One microprocessor has replaced 936 moving parts—but how many jobs?

Microelectronics in the World Economy

BY COLIN NORMAN

Fears of massive unemployment have greeted technological changes ever since the Industrial Revolution. Far from destroying jobs, however, rapid technological advance generally has created many new ones. In the quarter-century following World War II, for example, the industrial economies were flooded with new technologies, while unemployment shrank to exceptionally low levels. Yet there is good reason to take seriously the recent outpouring of concern that microelectronic technologies will have a fundamental impact on both the numbers and types of jobs in the industrial world in the coming decades.

Central to this concern is the pervasiveness of microelectronics. The microelectronic revolution could affect employment in enterprises ranging from steelworks to banks, since no technology in history has had such a broad range of potential applications in the workplace. For another thing, goods that incorporate microelectronic devices generally require significantly less labor to produce than the goods they replace, a fact that extends the employment implications of the technology well beyond its direct impacts on automation. And a third cause of apprehension is the speed with which the technology is advancing. Although microelectronic controls will not sweep through the industrial world overnight, most experts expect them to be firmly established in production processes, products, and daily activities over the next two decades.

Set against these concerns, however, is the fact that microelectronic technologies hold the promise of increased productivity over a broad range of industrial enterprises. In theory this should lead to enhanced economic growth, which in turn will translate into new jobs. That, in essence, is how technological change has operated to increase employment in the industrial world—at least until the mid-'70s. Put crudely, the extra production made possible by technological changes coincided with rising wealth and increased demand for manufactured goods and services, a combination that led to high rates of economic growth and near-full employment. But there are good reasons why those historical trends may not provide a reliable guide to the future. Both the hopes and the concerns for microelectronics must be seen in the light of other economic forces and in the context of deep structural changes that have been taking place in the industrial labor force over the past few decades.

"JOBLESS GROWTH"

As is well known, a combination of technological changes and economic and social pressures led to a sharp reduction in the developed world's agricultural work force over the past half-century. In every major Western industrial country the agricultural labor force now represents less than 10 per cent of the working population; in the United States and Britain the proportion is below 4 per cent. While the number of agricultural workers has decreased, however, output has risen substantially in general—a phenomenon that has been dubbed "jobless growth." Now there are indications that in many parts of the world jobless growth is occurring in manufacturing industries as well.

According to studies by Britain's Science Policy Research Unit, employment in manufacturing industries in most Western industrial countries rose steadily in the '50s, began to tail off in the '60s, and declined in the '70s. At the same time, output, while fluctuating in tune with recessions, has increased. "The phenomenon of jobless growth has now become established in the goods producing sectors of the advanced industrial countries caused mainly through technological change," the study suggests. Underlying this trend is the fact that investment in new production technologies has sought largely to rationalize and streamline production processes rather than to expand output at a time of depressed demand and high wage rates. This was especially true of investments in new automobile manufacturing technologies in Britain and the United States during the late '70s.

While these job and investment patterns have been developing, employment in the tertiary sector of the economy—finance, insurance, government, services, and so on—has been expanding rapidly (Table 1). In the United States, for example, 92 per cent of the new jobs created between 1966 and 1973 were in this sector, and in every major industrial country the tertiary sector now accounts for at least half the labor force. It is important to note that it is the productivity increases in the manufacturing industries that have themselves created the economic growth that in turn led to the increased demand for the services of the tertiary sector.

Colin Norman, a Senior Researcher at Worldwatch Institute, Washington, D.C., is author of a forthcoming book on technology and society, The God That Limped.

This transition from agriculture to industry, and more recently to tertiary sector employment, has not been smooth or even. Some industries have continued to expand their employment, while others, such as steel and textiles, have contracted. Within the service sector, too, growth rates have been highly uneven, with sharp increases in government employment in most countries and steady gains until recently in banking, insurance, and similar occupations.

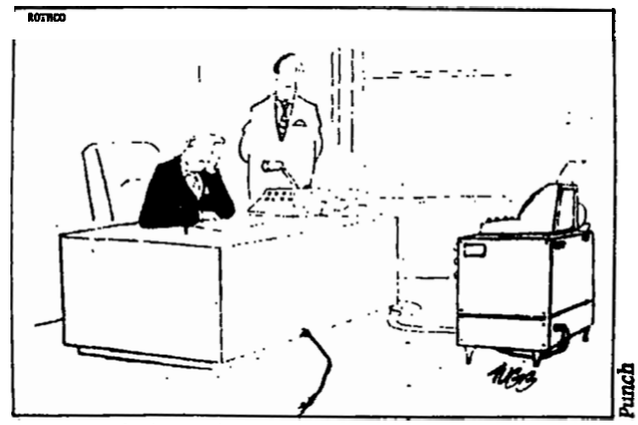
During the '70s the sharp rises in energy prices, the high rates of inflation, and slow rates of productivity growth have had deep and very obvious impacts on levels of employment. At the end of the decade, unemployment stood at more than six million in Europe, about 6 per cent of the American work force was out of a job, and even in Japan, where lifetime employment guarantees are common, the official unemployment total reached one million. These high totals are due in part to policies designed to dampen demand and bring down rates of inflation. Yet a return to high levels of demand for the products of some labor-intensive industries, such as steel and shipbuilding, is considered unlikely even if inflationary pressures moderate, because the market for these products is reaching saturation. It is against this background that the microelectronic revolution must be assessed. Since the technology is less than a decade old, it is impossible to draw conclusions about the specific impact on job levels. But there is already sufficient experience to reach some general conclusions.

