Technological change and employment: some results from BLS research

Bureau studies indicate that the pace of technological change varies considerably by industry; affected workers are more likely to be transferred to new jobs

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Technological change and its impact on the work force have become a focus of attention in the United States and abroad. The innovations include advanced communication systems, industrial robots, flexible manufacturing systems, computer-assisted design (CAD), and computer-assisted manufacturing (CAM). These modern technologies incorporate powerful and low-cost microelectronic devices that have the potential to increase productivity in office and factory production tasks. They share widespread appeal and are being diffused throughout the world.

There are, however, conflicting views about the implications of changing technology for employment. Some experts say that the pace of technological change is accelerating and that thousands of workers in plants and offices are affected as laborsaving innovations are diffused more widely. These experts contend that recent innovations represent a sharp departure from earlier changes, and that techniques for maintaining job security will be essential. Other analysts assert that technological change is beneficial for all groups in our society, that the changes are more evolutionary than revolutionary in nature, and that technology ultimately creates more jobs than it eliminates.

Concern about changing technology has been continual over our history—usually increasing during periods of higher-than-average unemployment, and abating somewhat when the economy and employment are expanding. Consequently, the Bureau of Labor Statistics has been studying technological change and its impact on the work force for a long time.

Assessing the impact of technology is very complex. Technological changes interact with, and are affected by, changes in output, consumption patterns, international competition, and other factors, and the relationship between changing technology and employment is by no means clear. Although the Bureau's technology studies do not provide comprehensive answers about any relationship, they do yield some useful insights. This article reports on some of the findings of these studies.

BLS research on technological change

In the mid-1950's, in response to concern about the implications of developments classified under the general term "automation," BLS began an intensive evaluation of the likely effects of the diffusion of electronic computers and other changes. To explore the impact of these emerging technologies on productivity, employment, job skills, and labor-management relations, the Bureau conducted a series of plant-level case studies in industries such as petroleum refining and electronics.

Currently, the program's focus is the preparation of a series of industry technology outlook reports which describe the types of changes gaining importance in key industries, explore the prospects for their further diffusion over the next

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decade, and analyze their impact on productivity, employment, occupational requirements, and labor-management relations.

A total of 35 industry reports, covering a cross-section of the economy, are available in the most recent series. The reports include industries such as motor vehicle manufacturing and telephone communications where the pace of change is rapid, as well as industries such as bakery products where change is slow.[1] These industry reports are based on visits to leading firms, interviews with company and union officials and suppliers of new technologies, and a review of a variety of published sources.

In addition to these reports, the Bureau conducts in-depth studies of major technologies that cut across industry lines. The impact of the introduction of computer-process control in six major industries, including steel and petroleum refining, was one of the innovations examined.[2]

These studies of major innovations that affect a number of industries are based primarily on intensive interviews with plant managers, technicians, affected employees, union officials, and others.

Major findings

The pace of introduction of new technology appears to be increasing in many industries as these industries modernize to reduce costs and compete more effectively in domestic and overseas markets. Our research confirms the general perception that advanced electronic computers, robots, flexible manufacturing systems, CAD/CAM, and technologies to increase productivity in office tasks are being introduced more extensively in industries, such as steel, motor vehicle manufacturing, metalworking, and banking, to name a few.

However, as would be expected in an economy as large as that of the United States, the pace of change varies by industry. It also varies among plants within an industry—not all have the funds or the volume of business that would support the adoption of the latest technologies, which often are very costly. Moreover, each industry has its own story and it is not always in terms of robots, computers, and other advanced technologies that receive the most widespread attention by the media. Conventional changes, including materials handling mechanization, larger capacity equipment, and machines with faster speeds are often major developments with implications for productivity, employment, and job skills.

In general, relatively few employees have been laid off because of technological change. The introduction of new technology can be consistent with higher levels of employment and minimal displacement when the economy is strong. Moreover, investment in new technology generally takes place during periods of economic expansion when there is also growth in employment.

When computers were introduced for office data applications in the United States in the mid-1950's, predictions that large numbers of clerical and kindred workers would be displaced were voiced by some experts; and that job opportunities for millions of people, in what is one of the largest occupational employment categories, would be curtailed.

Yet, over the last three decades, employment of clerical workers has continued to increase. Table 1 shows the changes in employment by occupation for the United States, just in the last decade or so when the occupations affected would have been expected to diminish. Over the 14-year period, one-fourth of the employment growth in the United States was found among the professional, technical, and related workers. In addition to managers, administrators, and service workers, clerical workers were one of the broad occupational groups which experienced rapid growth in both absolute and relative terms.

