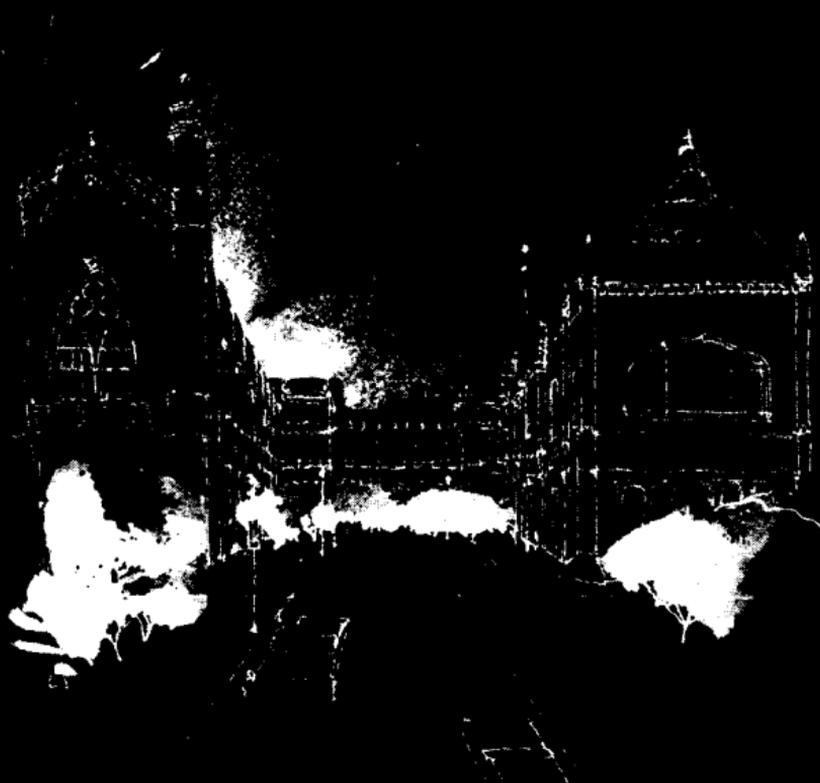


Selected Papers • No. 18

Automation and Jobs

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Automation

and Jobs

At the accession of George III (1760), the manufacture of cotton supported hardly more than 40,000 persons; but since machines have been invented by means of which one worker can produce as much yarn as 200 or 300 persons could at that time, and one person can print as much material as could 100 persons at that time, 1,500,000 or 37 times as many as formerly can now earn their bread. . . .

And yet there are still many, even scholars and members of Parliament, who are so ignorant or so blinded by prejudice as to raise a pathetic lament over the increase and spread of the manufacturing system . . . there are persons who regard it as a great disaster when they hear that 150,000 persons in our spinning works now produce as much yarn as could hardly be spun with the little handwheel by 40,000,000.

These people appear to cherish the absurd opinion that if there were no machines, manufacture would really give employment to as many millions as now; nor do they reflect that the whole of Europe would be inadequate for all this work; and that in that case a fifth of the whole population would need to be occupied with cotton-spinning alone! Both experience and reflection teach us just the contrary; and we should certainly maintain that, if we still had to spin by the handwheel today, cotton manufacture would employ only a fifth of the present number.

From Edward Baines's *History of the Cotton Manufacture in Great Britain*, 1835.

THE MATHEMATICIAN who developed much of the logic underlying computer design predicted, in 1949, that we faced "a decade or more of ruin and despair." He forecast wholesale unemployment because automation, he felt, would abolish jobs on an unprecedented scale.¹ Despite his expectations, the number of people gainfully occupied in civilian pursuits increased from 59 million in 1949 to 63 million in 1955.

¹ Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society* (Boston: Houghton Mifflin Company, 1950), p. 189.

In 1955, a parade of witnesses testified before the Congressional Subcommittee on Automation that intolerable unemployment was in prospect unless automation was used wisely and well. Since 1955, the number of people with jobs has increased from 63 million to 71 million—a record number. In addition, four million people now hold second jobs—an increase of almost two million.

