using the system, others asked for terminals. By the end of 1983, more than 50 terminals had been installed. All secretarial staff will eventually receive stand-alone machines. There were 36 more microcomputers on order at the time of this study.

Training

Organized training activities for users of the trade data system expanded in 1981. A USTR Computer Users Manual was issued. Formal group training and orientation sessions were held. Individual training sessions and ongoing technical assistance was provided on demand to new users. A staff of six "information counselors" was hired within the Computer Group. Additionally, six part-time student workers were added to assist with the increasing workload of the Computer Group, including maintenance and updating of the systems, updating training manuals, and preparing the daily newsclip service.

A vendor provided training for secretarial staff members after acquisition of 18 microcomputers in late 1983. Training by outside sources of both professional and secretarial staff was cited often as one of the least attractive experiences with USTR automation thus far. All found it to be unsatisfactory because of the use of "computer language" to describe operations and lack of explanation of technical details. The agency has found it more satisfactory to use in-house staff for training because it is more useful to the employees and because it is more cost effective.

As the agency and the system grew, computer operations personnel were engaged almost full time in system construction, maintenance, and responding to requests for assistance, leaving little time for organized training. A "control desk" has been recently established to assure that someone is available to answer questions or help solve problems, releasing the Computer Group staff for other tasks including advanced training sessions.

Job Content, Skills

About one-half of the senior staff, including the agency's top official, uses the terminal in their office infrequently. The reasons most often cited are that they do little creation and revision of documents or data retrieval and analysis. Because the agency is so small, use of the calendar function is not crucial. They do not use electronic mail internally or between agencies because either they or their counterparts in other agencies do not have terminals available. They do not use the word processing capabilities, preferring to rely on their subordinates to produce required documents or data on request. They use the telephone or short memos and letters to conduct business. Negotiating trade issues, or discussing policy options, duties primarily reserved for senior staff, requires face-to-face contact with counterparts in other countries or government agencies. "Diplomatic niceties" would preclude the use of teleconferencing technology for conducting trade talks or other negotiations. As a result of not having a need to use a terminal, half of the senior staff interviewed expressed some reluctance about learning to operate the equipment.

The opposite was true of most professional staff. They use their terminals frequently. In the absence of time or opportunity to participate in formal training sessions, all said they learned the most about how the system worked by "playing with it." Each interviewee suggested that it had taken some time to become comfortable with the idea of typing rather than writing, or with the technical aspects of the equipment.

Most professionals described increased self sufficiency in document production as the greatest time saving, as well as adding greater satisfaction to the job. Without the need to rely on secretarial support to do drafts, rewrites, or make copies, the process became not only faster but less stressful. Secretaries commented that they believed there was less anxiety on the part of professionals, who used to wait for typing, and less stress on secretaries as a result.

Professionals noticed that deadlines on occasion had moved up as the ability to meet them had improved. Senior staff said that they had become more conscious of time saved, and as a result, delayed making assignments knowing their staff members were able to meet shorter deadlines. Professionals described significant changes in individual writing style; word processing capability enables them to spend more time thinking about their subject. Senior staff, again without exception, suggested they were more likely to send a document back to correct small errors or to add clarification because they knew it would take much less time with the automated equipment.

Several professional and secretarial staff members were more satisfied with their jobs because automation let them do their work better. Some secretaries performed more typing in the same amount of time; others spent less time typing the same amount of work. Some were dissatisfied because the job was uninteresting, especially those whose workload had been drastically reduced. In a few instances, secretaries had been able to take on new responsibilities such as research and writing. If that becomes general, the secretarial staff may seek increased pay to reflect these responsibilities. But because USTR is a small agency, opportunities for advancement may be limited.

Productivity

USTR has a growing workload and the need to keep up with changing conditions. The "product" of the agency is, at the broadest level, advice to the President regarding trade policy options and choices, and serving as "honest broker" between the many groups with an interest in trade policy. When measuring the effect of office automation at USTR therefore, one must evaluate fairly intangible products—coordination of discussion, interpretation of facts, analysis, and thought. More and better databases have contributed greatly to effectiveness in carrying out this mission.

