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Impact of Electronics on Employment: Productivity and Displacement Effects

Arthur L. Robinson

Structural unemployment is the technical name for the loss of jobs when changing technology makes currently held skills obsolete. If the question asked is "What impact will advances in electronics have on structural unemployment?", the answer is "Very little," according to most government economists and industry executives.

Nonetheless, individual workers will continue to feel substantial and sometimes traumatic impacts, including the need to learn new skills for jobs with different responsibilities and the necessity of relocating to other plants or to other parts of the country. Not only will the requirements for some old talents disappear and new ones be created, but, somewhat contrary to intuition, the electronics "revolution" may also open up opportunities for the relatively unskilled. In fact, the upcoming labor force may be structured into large numbers of relatively unskilled workers at one end and highly trained managers and engineers at the other, with very few medium-skilled individuals in between. And, as technological change continues at a rapid rate, a pattern of lifelong education and multiple careers will replace the tradition of training for one lifetime vocation.

According to some observers, the changes to be brought about by solid state electronics will, in the final analysis, be comparable to Henry Ford's move from custom to mass production. Since the invention of the transistor, the electronics industry has undergone a profound transition, and the changes of the last 25 years exceed those of the preceding 75. Moreover, there may be social impacts that even now are not fully appreciated. Some of these impacts most likely will involve the kinds of jobs that people work at and how many persons are needed for those jobs. If speculation about the electronics-dominated society of tomorrow turns out to be anywhere near the mark, then the impact of advances in electronics on employment could dwarf earlier concerns about automation, such as those typical of the early 1960's.

Hard numbers reflecting the impact of advances in electronics on employment are for the most part unavailable, in part because the problem is not yet of interest to manpower economists. Says one manpower specialist, "Displacement due to changing technology is now only a small part of the total job deficit, but the situation could change in the next two years if the recovery from the recession is slow and if technological change and competition from overseas increase." Technological change is also extremely difficult to separate from other influences, thus making its study unsatisfying.

One effect that can be documented is the large growth in the number of workers making and using electronics technology in the form of computers and communcations equipments. Marc Porat of the Department of Commerce's Office of Telecommunications has chronicled the rise of what some are calling the information economy (*1*). Included in the information economy are all jobs that involve the manufacturing of information machines, and the production, processing, transmission, distribution, or selling of knowledge or information. Also included are various information activities of both public and private bureaucracies, such as managing, planning, monitoring, marketing, and coordinating.

Not every occupation in the information economy depends, either directly or indirectly, on the existence of electronics technology, but a substantial fraction does. Porat's data show that, about 1955, a rising percentage of information jobs surpassed a declining percentage of industrial jobs, and that information activities became the dominant sector in the U.S. economy. From about 1965, the now dominant information sector accounted for about 45 percent of all employment (Fig. 1). Furthermore, as computers and information machines made their appearances in the late 1950's, exacerbating the trend toward large bureaucracies that began to build up in private industry and in government in the years after World War II, the percentage of the total national income earned by those in information occupations rose to more than 53 percent (Fig. 2).

Porat thinks that these trends offer considerable solace to those fearful of job displacements from electronics. In his view, every new computer or information machine introduced in an office, for example, leads to many more jobs than it displaces: in a more complex environment people are needed to gather information for the machine to process and to interpret what it puts out. A scenario of this type does, however, imply a steadily growing bureaucracy, and Porat worries how long society can support an increasing number of less and less productive individuals.

A more conventional viewpoint is that increased productivity arising from technological innovation will, given a reasonably healthy economy, create an increased demand for labor and raise real wages (*2*). C. Lester Hogan, vice-chairman of Fairchild Camera and Instrument Corporation, the third largest producer of semiconductor devices in 1976, says

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bluntly, "Advancing technology never reduces employment in the long run."

John Kendrick, chief economist of the Department of Commerce, pretty much echoes these sentiments. Kendrick, who has made a career of following the effect of technological change on labor productivity, recently told an IBM-sponsored seminar on this subject that "there is a significant positive correlation between industry rates of change in productivity and in output. . . . Thus, despite temporary problems of labor displacement, it would appear that technologically progressive industries create more jobs on net balance than the backward industries which are more vulnerable to dynamic change" (*3*).