During this period in which the number of civilian job holders increased by twelve million and the number of jobs by 14 million—the period predicted to include “a decade or more of ruin and despair”—real wage rates and per capita income also increased. The average hourly income of factory workers in 1949 was \$1.80 (measured in 1965 dollars). The average hourly income of factory workers now is \$2.60 (exclusive of fringe benefits), a more than 40 per cent increase. Since the typical work week is essentially unchanged (39 hours in 1949, 41 hours now), this has meant a more than 40 per cent rise in the weekly and annual income of the average factory worker. The typical non-factory worker wage rate and annual income rose 35 per cent in this same period. We have had a remarkable rise in the wage income of the average worker at the same time that the total number of people with jobs increased.

Why Is Automation Alarming?

In the face of this data, why do some cry that doomsday is coming? What is it about automation that causes alarm? Why is it that workers asked about their attitude toward mechanization feel no threat, yet appear frightened when asked about their feelings toward automation?

The hallmarks of automation, to distinguish it from mechanization or automatic methods, are its sensing, feed-back, and self-adjusting characteristics. Because it senses changing requirements and adjusts without

human intervention, it presumably does away with the need for human attendants or human labor. This is very fearful indeed to those who depend upon jobs for their livelihood.

Fear of automation can be traced to four sources. One is based upon the assumption that there is a fixed amount of goods which buyers want. Any new method which enables us to turn out more goods per man-hour will, it is believed, enable us to turn out the fixed amount of goods and services with fewer men. If a man helped by an automatic machine can produce twice as many widgets per hour as he formerly did, then, presumably, only half as many hours of work will be available for each man to do. If work weeks are not shortened, only half as many jobs could, it is asserted, be provided in these circumstances. The President of the United States used this sort of logic when he said "that approximately 1.8 million persons holding jobs are replaced every year by machines."

The second source of fear springs from the idea that automation or cybernation is something more than the latest stage in the long evolution of technology. Automation is said to be so different in degree that it is profoundly different in its effect. Automated machines controlled by computers do not simply augment muscle power as previous machines did. They replace and outperform human intelligence. In the future, machines will not only run machines; they will repair machines, program production, run governments and even rule men. Union leaders will collect no dues and business will have no customers because, supposedly, there will be no production workers required. Human beings, it is believed, will be made as obsolete by these machines as horses were by the tractor and the automobile.

The third source of fear is our greater awareness of the people displaced by automation than of the other unemployed and a greater

concern for these people. Among the more than three million unemployed are several thousand persons laid off because their skills are not usable by concerns installing automated processes to replace previously used technology. Presumably, possessing only obsolete skills, there are not job opportunities open to them. Others who are laid off or who are among the unemployed because they have voluntarily quit their jobs are less worrisome because their skills are not obsolete and they will have new jobs in a few weeks.

A fourth source of fear is the high incidence of joblessness among the unskilled. It is felt that the unskilled are unemployed because automated production reduces the demand for unskilled workers. Any increases in the demand for labor occurring because of automation are believed to be concentrated on highly skilled workers.

*Is the **Alarm** Justified?*

Automation causes displacement. Some people do become unemployed because of it, although most firms retrain and place employees in new jobs when eliminating old jobs.² However, automation does not create

² There is no single source which provides a census of the retraining done when new technology is installed by business firms. The U.S. Bureau of Labor Statistics studied the experience of twenty major firms converting to electronic accounting and found that only 0.03% of the 2,800 employees involved in the operations affected by the installation of computers were laid off. (*Adjustments to the Introduction of Office Automation, Bulletin No. 1276.*) Employees who needed retraining to hold jobs with the application of new technology were retrained by these firms.

In eight companies intensively studied by the Stanford Research Institute, seven of which installed automation equipment, not one person was laid off. All persons displaced were retrained, often for higher paying positions. "Expectations and Realizations of Automation," *Stanford Research Institute Journal, No. 2, 1964, p. 13.*

R. Conrad Cooper testified on March 28, 1961, before the Subcommittee on Unemployment and the Impact of Automation of the House Education and Labor Committee, that the replacement of the South Chicago Works of the United States Steel Corporation affected 1,346 em-

unemployment. The number of jobless men is not greater than it would have been if no automation had occurred.

It may seem paradoxical to argue that automation causes displacement but does not cause unemployment. Many observers point to specific persons unemployed as a result of this phenomenon. They fail, however, to point to the unemployed who found jobs because of automation. They fail to recognize those who would have joined the jobless if new technology had not been developed and applied. They fail to see that automation causes re-deployment, not unemployment.

Although automation has displaced some employees, the total number unemployed is smaller today than it would have been without automation, given *the present wage structure*. There are, certainly, some people among the unemployed who would not have been jobless but for these innovations. However, a larger number are among the employed who would not have been but for automation.