Increased productivity at the professional level was achieved by the use of the electronic mail system. The ability to send and receive documents by electronic mail has improved the process of comment and clearance. The time for review and clearance of trade policy positions and papers had been cut in half in some cases.

Professionals felt that they could get their work done much faster, which allowed them to clear up backlogs. Without exception, respondents described a decrease in real time of 50 percent in completion of projects.

Organization

As yet it is impossible to relate hierarchical organizational changes within USTR to the introduction of office automation. No major organizational changes have taken place since 1979. However, a number of established office relationships have been affected, especially between professional and secretarial staff members. As many professionals become adept at performing their own word processing, some secretarial staff have begun devoting more of their time to other work while others have become dissatisfied with their jobs and the lack of challenge.

The increased knowledge and contact with others in the trade community may change the career expectations of the junior staff. When senior staff become more familiar with the potential of the system, they may assume more direct responsibility for day-to-day conduct of operations.

Conclusions

The agency has a better understanding of issues under negotiation because of their automated system that provides more pertinent information on a wide variety of issues. Staff productivity has increased, the number of meetings required for document clearance has been reduced, and the time savings allow them to keep up as issues develop. The professional staff are faster to act and react, have been able to adapt to expanded responsibilities and have better data to support their analytic work. The secretarial staff produce work of higher quality and the office runs more smoothly.

The system is appreciated by all of the employees in this agency, although to varying degrees. The senior level employees do not have much occasion to use it, the professional employees are innovative and interested in their use of it, and the support staff's experiences range from boredom to hope for advancement.

The results of this study, while not unexpected or dramatic, provide indications of the types of personal and organizational changes that have occurred with office automation and also provide points of departure for speculation on future changes that might occur as personnel become more familiar with the system capabilities.

The Impact of Office Automation on the Municipal Work Force of New York City[6]

Introduction and Background

The primary theme evolving from a study of the office automation process in three agencies of the New York City Government is that management strategies and agency goals play a fundamental role in determining the effectiveness of public sector as well as private sector office automation. Improved productivity in terms of increased output was achieved in these agencies. However, two different methods of automating services had different effects on output, worker satisfaction, and quality of service. The assembly line style often used for processes which can be mass-produced and processed repetitively, resembles the industrial assembly line in its effects. Customized services that enable creation of databases for new analytical purposes were generally more successful in increasing output, worker satisfaction, and quality of service.

This study looked at four occupational categories—clericals, paraprofessionals, professionals, and managers. The principal findings were—an increase in work output; a perceived increase in the quality of output; and under certain circumstances, evidence of the creation of new work. Reduced employment has been an objective of the New York City Government since fiscal problems of the mid-1970s and the cost-justification of acquiring automated equipment has included a reduced work force.

The three agencies studied in New York City were the Human Resources Administration (HRA), the Department of General Services (DGS), and the Department of Finance (DF).

The HRA is the largest municipal agency in this city, with 24,000 employees and a budget of $4.1 billion. It serves over 1.5 million poor and elderly through public assistance, food stamps, Medicaid, day care, shelters, protective services, and job placement and training. Before 1979, all typing was done manually. The massive paperwork and spiraling costs caused HRA to develop a plan to automate. Today, 23 office systems serve 39 of the 52 program and administrative support areas, providing word processing, data processing, and communications in a single system.

The DGS provides support services to other city agencies, such as distributing and maintaining municipal supplies and services, producing all city publications, constructing and maintaining the park and street lighting systems, providing all construction services, maintaining city vehicles, and managing the public radio station. DGS had 2,500 full-time employees and a budget of $350 million for fiscal year 1984. In order to improve its service delivery, productivity, cost containment, and revenue enhancement, DGS set up a Technology Task Force made up of technical managers from various units. All employees were encouraged to take part in the selection and implementation of office systems. Word processing was first introduced in 1980. Two systems with 23 terminals in two buildings performed straight word processing tasks. The first users were volunteers. In a short time, the demand from workers resulted in more rapid introduction of the systems. The system has been upgraded twice since 1980, evolving from a word processing system to a hybrid system, which includes data processing applications. The system is also linked to the city's central mainframe computers to further integrate word and data processing applications.