Jerome Mark, assistant commissioner for productivity and technology of the Department of Labor's Bureau of Labor Statistics, explains why this might be so. Over all industries in the United States, there has been a relatively small spread in the hourly wage increases granted to labor, but there has been a much larger range in the growth of productivity. Thus, prices of goods are much more sensitive to productivity than to wages, and an edge in labor costs goes to the industry with the better growth in productivity. Reduced costs lead to more sales and ultimately more employment. Kendrick told *Science* that, far from causing displacements, technological change may even be having a smaller inpact than it did 15 years ago because of a reduced research and development investment that has caused the rate of productivity increase to decline in the United States. Productivity advance is now lower in the United States than in some European countries and Japan, according to a recent article by economist Lester Thurow of the Massachusetts Institute of Technology (*4*).

The electronics industry has been on the front line of those feeling the effects of technological change, as well as being the source of the changes that affect the rest of the economy. It is perhaps also an exemplar of the innovation-increased productivity-lower costs-increased sales-more jobs scenario. During the period from 1960 to 1976, for example, about 664,000 jobs were added to electronics out of a total of 2,130,000 new jobs in all manufacturing industries, according to statistics provided by L. M. Rice, Jr., a vice president at Texas Instruments, the largest U.S. semiconductor device producer.

Most spectacular of all has been the rise of the U.S. semiconductor industry. From its beginnings in the early 1950's, the industry mushroomed to sales of about $520 million in 1961 (the era of the discrete transistor) and to 1976 sales of about $2.4 billion (the era of the integrated circuit). The worldwide industry (excluding the Communist bloc) sales were about $5.4 billion (see Fig. 3).

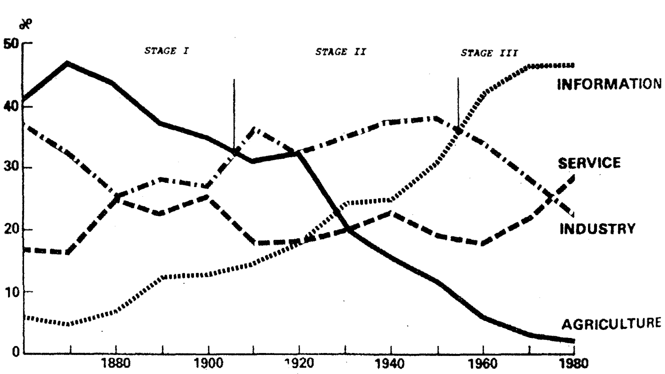
In 1961, between 10,000 and 15,000 employees produced about 520 million devices, nearly all of which were discrete transistors, diodes, and the like. By 1976, about 120,000 workers made a total of about 6 billion devices. (A device could be a discrete transistor or a complex integrated circuit containing 20,000 transistors; but, on the average, according to Fairchild's Hogan, who supplied the figures, a device contained about 50 transistors.) Thus, while the average labor productivity measured in devices per employee did not change greatly, measured in transistors per employee, the average labor productivity skyrocketed. And the increased sales stimulated by the resulting lower cost was the foundation for the more than a tenfold increase in employment during those 15 years.

At Fairchild, experience with manufacturing silicon diodes provides another perspective of the effect of productivity. In 1966, Fairchild sold $87 million worth of these devices with about 200 employees to make them. By 1976, sales had decreased somewhat—to $50 million; but the number of employees had increased slightly to 225. The startling statistic is that the number of labor hours required to manufacture 1000 diodes had decreased by a factor of 10. Therefore, the increased productivity had stimulated sales to about 10 times the number of diodes sold previously. In this instance, however, increased productivity did not greatly increase the level of employment, but did perhaps postpone the demise of a device that is being supplanted by other types.

Not everyone is quite so euphoric. One who is not is J. A. Haddad, vice president for engineering programming and technology at IBM. Haddad feels that careful and detailed econometric studies are necessary before expansive projections become anything other than speculation. The IBM executive points to two examples, one of which vividly backs up the productivity and growth argument and one of which does not.