We may grant that automation differs from other kinds of technology. Yet, we should not blind ourselves to history to the point of saying it is completely new. Perhaps the earliest automated device was the pressure cooker invented by Denis Papin in 1680. He originated a pressure control which is still one of the most widely used regulators. Despite this automated device, cooks are still extensively employed and housewives still find it necessary to

ployees. Of these, 71 per cent were retrained and 8 per cent were transferred to other departments. The others retired, quit, were discharged for violation of plant rules, etc. Only one employee was laid off. Similar instances are detailed in other testimony before Congressional committees and in published literature. See G. P. Shultz and A. R. Weber, "Technological Change and Industrial Relations," *Employment Relations Research* (New York: Harper & Brothers, 1960). For a national analysis of employer efforts in training and re-training, see J. Mincer, "On-the-Job Training: Costs, Returns and Some Implications," *Journal Of Political Economy*, Volume LXX (Supplement: October 1962), pp. 50-79.

devote time to their kitchen work. Although homemakers may spend less time in the kitchen, this has simply freed them to do more of other kinds of work, such as better educating their children and decorating their homes.

During the eighteenth century, several types of automatic regulators were applied to windmills. An automatic, card-programmed loom was devised by Jacquard over 150 years ago. An automatic flour mill was built in 1741. Eighteenth century steam engines were controlled by governors which had sensing, feedback, and resetting characteristics which are the hallmarks of automation. Despite increasing automation in the last two centuries, employment has risen continually.

In terms of a very recent type of automation, the use of electronic data processing equipment, a United States Department of Labor study of large firms which introduced such equipment concluded that:

Despite the reduction in labor requirements for the tasks performed by the computers, total employment of the offices as a whole rose. Over the four years from December 1953 to December 1957, total office employment at 17 of the offices studied increased an average of 7 per cent. . . . In 6 of the 17 offices, the increase was greater than 15 per cent; in 7, less; and in 4 there was a decrease. Although the immediate effect of electronic data processing suggests some retardation in the growth of office employment, particularly part-time work, the experience of some offices suggests the possibility of expanding employment in new areas of office activity to handle information which had previously been uneconomical to acquire.³

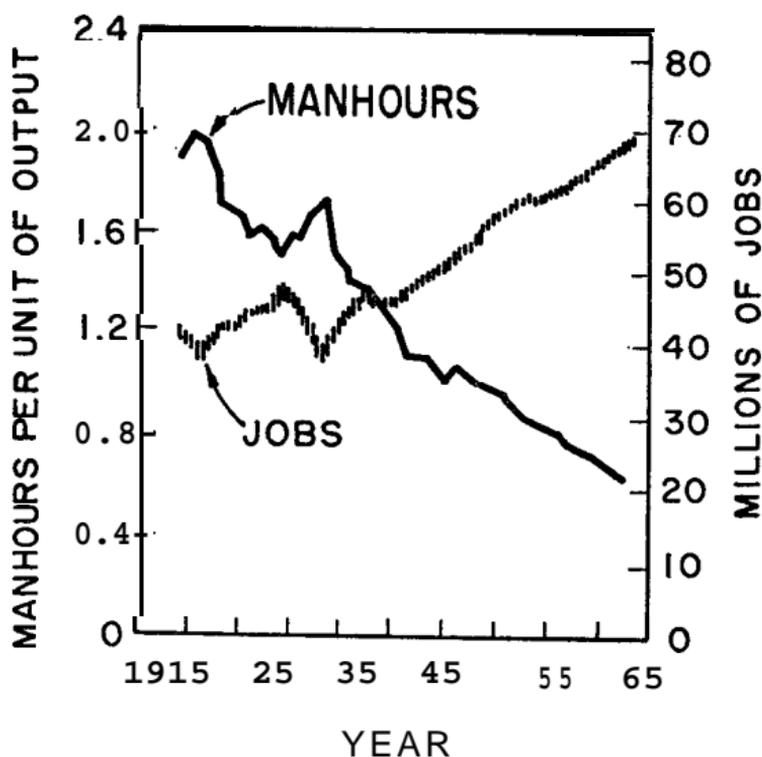
This experience of increasing office employment despite reduced labor requirements per unit of output is a specific instance of what has been going on generally in our economy. From 1919 to 1962, man-hours required per

³ U.S. Bureau of Labor Statistics, **Adjustment to the Introduction of Office Automation, Bulletin No. 1276** (Washington: U.S. Government Printing Office, 1960), p. 4.

unit of output in the American economy dropped by 67 per cent, yet total number of jobs rose from 42 million to 68 million (see Chart I). The tripling of output per man-hour did not reduce the number of jobs by two-thirds as those who believe in a fixed amount of work available would predict.