The DF administers and collects all taxes, real estate assessments, and other city revenue. It manages and invests city finances and administers the payroll. Office automation systems have contributed to the department's efforts to reach its revenue goals. Before 1980, 90 percent of the work at the DF was batched, typed, and handwritten. Over 1,500 installment agreements for tax payments were tracked on 3x5 cards. The quality of letters mailed to taxpayers and the productivity of the workers was low. There were few production reports or controls and a general lack of management control. Since 1980, a centralized word processing pool and a microcomputer center for tracking of tax records and producing reports has been created. In 1984, the DF had 34 micros, 20 word processors, and 40 to 50 terminals connected to the mainframe. The agency is requesting 80 more microcomputers.

[6]This section is based on research performed for OTA by Joan Greenbaum of City University of New York, and Cydney Pullman and Sharon Szymanski, The Labor Institute, New York City.

Methodology

The approach for this case study was to locate a number of distinct mini-case sites within the municipal government in which to conduct data gathering workshops. A matrix was developed of the following variables—type of office automation, date of system introduction, and agency service type. Interviews were conducted with appropriate commissioners, city directors, department managers and supervisors, and union officials to gather background information and to gain acceptance for the study.

Data gathering workshops were conducted for each group of employees (clerical, paraprofessional, professional, and managerial), except in the case of managers using personal computers, where it was more appropriate to carry out individual interviews. Participants were selected on the basis of the length of time in the department, with priority given to employees who had been in the agency before the introduction of the new system. Participants in the workshops filled out activity sheet/questionnaires on background and education, job content, work organization, history of work site, health and safety, and their recommendations. Discussions then facilitated an interchange of information about each subject area and greatly enhanced the information gathered.

Employment Effects

The increase in output has resulted in some reduction in staff and there are plans for future reductions. City officials must cost-justify their requests for additional automation and clerical work is usually targeted for cost savings, because it is easy to demonstrate that data-entry and word-processing functions can be performed with fewer workers. *The Financial Plan: Fiscal Years 1984-1988* for the three agencies studied projected reduction of 13 administrative positions in HRA, 36 staff positions in DF, and 15 clerical positions in DGS. These reductions would be achieved by means of attrition.

As a percentage of full-time city workers, office and clerical workers declined from 19.7 percent in 1982 to 18.6 percent in 1983, although there had been increases between 1980 and 1982. The percentage of professionals has declined while paraprofessionals increased. The most consistent increase is in the category of "Officials and Administrators," which increased from 4.8 percent in 1979 to 8.9 percent in 1983. The total number of city employees did not increase nearly so much, indicating that there is a trend towards more administration and supervision, which mirrors trends in the private sector.

Work Organization, Job Satisfaction and the Working Environment

The overall response towards office technology by workers participating in this study was favorable. Clerical workers tended to define their satisfaction in terms of release from tedious manual work. Word processing operators found automation "more fun" than previous work and perceived that work quality was improved. Professionals' favorable rating is related to the amount of information that technology makes available, the speed and control it provides and the potential for new uses of information.

Worker participation in the introduction and use of office automation was most limited in work units in which the tasks were previously rationalized. The automation intensified the rationalization of these tasks. Agencies that had more flexibility in the services they offered, experienced greater worker involvement in the planning and implementation process.

Dissatisfaction was expressed by clericals, specifically with increased amount of work, routine and boring tasks, lack of promotional opportunities and physical problems such as eye strain, headaches, backaches, and stress. In a centralized work organization in the DF, the process involved moving the typists and support staff in 30 work units to a windowless basement room with inadequate ventilation, lighting, and noise control. Typewriters were removed from work units so that all correspondence would flow through the central pool. Correspondence was standardized to include boiler-plate paragraphs. Management sees the benefit as a more integrated work process that can respond to set quotas, increased quality of work that elicits more confidence from the public, and increased tax collections. The women in this unit felt that they were doing more work for which they were not being compensated, that the work was boring and that learning new skills was thwarted. An unintended side effect was that to overcome lack of an adequate supervisory system, the women had to work together to coordinate and organize their work; this provided them with a feeling of "running the show" albeit without adequate training and supervisory assistance.