In the former category is the well-trod example of the hand-held calculator, which was made possible by the development of inexpensive but computationally powerful general purpose integrated circuits. While makers of slide rules may have taken a beating, relatively few persons ever bought slide rules in the first place. The hand-held calculator, on the other hand, has so caught the public fancy that practically "every kid has one now." The volume of calculators produced has probably more than made up for the number of displaced slide rule manufacturers and their employees.

Digital watches are a different story. Mechanical watches were already pervasive among all groups of society and



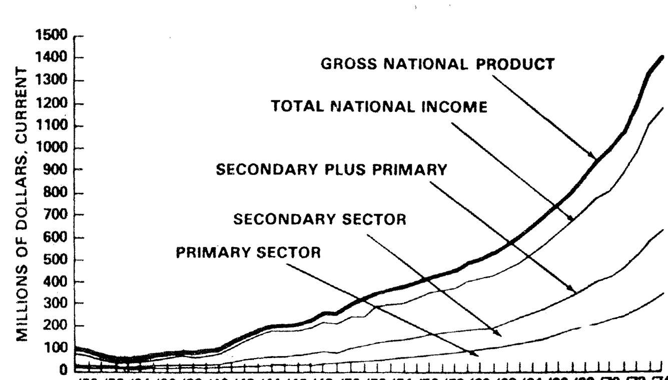


Fig. 1 (left). Changing composition of U.S. work force by percent from 1860 to 1980. Stage I is a primarily agricultural economy; stage II is an industrial economy; and stage III is the information economy. Fig. 2 (right). Portion of total national income originating in the information sector, 1929 to 1974. The information sector comprises a primary (manufacturing, information producing, information processing and transmission, and information selling) sector and a secondary (information services produced and consumed internally by industries and government) sector. [Source: M. U. Porat, Office of Telecommunications] probably not that many people own more than one or two. Since relatively few man hours are needed to make a first-class digital watch, Haddad guesses that the net effect of electronics in this case may be to decrease employment.

A concern of many nowadays, including Haddad, involves the question of how much longer society can continue to rely on unlimited economic growth. "Sooner or later, continuing economic growth will no longer be sustainable because of dwindling natural resources and supplies of energy," Haddad insists. "We will be as big as we can get." At this point, the question will be one of finding how to improve the standard of living without further growth. Other industry executives would counter Haddad's argument by saying that they never meant that growth is the same as increasing consumption. Says William Hittinger, executive vice president for research and engineering at RCA, it is a matter of "growth by new concepts, not just consuming more."

Whatever the outcome of debates about economic growth, it is clear that within the electronics industry, changing technology has already effected major changes in employment of a qualitative nature in addition to the quantitative one already discussed. From a different viewpoint, RCA's Hittinger restated some of Porat's conclusions about technology leading to increased bureaucratic activities. According to the RCA research director, solid state technology of all types, not just silicon integrated circuit technology, has caused an expanding demand for people of many backgrounds and skills.

After World War II when vacuum tubes were still the dominant active devices, electronics companies mainly provided an off-the-shelf, catalog service for discrete devices that other companies used to build their products, and most employees had physical science backgrounds. Today there is a full spectrum of practitioners of basic sciences (physics, chemistry, metallurgy) and applied sciences (electrical and mechanical engineering, statistics), and there is, as well, a great demand for the "softer" sciences (sociology, economics).

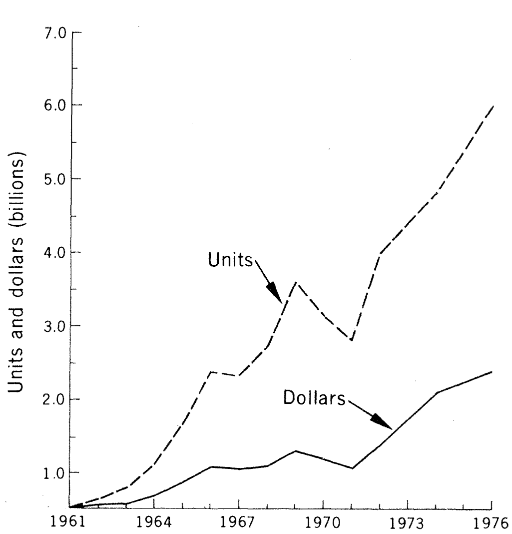
The need for the softer science practitioners has arisen because semiconductor houses are now marketing products and systems of their own, and must therefore engage in such market research activities as demographics, consumer preference testing, and input-output studies. If your company's microprocessor is the essential ingredient of a pocket calculator, why sell the microprocessor to someone else to package? Sell the complete product yourself.