CHART I

JOBS INCREASE WITH LABOR SAVING IMPROVEMENTS



One group which subscribes to the fixed lump of work philosophy points to the 1960-63 annual rise in output per man-hour of 3.6 per cent with alarm. It says that this exceeds the long-term average annual rise of 2.4 per cent from 1909 to 1963 and the average annual postwar rise to 3.0 per cent. This, it says, indicates that the pace of technological change is accelerating and will create a great unemployment problem.

The more rapid rise of output per man-hour from 1960 to 1963 was accompanied by an increase in the number of civilian jobs from 67 million to 69 million. An even more rapid

increase in output per man-hour from 1949 to 1953, amounting to 4.0 per cent per year, was accompanied by an increase in civilian jobs from 59 million to 62 million. On the other hand, a slowed rate of increase in output per man-hour from 1953 to 1954, when output per man-hour rose by only 1.8 per cent, well below the long-run average rise of 2.4 per cent, was accompanied by a drop in employment from 62 million to 61 million. "It is noteworthy that while many Americans worry about the loss of jobs due to technological change, the much more rapid increase in productivity abroad has been accompanied by a great reduction, not an increase, in unemployment."⁴ It would seem that a more rapid rise in output per man-hour should be welcomed as a means of creating jobs more rapidly than they can be destroyed by other factors at work in our economy.⁵

The primary effect of automation is not a reduction in the number of jobs available. Rather, it makes it possible for us to do many things which otherwise could not and would not be done. Automation enables us to earn larger incomes and lead fuller lives. It will, in the future, literally make it possible to travel to the moon. It saves lives through the aid it gives doctors. By controlling traffic signals in response to traffic flows and reducing traffic congestion, it adds hours to the free time of commuters every week. It helps scientists, with the aid of high-speed data processing, to de-

⁴ R. N. Cooper, "International Aspects," *Automation and Technological Change*, edited by J. T. Dunlop (Englewood Cliffs, N.J., Prentice-Hall, 1962), p. 148.

⁵ A study by S. Fabricant for the pre-war period found that "trends in unit labor requirements have been negatively correlated with trends in man-hour employment in different industries" (that is, decreases in hours of labor per unit of product-increases in output per man-hour-have been correlated with increased employment while increases in hours of labor per unit of product have been correlated with a decline in employment). *Employment in Manufacturing, 1899-1939* (New York: National Bureau of Economic Research, 1942).

velop new knowledge that otherwise would not be available in our lifetimes. We are increasing the scale of educational activities because mechanization, automation, cybernation, or whatever we choose to call our new technology, makes it possible to do more than we could formerly. With the coming of automation, men are able to do more and have more. Both sublime and mundane activities are being enlarged.

Types of Jobs Change

Technological change does tend to change the nature of work. We know from experience that automation in the factory turns machine operators into machine tenders and maintainers. This has already occurred in the textile industry, to name one example. Upon walking into the loom room of a modern mill, the first impression is that of a vast space filled with busy machinery and no people in sight. (Yet employment in textile mills totals nearly 900,000 workers.) Controls on individual machines enable one man to supervise a dozen or more looms. The chemical and petroleum refining industries use automatically controlled, continuous processes. (They, too, provide employment on large scale amounting to more than 1,000,000 jobs.) Instead of men running to distant points in a refinery to twist valve wheels, they now monitor instrument panels.

The effect of automation has been to increase the relative number of maintenance men, engineers, office employees, production control specialists, and other non-machine operators that are required. (These are the people the U.S. Census Bureau calls non-production workers.) This is simply a continuation of a trend which has been going on for decades. In 1899, only 7 per cent of the manufacturing industry labor force consisted of persons other than production workers. Today 26 per cent of manufacturing employees are

non-production or indirect workers (see Table 1). Since 1939, production worker employment in manufacturing has increased 65 percent, while that of other workers has increased by over 160 percent.