The DGS reorganization resulted in small clusters of women working as a team with considerable control over all facets of their job. The microcomputers were introduced as a resource and tool for those who chose to use them. Training was provided to all employees by an agency-wide training center, with no segregation by level of employees. The managers of this agency see the lines between clericals and managerial workers blending such that a clerical worker is not "only a clerk" and that managers increasingly take on more clerical duties.

A correspondence was found in this study between the number of hours clericals spent on the equipment and complaints of eye strain, backache, stress, and fatigue. Paraprofessionals overwhelmingly linked increased stress with an increase in workload and to an increase in supervision in the form of more required reports. The poor quality of the working environment contributed to health and morale problems. In most instances, clerical and paraprofessional workers were not consulted about how the introduction of office automation would affect the design of the work process and work areas.

Unlike clericals, professionals tend to use micros for inquiry that is immediately job specific. All of the professionals liked the equipment, but the amount of work they do has increased. Caseworkers in HRA expressed frustration with having to spend additional time checking on the information that is generated by the automated forms system. Before automation, they were responsible for determining what basic information was needed and what forms would be sent out to obtain it. Now, a new clerical position and a paraprofessional position are responsible for these procedures. The caseworkers feel that these workers do not understand what information is important to the process and tend to make more mistakes, increasing the workload of the caseworkers.

Tax auditors in the DF, question the effectiveness of the automated system since their procedures have become fragmented and, according to the auditors, more clerical in nature. They acknowledge that the computer generates more information quicker and provides more control over the status of each case, but feel there is less need for their professional training and judgment.

Analysts in the DGS quickly discovered the speed and wider range of reliable information that was available to them. They cited two results—a power shift in their favor (they had more data on the various work units they visited) and an enlargement of their jobs to include providing more technical support. Analysts felt peer pressure and self pressure to become more computer literate. Spending so much time on the system caused one analyst to say, "I need to pause occasionally to remember that I'm a human being."

Job Content and Occupational Mix

Whether skills increase or decrease with the introduction of office automation did not seem so pertinent in this study as did a redefinition in the meaning of skill. The traditional view of clerical work sees it as a series of routine, highly repetitive tasks that must be incorporated into machines to improve efficiency and productivity. However, there are "invisible skills" that cannot readily be discerned by an observer but are crucial to the smooth functioning of the organization. For example, coding and entering information from the mail into a CRT terminal requires knowing a vast number of current codes and numerous outdated codes which must be updated. The process is also dependent on the worker's sequential decisionmaking and actions. Since the information entered by clerical workers instantaneously becomes part of the database from which other information, conclusions and actions will be generated, the responsibility of the position has increased. The clericals organized into pools and clusters found an increased need for communication with many different work units and for judgments as to the meaning of the job orders. These "invisible skills" tend to be used for job descriptions, evaluations, and salary decisions only for professionals.

Tax auditors felt that their jobs were being redefined by "clerical" tasks. With the new system, their tasks involve checking various forms generated by the computer, reviewing other auditor's work for errors and lack of clarity, and screening batches of tax returns.

The changed nature of the work has not changed either the job descriptions or salary level for auditors, but such a possibility is reflected in the history of the change in the job content of caseworkers, classified as professionals. During a restructuring in 1971, the information gathering portion of the caseworkers' jobs was removed and assigned to lower paid positions. Many caseworkers were reassigned as lower paid "Income Maintenance Specialists" and "Eligibility Specialists." As a result, the 10,000 caseworkers in the city have been reduced to 4,000. No caseworkers have been hired since 1972 and there have been virtually no promotions.

Job mobility for clerical workers was dramatically changed in the 1970s when steps in the clerical career ladder were eliminated by collapsing some job titles and eliminating others. Because the city is in the process of adapting to office automation, job titles, and job lines are in flux and continue to be "worked through" by the city and the union.

