Chapter 8

Moving Toward a High-Skill Economy:

Computer Applications and Work Organization in the Services

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SUMMARY

The preceding chapter outlined the patterns emerging in the U.S. labor force over the past 15 years—a period during which manufacturing employment stagnated and began to decline while job opportunities in the services continued to expand. Some of the jobs created have been low-skill, low-wage positions in the tertiary services; others have been knowledge-based, with far better prospects for upward mobility and job security. Where possible, chapter 7 examined these trends quantitatively, in terms of numbers of people employed, their ages, educational backgrounds, earnings,

This chapter is descriptive rather than quantitative. In places it is speculative. The chapter explores work organization and computer applications in the services, asking: How does international competitiveness depend on skills and knowledge? How do companies make use of computer-based systems to enhance or to replace the capabilities of their employees? With 74 million people in the Nation's service work force, and some **38** million in the knowledge-based sectors, generalizations remain open to question, But conclusions do follow. To get and hold good jobs in the services, Americans will have to bring better knowledge and skills to the workplace. Public education will have to respond to new demands. Companies will have to provide better training, and do so on a continuing basis. In the knowledge-based services, employees at all levels will find themselves taking on more responsibility. And, while large numbers of relatively unskilled (and low-paying) service jobs will remain in the U.S. economy, many of these jobs will depend on prosperity created in part by knowledge-based services.

More often than not, technology in the services means applications of computer and communications systems, The knowledge-based services are in the midst of a transition from large and expensive mainframe computers, tended by experts, to distributed computing, used by everyone. The personal computer is only the most obvious sign of this transition, Yet before companies and their employees can come to grips with today's technology, new waves of hardware and software will arrive—making it much easier, for example, to link PCs with powerful mainframes, helping create far-flung integrated networks. People and organizations will have a hard time keeping up, much less planning for the future.

In many U.S. service firms, proprietary technologies—including computer applications—have become integral elements in competitive strategy. Isolating the contributions of proprietary know-how tends to be a good deal more difficult for service products than for tangible goods. Manufactured products can be inspected and tested, performance evaluated by objective measures, making it easier to judge relative contributions of proprietary technology, and—much the same thing—human capital. Chapter 3 illustrated some of these complexities for banking, chapter 5 for computer software; software is much the easier case because computer programs can be compared on a price/performance basis far more readily than banking services. But when the question becomes: Precisely why is one program better than another? answers can be hard to find. In the end, proprietary technology is a matter of judgment and experience more than well-codified knowledge. Individual expertise makes a difference; so do

group and social skills. Both the people in a company and their tools matter. When a company decides to buy a million-dollar software package from a vendor, its employees must select the right package; typically they will also contribute to design modifications that tailor it to the company's needs.

No one can specify with any precision *how* human capital affects competitiveness, although no one denies its importance. Much of this chapter focuses on applications of computers, because, for many years to come, this set of technologies will have enormous impacts on competitiveness in the services, and on the jobs and skills of people who work in service industries. At the micro level, work organization—how companies design tasks for individuals (e. g., data entry), and combine these tasks into groups (e.g., for processing financial transactions) —strongly influences the cost and quality of service. Some companies have sought to develop flexible systems for the delivery of services (and goods) —systems highly responsive to market demands (e.g., portfolios of mutual funds, among which customers can switch), as well as strategic applications of computing power such as on-line customer ordering, or corporate cash management systems. But cheap computing power also creates opportunities for rigid, mechanistic forms of automation (check processing in many banks, directory assistance from the telephone company). Sometimes improved competitiveness calls for flexibility, sometimes for cutting costs through rigid and tightly controlled forms of work organization. Obviously, a vast middle ground separates these two poles.

Over the longer term, strategic applications leading to new products, different services, and expanding markets will have greater impacts on international competitive standing than cost-cutting applications of computers. Some of these strategic applications will emerge at the micro level of individuals, work groups, and departments; they can be viewed in a work organization framework. Examples include Citibank's replacement of centralized transaction processing by a decentralized, product-oriented system—described later in the chapter. Other strategic applications must be viewed in organization-wide terms—often at the macro level of multinational integration.

Despite a shortage of concrete information on how computer applications and computer integration affect the competitive ability of particular companies, at either micro or macro levels, OTA's analysis suggests differences in approach internationally, which appear to translate into differences in competitive strength. At the micro level of work organization—integration of people and machines, rather than integration of dispersed corporate operations—many foreign firms do as well or better than their American counterparts. At the macro level of international integration, U. S.-based firms seem to be well ahead of their foreign competitors in the ability to link and coordinate the activities of divisions and affiliates thousands of miles apart.

American companies may spend more money on computers, but some foreign firms—particularly in Japan—use the money they spend more effectively. They scrutinize investment decisions for hardware and software more closely, and at more levels in the organization, invest more heavily in the training of their people, and operate highly developed systems for maximizing individual contributions to corporate goals. (These differences seem more evident in manufacturing than the services; Japanese service industries, with exceptions such as telecommunications and banking, appear relatively undeveloped compared to American industries—although this may simply be because analysts in the West have not focused as much attention on them.) Large Japanese corporations lag behind their American counterparts in the raw capability of their installed computer and communications systems, but use what they have at least as effectively. Moreover, concerted efforts in Japan to move towardan''information economy" (chs. 5 and 9) suggest that Japanese companies may begin to catch up in computer utilization during the 1990s,

At both micro and macro levels, current positions matter less than decisions being made today. These decisions—how to use computer and telecommunication technologies (which will depend in part on the capabilities of the people a company can hire, and on the training it chooses to provide) —will influence competitiveness 5, 10, 25 years from now. Managers face difficult decisions, A great deal of technology exists; many of the possible applications remain largely unexplored. As noted below, nobody knows the capabilities that artificial intelligence (AI) may bring to the workplace in the 1990s. The specialists who develop the systems tend to be interested in technology for the sake of technology, rather than in appropriate applications. Some companies plunge ahead, making investments and reorganizing work in the hope of establishing a competitive advantage, even though they may have no more than a hazy idea of the outcomes to be expected. Others move more slowly, sticking to what they know and understand. Sometimes one approach will prove right, sometimes the other,

Two examples—one at the micro level, one at the macro—illustrate the uncertainties. Today, many companies must ask whether AI, touted for 25 years, is finally ready to enter the workplace on a large scale. Expert systems intended to supplement people's skills have become one of the favored near-term applications, What should the prospective user—bank, insurance company, medical clinic—do? Invest its money, time, and effort now? Or continue to wait, at the risk of losing out to competitors who get a head start? At the macro level, the well-publicized strains between General Motors and its EDS subsidiary illustrate another set of problems, GM purchased EDS in large measure to get help in implementing its strategy of multinational integration (ch. 5). Since the acquisition, GM's management has come in for ample criticism, Some of it is no doubt justified, but the fact is that the task of putting together and learning to use a worldwide computer and communications network is enormously complex, the territory largely uncharted, mistakes inevitable.

Despite the confusion and uncertainty such examples hint at, the outlines of a new model of computer-integrated production have begun to emerge. The model fits some companies in both the services and manufacturing, but so far probably only a few thousand American firms in total. The common characteristic of these new-model firms is their combination of efficiency and flexibility. In the past, flexibility—the ability to respond to changing market conditions, to alter the firm's output or way of doing business (because of shifting consumer tastes, ups and downs in the business cycle, competitive pressures, new technological opportunities)—generally came at the price of efficiency. Flexibility meant labor-intensive operations. People are flexible, they can adapt. Machines, in the past, could not, The trade-off was a simple one: either a flexible organization, labor-intensive and relatively low in productivity, or an inflexible, mechanized production system, Mechanization brought higher productivity but also higher costs for adapting to change. What the computer brings is the potential (not always realized) for both productivity and flexibility,

Achieving both flexibility and efficiency places new demands on the labor force. Employees at all levels in new-model organizations must take on greater responsibilities. Integrated systems will put them in touch with more people, both inside the firm (colleagues in work groups, people in other departments) and outside (customers with problems or inquiries). Some kinds of work, in some companies, will be more fluid, less predictable. Some jobs will be upskilled; the people that fill them will need both broader and deeper skills—problem-solving and reasoning, social skills. Companies will rely on employees with these skills to compete. People will need these skills to get good jobs and keep them, to advance. New applications of computer and communication technologies mean new demands on the public education system; they will also mean new kinds of corporate training programs. At the same time, other jobs will be deskilled: the computer will make them simpler, more routine, less demanding, less interesting. Stratification in skills goes hand in hand with the stratification in wage levels and mobility prospects discussed in chapter 7. To keep job ladders and mobility channels open, the U.S. economy will need to continue creating large numbers of jobs at the high-skill end of the spectrum; policy makers will need to make sure the United States creates education and training systems that can prepare people for these jobs.

This chapter, then, suggests that a labor force rich in the skills needed for integrated production systems—in which applications of computer technologies enhance people's skills and contribute to organizational flexibility-will aid American firms in international competition, contributing to job creation and the Nation's standard of living. Indeed, *to compete effectively with economies having lower wages and living standards, the United States has literally no option but to create greater numbers of jobs in which computer and telecommunications systems enhance people's skills, helping them produce higher value-added services and goods.* This implies better education and training, especially for new entrants to the labor market and younger employees; a high-wage economy can only remain competitive through continuing investment in human capital. The alternative? Continued loss of ground to low-wage economies, followed by declining wages and lower living standards in the United States.

SERVICE JOBS AND MANUFACTURING JOBS

Preparing hamburgers in a fast-food restaurant has a good deal in common with assembly work in an automobile factory; the job of a white-collar clerk feeding forms into an optical character reader resembles that of a blue--collar employee tending a punch press in a metal stamping plant, or a kitchen worker loading food onto trays in a hospital, As such examples imply, the nature of a job may depend as much on work organization as on whether the job falls nominally on the service side or the manufacturing side of the economy. Indeed, viewed as encompassing skills, expertise, knowhow, and work organization, technology becomes a major competitive weapon even in many of the tertiary services. The most casual observer sees the differences among fast-food restaurants, Each faces the same fundamental problem: defining a menu; managing a high-turnover labor force with limited skills and little job experience; dealing with a work load that fluctuates greatly during the day. How to organize production to give customers what they want, when they want it, while minimizing operating costs? Each chain has reached its own solution—a matter of proprietary technology in the sense of firm-specific knowledge and expertise, standardized procedures, training manuals. Some look more like production lines; others emphasize customer choice,

Differences between the services and manufacturing run deeper when it comes to jobs for professionals, In manufacturing firms, most of these people fill managerial and staff positions. They may supervise production in manufacturing, but in the services many professionals will be an integral part of the process; lawyers, surgeons, and teachers produce service outputs with their own minds and hands. In an accounting firm, professionals carry much of the responsibility for direct production; the accountants employed by a stamping company are no more part of the production process than the supervisors.

Despite such contrasts, numerous similarities emerge when comparing knowledge-based service jobs with high-technology manufacturing—the most obvious being applications of digital electronics to rationalize production, support managerial decisionmaking, and aid in design, development, and marketing, If some tertiary service firms depend heavily on proprietary technology, almost all those in the intermediate or knowledge-based services do. All financial service firms of any size, for instance, have had to develop the internal expertise needed to implement complex computer applications. Hartford Insurance Group employs well over a thousand programmers. Airlines that have developed their own reservation systems have reaped competitive advantages; with price competition holding down differences in fares, quick and easy bookings for customers who telephone directly, a well-established network of relationships with travel agents, and responsive service for major corporate customers count for a good deal. Note that an effective reservation system depends not only on computer hardware and software, but also on the airline's employees—their training, responsiveness, and commitment to their employer's goals. Everything else the same, the airline that makes customer service a genuine objective, and conveys that successfully to its employees, should be able to fill more seats than its competitors,

In many industries, knowledge and skills ultimately determine international competitive position; there is plenty of truth in the saying that investment bankers live off their wits. Regardless of industry, the capabilities that people bring to the workplace affect productivity and competitiveness: through technical skills, those of the software engineer or the computer repairman, loan officer or insurance underwriter; through managerial and administrative skills, those of the buyer in a department store, the branch manager in a bank, the foreman in a copper mine. The work may range from finding investment capital at the lowest costs, to planning new products, to lobbying government agencies, Sometimes the knowledge that matters is well-codified (as in the computer-aided engineering methods used to design a hydroelectric power station), sometimes tacit (as in the experience-based judgment that bank employees bring to the arrangement of financing for that power station). In all cases, the technology is developed by people, embodied in people's skills, transferred and diffused by people,

USING COMPUTER AND COMMUNICATIONS SYSTEMS

In industries like financial services, some computer applications simply automate portions of an existing production process. Other applications enable firms to create new service products, or provide existing services in new ways. Prentice-Hall now supplies its tax service, formerly delivered in loose-leaf form, on-line to law and accounting firms, as well as to corporate tax and legal departments.