However, significant declines in employment and in their share of total employment were found among operatives and private household workers. The decline among operatives (such as machine operators) was in part related to the depth of the 1981–82 recession when the number of jobs in durable manufacturing, where most operatives work, was lower than that in previous years. Subsequently, the recovery in durable manufacturing employment from 1982–86 has been accompanied by at least partial recovery in operative jobs. The recession probably also accounted, at least in part, for the slower-than-average growth among craftworkers, laborers, and transport operatives. The number of salesworkers increased during the 14-year period, but their share of employment changed very little.

Why did clerical employment increase and not decrease as predicted? First of all, normal growth in the volume of clerical work offset jobs eliminated by the computer. Sec-

Table 1. Employment by major occupational group, 1972–86

[Numbers in thousands]

Occupation	1972	1986	1972–86	
			Absolute change	Percent change
Total	82,153	109,597	27,444	+33.4
Professional, technical, and kindred [1]	11,538	18,532	6,994	+60.6
Managers and administrators [1]	8,081	11,385	3,304	+40.9
Salesworkers [2]	5,383	10,935	5,552	+103.1
Clerical and kindred workers [2]	14,329	20,055	5,726	+40.0
Craft and kindred workers	10,867	13,405	2,538	+23.4
Operatives, except transport	10,388	8,892	−1,496	−14.4
Transport operatives	3,223	3,583	360	+11.2
Laborers, except farm	4,242	4,685	443	+10.4
Farmers and farm laborers [3]	3,077	3,444	367	+11.9
Service workers, except household	9,584	13,699	4,115	+42.9
Private household workers	1,442	981	−461	−32.0

[1] To improve the comparability of these data, we include accountants with professional occupations rather than with managers for 1986.

[2] For 1986, cashiers are included with clerical workers rather than with salesworkers.

[3] The 1986 figures include forestry and fishery occupations.

NOTE: These data are from the Current Population Survey. The data are on a "person" concept and, therefore, count each individual only once, even if he or she is a multiple jobholder. The occupational classification in the household survey was changed in 1983 so that strictly comparable data are not available for 1983 forward.

ond, the introduction of computers made possible work that was previously impractical because it would have been too costly and time consuming. This is true in everyday-management functions where it is now possible to prepare reports and analyses that previously were deemed desirable but too costly. Thus, the computer extended the scope of activities for many industries, creating employment opportunities.

In addition, the computer led to job opportunities in new occupations such as systems analyst, programmer, keypunch operator, console operator, and tape librarian. New industries to manufacture the computer and its related equipment and furniture were formed, resulting in employment for many workers in all types of occupations. Today, thousands of workers also are employed in manufacturing robots, microelectronic devices, advanced communication equipment, and other technologies that are gaining prominence.

The generally favorable experience in the United States also results from the various mechanisms to minimize adverse effects on the employees. At firms contacted by BLS, techniques such as providing advance notice, retraining, and reassigning displaced employees to alternate jobs have been of major importance in easing the introduction of new technology.

The adverse impact of change also is mitigated by the relatively long period required before most new technologies are widely diffused throughout industry. Thus, time usually is available to plan work force changes, undertake training, and carry out related measures to maintain job security.

Industries that lead in the adoption of new technology generally are among those with above-average rates of productivity growth. Although the specific contribution of an innovation to productivity growth cannot be isolated from other factors and measured precisely, technology is widely regarded as a major source of productivity gains, with a reduction in unit labor requirements frequently associated with the introduction of robots, CAD/CAM, and other advanced innovations.

Between 1980 and 1985, output per employee hour increased at an average annual rate exceeding 5 percent in such industries as motor vehicle manufacturing and telephone communications—industries which have modernized facilities to boost efficiency. These rates were well above the 1 percent per year productivity growth recorded by the nonfarm business sector as a whole during the same period.

New technologies are helping to change the structure of occupations. Professional and technical workers, computer systems analysts, and programmers are examples of groups increasing in importance. In contrast, the industry technology studies and BLS projections to 1995 indicate that the growth rate of operatives and laborers is slowing, as advanced machine tools, robots, computer-process control, and advanced materials-handling systems increase output per employee in key tasks.

Moreover, the content of jobs is being modified by technological change. Although job titles frequently remain the same while innovation is taking place, over time, employers have less demand for manual dexterity, physical strength for materials handling, and for traditional craftsmanship. In the printing industry, for example, electronic composition methods have replaced longstanding craft skills, and employment of compositors and typesetters has declined sharply.

On the factory floor, manual tasks are being eliminated by computer-process control, advanced materials-handling equipment, and other innovations, with workers increasingly becoming monitors of highly mechanized production lines. The reduction in menial, repetitive tasks is welcomed, but the isolation and constant monitoring associated with advanced technology in some instances can create new stresses which require worker adjustment.