Productivity

Some managers in the New York City offices feel that to increase efficiency in the production of their services, as many clerical procedures as possible must be standardized and automated. Other managers see no reason to focus on developing word processing skills, much less job ladders, because they believe fewer word processing clericals will be required when more managers learn to use microcomputers.

All workers perceived an increase in work due to a combination of factors including work intensification, creation of new work, reorganization of work and need for more error correction. For clericals and most paraprofessionals, the increase in output came when automated systems were used to incorporate large amounts of previous manual work into precoded forms and standardized letters. This meant the elimination of handwriting and typing hundreds of forms and letters per week and a reduction in the time spent hunting for files throughout the work unit, which spans several floors. But although clerical workers were enthusiastic about being released from the manual processes, many of them now spend almost their entire day in front of VDT screens. In centralized work units, the integration of the process gives the manager more control through the establishment of work quotas.

In a decentralized reorganization, the change in workload resulted from a unique set of circumstances—managers were performing their own writing and editing to such an extent that the secretaries were bored from lack of work. They requested extra work from other groups inside and outside the agency.

Training

Clerical workers who primarily performed data entry functions were given only a few days training in entering codes into the system. They felt frustrated about their lack of knowledge of the system and had a low level of motivation. They received no word processing training and there were no plans to offer them further training. Another group of clericals who were former secretaries had been sent to training class when they were placed in the word processing pool. Informally they exchanged information to solve problems collectively and learn new word processing procedures, but they felt better training would have reduced the time spent in problem solving. Secretaries in a third group, who had organized their own word processing cluster and participated in the decision about system purchases, were satisfied with the training they had received.

Training in DGS encompassed a broad spectrum of courses for all employees; introductory classes were available for both clerical and managerial personnel. A great deal of on-the-job informal training took place. The training center for this agency was funded in part by outside grants and also operated a retraining program for public assistance women, who were trained in word processing and given temporary trainee jobs within the agency. The program is apparently very successful and the access of clerical workers to a wide range of courses seemed to enhance their motivation and self-esteem.

While professionals complained most about lack of time to learn new applications, they were generally pleased with their training. Complaints centered around their reliance on a minicomputer network and a mainframe database which kept them dependent on the technical staff to solve problems. "Downtime" due to an expanded communications system exacerbated this problem.

Managers, like professionals, said that they were too overworked to take advantage of formal training programs but felt some peer pressure to do so. In order to overcome this problem, courses would have to be acknowledged as having priority over some work.

Conclusions

This case study paid particular attention to the interaction of office automation and changes in job content, work organization, and the physical environment. An overall increase in the output per worker was found; however, this was not necessarily followed by an increase in the quality of services produced.

Job content was changing; the redefinition of skill caused an increase in the number of definable tasks performed and a shift in the type of tasks. Office automation enhanced the need for conceptual knowledge and abstract thinking at all occupational levels. Changes in job content are affecting job ladders and promotional opportunities. There are few promotional paths that could be used to encourage clerical workers to use their invisible skills to gain entry to high-level jobs.

Departmental reorganizations accompanied office automation with some centralizing of clericals into pools and some decentralizing into clusters and small project teams. The technology did not dictate one form of organizational structure.

Complaints of greater stress have been heard at all occupational levels, most notably from clericals and paraprofessionals.

These Municipal Government agencies are sufficiently large and complex to serve as a microcosm for identifying office automation issues in the Federal Government as well as other large city and State governments and corporations.

Office of Technology Assessment

The Office of Technology Assessment (OTA) was created in 1972 as an analytical arm of Congress. OTA's basic function is to help legislative policymakers anticipate and plan for the consequences of technological changes and to examine the many ways, expected and unexpected, in which technology affects people's lives. The assessment of technology calls for exploration of the physical, biological, economic, social, and political impacts that can result from applications of scientific knowledge. OTA provides Congress with independent and timely information about the potential effects—both beneficial and harmful—of technological applications.

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