New products can lead to new jobs, Whether they door don't, they typically mean new skills and new learning for the existing work force. Appendix 8A, at the end of the chapter—a case study of restructuring at MetroBank (a fictionalized name) —illustrates. MetroBank's strategy required that customer service representatives (CSRs) actively sell a new line of products (e.g., credit cards, individual retirement accounts), In the process, the CSRs had to learn to use a redesigned and expanded computer system giving on-line access to customer accounts. Managers whose roles had been largely administrative had to learn to coach the CSRs, as well as to market the bank's services, including loans, to business customers. Moving into these new roles proved difficult, and sometimes painful, for both sets of employees. MetroBank's systems division, meanwhile, carried out its redesign of the computer network with little attempt to understand the CSR's working situation and needs, aggravating the difficulties. This bank's experience is not unusual; similar stories can be heard in other financial services firms and in other industries.

In some applications, the computer follows the same rules and procedures as the people it supplements or replaces: knowledge—once the monopoly of people with skills and experience—becomes embedded in the system, Box Z, which traces the evolution of automated claims processing in the insurance industry, describes how companies have put computers to work doing what people once did, faster and cheaper.

As box Z shows, work has changed radically for both clerical employees and claims adjus-

Box Z.—Claims Processing in the Insurance Industry[1]

Insurance companies began automating in the 1960s, installing computer systems for batch processing of high-volume but relatively routine claims—group health plans, automobile coverage. Labor intensity remained high through the middle 1970s, with clerks continuing to check and double-check the process at many points. These partially automated systems functioned as outlined below, using workers' compensation as an example:

1. Claims went first to an adjustor, who would verify the loss and the identity of the insured.
2. The adjustor then filled out an instruction sheet, by hand, got it approved by a supervisor, and sent the sheet to a typist who prepared a data entry coding form.
3. Each day, a batch of these forms went to the company's data processing center, where a clerk would pull a copy of the policy to check the coverage levels, then complete a different form and send it on to the keypunch department. If the policy were missing from the file—often the case—the clerk had to write to another office for a duplicate of the original rating sheets. A claims coder would then recode the policy before the claim could be processed and sent for keypunching.
4* After keypunching, the computer took over, printing checks to be mailed to claimants and recording payments. Processing took place in batches at night. Clerks continued to log each payment by hand. These logs were reconciled with the computer records once a year.

This process may seem complex, but others were more so; before paying a fire insurance or automobile claim, for example, an examiner would have to inspect the damage. Often, negotiations with other insurance carriers or with repair companies would follow.

Work reorganization in this industry has been driven by domestic competitive pressures (there is little international competition), with companies striving to cut costs and increase productivity in order to improve profitability and market share. Around the middle of the 1970s, insurance companies began to invest in on-line systems. Here, two alternative patterns of work organization have emerged, one with claims adjustors as end users, the other with most tasks performed by clerical employees.

- Where adjustors use the system themselves, clerks first screen and sort incoming claims. The adjustors investigate, authorize, and print settlement checks at their terminals, avoiding most of the intermediate steps of the older batch processing procedures.
- With clerical workers as end users, the software must contain decision rules that can dispose of the majority of claims. When a clerk at a terminal runs into a case that the system can't handle, she or he calls on an adjustor for help.

Productivity has grown enormously with both approaches, which differ in the ratio of more highly skilled adjustors to clerical workers, and in the intelligence built into the system.

Today, vendors market dedicated systems for health care claims that function as follows:

1. Incoming claims go directly to a clerk or assessor, who checks the form for completeness and assesses the claim (for coverage, contractual limits, reasonable and customary limits).
2. The operator calls up files with personal information on the insured [and may amend them), while the system creates windows that display allowable payments and explanatory codes (e.g., for physician charges, laboratory tests, drugs).
3. Using other windows, the clerk or adjuster can take account of co-insurance, catastrophic clauses, deductibles, and yearly or lifetime maximums,
4, A final window displays a draft payment form for the operator to verify or modify, and approve.

These systems not only issue checks automatically; some can prepare form letters with upwards of 2,000 variations. The system will automatically generate accounting and management reports that help the company predict claim frequencies and estimate its loss ratios. It can also track employee productivity. With insurance companies continuing to extend the capabilities of these systems, clerical workers (where they are

[1]Adapted from "Draft Report: Insurance," prepared by B. Baran under contract for the OTA assessment, *Technology and the American Economic Transition,* pp. 49-54.

the operators) can handle two-thirds or more of all claims with no need to call for help from an adjustor.

The new systems eliminate coding, keypunching, and manual verification. With most of the repetitive and redundant tasks gone, opportunities for mistakes are fewer. So are opportunities to catch them. While some checks on accuracy can be built into the software, employees—whether clerks or adjustors—must take most of the responsibility for the correctness and completeness of their own work.

The next steps? A number of large automobile insurers have begun to give adjustors in the field portable PCs. By dialing into computers at a branch or main office, adjustors get the names and addresses of claimants to be contacted. They can print checks with their PCs. With almost all the work done remotely, there are no backups except those that can be built into the computer system.

tors in the insurance industry. Clerical jobs have grown more demanding, with people previously viewed as unskilled asked to take on many of the responsibilities of adjustors and assessors, While clerical jobs have been upskilled, pay has not changed much. The work of the remaining adjustors has also been upskilled, They get fewer routine cases; more of their workload consists of claims that the computer's built-in decision rules cannot handle,

In other commonly found patterns, it is the middle levels of knowledge and skill that become part of the system—leaving people with, say, data entry jobs at one extreme, and highly skilled tasks beyond the computer's capabilities at the other. In effect, work reorganization deskills some jobs while upskilling others. Eventually, many of the jobs like data entry will also disappear (because operators working at on-line terminals normally do this themselves).

As digital systems become still more pervasive (in many industries, their power has barely been felt), their influence on the organization of work still greater, both people and organizations will have to learn and adapt. This means designing applications that are well-suited to the skills, aptitudes, and motivations of the firm's employees, integrating their skills and abilities with those of the system—no easy task. Suppose, for example, that a multinational bank decides to invest in a computer network for linking its branches and subsidiaries. Viewed as a straightforward application of available technology, the critical skills lie in the design of the system: choice of equipment; when to use leased lines and when to rely on the public infrastructure; software for running the network, But viewed as a means for the bank to minimize financial risks and maximize profits, the problem is to develop a system with installed performance (as opposed to design specifications) that will meet the needs and complement the abilities of the bank's worldwide staff. Such a view helps clarify the difficulties involved: few if any of the bank's operating employees will understand computer networks; the system designers will not understand banking. Still, if the bank manages this task well, it may be able to capitalize on fleeting differences internationally of l/32nd of a percentage point in interest rates. If it manages the task poorly, the network might be close to useless, and require extensive redesign.

Business Applications of Computer Systems

Over much of the 30-year history of computer use within business organizations, companies have simply automated existing tasks. Insurance companies began with batch processing of claims, as described in box Z. Banks learned to process checks more cheaply, helping them keep up with rapidly expanding transaction volumes. Businesses of all kinds automated routine functions such as payrolls to cut costs. Analytical applications such as computer-aided decision support for financial risk analysis came later,

Today, computing power is so cheap that its applications have become part of everyday working life for millions of Americans, New applications can be tailored to the requirements of upper managers and executives (work stations for the corporate treasurer). Companies can use computers to regulate and monitor routine production (as in the well-publicized cases where telephone operators find their work overseen by call-monitoring systems).[1] Some people find themselves with jobs that are more challenging and perhaps more rewarding; others find themselves part of a mechanized system little different from a 1930s-era assembly line except for the computer at its heart.

In the early years, as computers began to proliferate, corporate data processing (DP) departments with professional staffs took most of the responsibility for selecting hardware and software, particularly in the larger firms that pioneered back-office applications in banking and insurance. Smaller businesses began purchasing systems during the latter part of the 1960s, as prices dropped.[2] Applications broadened well beyond the accounting and records-keeping packages that had been on the shopping lists of most first-time business customers, Digital equipment also began turning up on the factory floor for industrial process control.

The centralization of the early years started to wane during the late 1970s—a result of distributed processing, friendlier systems, and, a few years later, the spread of personal computers. With perhaps 8 million PCs in use in American businesses—half as many as have been bought for home use, and a penetration that remains below 15 percent—massive new waves of expansion and technological change lie ahead (box AA).

Business purchases of PCs, along with continued progress in networks and distributed computing, have helped destroy the monopolies that centralized DP departments once enjoyed in American corporations. With large firms moving toward decentralized information utilities, a few have even converted their DP centers to employee training facilities. Although some companies continue to write their own software, standardized applications packages have taken over much of the corporate market in the United States (ch. 5). When vendors like McCormack & Dodge and MSA sell integrated software for accounting (general ledger, accounts payable and receivable, fixed assets, personnel and payroll, purchasing, inventory management), there is no longer much point in a firm putting its own programs together.

The need today? Software and systems applications for strategic purposes. Most firms that operate on an international scale have already achieved many of the savings possible through automation of existing functions. The next wave of applications will help them deliver goods and services to customers more effectively. American Hospital Supply, to take one example, has linked its computers with those of hospitals and clinics, which can now place their orders electronically. In such cases—i.e., if a firm can establish a competitive edge with a unique software package—internal development may still make senses

[1]See, for example, M.W. Miller, ''Computers Keep Eye On Workers and See If They Perform Well,'' *Wall Street journal,* June 3, 1985, p. 1; W. Serrin, "More Workers' Terminals Are Staring Back, " New *York Times,* May **14, 1986,** p. B8.

[2]See, for example, Appendix C, "Computers: A Machine for Smaller Businesses," International *Competitiveness* in *Electronics* [Washington, DC: Office of Technology Assessment, November 1983), pp. 531-535.

[3]Some companies have also chosen to market software originally developed for their own use, as a new line of business or to recoup some of their development costs. Accounting firms like Arthur Anderson and Peat, Marwick, Mitchell have been marketing software packages to their customers for years, as have a number of investment banks—E. D. Myers, "Big Eight V. ADAPSO?" *Datamation,* Jan. 1, 1986, p. 32; P Hodges, "Do the Big Eight Add Up?" *Datamation,* Feb. **15, 1987,** p. **63.**

Salomon Brothers, for another example, offers software for economic forecasting and equity screening; originally developed to support their in-house investment management operations, outside sales have been directed at institutional investment managers. Manufacturing firms including Westinghouse, Standard Oil, Republic Steel, and Boeing have established subsidiaries for marketing soft ware (or computing services) to other companies. Boeing Computer Services sells time on its Cray X-MP supercomputer, A telecommunications link between Boeing's offices in England and the United States gives engineers at Britain's National Nuclear Corp. access to a simulation program originally developed by Lawrence Livermore Laboratory for the U.S. Department of Energy. The program predicts the consequences of failures in the cooling system of a nuclear powerplant. See "Boeing Draws on Its Years of Experience, " *Financial Times,* Oct. 14, 1985, p. 12.

Box AA.-Technological Advances in Computing Systems

In the services, computer and telecommunications systems do two fundamental kinds of things:

1. provide error-free management, manipulation, and transmittal of almost unimaginably large volumes of data and information (the primary sources of error will normally be at the input end, except for software bugs and system design flaws); and
2. solve mathematical (and logical) problems previously intractable, leading to new analytical tools (expert systems for decision support) and real-time control models for production processes (optimization of message traffic in a telecommunications network).

Over the medium term of 5 to 10 years:

- Businesses will continue to invest heavily in distributed systems and dispersed computing power, with cheap machine intelligence and inexpensive mass storage available in many locations (through local and wide area networks, LANs and WANs—ch. 5). * Half or more of major U.S. financial services firms expect to have expert systems installed on at least an experimental basis by 1990. (One result will be to begin a new wave of deskilling in banking.)
- Companies will use these distributed computing systems for manipulation and communication of text and graphics, as well as quantitative data, the system becoming a telecommunications network and information storage device as much as a calculating machine. This evolutionary change will culminate in the widespread availability of ISDN services.
- The growing range of inexpensive, off-the-shelf software for small machines will enable people without specialized training to use computers for routine applications that go well beyond the word processing and bookkeeping common today. Examples include desktop publishing and much more powerful graphics packages. While falling prices for hardware lie behind the explosive growth in computer applications in business and industry, it is software that determines what computers can ultimately do.

The early expert systems for banking will be expensive. Standardized software packages for PCs are cheap. ISDN will be a massive and costly undertaking. The point is simply to suggest something of the directions and scope of technical change. Within the next few years, still less costly mass storage on optical discs will provide a major boost for business applications. Somewhat further ahead, corporate users should be able to begin making extensive use of AI, and, perhaps, natural language processing. Where very large data bases and fourth-generation languages combine to overload the largest current business-oriented systems, some companies may turn to supercomputers.