There has also been change within the manufacturing divisions of semiconductor companies, as the transition from discrete devices to integrated circuits transpired. Hollis Caswell, director of applied research at IBM's Yorktown Heights laboratory, describes some of these changes. Fifteen years ago, an engineer designed a silicon transistor with a slide rule (chose the vertical dimensions, the specific impurities and their doping levels, and the geometry needed to give the desired characteristics); he had the transistor fabricated; and he tested it. He could do this and not be overly concerned with the interactions of the transistor with other discrete components of his circuit.

Now with silicon integrated circuit technology, building individual transistors and designing logic or memory circuits merge into the same task. Furthermore, the engineer will design the circuit with the help of a computer with which he can interact by way of a light pen and a cathode ray tube display. He will simulate the circuit performance on the computer, a process known as software bread-boarding, in contrast to the previous practice of wiring transistors together into a circuit to see how the assembly worked.

Similarly, the process of making the series of masks used in the integrated circuit fabrication process has been computerized. Where once the engineer would actually draw patterns on a piece of paper, the patterns being photographically reduced after being manually transferred to a suitable working material, today the engineer and his interactive computer can bypass much of the manual labor. In fact, according to Hogan at Fairchild, much of the work can be carried out by technicians trained to use the computer once the basic logic design for the circuit has been worked out.

As does IBM, the Western Electric Company, which is the manufacturing arm of the Bell System, itself makes a substantial fraction of the electronic devices needed for its products: telephones, switching machines for branch and for long distance (toll) offices, and other equipment. The pervasiveness of advanced electronics in the telephone system was the subject of a recent speech to Bell Laboratories officials by Joseph West, vice president and chief operating officer of Western Electric. The theme of West's presentation was that, although advancing technology is the lifeblood of the Bell System, it is not



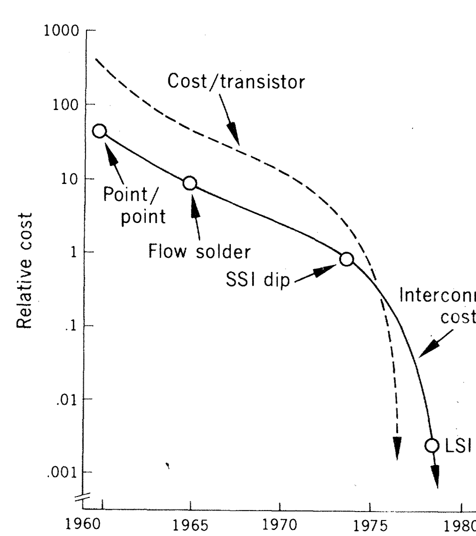


Fig. 3 (left). Semiconductor industry sales by year for the period 1961 through 1976. A unit is the semiconductor device defined in the text. Over the period graphed, the average price per unit sold declined from $1.00 to about $0.32. Since the average number of transistors per unit increased from 1 to about 50, the cost per transistor plummeted by a factor of 150. [Source: C. L. Hogan, Fairchild Camera and Instrument Corporation] Fig. 4 (right). Cost trends of transistors and interconnections at Western Electric. Point/point refers to connecting discrete transistors on a panel. Flow solder refers to connecting a transistor into a circuit on a printed circuit board. SSI dip refers to an estimated cost for the interconnection between transistors in an early small-scale integrated circuit. LSI chip refers to the same cost for a contemporary large-scale integrated circuit. [Source: J. T. West, Western Electric Company]

Table 1. Impact of changing technology upon the Switching Division of the Western Electric Company. [Source: Western Electric Company]

Year	Employees at year end		Switching lines shipped	
	Total corporation	Switching division	ESS	Total
1962	144,874	26,962	1,000	2,723,100
1963	141,468		5,000	2,734,100
1970	178,000	39,000	1,728,000	5,400,000
1975	147,651		3,386,000	4,358,200
1976	144,123	27,172	4,683,000	5,473,000

without certain problems for those managing its implementation.