Measures have been undertaken to facilitate the orderly introduction of new technology. Advance notice to affected employees and training programs to provide employees with the skills required for new and modified jobs have cushioned the impact of change in plants studied by BLS. The extent to which these measures are successful varies, of course, and depends upon the nature and extent of change, the industry involved, and the climate of labor-management relations.

From BLS research, the following three measures emerge as important:

- *Provide advance notice to workers affected by the new technology.* Advance notice is essential to assist orderly changeover to new methods. It provides time for individuals and unions, if the facility is organized, to formulate plans and to weigh carefully alternative jobs or layoff arrangements. Many companies that install new technology explain to their employees the objectives for introducing an innovation and some potential impacts on the work force.

  Some companies make extensive efforts to announce early in the changeover that affected employees will continue to have a job with the firm, though not necessarily the one they occupied before the new technology was implemented. Advance notice lessens anxiety and resistance to change and can serve as a positive first step to a cooperative labor-management approach to maintaining job security.

- *Coordinate labor adjustment with technical planning.* This technique increases the likelihood that attrition can be used to reduce the labor force, thereby minimizing the hardship of sudden layoffs and the loss of skilled and productive employees. In a study of planning for changeover in the telephone industry (BLS Bulletin 1574), for

example, the telephone companies followed the practice of projecting their labor requirements a year or two in advance. Displacement was minimized by controlling the hiring of permanent employees, through the use of temporary employees, overtime, and related measures, and by estimating attrition rates. As another technique, some companies time the introduction of new technology to a period of business expansion to cushion the impact.

- *Provide employees with new skills associated with modern technology and retrain those displaced for other work.* Modern technology requires an increasing amount of training. With the computer and similar complex equipment, training is becoming more formal, continuous, and costly, but essential to keep the work force up-to-date and flexible. Making available training opportunities can diminish resistance to change and hasten the diffusion of new technology with minimum hardship.

  In the United States, substantial training in electronics and computer-related topics is provided in the private sector by business firms, labor unions, and educational institutions, including junior colleges. This training is provided both for those already in the labor force and for new entrants.

  Technological change has important implications for personnel management and collective bargaining, and it has been found that the introduction of computers, advanced machine tools, and other innovations requires additional measures to maintain job security. The BLS reports show that measures such as advance notice, retraining, and reassignment of affected employees have been successful in facilitating orderly change, suggesting that others planning to introduce new technology should consider the strategies in planning their changes.

Conclusions

Several conclusions emerge from the Bureau's research on changing technology. Employment in the United States has experienced and is expected to continue to undergo vast changes in its industrial and occupational structure. The pace of technological change varies considerably by industry and among plants within industries. In most industries studied, technological change displaces few workers when introduced, but is more likely to create dislocations involving transfer of employees to alternate jobs. The analyzed changes in technology show professional and technical occupations increasing, at least in part because of new technology, while operative, laborer, and other lower skilled jobs decline—at least relatively—with the advent of new technology.

The Bureau of Labor Statistics still projects clerical occupations in total to grow at about the same rate as total employment because the shifts in the distribution of demand away from goods production to services—where a larger share of employment is clerical—is expected to enhance the growth of clerical occupations. Some occupations associated with durable-goods industries are declining because of changes expected in technology or shifts in demand.

In many ways, however, the future may be as the past. Professional and technical occupations are projected to grow absolutely and relatively, in part because of changes expected in technology. Demand for lower skilled occupations—laborers, operatives, and farmworkers are projected to decline as both changes in technology and the distribution of demand work toward reducing requirements for jobs in these occupational groups.

Our tentative conclusion from these observations is that changing technology is not incompatible with employment growth. In the short run, dislocations take place, but these are associated as often with changing consumer preferences or governmental priorities or shifts from domestic to foreign producers as with the introduction of new technologies. Although, in many instances, some of the demand shifts may be the result of technology, they are generally slower than expected.

Still, the pace of technology needs to be kept in perspective. For example, even with 25 years of rapid growth in computers, there were, in 1980, still more hand bookkeepers in the United States than all workers of the computer-related occupations combined. □

——*FOOTNOTES*——

[1] The 35 reports are published in a series of 8 BLS Bulletins. The two recent bulletins, published in 1986, contain reports for the following industries: lumber and wood products, footwear, hydraulic cement, and wholesale trade in *Technology and Labor Developments in Four Industries* (BLS Bulletin 2236), and tires, aluminum, aerospace,, and banking in *Technology and its Impact on Labor in Four Industries* (BLS Bulletin 2242). See BLS Report 722, *BLS Publications on Productivity and Technology,* for a complete listing of the other 27 reports available in this series.

[2] *Outlook for Computer Process Control* (BLS Bulletin 1658).