* Of 40 multinationals surveyed for OTA, more than 80 percent had introduced or were planning to install LANs, with office automation the most common initial application—''Data Processing in Multinational Corporations,*' draft prepared for OTA under contract No. 533-6410 by Mackintosh International Ltd. This survey, which forms the basis for portions of the analysis elsewhere in the chapter, covered multinational corporations (MNCs) with headquarters in the United States, Europe, and Japan (16 American, 16 European, and 8 Japanese). Seventeen companies were primarily service suppliers; the rest did most of their business in manufacturing.

The survey found that many managers, somewhat at sea with the possibilities of computer-based systems, feel there is too much new technology to successfully understand and utilize. Not only do managers and lower level emp[oyees who feel intimidated or threatened by the new technologies resist learning about them, but many executives seem confused over the economic benefits. The MNCs most comfortable in this environment tended to be those already quite familiar with the new technologies, either because they produce them or because they have lengthy experience as users (computer manufacturers, aerospace companies, large financial services firms).

On expert systems in financial services, below, see ch.3; on ISDN (Integrated Services Digital Networks), see chs. 5 and 9.

Motivations: Cost Control and Strategy

Multinationals expand and improve their computer and communications networks to cut costs and/or pursue new business strategies. Their expectations may or may not be met; in many cases, system performance fails to live up to expectations—or, putting it another way, the impacts on cost structure and competitive ability differ from those anticipated. Often, no more than a hazy idea of future benefits will be possible in advance, This was probably the case with IBM's venture into a unified worldwide engineering and manufacturing database during the early 1970s—an undertaking that evidently proved far more time-consuming, costly, and painful than the company anticipated. With the focus shifting toward providing new services and entering new markets, risks will go up because failure may endanger a company's strategy as well as its cost structure, But to the extent that strategic applications work out as planned, the company may benefit in indirect ways, hard to capture with conventional accounting measures. For instance, a firm may be able to create new forms of customer loyalty.

In the United States, particularly in contexts such as computer-aided manufacturing, investment decisions have frequently been criticized as short-sighted, most commonly on grounds that managers fail to anticipate and account for some of the potential benefits,' The crucial decisions generally concern pace and priorities. How fast should the company move into expert systems? Which links in a planned global computer network should be installed first? If nothing else, such questions point to the broad gray area separating investments made to control costs (where paybacks can be estimated in straightforward fashion) from those undertaken for strategic reasons (where uncertainty will be much greater).

Current priorities for strategic applications in the services include on-line access to customer records for tracking shipments and handling inquiries, and database applications for marketing, along with electronic customer ordering.[5] Banks and financing companies have begun using interactive systems to prepare home mortgage agreements. Hotels provide automated check-in/check-out services. Securities dealers supply major customers (e.g., pension funds) with terminals that not only display quotations but enable the customer's traders to execute buy and sell orders.

Table 41 lists other examples of strategic applications. These have been divided into two categories, corresponding to the distinction between micro and macro levels of integration treated in more detail in the next section, Briefly, computer integration at the micro level has its primary impacts on individual and group tasks; a work organization perspective becomes appropriate. The macro level of integration refers to linkages among departments, divisions, and affiliates, as well as to linkages among firms; an organizational perspective will generally be most useful.

Computer links between firms are not new. Airbus Industrie, the international joint venture, relies on computer networks to coordinate engineering design and development, as well as production, Earlier chapters described the SWIFT banking network, along with air travel reservation systems that interconnect airlines and travel agents, But in recent years interfirm computer links have been expanding more rapidly, with ramifications that have yet to be explored. Certainly these implications seem to differ from those of telephone or postal communications. Netting arrangements among gasoline suppliers, for example, suggest that the computer systems of major oil firms may be more closely coupled with one another than with those of their own wholesalers and dealers, or pipelines and refineries.

Some analysts have argued that, at the most fundamental level, corporations evolve to minimize transaction costs—basically, the costs, most of them indirect and less than visible, associated with moving, manipulating, and otherwise making use of information.[6] Continuing

[4]See, for example, G.J. Michael and R.A. Millen, "Economic Justification of Modern Computer-Based Factory Automation Equipment: A Status Report, " *Annals of Operations Research,* vol. 3, 1985, p. 25. Of course, accounting calculations sometimes serve simply to validate decisions made for other reasons.

[5]For example, a French chemical manufacturer permits customer access to the chemical firm's own database for placing orders and tracking shipments, A chemical company based in the United States has installed PCs at the water treatment plants it supplies; the PCs are linked to a host computer for automatic ordering and billing. In the future, the host machine will be directly linked to process control computers in the water treatment plants, These examples come from "Data Processing in Multi-national Corporations," draft prepared for OTA under contract No. 533-6410 by Mackintosh International Ltd. Imperial Chemical Industries, a British company, likewise plans links with 100 of its customers by the middle of 1988 using a commercial value-added network—" ICI Set To Forge Data Exchange Links With Its Customers, " *Financial Times,* Apr. 23, 1986, p. 10. Not only purchase orders and invoices, but shipping forms and requests for quotes can now be handled over the electronic grid. Electronic payments may follow. The American National Standards Institute has been working on a generic electronic order form that firms could use regardless of industry–A. Pollack, "Doing Business by Computer, " *New York Times,* July 10, 1986, p. D2.

[6]See, for example, O.E. Williamson, ''Transaction Cost Economics: The Governance of Contractual Relation s,' *Journal of*

Table 41 .—Examples of Strategic Applications of Data Processing and Communications Systems

Computer integration at the micro level:
- An American manufacturing firm coordinates customer service calls based on a set of software rules that assign priorities dynamically to the queue of requests.
- A West German bank, which introduced a home banking system in 1983, makes customer account records available on-line to its sales and marketing representatives through 4,800 terminals, (The advantages are greater than for an American bank because German banks can hold and trade in securities for their clients.)

Computer integration at the macro /eve/:
- Customers can call a fast-food chain's 800 number for home delivery. A network of regional centers distributes the orders among local outlets on the basis of work load as well as proximity to customers, The chain has equipped 10,000 delivery trucks with hand-held computers to help reduce paperwork, and uses a nationwide database of demographic information when planning and promoting new products,
- A diversified Japanese MNC provides all of its upper managers with on-line access to the corporate database on production, pricing, and sales. Experience so far has shown that some of the managers access the database hundreds of times per month, others hardly at all,
- An American-owned book wholesaler uses point-of-sale terminals to automate ordering, provide stock control, and speed response to customer orders.

SOURCE 'Data Processing in Multi national Corporations draft prepared for OTA under contract No 5336410 by Mackintosh International Ltd

technological developments reduce transaction costs both within firms and among firms. If the new systems alter or shift transaction costs sufficiently, quite dramatic changes in organizational form and business practice could result, with major impacts on international competitiveness. Note that such outcomes need not depend on large direct savings in easily measured cost categories. Realignments among firms and industries could result from indirect or less visible effects of computer-based technologies. For example, shared computer networks will make communications between firms both easier and more easily hidden. Will information sharing lead to collusion and other forms of anti-competitive behavior?

Already, Chrysler Corp. 's suppliers can tie their computers into the automaker's engineering/manufacturing network, or use terminals supplied by Chrysler. T GM's planned worldwide data processing and communications network will also link thousands of suppliers, as well as GM offices and plants. Chrysler and GM share many of the same suppliers. These suppliers may also sell to Ford and Toyota. Indeed, Ford and Toyota may sell components or subassemblies to Chrysler and GM. How far will integration of the various systems go? From a technical standpoint, the growing consensus around GM's Manufacturing Automat ion Protocol suggests that mutual compatibility will be the eventual outcome. If so, what will the consequences be, if any, for competition, nationally and internationally? At the least, such possibilities pose new questions for antitrust policy.

Integration: Technical and Organizational Dimensions

By now, many companies in advanced industrial economies have enough experience with computers, peripherals, communications links, and software to regard them as standard tools of business practice, But if familiar, hardware, software, and their applications have grown up independently of one another, and often remain incompatible. Equipment from different manufacturers may not be able to communicate. Users in different parts of a company often make differing technical and organizational choices.

Integration at the Macro Level

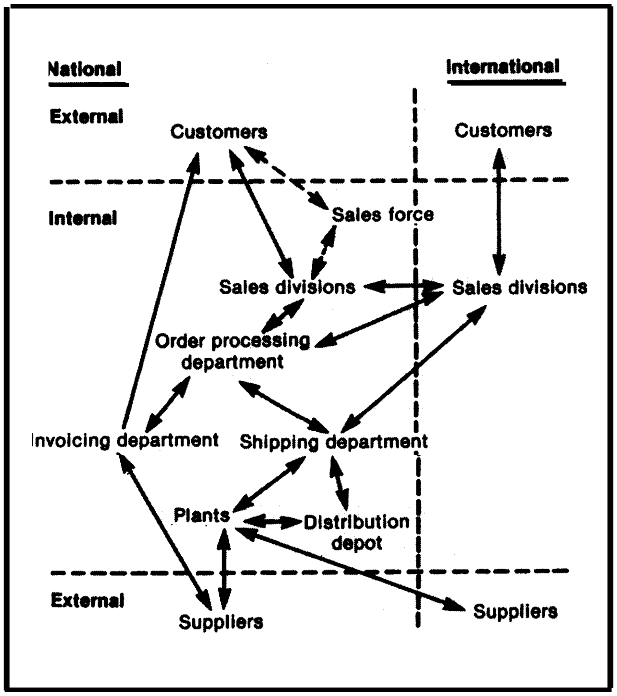
Worldwide integration requires effective communications among people who may be thousands of miles apart. Firms with managerial responsibilities dispersed to many locations need systems that can provide effective communications both horizontally and vertically (figure **48).** Typical applications include:

- finance (reporting by divisions and subsidiaries; consolidation of accounts; manage-

Law and Economics, vol. 22, 1979, pp. 233-261; M.E.Casson, "Transaction Costs and the Theory of Multinational Enterprise," *New Theories ~)/ Multinational Enterprise, A*, M.Rugman (ed.) (London: Croom Helm, 1982), pp 24-43.

"Productivity, Quality and Profitability Through Emerging Technologies," *Automotive Engineering*, March 1986, p. 52, The Chrysler system, centered on 28 large processors, includes more than 1,100 terminals, about half for computer-aided design ,111(1 manufacturing.

Figure 48.— Intra-Corporate Information Flows



SOURCE: Mackintosh International Ltd , under contract No 533-6410 to OTA

ment of both short and long term financing, including international diversification of risk and cash management);

- marketing and distribution (coordination of advertising/marketing strategies; processing of orders; inventory management; pricing; shipping);
- R&D, product design, and production control (international coordination of R&D projects; computer-aided design and manufacturing or CAD/CAM databases, including customization of products for particular markets; production planning and scheduling, including change notices, quality control records, and inventory control for purchased inputs as well as final outputs);
- administrative and clerical (electronic filing; messages and mail; employee travel arrangements).

Many companies began with financial reporting, but as multinational manufacturers gained experience with international data networks, more of their internal traffic has dealt with planning, production control, purchasing, and sales.

During the 1970s and early 1980s, large corporations often put together separate networks for marketing, engineering (perhaps including production), and administration. In many cases, these networks, with beginnings in different places at different times, remain incompatible; IBM currently operates five or more (table 42). American Express maintains separate databases for its regular and gold cards.

Integration in a technical sense suffers when one piece of hardware cannot talk to another, and when software developed for one computer will not run on others. Integration in an organizational sense suffers when people in different parts of the corporation with related jobs continue to work with different systems. In the past few years, managers in Japan and Europe, as well as the United States, have begun seek-

Table 42.—IBM's Intra-Corporate Computer Networks

Network	Function
Professional Office Support System	Worldwide electronic mail linking 290,000 of IBM's 400,000 employees.
Digital Communications System	Radio-based system for 20,000 field service repair engineers in the United States, each of whom has a hand-held computer for communicating with a dispatch center, getting technical guidance, checking on the availability of parts, and billing customers.
Remote Technical Assistance Information Network	Links 40,000 engineers in 62 countries, primarily for troubleshooting.
Hands-On Network Environment	Sales and marketing system for 25,000 employees.
Administrative Access System	Ordering and payroll for 35,000 employees.

SOURCE D. Kneale, "Sharpening An Edge, " *Wall Street Journal*, NOV 10, 1966, p. 38D

Photo credit Chase Manhattan Bank

Large American banks maintain offices in dozens of countries.

ing to reduce these incompatibilities and to more effectively integrate computer applications into ongoing operations. While capital costs will be high, many MNCs have decided the time has come when the benefits of greater system integration (including lower operating costs) will outweigh the investment costs.