Western Electric experience with the transition from discrete semiconductor devices to integrated circuits has paralleled that of the semiconductor industry. But because Western Electric is primarily concerned with the manufacture of end products, there have been other effects. The manufacturing of devices, for example, has taken on a substantial portion of the manufacturing effort that was formerly carried out in the final assembly operation. This has occurred because so much of the circuit interconnections are incorporated as an essential part of the integrated circuits now being manufactured. Thus, says West, "where historically the task of interconnecting circuit elements has been very labor intensive, as we move more and more into large-scale integration, we see an interconnect cost trend which closely tracks that of the cost per equivalent transistor" (Fig. 4).

Switching machines to route telephone calls through branch exchanges and long distance toll offices are a major product of Western Electric and indeed are central to the telephone business. They also provide some excellent illustrations of the impacts of technology. Shown in Table 1 are some statistics for production and employment in Western Electric's Switching Division over the last 15 years.

At the start of this period, the dominant switching technology was an electromechanical one generally known as crossbar. In 1962, the first all-electronic switches were manufactured under the appellation ESS. The most recent versions of ESS make extensive use of integrated circuitry and are heavily computerized—that is, their functions are determined by stored programs rather than by fixed or "hard-wired" circuits.

West told the Bell Laboratories officials, "An unglamorous way of describing your new designs in manufacturing terms is to point out that you have designed for us a switching machine that in terms of lines switched weighs one-sixth as much as [crossbar], has one-fifth the connections, takes one-third the floor space to make, and somewhat surprisingly, takes one-third the capital and substantially less installation and engineering. Direct impact can be seen on Western's need for wiremen—installers—standards engineers."

But the impact on Western Electric's need for switching division employees has been more qualitative than quantitative. Twenty-five years ago, according to Western Electric officials, a typical communications equipment factory comprised three categories of operations: (i) materials working using punch presses, molding presses, and automatic screw machines; (ii) apparatus assembly and adjusting; and (iii) equipment assembly, wiring, and testing. Cable forming and manufacture of vacuum tubes also were part of the factory.

Nonetheless, displacement effects due to the changeover to integrated circuit technology with more chemically based processes and more computer aided processes were not large. From 1962 to 1976, the number of workers there did not change greatly; indeed total Western Electric employment did not change much, but the total number of switching lines doubled. Furthermore, a projection further into the future reveals that the demand for switching lines may continue to rise but without a need for additional division employees.

As compared to switching division employment in 1970, the lower numbers of employees in 1976 would seem to indicate dramatic displacement effects. But for various reasons company officials regard employment that year as anomalously high. Also to be borne in mind is that not all division employees are directly involved in manufacturing switches.

That the qualitative nature of jobs will change with different skills, different levels of training, and different responsibilities being involved has other repercussions. In addition to a 44 percent decrease in employment in the Switching Division between 1970 and 1976, there was, according to Western Electric officials, a marked shift in the distribution of personnel over grade levels. Where once there had been a smooth distribution in hourly skills, gradually decreasing in numbers at higher skill levels, now the curve shows two pronounced peaks. The first occurs at high grade levels and reflects the need for highly trained testers and analysts. The second peak occurs at the lower end of the range of skills. A rather large valley corresponding to decreased requirements for middle level skills rests between the two peaks (Fig. 5, a and b).

At IBM, Haddad, who more or less seconds this perception, points out that the thrust of technological advance is generally to "take out the middle." Sophisticated levels of training are needed to design and less training is needed to "make things happen." Haddad philosophizes that this trend is part of an overall drift in society that is taking away from the concept of the whole, self-sufficient man. Everyone, whatever the skill and level of training, is becoming more interdependent.

Most of the individuals who will feel the impact of the advances in electronics, no doubt, do not work for the semiconductor industry nor for companies like IBM and Western Electric. Thus, the effects of electronics on employment in these industries may not be entirely representative; they just happen to be the easiest to document for the present. One example, possibly more representative, resides in the experience of the operating telephone companies, those which use the switching equipment manufactured by Western Electric. The data in Table 2 show that the introduction of the all electronic switching equipment in long distance toll offices is estimated to have reduced the need for administration and maintenance people to from less than one-half to less than one-third, depending on the size of the office. The reduction is due in part to the availability of computerized diagnostic and testing systems for use in administration and maintenance. Where once an administrator was needed to order maintenance work after detection of a malfunction, now detection and decision-making can be done electronically.