TABLE 1
GROWTH OF INDIRECT WORKER EMPLOYMENT
IN MANUFACTURING, 1899-1963
(Thousands of Persons)

Year	Total	Production Workers	Indirect Workers	Indirect Workers (Per Cent of Total)
1899	4,850	4,502	348	7
1919	9,837	8,465		14
1939	9,527	7,808	1,719	18
1959	16,675	12,603		24
1963	17,035	12,586	4,449	26

Sources: U.S. Bureau of the Census, *Historical statistics of the United States, Colonial Times to 1957* (Washington: U.S. Government Printing Office 1960), p. 409; Manpower Report of the President (Washington: U.S. Government Printing Office, 1964), pp. 226-228.

In addition to changing the balance among occupations in a given industry such as manufacturing, technological progress is also changing the balance among industries. Only a century ago, fifty out of every one hundred workers toiled on farms producing the nation's supply of food and fiber. Only two to three out of every one hundred workers were producing educational, medical, recreational, and other services which contribute to a richer, fuller, healthier life. Today, the number of workers in these life-enriching occupations is relatively five times as great (see Table 2). Those toiling on farms have been reduced relatively to one-sixth their former number. They now direct machines instead of using animal power and their own muscles. The quality of life has been improved and brute toil has been reduced because technology has increased our incomes to the point where we can afford these services and these machines.

Increases

Those who are concerned about unemployment should welcome rather than fear auto-

TABLE 2
DISTRIBUTION OF THE WORK FORCE IN
THE UNITED STATES, 1870-1960

	1870	1900	1930	1960
1. EXTRACTIVE INDUSTRIES.	52.3%	40.7%	24.3%	9.9%
Agriculture. . . .	50.2	37.4	21.5	8.3
Mining. . . .	1.6	2.6	2.5	1.1
Forestry and Fisheries. . .	0.5	0.7	0.3	0.5
2. FABRICATING INDUSTRIES. . . .	23.5%	27.8%	29.2%	31.8%
Manufacturing. . .	17.6	22.0	22.8	24.5
Construction.	5.9	5.8	6.4	7.3
3. SPECIALIZATION-AIDING INDUSTRIES.....	11.4%	17.0%	26.4%	31.9%
Trade.	6.1	8.6	13.1	17.7
Finance, Insurance and Real Estate:	0.3	1.1	3.1	4.3
Transportation and Public Utilities.	5.0	7.3	10.2	9.9
4. PERSONAL SERVICE INDUSTRIES. . . .	10.1%	10.5%	13.1%	15.2%
Domestic Service.	7.3	6.0	5.4	3.7
Personal Service.	2.0	3.5	5.3	6.3
Government (n.e.c.)	0.8	1.0	2.4	5.2
5. LIFE-ENRICHING INDUSTRIES. . . .	2.6%	4.0%	7.0%	11.1%
Education. . . .	1.5	2.2	3.4	5.0
Other Professions. .	1.1	1.8	3.6	6.1

Sources: U.S. Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957* (Washington: U.S. Government Printing Office, 1960), p. 74; *Survey of Current Business, July 1961*; G. J. Stigler, *Trends in Employment in the Service Industries* (Princeton: Princeton University Press, 1956).

mation. If it were not for the technical advances of the past decade, unemployment, at present wage levels, would be above the astronomical levels of the early 1930's. Alternatively, if real wage rates were at levels consistent with full employment using the same technology as that available a decade ago, wage rates would be lower by about \$8.00 a week (or 20 cents an hour) than they are now.

Technological change has created more jobs than it has destroyed. The number of civilians

at work in 1965 is eight million higher than a decade ago. A number of forces including advances in technology created nearly 60 million additional jobs during the past decade. More than fifty million jobs were destroyed, however, by various causes (primarily by the upward movement of wage rates). The nearly 60 million new jobs created less the more than fifty million jobs destroyed left a net gain of eight million positions.