While desirable in principle, technical integration—so that equipment can communicate easily, software run on different machines—promises to come slowly at best. Suppliers differentiate their equipment for marketing as well as technical reasons. So long as centralized batch processing was the rule, few users made compatibility a high priority; they simply picked equipment for a given, specific purpose, As a result, most users now have substantial investments in incompatible hardware and software, inventories that have grown piecemeal over the years. The fast-food chain MacDonald's, for example, operates computers from half-a-dozen manufacturers at its headquarters alone, none of which can communicate with the others. e

The choices of hardware and software a firm makes as it seeks to integrate its computer systems will depend on the company's existing lines of business and strategy, but will also help shape the firm's *future* structure. Horizontal/vertical integration may be encouraged or discouraged. Product lines and manufacturing technologies of certain kinds may be favored. Employees with certain skills will become more or less valuable.

If many of the corporate networks operated by U.S.-based multinationals remain independent and incompatible, American firms nonetheless seem to be ahead of their foreign competitors at macro level integration.[9] They have invested more heavily in wide area networks, and use them more extensively and effectively. This lead holds both in high-technology manufacturing (commercial aircraft, computer hardware) and in services (banking, insurance).

U.S.-based service firms have generally moved further toward integration in a technical sense (e.g., standardizing on network protocols and software packages) than either European or Japanese MNCs. Nonetheless, the decentralized management typical of American companies, while creating an environment in which innovation can flourish, often leads to differing technology choices across departments and divisions, as well as across countries. In contrast to American firms, operating divisions in Jap-

[8] Besides specialized workstations from several vendors, the company has general purpose machines built by IBM, Tandem, and AT&T, plus Wang word processing equipment-j. Rippeteau, "Enter the Intelligent Telephone Line, " Financial Times, Apr. 4, 1986, p. 12. Note that many computers cannot communicate even if built by the same manufacturer.

Ch. 5 included other examples of incompatibilities among systems, and the growing impetus for integration and commonality. Many MNCs view their compatibility problems as serious already, and bound to get worse before they get better. In general, a company that imposes compatibility standards will face greater expenses in the short term because different departments may not be able to choose the low-cost system for their particular needs. Multinationals that have grown by acquisition face particular problems in terms of compatibility}', but lack of international standards for hardware and even more for software makes integration a long-term goal for everyone. Chs. 9 and 10 illustrate some of the problems from the standpoint of international agreements on technical standards.

[9] "Data Processing in Multi-national Corporations, " op. cit. Decentralized American companies experiment more with new data processing and communicant ions technologies. European multinationals tend to be hehind U.S.-based MNCs in technology and behind Japanese MNC's at micro-level integration of people into the system.

anese corporations have less autonomy in deciding on computer applications. Company-wide standards are more common; greater effort goes toward searching for consensus on how to implement computer-based automation. Japanese companies are slow to adopt computer and telecommunications technology, and have lagged in putting together integrated multinational organizations (as noted elsewhere, their strategy in manufacturing has generally been to export from Japan unless or until forced to invest abroad), But at the micro level of work organization, their careful and cautious approach has served the Japanese well, at least in manufacturing industries.

Integration at the Micro Level

U.S.-based MNCs tend to be ahead of their Japanese counterparts in the use of the most advanced hardware and software. But it seems clear that the Japanese are well in the lead when it comes to manufacturing systems that effectively integrate people and machines—matters of task design and work organization more than choice of equipment.[10] This has been a major source of competitive success in industries including automobiles and microelectronics, One indicator: the ability of Japanese firms to achieve higher yields and higher quality in the production of large-scale integrated circuits while using the same equipment as American firms.

The consensus-building mechanisms that have left some Japanese corporations behind in multinational integration here give them advantages: their *ringi* decisionmaking processes lend themselves to conflict resolution and the development of shared values, necessary attributes of integrated systems at the micro level (for reasons discussed in the next section). In general, large Japanese companies also invest more in human capital than their American counterparts—e.g., in corporate training and retraining programs. Thus far, however, there is little evidence that Japanese service firms gain competitive advantages through better integration of available technologies into ongoing operations.

The question then becomes: If large Japanese manufacturing companies get a competitive edge through their ability to design and manage integrated production systems, will Japanese service firms eventually do the same? OTA's analysis suggests that they will, although the relative immaturity of many Japanese service industries means that it may take 10 or 15 years.

Over the medium to long term, Japanese companies should be able to successfully adapt their consensus-based organizational traditions to production processes characteristic of the knowledge-based services. Japan's push into software and fifth-generation computer systems, discussed elsewhere, indicates high levels of resolve in both government and industry. As they have done in the past in manufacturing, Japanese companies will probably be able to avoid some of the mistakes made by pioneering U.S. firms. If today their hardware and especially their software remains well behind that found in American service firms, there seems little doubt that Japanese companies will eventually make good technical choices, and arrive at production systems well-suited to the characteristics of their labor force.

[10] See, e.g., *International Competitiveness in Electronics*, op. cit,, chs. 6 and 8.

SYSTEMS DESIGN AND PEOPLE'S SKILLS

Data processing and communications systerns in all their variety place new demands on the people who use them. Ideally, of course, both hardware and software would be developed with the needs and abilities of users in view, But the ideal is seldom approached, given the pace of technological change, the foibles of designers and their fascination with technology for its own sake, the universe of alternative system architectures permitted by the many component and subsystem choices, (See, for example, the section entitled “Technology” in the MetroBank case study, app. 8A,)

Technical capabilities impose one set of constraints. Some things are possible, some are not; some expensive, some cheap. Managers at a distance from the workplace may impose their own constraints. Who, then, actually designs computer-automated jobs? In most cases, technical experts have more control than any other group, simply because they are the only ones who fully grasp what can be done. Given their monopoly on technical knowledge, the experts —including those who work for vendors and suppliers—have a great deal of influence over the perceptions and expectations of everyone else. Sometimes the experts or the managers consult the people who will have to use the system, sometimes they don’t. In many cases it seems safe to say that, when it comes to the design of work, as opposed to the design of the system in a strictly technical sense, no one is in charge.

In such a setting, job requirements evolve, often with a great deal of trial and error. Despite confusion, uncertainty, and mistakes, large and small, new patterns in the use of computer-based systems have begun to emerge in American industry—albeit patterns that are not yet sharply defined. Flexible product development and production systems, in the extreme verging on customized production, have become primary objectives for businesses operating in shifting and unstable environments, domestic and international, in service industries and manufacturing.

Flexibility means different things in different contexts, but first and foremost implies rapid response to shifting competitive circumstance:[11]

- tailoring product attributes in response to changing patterns of demand, or to create changes in demand (the sport shoe example in ch. 5);
- thrusts into new geographic or product markets (interstate and offshore banking, the home equity lines of credit spurred by changes in U.S. tax law);
- new products made possible by new technological opportunities (on-line information services);
- shifts in operating level or product mix, as a consequence of business downturns or new competition (American automakers, hit hard by Japanese competition in the early 1980s, sought to drive down their break-even points, enabling profitable operations at lower production volumes);
- changes in government policy (leading, for instance, to new opportunities for service firms that provide hazardous waste disposal).

Plainly, technology itself is part of the problem; technical change comes more rapidly than ever before, and firms in many industries find it hard to keep up. But technology is also part of the solution. The ability of an organization to respond to change depends on its store of technical knowledge, on how well its employees can use the tools available—whether these are developed internally or purchased in the marketplace.

Sometimes competitive circumstances call for computer systems that replace peoples’ skills, sometimes for applications that enhance peoples’ skills. In the first case, typified by transactional applications emphasizing cost control and illustrated by (most of) the insurance claims processing examples in box Z, the automated process is a relatively mechanical one; the system does more or less what people once did. (Box C inch. 1 distinguishes between transactional and analytical applications of computer systems.) Back-office paper processing in banks provides another set of examples. In the services, semi-skilled clerical employees are generally the first to find their jobs deskilled or given over to the system.

The second case, enhancement of people’s skills—illustrated by the ways in which MetroBank’s CSRs can use their terminals—includes

[11]Students and practitioners of management, along with critics, periodical}’ rediscover the virtues of flexibility, Simon, writing more than 20 years ago, covers much the same ground as those in the 1980s who call for flexible organizations and customized production as remedies for the competitive dilemmas of American industry. See, for example, H.A. Simon, *The Shape of Automation* (New York: Harper & Row, 1965).

On flexibility in manufacturing, including applications of robotics, see *International Competitiveness in Electronics*, op. cit,, pp. 233-246.

both analytical and strategic applications. Here the computer helps people do things they could not do before—e.g., interpret signals from a CAT scanner—or helps them do things faster or more easily. Giving employees in the front office of a bank on-line access to customer records creates a new menu of organizational opportunities. Their work now an intrinsic part of the firm's marketing strategy, MetroBank's CSRs had to acquire a new set of skills. This entailed much more than learning to use an "information utility. " The greatest changes were attitudinal—learning to actively sell the bank's products. The new demands on the CSRs were part of a much broader set of shifts, as MetroBank tried to alter its culture—in part to cope with uncertainties posed by deregulation. With new job requirements and new learning come better career prospects, should the CSRs wish to take advantage of them (some do not).

Other examples from banking include decision support systems incorporating economic models for use in judging lending risks. (How will falling oil prices affect a small, independent gasoline distributor's business?) Again, the computer system enhances people's skills—here people who will probably have professional skills to begin with. To take a different example, when computer-aided drafting replaces manual drawing in architecture, engineering, and construction firms, productivity goes up, sometimes by factors of 10 or more. Beyond the direct impacts, designs can be changed more easily and more quickly; the computer can estimate construction costs for alternative designs, prepare bills of materials, estimate heating and cooling loads, prepare perspective drawings in sun and shadow. Designers can explore more options. Clients can pursue them in greater depth. The design firm has greater flexibility: it can respond more readily to customer needs and desires, pursue new kinds of business. (Somewhat paradoxically, another result of computer-aided drafting is likely to be greater standardization; the computer can store and recall design features from a library, for the operator to put together more or less mechanically.) But while the automated system opens up new avenues for the designer,

W

it takes over many of the manual skills of the draftsperson. Jobs for drafters are deskilled. Companies with these systems commonly hire people with vocational-technical schooling but no more than, say, a year's manual drafting experience. They feel that those with longer experience will be overqualified (and perhaps overpaid), and unable to adapt as well.

As the drafting example suggests, computer applications in the services lead to the deskilling of some jobs and the upskilling of others. The patterns can be complex and confusing, with many exceptions, but the empirical evidence indicates that upskilling will be more common where people already have good skills and good educational credentials. Other jobs tend to be deskilled.[12] Computers spread know-how through an organization, making it available to many more people, raising the average skill level at which employees can operate, and helping to preserve and maintain knowledge;

[12]For a summary, see P. Flynn, "The Impact of Technological Change on Jobs and Workers, " final report to Department of Labor, Office of Employment and Training, 1985. Also *Technology and Structural Unemployment: Reemploying Displaced Adults* (Washington, DC: Office of Technology Assessment, February 1986), pp. 335-354.

in the process, they make some people, and the skills these people have, redundant.

The implication is straightforward but daunting: American companies and American education and training institutions will have to do a better job of preparing people for high-skill jobs, Plainly, many Americans will continue to fill low-skilled, dead-end jobs. But jobs in tertiary services like retailing, hotels and restaurants, and recreation depend on the size of the Nation's economy, on living standards, and in some sense on international competitiveness. Expenditures on health care, entertainment, and vacation travel go up with levels of affluence; most people would prefer jobs at Bloomingdales to jobs at K-Mart. The more high-skill jobs the U.S. economy can create, the more work of other kinds there will be. This section, then, touches on the nature of skills themselves, before going on to the ways in which companies use the skills of their employees. (Ch. ***10*** treats the implications for human resources policies.)

Well-defined skills characterize some professions, vocations, and occupations, but the notion of skill remains fuzzy and ambiguous beyond rudimentary levels. Box BB touches on some of the reasons. Reading, writing, and arithmetic as taught in schools are skills. So are reading critically, writing incisively, and thinking quantitatively (along with learning itself)—but these are much harder to pin down or to teach. And at higher levels, as Polanyi points out so aptly, skilled people "know many more things than they can tell."[13] Schooling, of course, also conveys the rudiments of workplace discipline—showing up on time, tolerating if not respecting authority. Along with their other objectives, schooling, apprenticeships, and training programs help people learn to deal with co-workers, customers, and clients.