The mail (*5*), banking (*6*), offices (*7*), schools (*8*), factories (*9*), and communications industries (*10*) are some of the places where electronics will change employment patterns both qualitatively and quantitatively, although in most cases the impact is as yet more speculation than fact.

At the Bureau of Labor Statistics,

however, two studies were made in the early 1970's of the effects of computerization, one on electronic data processing machine makers and users (*11*) and one on process control in factories (*12*). According to Mark at the bureau, there was no dramatic evidence for widespread displacements in either area, although both studies were completed before minicomputers had become as pervasive as they are now. Mark did, however, support the observations made at Western Electric and IBM as to the changing distribution of skills needed. He added the further observation that the grade levels comprising the lower peak of the distribution approximately corresponded to semiskilled, not unskilled, personnel. In addition, there was some demand for mid-level skills in the form of repair and maintenance people.

Martin Ernst of Arthur D. Little, Inc., thinks that retail store automation systems will be among the first to have significant employment effects. Point-of-sale terminals in retail and grocery stores have the potential of enabling automatic checkout and inventory management with the consequent lessening need of labor for these functions. Connection of terminals in stores directly to computers in banks and other financial institutions and of computers in financial institutions to one another may also lead to a less cash-oriented society with less need for persons to process financial paperwork. Ernst guesses, however, that what personnel reductions do occur will be by attrition—failure to rehire—rather than by firing or layoffs.

The United States Postal Service is another likely candidate for large-scale impact by electronics. With about 650,000 employees, the Postal Service is the third largest nongovernment employer in the United States. Currently, it is in big trouble, as rising costs and decreasing revenues are leading to larger and larger deficits ($1.2 billion in fiscal year 1976) and the prospect of poorer and poorer service. (Surpluses in the second half of 1976 are regarded as unreliable indicators of the long-term situation.) Both the public and the U.S. Congress, which supports the mail organization with subsidies, are screaming for change. At present a congressionally established Postal Service Commission is feverishly putting together a set of recommendations on what should be done; its report is due by the end of the month.

One of the reasons for decreased revenues—a reason that most likely will become ever more important if postal service declines further—is that electronic technologies are permitting users to find alternative ways to send first class mail. Electronic transmission of messages, electronic transmission of funds, and data transmission systems will soon be able to service most of the needs of commerce; and business mail accounts for 74 percent of the nation's letter mail. A just completed National Research Council study on electronic message systems for the U.S. Postal Service estimated "as much as 30 percent of all government and business mail may be amenable to transmissions as electronic messages" (*13*).

Table 2. Estimated impact of changing technology on the operating telephone companies of the Bell System. [Source: Western Electric Company]

Type office	Administration and maintenance people required	
	ESS	Crossbar
Small toll (20,000 trunks)	32	68
Large toll (100,000 trunks)	60	200

Interestingly enough, in the Postal Service's 6-year life, this is the fifth report recommending the adoption of electronic message transmission by the Postal Service (a sixth is still under way), yet practically no planning in this direction has begun. In this case, even the labor unions are clamoring for the Postal Service to adopt electronics technology. J. Joseph Vacca, president-elect of the 230,000-member National Association of Letter Carriers testified to the Commission on Postal Service that "I am firmly convinced, though that if we do not soon become . . . comfortable with the language of Electronic Message, Fund and Data Transmission, we will be literally out of business" (*14*).

Vyra Imondi, director of electronics communications studies on the commission, points out that approximately half of the current Postal Service employees will be eligible for retirement in the next

Fig. 5. (Top) An assembly line for crossbar switches at Western Electric's Oklahoma City plant. The assembly line typified the electromechanical crossbar technology of 15 years ago. (Bottom) Assembly area of Oklahoma City plant today. The operation illustrated is the wiring of grids on multilayer printed circuit boards. [Source: Western Electric Company]

10 years. If the Postal Service adopts the new technology, many will be hired with new skills to fill in for those retiring. But the failure to adopt electronic mail technology made possible by advancing electronics could be the driving force for the further deterioration of postal service and the concomitant loss of jobs.