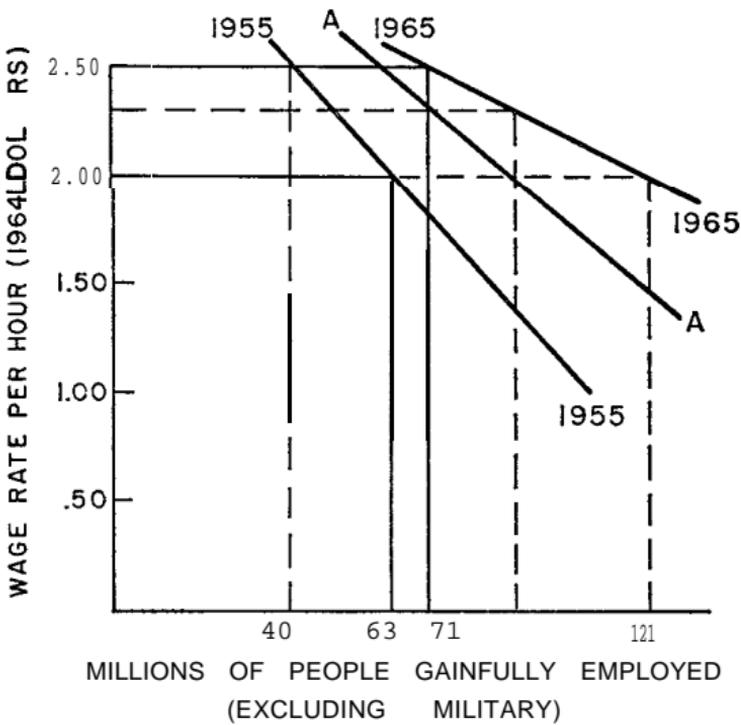
This does not mean that fifty million separate individuals changed jobs in the last ten years either in the sense of shifting to a new employer or shifting to a different job with the same employer. In any given year, eight million people leave their jobs and take jobs with other employers.⁶ Often, they are the same people who again quit their jobs to move to still other positions.⁷ Also, the typical firm trains people for one set of positions, then re-trains the same people a few years later for new jobs. The average employee in General Motors, for example, is retrained six times in ten years. People in the American economy are astonishingly mobile and adaptable.

The net result of automation and other job-making forces at work in the economy during the past decade can be displayed in the form of graphs representing the demand for labor. Chart II, drawn to represent a hypothetical demand for labor in 1955 and 1965, roughly approximates the situation existing in labor markets in those two years. In 1955, average earnings were approximately \$2.00 per hour (1965 dollars) and 63 million people were gainfully occupied. In 1965, average earnings are \$2.50 an hour and more than 70 million people are gainfully occupied.

⁶ Bureau of Labor Statistics, *Special Labor Force Report No. 35*, p. 1. *Monthly Labor Review*, August 1963.

⁷ The average employee spends only 4.6 years with the same employer. H. R. Hamel, "Job Tenure of American Workers, January 1963," *Monthly Labor Review*, Oct. 1963, p. 1145.

CHART II



Sources: *The Economic Report of the President* (Washington: U.S. Government Printing Office, 1965); *Economic Indicators*, March 1965; P. Douglas, *The Theory of Wages* (New York: MacMillan Company, 1934); and Z. Griliches, *Production, Technical Change, and All That* (Report 6328, Rotterdam: Netherlands School of Economics, Econometric Institute, October 9, 1963).

If wage costs had risen to \$2.50 an hour with no change in the demand situation (that is, if the demand curve showing the number of men who would be employed at various wage rates in 1965 were the same as that shown in Chart II for 1955), the number of men gainfully occupied would have dropped to 40 million. What actually happened, of course, is that the demand for men shifted between 1955 and 1965. It did not remain static. As a consequence, wage rates and employment both rose.

The primary causes of the shift in demand were an increased quantity of capital available to assist each worker in doing his job, a rise in the average level of skill, and improvements in techniques of production (and design of products). The net result of these forces was a shift in the demand for labor to the position shown for 1965. If no increase in wage rates had occurred (and all other factors developed

in the manner in which they did), there would now be 121 million jobs available. An increase of nearly 60 million over the number of jobs available in 1965 would have occurred.

Since 121 million people are not available to fill jobs, employers would now be confronted by extreme labor shortages with this rate of demand for labor. During the past decade, employers in most industries did find themselves short of labor from time to time. They offered higher rates to attract the additional people they wanted. Wage rates in these industries were, in effect, successively bid up by employers. In some industries, unions and employers agreed on wage increases through collective bargaining rather than employers unilaterally bidding higher rates to attract employees. The net result of these wage rate increases (including the raising of minimum wage rates by statute) was to destroy more than 50 million jobs, leaving a net increase of 8 million positions.