The better a firm uses the skills and knowledge of its employees, the more competitive it can expect to be. There is more to this than grouping tasks as if they were building blocks, just as there is more to computer applications than distinguishing between replacement and enhancement of people's skills. But from the perspective of the system and how it functions, two extremes in the design of work can usefully be distinguished. At one extreme—when the computer is used in more-or-less direct fashion to automate what people once did—the system will be rule-based and mechanistic. The "program" is a rigid one, procedures formalized, mass production—of insurance claims or Model Ts—the objective. At the other extreme, where product and process characteristics vary and flexibility becomes a buzzword, the organizational program must vary too. This, of course, is one of the things computers are good for: flexible rather than fixed automation. Software can be written to accommodate variation, new programs loaded as needed. On the left axis in figure 49 (which is identical to figure ***6*** in chapter ***1),*** the two extremes have been labeled adaptive and rigid, suggesting the difference between a system that can adjust dynamically to its environment—even if that environment is shifting and unstable—and one that can change only slowly.

Figure 49 suggests how various industries and enterprises might be characterized in terms of work organization and computer utilization. Where a firm belongs will depend on patterns of computer use among the occupational groups in its work force. Table 43 provides a general framework. The table breaks occupations down into two major categories: those in which computer systems have not (yet) had substantial impact on work and skills (the first 3 of the 11 occupational groups); and those where utilization of computer systems in the production process is common and helps define the nature of the work (the remaining **8** occupational classes).

Organizations with limited and/or routine use of computers tend to cluster at the left in figure 49, some characterized by rigid forms of work organization (fast foods), others by more adaptive forms (real estate). Most of the jobs in such organizations would fall in *occupational* categories 1-3 in table 43, with some perhaps in 4-7 (extensive but routine computer use].

A second major cluster of enterprises, at the top right, consists of those in which computer

[13] M. Polanyi, *Personal Knowledge* (Chicago, IL: University of Chicago Press, 1958), p. 88.

Box BB.—Tasks, Jobs, and Skills

Even "unskilled" workers must possess a wide range of very real abilities, including some degree of problem-solving skill. They must get along with co-workers, conform to the discipline of the workplace. Literacy may or may not be necessary, but communication certainly is. Skilled workers rely on broader and deeper stores of tacit know-how (anticipating problems, troubleshooting, generalizing from a limited number of cases), along with well-codified knowledge (how to use DO statements in Fortran programs). Most professionals depend heavily on book learning, but need tacit knowledge and good judgment as well —skills that go far beyond knowledge acquisition and reasoning.

Some tasks are simple and fixed, repeated in the same sequence every few minutes or few seconds. This is the case for much unskilled and semi-skilled work: data entry, collecting bridge tolls from motorists. Skill levels go up as judgment and experience come into play; supermarket checkers must be better at making change than toll collectors. Sales clerks in department stores need to assist customers as well as take their money. Social skills come into play in almost all jobs. Retail chains train their sales clerks in how to behave toward customers, Police officers need good sense when it comes to people and their behavior. In the professions, education and training shape social skills and attitudes (so that physicians, for example, behave quite differently among themselves than they do in front of nurses or patients).

For skilled work, the universe of possible tasks and procedures (hence the tool kit of skills, the base of knowledge and experience) will be large. The surgeon or cabinetmaker selects from these as needed to do his or her job. Some of the skills are manual, some mental. Lawyers may need good instincts, the ability to think on their feet (like the police officer), coupled with the conceptual skills and fortitude to deal with complex cases that may last for years. A software engineer designing a large program may face thousands of choices in arranging instructions, branches, and subroutines; arriving at the overall shape of the program takes a different set of skills than writing reasonably error-free code on a line-by-line basis.

As such examples suggest, only relatively routine work can be viewed in terms of procedures put **together from sequences of well-defined tasks. The** greater the need for conceptual and judgmental skills, the less precision the notion of work organization conveys.

By the same token, outputs are harder to evaluate when work depends on higher-order skills such as planning. Standards of quality become subject to debate and disagreement; as discussed in chapter 2, consumers may have little basis for evaluating the services of physicians or lawyers, even after delivery of the service. Evaluation may itself demand judgment and skill (thus creating jobs for people such as music critics). Distinctions between minor league and major league baseball pitchers, chess masters and grand masters, artists (including computer programmers and architects) whose work will last or disappear, may escape observers who are not themselves highly skilled. Instinct, feel, judgment, intuition, inspiration—this is the vocabulary of such distinctions. Measures of productivity may be equally uncertain. Baumol has often noted that string quartets performing for alive audience are no more productive today than a hundred years ago; one might add that people's ability to evaluate and appreciate such performances has probably not improved either.[1]

Measures of skill, then, can rarely be very precise beyond some point of relatively ordinary competence. For such reasons, it is too much to expect expert systems to be able to replicate the procedures of people who truly are experts, though it is not too much to expect computer programs to be ordinarily competent.[2] When learning, people follow rules and instructions for playing a violin or writing software. Those who have become acknowledged experts may sometimes follow clearly visible rules and procedures, sometimes not. Sometimes they break the rules. Higher-order skills involving problem-solving

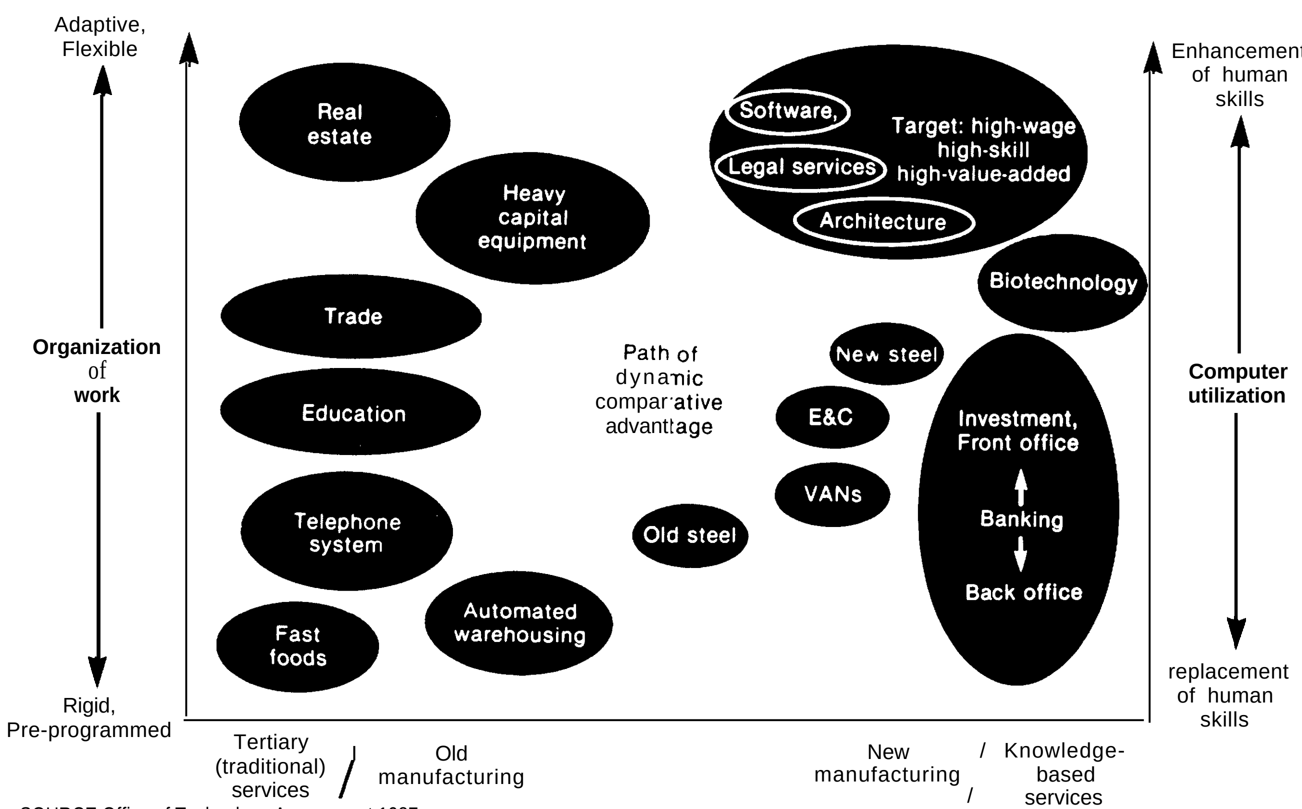
[1] See, for example, W.J. Baumol, "Productivity Policy and the Service Sector," *Managing the* Service *Economy: Prospects and Problems*, R.P. Inman (cd.) (New York: Cambridge University Press, 1985), p, 301. Beyond the live audience case, broadcasting and recording technologies have of course led to huge productivity advances,

[2] See H. Dreyfus and S. Dreyfus, "Why Computers May Never Think Like People," Technology *Review*, January 1986, p. 43; also H.M. Collins, R.H. Green, and R.C. Draper, "Where's The Expertise?: Expert Systems As a Medium of Knowledge Transfer," *Expert Systems* 85, M. Merry (cd.) (Cambridge, UK: Cambridge University Press, 1985), p. 323.

normally come only with time. Extended training, with a good deal of supervised practice, go into making a competent physician or air traffic controller; expertise follows with accumulated experience.

Finally, it is seldom that isolated tasks set the bounds for work. Many jobs require a good deal of contextual knowledge—an understanding of how the organization and its processes function (table 43), An employee with good contextual knowledge should be able to diagnose problems, help customers, and otherwise get things done because he or she knows where to go and who to talk to; relationships with other people may in fact be the primary defining features of computer-assisted jobs. The associated skills may also be the most difficult to learn: the changing interactions between bank employees and their customers discussed in appendix 8A—and the changing relationships between supervisors and subordinates—illustrate some of the complexities of developing new social and managerial skills.

Figure 49.— Characteristics of Firms and Industries



SOURCE Office of Technology Assessment 1987

Table 43.—Patterns of Computer Use by Occupation

Occupations with limited and routine use of computer systems

1. Shopfloor work in manufacturing where computer-based automation is uncommon.
2. Service industry jobs with little or no use of computers (hair stylists, entertainment).
3. Managerial and professional work where people use the system at their own discretion, or for routine functions only (e. g., word processing).

Occupations with extensive computer utilization

Routine:

4. Input-output (data entry, materials handling, loading and unloading of automated production equipment). In general, input-output jobs require little or no interaction with customers, in contrast with data gatekeeper jobs, below.
5. Data gatekeeper—jobs at the boundary between the firm and its customers or suppliers, but requiring little contextual knowledge of the product or production process (e.g., directory assistance operator, order taker for classified advertising).
6. Machine tender (routine monitoring of computer-automated equipment).
7, Troubleshooter (component or equipment level, including routine maintenance and repair, as well as quality control).

Non-routine:

A. Technical and paraprofessional

8. Customer/client/intrafirm service representative—provision of services, outside or inside the firm, requiring greater contextual knowledge than data gatekeeper jobs (e.g., loan officer, travel agent, insurance adjustor, administrative assistant). In jobs with high contextual knowledge requirements, people must understand how the organization works and be able to use that knowledge to get things done.
9. Diagnosis, evaluation, repair, operation, system maintenance (database librarian, paralegal, medical laboratory technician, currency trader).

B. Design, system control, professional

10. Process control, system troubleshooting, crisis intervention (air traffic controller, powerplant operator, financial manager, numerical control machine tool programmer).
11. Product, process, and system design (urban planner, architect, chemical engineer, research scientist).

SOURCE: Adapted from 'International Competition in the Service Industries Impacts of Technological Change and International Trade on U S Employment, " prepared for OTA by E Appelbaum, P S Albin, R Koppel, and F Hormozi under contract No 533-5560

systems enhance the skills of employees in adaptive settings. The greater the fraction of a firm's jobs that fall in categories 4-11 of table 43, the farther to the right the firm would be placed in figure 49. A preponderance of jobs in categories 4-7 implies using the computer as a replacement for human skills, hence a position in the lower right portion of the chart. More jobs in categories 8-11 would move the firm upward, closer to the pole marked enhancement of human skills.

Firms with rigid forms of work organization typically employ many people in routine occupations, complemented by a small superstructure of technicians and professionals. Adaptive organizations, on the other hand, generally need people with both broader and deeper skills, and employ relatively large proportions of workers in technical and paraprofessional categories. Rigid work organization correlates with deskilling (except for the technicians and professionals who design the system and keep it running), adaptive with upskilling.

As figure 49 and table 43 suggest, among the occupations most susceptible to technological displacement are routine input-output and data gatekeeper jobs with low contextual knowledge requirements. For instance, self-service, aided by computer systems, has meant declining job opportunities for gasoline station attendants and bank tellers. Other service jobs requiring little contextual knowledge can be exported to low-wage offshore locations (ch. 7). In contrast, high contextual knowledge implies judgmental skills; such jobs are harder to automate, although offering many opportunities for computer enhancement and assistance. Also note that tenure in jobs with low contextual knowledge requirements does little to prepare workers for upward moves within the firm.