From the point of view of the individual who is impacted by advancing electronics technology, the most immediate questions are personal. Will I lose my job? What provisions are there for me to retrain into another job in the company? Will I be transferred to another location? To the individual faced with these and other uncertainties, euphoric pronouncements about productivity, multiplier effects on employment, better standards of living, and the like, are pretty irrelevant.

Economists and some industry executives view the problem as one easily solved by retraining. Says the Office of Telecommunication's Porat, "Displacements are important to economists only if people are not retrainable and if phasing out of occupations is not anticipated. One wants labor resources to shift as soon as possible because it is inefficient for them to be idle." Furthermore, the very technology that may cause temporary displacements can be used to ameliorate their effects. For example, two-way computer aided instruction sent into the home or neighborhood learning centers by way of satellites or broadband cables could be one vehicle for retraining. Porat underscores the desirability of the now developing enthusiasm for lifelong learning as being especially important for times of low population growth, when lateral mobility will be the major kind.

Retraining has become a big business at Western Electric. In the next several years, the company will put into service some 800 electronic switching systems. About 20 percent of the company's installation efforts are now in this area, but this figure will increase as more telephone systems become all-electronic. In former years, Western Electric would generally not retrain installers experienced in electromechanical technology, but would start from scratch by training new personnel. Now, as crossbar demand slackens, the company has a near-crash program under way to retrain electromechanical people to proficiency in ESS installation. Since 1975, about 1000 such people have received some ESS instruction (*15*).

Widespread retraining is not always needed. Says a company official, "Displacement effects in the Switching Division were small because attrition was such in the crossbar operations that limited hiring was required to maintain a crossbar work force" in the 1960's. Retraining was necessary, however, to "develop electronics diagnostic capabilities in the testers. This was accomplished in a number of ways, including in-hours classroom training, after-hours company sponsored schools and on-the-job training."

Priding itself on not having to lay off employees, IBM also has extensive retraining programs. But, points out Caswell, "of those having skills needed 15 years ago but no longer needed, many are retrained into sales, sales support, and service jobs, not other manufacturing jobs." Haddad observes that retraining is very effective, but its usefulness varies with skill level. People with Ph.D.'s are generally flexible and can do many jobs from the start, so retraining needs are minimal. On the other end of skill curve, retraining is very effective because there is not that much skill to be learned. Even unskilled people off the street can be quickly trained for many electronics manufacturing jobs. It is the mid-level people who are hardest to change. A person with a lifetime devoted to mechanical skills just does not pick up electronics the way a younger person raised in the era of calculators does, according to the IBM executive.

For precisely this reason, as well as for many others, labor union officials do not regard retraining as the panacea for all displacement due to technological change. According to Markely Roberts, an economist in the department of research of the AFL-CIO, there is "no single solution, but a whole variety of approaches. Which is best depends on the industry and the quality of the labor-management relationship." Roberts has summarized some of the possible strategies for dealing with displacement effects (*16*). In addition to retraining, he included prior notice, attrition, seniority rights, early retirement, transfer and relocation rights, and severance pay as possible mechanisms to cushion labor from the effects of change. In all cases, the labor philosophy is that the companies should regard the costs of cushioning labor as one of the expenses of introducing new technology, and these costs should be just as important in deciding upon the economic viability of new technology as any other. Roberts concluded, however, that the best protection for labor resided in a full employment economy.

Another tactic will be tried by the Communications Workers of America in its upcoming negotiations with the American Telephone and Telegraph Company (AT&T). Since 1974, AT&T has reduced its work force by almost 100,000 to a current total of about 900,000 employees. The communications workers want the Bell System to spread the available work by reducing each person's work hours without a cut in pay (*17*).

Few of those who ought to be concerned with the effect of electronics on employment seem to think of it as other than one more step in the evolution of technology. Such phenomena as the rise of bureaucracies, simultaneously made necessary and possible by communications technology, and the lumping of worker skills at the ends of what was once a smooth distribution would seem to indicate that more than evolution is going on. The evolution not revolution viewpoint may well be correct, but if it is wrong, a long line of unemployed may find themselves with the wrong skills for the wrong job.

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