THOSE AFFECTED

First, it is clear that microelectronic technologies will create jobs in those industries manufacturing novel electronic products. The $4 billion now being lavished on electronic watches, calculators, games, and other microelectronic products has spawned a whole industry that did not even exist a decade ago. According to a projection by the American consulting firm Arthur D. Little, the manufacture of these items, together with computers and other electronic equipment, could create about a million new jobs between 1977 and 1987 in the United States and Western Europe combined. About 1.5 million people are now employed in the electronics industry in the U.S.

But these jobs will not represent net additions to the work force, for they will be offset to some extent by job losses in the manufacture of goods with which the new microelectronics-based products are competing. The Swiss watch industry, for example, lost 46,000 jobs in the '70s as customers switched in droves from mechanical timepieces to electronic watches made in the United States and Japan. Seventeen Swiss watch manufacturers went bankrupt in this period. Moreover, as manufacturers replace mechanical or electromechanical devices with microelectronic ones in their products, their labor requirements often plummet. The reason is that one tiny piece of microelectronic circuitry can substitute for hundreds of moving parts, which eliminates not only the labor required to make those parts but the labor involved in assembling them as well. An electronic telex machine manufactured by the West German company Standard Electric Lorenz, for example, has one microprocessor to replace 936 moving parts; its manufacture requires only about eighteen hours, compared with seventy-five for an electromechanical one.

The European Trade Union Institute, which has surveyed the job losses reported in companies that have recently begun to manufacture microprocessor-controlled goods in place of older equipment, found a substantial reduction in labor requirements. Among the firms most affected are the manufacturers of cash registers. The U.S.-based National Cash Register (NCR) company noted in its 1975 annual report, for example, that an electronic cash register requires only 25 per cent as much labor to produce as its mechanical or electromechanical counterpart. As a result, NCR reduced its work force in the United States from 37,000 to 18,000 between 1970 and 1975, the West German branch of NCR shed 3,800 workers between 1974 and 1977, and employment in the firm's Dundee plant in Scotland dropped from 3,000 in 1975 to 1,000 in 1978. Manufacturers of telecommunications equipment are similarly affected. Telecommunications Ericsson in Sweden reduced its work force from 15,000 to 10,000 between 1975 and 1978, and employment in telecommunications manufacturing in Britain dropped from 88,000 to 65,000 during the same period.



"... I find myself sitting here waiting for it to cross its legs ..."

A committee of the Organisation for Economic Cooperation and Development, studying the relationship between technological change and economic growth, has reached similar conclusions about the employment impact of the change from mechanically controlled products to those based on microelectronics. The committee surveyed the plans of major electronics corporations and found that few of them expected to increase employment over the next few years. "Electronics has dramatic growth prospects ahead in the next decade. If this industry expects to achieve such growth with little or no increase in employment," the committee noted, "then the question may be asked where in the manufacturing sector is...growth in employment to come?"

Many of the industries that traditionally have been leading employers, such as those producing automobiles, chemicals, appliances, and so on, are likely to incorporate microprocessors and small computers into production processes to improve efficiency and productivity. Already the introduction of robot welders in

Table 1
Average Annual Growth in Employment in OECD Countries, 1965-75

Sector	*1965-70*	*1970-75*
	(per cent)	
Agriculture	−.5	−.5
Industry	.4	−.1
Tertiary	1.2	1.3
Total Civilian Employment	1.1	.8

Source: Organisation for Economic Co-operation and Development, *Medium Term Strategy*.

Table 2
Annual Change in Employment in Banking and Insurance in Five European Countries, 1964-77

Country	*1964-74*	*1974-77*
	(per cent)	
Belgium	10.2	.7
Denmark	6.1	.7
France	6.3	3.1
United Kingdom	3.3	.6
West Germany	3.7	−1.9

Source: European Economic Commission.

automobile assembly has resulted in sharp reductions in jobs and consequent increases in productivity in a few plants. According to one study, the General Motors plant in Lordstown, Ohio, boosted production by 20 per cent but reduced its work force by 10 per cent after the introduction of robot welding machines. New automation technologies, including computer-controlled welding machines, in BL Ltd.'s Longbridge plant in England are expected to raise productivity from the former level of sixteen cars per worker per year to twenty-three by late 1980 and ultimately to thirty-two. That would bring their productivity close to that which prevails in Japan's highly automated plants. And such machines are not limited to heavy, dangerous tasks: A microprocessor-controlled machine has been developed for screwing light bulbs into the instrument panels of General Motors cars.