INTEGRATED PRODUCTION SYSTEMS: THE NEW MODEL

Figure 49 suggests the outlines of a new model for computer-assisted production, one typified by U.S.-based firms in the upper right of the picture. These new-model firms design, develop, produce, and market knowledge-based services and goods, emphasizing strategic applacations of computers and patterns of use that enhance the skills and abilities of at least some of their employees. Many have organized themselves as integrated production systems, with integration implying substantial use of computers and telecommunications to more closely couple product design, production, and marketing and to tie together dispersed geographic locations. In search of flexibility and entrepreneurial behavior, these companies tend to stress employee training and skill development, along with controlled risk taking, delegation of authority, and decentralization. They often approach their markets on a global basis, even when small (e. g., PC software firms).

Some manufacturing firms, as well as knowledge-based service suppliers, fit the new model, In both the services and manufacturing, the new model differs from the old in the social system as well as the technical system, with managers recognizing that it is the interrelationships of computers and people, more than the technical system in isolation, or people's skills and abilities in isolation, that determines the firm's ability to respond to changing circumstance, and, over the longer term, to meet international competition.[14] New social systems generally attempt to increase employee identification with the organization, and commitment to its goals. Sometimes this means real if localized power for employees at lower levels —e. g., a voice in hiring new members of work groups (and perhaps in firing), peer approval for pay raises, Sometimes it means no more than consultation on changes in work organization. In other cases, it has become little more than a sophisticated form of paternalism.

A greater fraction of the employees in new-model firms will need specialized knowledge and training, sometimes job- or occupation-specific, sometimes firm- or industry-specific. Computer graphics, for example, has narrowed some of the differences in skills among people who do cartoon animation, design theater and movie sets, draw maps, or prepare graphic layouts for magazines and books, financial displays, scientific illustrations. Such jobs are found in different industries, and traditionally have been viewed as requiring different skills. With computer automation, they are converging. Likewise, data gatekeeper jobs call on similar kinds of skills across industries—communicating over the telephone, customer service, using data processing systems to access, store, and retrieve information. Note that overlap in job skills among seemingly different occupations and industries eases lateral mobility, one reason for growth in temporary employment (ch. 7). In general, employees of new-model firms will be expected to bring broader (and perhaps deeper) skills to the workplace; the company may use job rotation, work sharing, and small-group production to help develop a multi-skilled labor force. Contextual knowledge will be more important for more people, who will need to know how their work fits into the chain of production, so that they can troubleshoot problems, help customers, make good decisions.

Somewhat more concretely, most companies with organizational structures evolving toward the upper right portion of figure 49 share characteristics from the following list:[15]

- *Firms define jobs somewhat more broadly than in traditional organizations.* Sometimes broader skills and responsibilities follow more or less directly because computer automation permits each person to do more. Sometimes groups take over responsibility for a number of tasks, with individuals learning several jobs and rotating among them. By working in groups, people learn from one another, more easily share skills and information. When people know each others' jobs, or can simply do more, the organization becomes more flexible.

[14] This corresponds to the classical statement of objectives of the sociotechnical systems approach to job and organizational design-the search for a joint optimum between the technical system (including both process and product technologies) and the social system (that is, the people in the organization, with their skill endowments and foibles, preferences for cooperation or conflict. informal groupings). See, for example, E. L. Trist, et al., *Organizational Choice: Capabilities of Groups at the Coal Face Under Changing Technologies* (London: Tavistock, 1963); E. L. Trist, "The Evolution of Sociotechnical Systems as a Conceptual Framework and as an Action Research Program," *Perspectives on Organization Design and Behavior*, A. H. Van de Ven and W. F. Joyce (eds.) (New York: Wiley, 1981), p. 19.

[15] An earlier version, adapted for manufacturing, appeared in *Technology and Structural Unemployment: Reemploying Displaced Adults*, op. cit., pp. 356-357,

New-model firms, where an employee's actions may have impacts that reach deeper and spread more broadly than in a traditional organization, call for greater contextual knowledge. With many centers of responsibility, and people at relatively low levels making decisions and taking action, employees need to understand how their work affects the rest of the organization. When the same person sells insurance and prepares the policy documents at an on-line terminal, that person must know more and take more responsibility.

When people gain more responsibility and control over their work, they may get more satisfaction from their jobs (some do, some don't).

- As a result of broader job definitions and the need for contextual knowledge, corporations may find they need to give their employees *more and better training,* and may seek *deeper* as well as broader skills (even among employees normally classed as unskilled or semi-skilled).

  Firms that have moved to product-centered rather than functional organizations (a distinction discussed at greater length below) usually provide training covering the product line; a few companies have gone beyond, say, marketing information, beginning to discuss profitability or long-range planning with their employees—topics ordinarily reserved for managers.
- Many training programs are intended to expose employees to corporate goals and enhance *motivation, sense of belonging, and commitment* to those goals. Such objectives often merge into the development of contextual knowledge; for instance, a company may devote considerable effort to showing employees how their jobs contribute to the firm's end products. People may be encouraged to view themselves as immediate participants in the production of final services, rather than simply doing a job somewhere along the chain of production, ("I work for MetroBank" rather than "I'm a bank teller.")
- Employees at lower levels maybe granted *a say in decisions on equipment and procedures (e. g.,* word processing or spreadsheet software), as well as day-to-day operations.

  Typically, participation takes the form of meetings between employee representatives and the company's technical and managerial staff. Planners may seek to draw on the experience of the current work force.

  Consultative mechanisms, regardless of form, seldom give low-level employees any real control over major decisions—those that shape the system. Only in cases of massive opposition to proposed changes, or where employees are represented by strong labor unions with independent sources of technical expertise, are they likely to be able to influence the fundamental choices that shape the organization of work and the application of technology.
- Managers may give *groups of workers* some or all of the authority formerly vested in first-line supervisors, perhaps including limited control over pace, task design, and work methods, along with responsibility for quality and for coordination with other departments.

  When groups take over responsibility for monitoring absenteeism, for allocating work, and for quality control, the supervisor's role may become primarily that of facilitator and communications channel with higher management, As illustrated in appendix 8A, supervisors commonly find themselves spending more time on management, less on administration. Often, the ratio of supervisors to production employees declines; some companies have eliminated first-line supervisors entirely.

  Giving supervisory control to work groups can heighten job stress. Among the causes are intra- and inter-group competition—forces that managers look to for greater productivity. Moreover, work groups often have some control over membership—perhaps the power to veto prospective new employees. People who do not fit in may find themselves not only uncomfortable, but out of a job, Work groups carry potential for inequities and abuse that few

American companies have as yet acknowledged.

- In selecting new employees for some kinds of jobs, companies may weigh *motivational and attitudinal factors* more heavily than past experience (or, in some cases, education). Social skills may get new emphasis.

  Some American firms have adopted multiple levels of screening, with aptitude and perhaps psychological tests followed by interviewing. The interviews might involve prospective peers as well as the personnel department and supervisors.
- *Pay scales* may reflect the skills an employee has acquired (e.g., the jobs he or she has mastered—pay for skills) and/or performance (payment for results). In addition to meeting objective standards such as written tests, an employee seeking a pay-for-skills increment may have to be passed by other members of the group, as well as by supervisors.
- In decentralizing, some companies have replaced functional with *product-centered organizations*. The common objective is to channel work smoothly and directly from input to output of the system—creating a faster, more flexible (if not necessarily more efficient) production process.

  The benefits of "channelization" can be quite real, even if hard to quantify. As discussed below, banks have replaced centralized data processing divisions with smaller departments specialized by type of customer (retail stores) or transaction (currency exchange). When a single department provides most or all of the services a given client needs, the bank's employees can respond more quickly, the system becomes more nearly transparent to the client (and to the bank's own employees).

  Product organizations can also contribute to employee motivation and commitment; people may identify more readily with a department that supplies a complete product rather than a piece of one.

While the primary thrust in most new-model firms has been to select and fit people to existing or redesigned jobs, jobs can also be fit to people. This may be a matter of circumventing a lack of literacy or numeracy in the labor pool, designing equipment so that it can be used more easily and more productively (user-friendly computer systems), or finding better ways to call on the capabilities of those who are over-educated for the jobs they find themselves in,

Although no census exists, several thousand U.S. companies appear to share a substantial number of attributes from the list above, with the number in manufacturing probably exceeding that in services.[16] A much larger number of American firms have taken smaller steps, such as the introduction of quality circles. In the services, new model organizations are far more likely to be found in, say, banking, than in construction,

As more organizations consider alternatives such as those outlined above, the questions for U.S. companies and their employees include: Compared with foreign competitors, will American service firms react slowly and uncertainly? Or will they take the initiative? How will decisions taken by corporations, collectively, affect competitiveness? How will skills be affected? Will people be integrated into the system or out of it? Will job ladders and prospects for upward mobility be truncated?

The answers depend mostly on whether American managers in large numbers search out new ways of maximizing the contributions of individual employees to competitive performance—a search that some **U.S.** firms have embarked on, along with a few European companies and many Japanese organizations (the latter particularly in manufacturing). It seems clear that widespread adoption of at least some features of the new model can help improve the competitiveness of American industries, and thus aid in preserving job opportunities over the longer term. Nonetheless, in the short run, work reorganization in conjunction with computer automation typically causes some

[16] See R, E. Walton, "From Control to Commitment in the Workplace, " *Harvard Business Review*, March-April 1985, p. 76. Also, *Productivity Through Work Innovations: A Work in America Institute Policy Study* (New York: Pergamon, 1982), p. 35.

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kinds of job opportunities to disappear, people to be displaced.

While a number of the steps outlined above may contribute to making some kinds of work more satisfying, new forms of production systems also bring new dangers, born of the inherent conflicts of interest between firms and their employees. Training programs can end up resembling indoctrination. And what, for example, of people who find themselves at odds with a work group? The more authority managers cede to such groups, the greater the potential for abuse by the group. (Which is not to imply that managers never abuse their power.) Questions of equity would seem to exist already, first and foremost where groups can veto new employees. The modern, bureaucratic corporation, after all, emerged in part from efforts to counter the favoritism, nepotism, and corruption that afflicted earlier forms of organization. In 19th century U.S. factories, Irish gang bosses hired other Irishmen. Groups of Cornish miners working on contract in the Midwest, if not members of the same family, often came from the same village. Work groups today are hardly likely to take such forms, but possibilities for coercion and abuse can plainly arise.

Furthermore, practices such as screening hundreds of applicants before picking a few dozen will strike many Americans as less than fair; a corporation, after all, is not an athletic team. Labor unions, where they exist—and they are relatively rare in U.S. service industries (ch. 7)—can help safeguard the rights of individuals and protect against discrimination in hiring and firing, But some American managers see organizational change as a way to keep out labor unions, and not a few companies view unions as incompatible with new forms of work organization.

IMPACTS ON COMPETITIVE ABILITY

As noted earlier, American managers have often been criticized for placing higher priorities on immediate cost savings and short-term profits than on investments leading to indirect and/or strategic payoffs visible only over the longer run, As this section will show, many of the most significant impacts of new-model production systems come about indirectly. For instance, greater job satisfaction can help reduce employee turnover, hence costs for training new employees (including lost production during on-the-job learning). Thus the speed with which American companies move toward new-model organizational forms may provide one test of the proposition that incentives in the U.S. economy skew managerial decisions toward the short term.

Citibank's shift in its back offices from a functional to a channelized or product organization illustrates some of the indirect impacts, here through improved customer service.[17] During the ***1960s*** and into the 1970s, Citibank, like most financial services firms, fed all its transactions through a large centralized data processing division—the functional approach common in an era of batch processing on expensive mainframe computers. In Citi's DP division, all transactions (e.g., checks) passed in sequence through half a dozen departments organized by function (e.g., coding and keypunching—the system roughly paralleled that described in box Z for batch processing of insurance claims). Different transactions—checks, letters of credit, foreign exchange—took different routes through the DP division, but all were handled in basically the same way, There were no distinctions between, say, corporate and individual accounts. Each time the paperwork for a transaction crossed the boundaries between departments, it moved from the province of one manager to another, With responsibility fragmented, errors were easy to make and hard to trace.

The company redesigned and decentralized its transaction processing system so that a single manager would have end-to-end responsi-

[17] R. W, Walters, "The Citibank Project: Improving Productivity Through Work Redesign," *The Innovative Organization: Productivity Programs in Action,* R. Zager and M.P. Resow (eds.) (New York: Pergamon, 1982), p. 109.

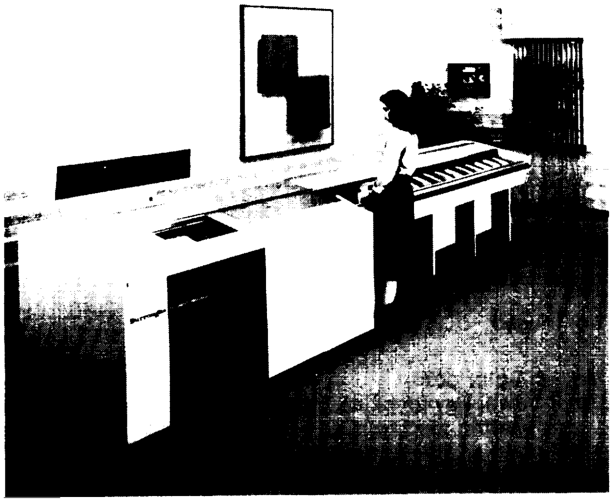

Photo credit Burroughs Corp

Automated reader/sorter for processing checks.

bility for a single type of transaction (product). Different departments now handle letters of credit, depending on the customer (government, correspondent banks, Citicorp branches) as well as the geographic market. Each transaction follows a well-defined path or channel from the time it enters the Citibank system until it leaves, with management responsibility clearly defined at each point.

Just as in the insurance industry, cheap computing power, specialized work stations, and friendlier software make product forms of organization practical in banking. Of course, assigning different departments full responsibility for the needs of different groups of customers inevitably means duplication of equipment. Capital costs may rise. But today, in many banks, checks stay within one department, lines of responsibility are shorter, and, in principle, service is faster and more responsive. A customer with a question should get a quick answer. Even if the company's cost structure does not show improvement, better service should be good for business and for competitiveness.

Given such examples, it should be no surprise that little concrete data exists for evaluating work reorganization and computer integration in new-model organizations. Certainly, most companies, when they introduce new forms of production systems, do so to improve efficiency, defined broadly. But they seldom reveal quantitative information on the success of these efforts. Indeed, it can be hard for the company itself to tell whether new forms of work organization have been successful, if only because conventional accounting measures may fail to capture the full range of benefits. After all, what is the dollar value of better customer service or greater flexibility? How can projections into the future capture strategic advantages?

Some generalizations, nonetheless, hold quite broadly. New-model organizations normally have somewhat higher fixed costs compared with old-model systems. Even in the absence of heavy investments in computers, peripherals, and software, capital costs typically go up for the simple reason that many job redesigns entail redundant equipment for parallel product departments or work groups. New buildings will cost more to the extent that they provide more space or need coaxial cabling and light guides for computer networks and telecommunications links. As table 44 indicates, direct labor costs may go up or down, with substantial indirect cost savings possible. Training costs per employee increase when jobs become broader or more complex, although net expenditures on training may drop if turnover declines. Reducing or eliminating first-line supervisors cuts labor costs directly. Shorter, more direct interpersonal communication channels can also save money.

But costs give only part of the picture. When MetroBank (app. 8A) reorganized, it accepted relatively high costs as part of its new strategy. purchasers who get more responsive service may order more; new customers may be attracted by word of mouth. The point is a general one: work reorganization can help companies initiate and pursue new business strategies. There is every reason to believe that, over the longer term, new-model firms in U.S. service industries (and in manufacturing) will be able to gain advantages in both domestic and international competition.

Table 44.—Typical Changes in Cost Structure for New-Model Organizations

	Direction of cost shift
Capital costs:	
Buildings and equipment	Up (smart buildings, more computers)
Transient costs associated with work reorganization:	
Start up	May go up or down. Broadening of jobs and skills tends to increase startup costs
Lost time for meetings and consultations with employees during the design phase	up
Consulting and contract services	Up, if used
Direct operating costs:	
Direct labor content per unit of output	May go up or down
Pay scales	Up or down. Pay-for-skills, bonus, and gain-sharing tend to raise wage levels, but many of the companies in the United States adopting such plans will probably remain non-union.
Quality control, inspection and error-correction costs	Down
Indirect operating costs:	
Downtime (unplanned idle time)	Down, especially where more flexible systems replace old-model organizational forms such as assembly lines, with their potential for shutdowns caused by minor problems.
Lost production during meetings	up
Training costs per worker	up
Heating, lighting, other utilities and services	Up or down. Employee suggestions may lead to savings.
Maintenance costs	Generally up. (More equipment means more maintenance, although computer and telecommunications equipment is growing steadily more reliable.)
Indirect labor and supervisory costs per unit of output	Down
Cost categories with both direct and indirect components; intangible costs:	
Cost penalties and avoidable mistakes resulting from insufficient employee involvement in the initial design of the production system	Down
Costs associated with employee absenteeism and turnover (including recruitment expenses, training, overtime, wages for relief and utility workers)	Down
Added costs associated with operating at part-capacity	Down
Communication costs within the organization	Up or down
Wastage, including theft	Down
Grievances	Down
Costs associated with minor changes in product design	Down, unless new equipment needed
Customer dissatisfaction	Down
Other costs attributable to employee dissatisfaction or low morale	Down

SOURCE Office of Technology Assessment, 1987

CONCLUDING REMARKS

Applications of technology matter for competitiveness in services: they exert direct and indirect impacts on costs; lead to new strategic opportunities; help ensure consistent and high-quality output; keep customers satisfied; enhance the firm's reputation. Most of the early uses of computer and communications systems focused on cost cutting. Today, strategic considerations—seeking to establish new products, push into new markets, provide better service to customers—have overtaken cost control as a managerial priority. Reorganized and more flexible production systems have become intrinsic elements in the strategies of a growing number of American service firms. Japanese companies have turned effective work organization into a potent source of competitive advantage in manufacturing; they could eventually do so in the services, American service firms cannot afford to fall behind.

Given the unstable operating environments that now characterize so many international industries, greater flexibility-in part through a labor force with broader and deeper skills (and in part from greater use of temporary and part-time employees)—can enhance competitiveness. So can technology that helps people use their skills effectively, New possibilities for the applications of technology often appear faster than people can apply them. Managers have been confused, unsure of how to invest their firm's resources, Lower level employees have been confused, unsure whether or not to welcome the terminal that appears on their desk one morning. Economists have looked at the statistics and concluded that much of the money has been wasted, that new technologies have been deployed unwisely because productivity growth in the services remains low; they are confused because their measures fail to capture changes in output characteristics.

This avalanche of technology opens new avenues for designing production systems that match the needs of the people using them—and the needs of customers, By adopting system design criteria that judge technology in terms of its contributions to the system as a whole, companies can—in principle—achieve combinations of flexibility and efficiency unheard of when computers were expensive, Good solutions to the problems of computer utilization in new-model production systems can cut costs and improve productivity while also yielding strategic advantages.

New-model production systems will be simultaneously more integrated and more flexible, What does this imply? On a macro level, greater use of computer networks to link dispersed operating units, and greater commonality in equipment and in databases—the goal being to tie product development and marketing more closely to the production process, On a micro level, it implies decentralized and semi-autonomous forms of work organization—product departments, end-to-end production channels, employees with broader and deeper skills, job rotation.

In theory—practical implementation is another matter, as the appendix to this chapter shows—a more integrated system should (perhaps somewhat paradoxically) be able to adapt more readily to new product designs, to shifts in mix or volume, even to changes in government policies, To do so, the system must effectively integrate people and machines, which, in turn, means that employees at all levels will need new skills—reasoning, problem-solving, acting autonomously.

Micro level integration becomes easier with smaller, cheaper, more friendly computer systems. For instance, fourth-generation languages mean that end-users with relatively little training can create their own applications programs, Indeed, fourth-generation software, making possible fluid and evolving system designs, may permit firms to move toward organizational structures, as well as particular applications, that can evolve over time to meet the needs and desires of individual employees,

In general, effective integration implies giving employees at all levels greater responsibility, This may mean giving them a stake in the success of the enterprise—and in the security of their own jobs—through gain-sharing, bonus, or profit-sharing plans. Even among the most tradition-bound American managers, many have begun to acknowledge the need for greater employee involvement as companies move into high technology and face new competitive pressures,

Given better computer and communications systems, and a better educated, better trained, and more responsible work force, companies should be able to maintain effective internal coordination and control, even as management styles loosen, Why? Because managers seek tight control in part as a hedge against partial or faulty information. With an integrated production system, enlightened corporations may loosen the reins, upper managers lose some of their fear that the system will go out of control.

Meanwhile, less enlightened companies may move in the opposite direction, towards more rigid forms of work organization, Some will seek to use more and better information to tighten supervision, losing the benefits of flexibility. Of course, productivity in some industries will continue to depend on close control over task assignments, and on rigid forms of work organization: there is little need for flexibility (outside well-defined bounds) in most fast-food outlets, or in a telephone company, And, although managers may seek to reduce costs associated with employee absenteeism, turnover, even sabotage, they do not develop new production systems just to keep people happy, Particularly in the tertiary services, tensions between productivity and quality of working life may change little if at all; managers will push for efficiency, employees for less stress, a more tolerable environment. Productivity will continue to come at the expense of job satisfaction and quality of working life, if only because some kinds of production—in the services and in manufacturing—will continue to demand routine and repetitive work; flexibility is not always needed,

More broadly, however, continued development of new-model organizations seems likely to slowly extend the bounds of employee control. The reasons are largely technological, inherent in the design and operation of complex systems. Distributed computing will be a primary tool for automation and integration. Highly automated systems may need fewer employees, but these employees will bear heavier responsibilities. Automated systems cannot be idiot-proofed; indeed they tend to be more sensitive, less robust than labor-intensive systems.[18] One person's mistake can shut down a highly integrated system, where in a more labor-intensive organization the consequences would remain localized. If integrated systems are to function effectively, employees must have considerable freedom of action, and the knowledge and skills to intervene swiftly and appropriately. In consequence, some of the distinctions between managers and other employees will narrow. As ordinary employees take on greater responsibilities, companies will find it in their interests to treat and train them more like supervisors and professionals. A high-skill economy will depend on a labor force that can accept authority, use good judgment.

The technology of integrated production systems, then, will break down some of the barriers in hierarchical organizations. In many cases, the barriers will come down fastest and farthest within management. Natural enemies —marketing departments and back offices, managers on the same level in the hierarchy—will have to work together, much as production and quality control must be integrated in new-model manufacturing plants. Particularly at middle levels, managers will lose power (and some will lose their jobs). None of this will happen without a struggle. American industry carries a heavy burden: hundreds of thousands of managers who learned the ways of the 1950s and 1960s, many if not most of whom will never feel at home in a new-model system.

[18] The reasons begin but hardly end with the elusiveness of software errors, In general, control models themselves can only represent a portion of the system, so that people must bridge the resulting islands of automation. Furthermore, control models tend to break down because of contingencies that were overlooked or simply cannot be incorporated into the model. By definition, when the model breaks down the system is out of control and people must take over, Technical constraints inherent in control models mean that development of large-scale computer-integrated systems will continue to be slow and painful, with progress depending on trial-and-error arid incremental improvement.

In the end, it will be more difficult to trace power and authority to particular people except at the upper executive levels. The implication: evolving organizations will need new mechanisms for resolving conflicts among managers with different goals and priorities (one of the things Japanese companies are good at), as well as for resolving conflicts between labor and management. Where these mechanisms do not develop, competitiveness will suffer. Likewise, where companies rely too heavily on computers, particularly in routine applications, they may find their work force slowly losing the core of experience-based learning that will always be needed, A further implication: group responsibility will have to replace individual responsibility, managers will have to begin thinking of themselves as members of multi-skilled work teams.

What does this mean for Americans in the labor force, or ready to enter it? In some cases, it will mean greater stratification within service-oriented companies. Some highly skilled (and highly motivated) employees will have relatively secure jobs, with good pay and prospects for rapid advancement, Others will have full-time jobs but limited upward mobility, A third group may find themselves limited to part-time and temporary work, serving as buffers against uncertainty and market fluctuations. Credentials will become more important for securing the kinds of entry-level positions that lead to on-the-job learning and skill development, More career ladders will begin with post-high school education—2-year and community colleges, vocation-technical schools, bachelor's level programs. High-school graduates—and those who have not graduated–will have a more difficult time proving to employers that they deserve a chance to learn and move upward. On-the-job learning in the new services maybe just as important as in the older manufacturing industries, but the preponderance of mental and social skills over manual skills will lead employers to place more emphasis on educational credentials for entry.

Greater flexibility and improved competitiveness will prove a two-edged sword in another way: some service industries may be able to increase their competitiveness only at the expense of jobs and job opportunities. In others, output may grow sufficiently to keep everyone at work, or to create new jobs. But companies that can respond quickly and effectively to shifts in exchange rates and world market conditions, the uncertainties of consumer demand, and changes in technology itself, will always be well-placed to prosper in international competition, To strengthen its long-term competitive capacity, the United States will have to strengthen its institutional mechanisms for continuing education and training (ch. 10).