A well-publicized area in which electronic technologies have taken a toll in blue-collar jobs is the printing industry. In West Germany, for example, employment among printers dropped by 21.3 per cent between 1970 and 1977, while productivity per hour rose by 43.5 per cent. Many American newspapers have also gone over to computerized typesetting in the past few years and have seen sharp boosts in the productivity of their print workers. The *New York Times*, for example, reduced its printing staff by 300 in 1978, when it introduced the new technology, and the Rhode Island *Journal Bulletin* decreased the number of workers in its composing room from 242 in 1970 to 98 in 1978, a figure that is scheduled to drop to 54 in 1980.

This level of job loss will not be felt in every manufacturing industry, but the potential range of microprocessor-based automation is broad indeed. A study by the National Electronics Council in Britain suggests that the industries most ripe for automation by computers include metal and plastic fabrication, instrument engineering, electrical engineering, shipbuilding and marine engineering, vehicles, electronic components and assembly, office machinery, aircraft, and printing and publishing.

The use of microprocessors in manufacturing industries will essentially intensify the jobless growth that has been taking place in industrial countries in recent years. The key question, therefore, is whether the number of jobs in the tertiary sector will continue to expand to absorb the projected growth in the labor force. There are two chief reasons why the answer could be negative. First, the number of jobs in government offices—an area of substantial employment growth in recent years—may not expand much more because of demands in virtually every country to reduce public expenditure and cut government payrolls. Second, most observers have predicted that the most far-reaching impacts of microprocessors will be felt in offices and in such service areas as retailing and maintenance work.

It should be noted that the use of computers and other intelligent machines will lead to increased employment in some areas. Computer programming, for example, is a labor-intensive activity that is a likely source of many thousands of new jobs in the '80s. Demand for programmers is already outstripping supply, and some analysts have even suggested that this shortage could constrain growth in the use of computers in the coming years. But in most other areas of the tertiary sector, microelectronics is likely to lead to slower rates of employment growth or even to job losses.

In areas such as insurance and banking, which are labor-intensive occupations that rely primarily on printed paper for their transactions, the application of electronic technology could have a major impact. Already, growth in employment in these industries in Europe has begun to tail off while their business continues to expand (Table 2). Some observers are therefore suggesting that the jobless growth apparent in agriculture and manufacturing is now visible in this sector.

The most widely publicized of such projections was made in a report to the president of France, warning that 30 per cent of the jobs in the French banking and insurance industries could disappear during the '80s as more and more work is consigned to computers. Such projections should not be treated lightly. Richard Matteis, a Citibank vice-president, describes how the company automated the handling of letters of credit using a variety of computer-controlled equipment and record storage: "Where it once took days, 30-odd separate processing steps, 14 people, and a variety of forms, tickets, and file folders to process a single letter of credit, it now requires one individual less than a day to receive, issue, and mail out a letter of credit—all via a terminal that is fully online to a minicomputer-based system."

The introduction of word processors, computers, and

other intelligent business machines will not always cause job losses. In many offices, the machines will be used to improve quality and upgrade services without displacing people. But several studies have suggested that the widespread use of these machines will ultimately lead to small job losses in large numbers of offices. A much quoted but as yet unpublished study by Siemens Corporation in West Germany, for example, has suggested that some 30 per cent of the office jobs in that country could be automated.

While it is difficult to determine just how many jobs will be lost or gained by the introduction of microelectronics, one study has drawn up estimates for specific industrial groups in Britain, concluding that over the next quarter-century almost a fourth of the jobs in the industries surveyed are likely to disappear. About 5 per cent of them would be lost by 1983. A more detailed examination of the probable impact of microelectronics on employment in an industrial region in Manchester, England, reached the conclusion that only about 2 per cent of the jobs in the area would be lost by 1990 as a direct result of the use of microelectronic technology in both products and processes. However, the authors of that study, which was conducted at the University of Manchester, warned that "it is in the 1990s that the job losses due to microelectronics will really make themselves felt."

THE FIRST TO GO

Microelectronics will affect not only the number of jobs in industrial countries, but also the types of jobs available. The early use of robots on assembly lines has largely been in dangerous, dirty, and difficult occupations that few people are lining up for. But as automation extends into design shops and machine rooms, highly skilled occupations could be affected. And, at the other end of the scale, the use of intelligent office machines and electronic information storage is likely to eliminate many filing and routine clerical jobs. Microelectronics thus has the potential to decrease skill requirements in some jobs and increase them in others. Moreover, if, as most experts are predicting, the chief impact of microelectronic technologies is felt in offices, women workers are the ones who will bear the brunt of the new technology.

Though the microelectronic revolution is likely to have a major impact on the numbers and types of jobs available in the industrial world over the next few decades, every expert who has studied the subject has reached the same conclusion: More jobs will be lost in those countries that do not pursue the technology vigorously than in those that do. Because microelectronics will enhance productivity so greatly, the industries that move swiftly to adopt the technology will have a competitive advantage in international markets. WV