Most of this chapter has focused on industries that have invested heavily in computers and communications, doing so in rather speculative fashion, But jobs in the traditional, tertiary services—including those least likely to be automated—will continue to depend in various ways on the knowledge-based sectors; a nation that grows more competitive in high-value-added industries will, all else equal, have higher living standards and more jobs for everyone, Because of this, one of the most effective, if indirect, roles for government comes through the complex of policies that support and encourage the development of human capital. This implies not only education and training—traditional responsibilities of Federal, State, and local governments—but aid for the adjustments and transitions involved when people and companies find themselves moving into new and different forms of work organization. The rationale is straightforward: by helping ease and guide the transition to a knowledge-based economy, public policies can contribute to maintaining U.S. employment, to the international competitiveness of U.S. firms, and to the Nation's standard of living.

APPENDIX 8A: RESTRUCTURING AND WORK REORGANIZATION AT METROBANK[19]

In the late 1970s, MetroBank—a medium-sized competitor in a large urban/suburban market—entered a crisis from which it is still recovering. Burdened with bad international loans, and locked into long-term deposit certificates at a time of rising interest rates, the company faced a cash flow squeeze; it was saved only when a consortium of other banks lent it capital. When the consortium partners insisted that MetroBank restructure its operations, the president and executive team were replaced, many middle managers were fired, branches, subsidiaries and real estate holdings were sold, and liabilities (including the deposit base) were cut in half, A new strategy and new structure meant new job responsibilities for nearly all the bank's employees.

New Products, Changing Jobs

Two years into its reorganization, MetroBank faced the question of formulating a strategy suited to its altered circumstances. Recent history showed it could no longer be a national player, while suggesting a focus on the regional market. Although many commercial clients had withdrawn their accounts when the bank was threatened, the retail base remained loyal. Household customers identified with Metro Bank, a local mainstay for decades. To build on this base in a period of deregulation—with ongoing competitive threats from other financial service firms, including entrants from outside the banking industry —MetroBank sought to broaden its range of products and to stress personalized service. This high-value-added niche strategy encompassed three main elements:

1. development of 14 new banking products (e.g., credit cards, Keogh and individual retirement accounts, money market accounts, money-saver checking accounts, car leasing), thus offering consumers a portfolio of services;
2. an active selling program at the branch level intended to increase the number of accounts and products per household; and
3. decentralization of responsibility for commercial lending to smaller businesses from the main office to the branches.

Together, these three steps were meant to stabilize the deposit base by increasing customer reliance on the bank, and to focus lending within MetroBank's market. Senior managers hoped to develop "relationship" banking at the branch level by strengthening ties with neighborhood businesses. At this time, MetroBank operated about a hundred branches, and employed 2,000 people.

With the new strategy in place, MetroBank's employees describe their jobs differently. Branch personnel, including managers, refer to a shift from *operations* to *sales,* from *administration* to *planning,* from *order taking* to *selling.* As one branch manager put it, "Before . . . all you had to do was to see if there were enough supplies, if procedures were followed, and get the paperwork done. You wanted to get people in and out the door. Now . , , we're in the retail business. "

Employee roles changed, particularly for customer service representatives, branch managers, and area managers:

- *Customer Service Representatives.* Prior to the crisis, the CSRs (or platform workers, as many employees call them) helped customers balance their check books and open new accounts, They were a cut above secretaries. But MetroBank's senior managers believed that the CSRs had to become the backbone of the selling effort in each branch, They were to "cross-sell" products—to convince customers coming in for help to buy other products and services. MetroBank's management created a budget for retraining the platform workers, and instituted a measurement system to assess their sales performance.
- *Branch Managers,* In the past, branch managers were primarily administrators, evaluated largely on their ability to control costs. Since the restructuring, they have been asked to generate loans, particularly among businesses with revenues of less than $10 million. Many of the branch managers, lacking prior lending experience, have enrolled in the bank's ongoing credit and lending courses. In addition, branch managers must coach and supervise sales efforts by the platform workers.
- *Area Managers.* This is a new position, the least defined of the three. Each area manager oversees a group of branches, helping with planning, marketing, and budgeting.

As this summary suggests, MetroBank's restructuring will, if successful, upgrade the jobs and skills of many employees in its 100-some branches, CSRs will sell rather than simply respond to inquiries, branch managers develop loans on the outside as

[19] This appendix is based on a case study prepared for OTA by L. Hirschhorn, Wharton Center for Applied Research, under contract No. 533-597o. The name of the bank and some details have been changed.

well as administer operations on the inside, Employees will have to cope with greater levels of uncertainty as the bank tries to actively shape its markets, rather than taking them as givens.

The Transition

Developing new skills and managing the shifting relationships between main office and branches has meant a series of adjustments, many of them less than smooth.

New Skills

The transition has been a difficult one for the hundreds of platform workers expected to do the bulk of the selling and cross-selling of new products that range from credit cards to second mortgages for financing a child's education. MetroBank purchased two off-the-shelf training courses from a vendor; all CSRs took the course dealing with selling skills, plus a shortened version of a course on financial counseling. The courses proved no more than marginally effective.

The platform workers face three sets of difficulties: taking authority; managing uncertainty; and planning their time. Two studies by consulting firms indicated that CSRs feel out of place selling the bank's products and services. A shopper's study (in which pseudo-customers came in with unstructured requests) found that platform workers could explain bank products effectively, but frequently failed to close the sale. Interviews with the platform workers showed that most still see their work as customer service-e.g., explaining bank statements—not sales. Almost all complained that they did not have time to cross-sell; moreover, they tended to see management pressure for greater selling effort as simply asking for more work. Striking disparities characterize the language of senior managers, who speak of *culture* change, and the words of CSRs, describing what to them seems a "speed-up. " Earlier, most of the platform workers (and other line employees] functioned primarily like clerks and secretaries. While their resistance reflects some of the classic tensions between managers and workers, it also reflects the difficulty of instituting major changes in the everyday responsibility of a relatively large group of employees.

Eventually, the question of career prospects and ambitions may prove central. Metro Bank has cut its costs in part by using more part-time tellers and a ''tight platform in many branches. The company has continued to view its line workers as expenses rather than assets, while at the same time wanting them to take on more responsibility. Interviews show that few CSRs identify with the bank as a whole. Many like to work close to home. They are not only reluctant to take on authority and to sell, they don't want a career that would take them to other branches, One said, "If I wanted to go up, I would have been out of this branch a long time ago. . . . All I want is my 10 years and to vest my pension. " Interviews also indicate that many CSRs still think of themselves in secretarial terms, raising the question of whether MetroBank is recruiting the right kinds of people. The desire to control costs leads to hiring of platform workers in the labor market for secretaries and clericals. Yet the image held by managers suggests someone who wants authority and opportunities to rise in the bank.

Technology

Some staff and managers at MetroBank believe that improvements to the computer network used by the platform workers will help. The redesign of the system will proceed in three stages. At first, CSRs will be able to call up information but not enter data. In the second stage, they will be able to change files on-line. Eventually, they will be able to produce final documents ready for customer signature. Experience at other banks suggests that this will help give employees a new perspective on their jobs. Platform workers will have full and complete data on the customer and on all the bank's products. They will no longer need to call the main office for information. In addition, they will be able to walk customers through various "what-if" demonstrations (e. g., the pay-out on an IRA] as a selling aid. Eventually, their terminals will be able to display taped presentations on the bank's products. As the terminal becomes an information utility, the platform workers may come to accept that they are in positions of real responsibility and authority.

Thus far, redesign of the computer network has not gone smoothly. Branch and division managers have had trouble working with the systems division. Systems engineers have shown little knowledge of, and little interest in, the development of user--friendly software—nor have they made any effort to learn from the platform workers, or get feedback from them, Most strikingly, the systems division has failed to provide training, despite repeated requests and protests from MetroBank's line managers.

Managing Uncertainty and Planning Time

Previously, the CSRs simply helped customers as they entered the branch, Platform workers did not have to plan who they would see, when and why, for how long. Now, they have been asked to develop a sense of priorities — to gage the value of time spent with each customer, and the value of time spent on service as opposed to sales. As one branch manager put it, "In an 8-hour day, you can't wait on one customer for an hour. I tell my people to develop each customer to the maximum. They should also try to get their operations work done outside of contact hours, " Some platform workers complain that they have too much paperwork, and cannot do the telephone selling expected of them after the branch closes in the afternoon.

The CSRs must also learn to live with uncertainty. The outcome of a sales encounter may not be apparent for weeks; success can only be measured by averages. Psychologically, this means that the platform workers must learn to live with failures by betting on future successes. Earlier, the platform workers could get a sense of accomplishment simply through helping customers as they entered the branch.

Relationships Between Branches and the Main Office

This aspect of the transition has two dimensions: working relationships between superiors and subordinates (which changed with the decentralization of lending responsibility); and relationships between line and staff. Before restructuring, branches were viewed as little more than mail drops for the main office's lending business. MetroBank's new strategy calls for branch managers to spend half their time calling on potential loan customers. To help them develop lending and selling skills, the branch managers were given credit and salesmanship courses. Senior executives also wanted to shift their managers' attention from expenses to profits, from absolute deposit levels to market share. As one area manager said "I tell my branch managers, 'You are a profit center. ' We are not telling them, 'You must ring *zoo* door bells . . ,' we are saying, 'tell us what you did, what you achieved. ' "

Thus the rules have changed just as much for lower level managers as for the platform workers they supervise. One branch manager said, ". , . in commercial lending, you walk out the door not knowing if you have accomplished anything." At the same time, branch managers must now coach their own subordinates, rather than simply monitoring their performance. Formerly, the CSRs and other branch employees had little discretion; they simply followed standard procedures. Now, the supervisors face a more difficult job: helping CSRs learn to sell, and to use the new computer system. Interviews indicate that few branch managers, as yet, have mastered the coaching process. Indeed, one noted that he needed supervision from his area manager: "We need someone to take a look at individual management styles, how you're doing compared to the norms. Not necessarily someone to look over your shoulder, but someone to go out on a sales call, and sit in on a staff meeting. "

Planning is also new for the branch managers. MetroBank's marketing department regularly asks each manager to assess his branch's performance, evaluate its strengths and weaknesses, and prepare a business plan. The head of the market planning unit has expressed considerable disappointment with this exercise, reporting that the branch managers were not very self-critical, argued that they had no real control, and were insensitive to market share as a measure of success. The marketing department has since taken over preparation of business plans for the branches.

The Area Managers

The most striking characteristic of an area manager's job is its poor definition, In principle, area managers are in charge of marketing for a group of 5 to ***10*** branches. Yet they have no marketing budgets, One said, "I need permission to spend $2,000 for a party at a senior citizens home. " Nor do area managers systematically review the performance of branches.

The poorly defined role of area managers may suggest that MetroBank has focused too heavily on the lower levels, placing most of the burden of change on those in the branches. Upper management may be "leading from behind, " reluctant to cede real power to those lower in the hierarchy even though this is necessary for decentralization to work. whenever top managers delegate authority, they face loss of control, MetroBank's senior executives may have felt more comfortable delegating to those at the bottom—whose authority will in any case be limited to a single branch—rather than to the area managers.

Such possibilities highlight what MetroBank executives call the problem of "creating a new culture. " Those at all levels speak of the old culture as a bureaucratic one. They know that success in the future depends on becoming less bureaucratic, which means authorizing people to act with more independence. But the older culture, and its norms, persists. while wanting the platform workers to take more initiative, some managers think they're lazy, Meanwhile, ample evidence exists that platform workers lack the support (e. g., coaching, computer training) needed to be effective in their new roles.

Customers

In many high-value-added industries, products are tailored to fit the client's needs; the customer has an intrinsic role in the production process, in effect co-producing the service. This leads Metro-Bank's senior managers to speak of relationship banking, while for the platform workers it means educating the customer. In interviews, many CSRs reflected on customer confusion over the features and benefits of IRAs and other new products: ". . . a lot of people don't know anything about money market accounts ., . people are afraid to use overdraft protection , , . customers can't see that if they pay off on their credit cards in time there is no finance charge.

In fact, marketing experiments suggest that many of Metro Bank's customers are quite conservative. Few have responded to offers such as free checking and free travelers checks as part of packages including other products. Some of MetroBank's product development efforts have failed for reasons that executives attribute to customer confusion. Regardless of the reasons for such failures, they highlight the need for firms in high-value-added industries to develop a good grasp of customer desires and motivations. In pursuing its high-value-added strategy, MetroBank has become dependent on how its consumers see the world, on what they want.

Summary

For MetroBank's strategy to succeed, its employees, including managers, will need new skills and attitudes. At the most general level, this means learning to live with uncertainty. For the bank as a whole, the marketplace is less predictable because of deregulation. For individual employees, uncertainty (and anxiety] comes with the need to sell new retail products and bring in loan business. By giving the platform workers more immediate access to information, and by increasing their apparent competence in the eyes of customers, the redesigned computer system may help resolve some of the tensions. But several years after restructuring, Metro-Bank cannot yet feel confident in its new strategy.