Curve A in Chart II is drawn to show what the 1965 situation might have been if no additions to technical possibilities had occurred. Without technological change, the number of jobs at the 1955 wage rate would have increased to only 89 million, a 26 million increase. Under these circumstances, wage rates could have risen by only 30 cents, instead of by 50 cents, and still have left the rate of demand sufficiently high to provide 71 million jobs (see Curve A, Chart II).⁸ The net effect of the melange of technological changes which occurred in various industries in the decade preceding this year is to make it possible for

8 These figures are approximations indicating magnitude and direction of the effect of technological change. They are based on the measurement of the amount of technological change (Z. Griliches, *op. cit.*) and the elasticity of demand for labor (P. Douglas, *op. cit.*; H. G. Lewis, *Unionism and Relative Wages in the United States* [Chicago: University of Chicago Press, 1963] and S. Sobotka, *Profile of Michigan* [New York: The Free Press of Glencoe, 1963]).

those at work now to earn about \$400 more this year than they could have earned if no new technical possibilities had been developed.

Could Results Be Different?

This specific outcome was the result of the balance among the kinds of technological change which occurred. If different sorts of new techniques had been developed, it is conceivable that the demand for labor could have shifted in a way which would have required a wage decrease to provide the 71 million positions available now. Categorical statements that a given result will always follow from even a given type of automation cannot be made, much less that the result would be the same for all types of automation.

A type of automation which, let us say, has the effect of reducing the amount of labor required per unit of product, without changing capital, material, or skill requirements, will have different results depending on the responsiveness of product sales to price decreases. If sales are very responsive to a price decrease, the introduction of this type of automation will result in a large increase in sales. With a large increase in sales produced by the cost reductions resulting from automation, the industry will hire more people. On the other hand, if sales of the product are somewhat unresponsive to a price decrease, the industry will use fewer people because of automation.

The different effects on employment can be illustrated. Suppose that a new technique reduces the amount of labor required per unit of product from one hour to nine-tenths of an hour. If the industry was producing 1,000 units of product per week, its labor requirements were 1,000 hours per week (or 25 men working a 40-hour week). With a reduction in the labor input required per unit of product, let us suppose that the price of the product falls

by 7 per cent and sales rise by 20 per cent. (It is assumed that product price falls less than 10 per cent despite the 10 per cent reduction in labor required per unit because the cost of materials, power, and equipment remains unchanged.) With an increase in sales to 12,000 per week, the industry will now require 1,080 hours of labor per week (or 27 men working a 40-hour week). More men will be hired despite the reduced labor requirement per unit of product. This has been the typical situation in many manufacturing industries in past years.

If, on the other hand, sales increase by only 3 per cent in response to a 7 per cent reduction in price, total sales will not rise sufficiently to maintain employment in the industry. With an increase in sales to 1,030 units per week, the industry will now require only 927 hours of labor per week (or 23 men). Two men will lose their jobs in this industry or two quits or retirees will not be replaced. This, of course, has been the typical situation with respect to most agricultural products.

However, the fact that an automating industry uses fewer people, if it does, does not necessarily mean that fewer jobs will be available in the economy as a whole at prevailing wage rates. The product of the automating industry sells at a lower price after automation than that for which it would otherwise sell. If sales do not increase markedly and provide more jobs, or at least rise enough to maintain the number of jobs, those buying the product must be spending less of their incomes for it than they formerly did. The leftover income will be used to purchase more of other products. The increase in sales of other products will provide job openings which will absorb people released from the automating industry. These released people may be absorbed with no cut in wage rate or may obtain higher wage rates.

Whether this specific result follows the intro-

duction of a new technique in an industry whose sales are not very responsive to price depends on the capital-man ratios in the automating industry relative to other industries. If the automating industry's capital requirements are reduced by automation along with its reduced manpower requirements, additional capital will become available to other industries as well as additional manpower. If the amount of capital released from an automating industry is large relative to the number of men released, other industries will increase their employment by a greater amount than the number of men displaced. In these circumstances, unemployment will drop or wage rates will tend to rise despite the displacement of men by automation.

A major part of the new techniques developed in the past decade has the characteristics and effects just described.⁹ They have reduced manpower and capital requirements of railroads, for example. This, however, has made possible the growth of other industries such as education, finance and insurance, wholesale and retail trade, and other service industries. (See Table 3.)

Even in railroading and coal mining, where employment has declined, the employment decline would have been much greater, given the increases in wage rates which occurred, but for automation. The reduction of costs following automation made it possible for railroads to retain markets which would have been lost to trucks, buses, pipelines, barges, and airlines. Cost reduction in coal mines made it possible for coal to retain markets which would otherwise have been lost to oil, gas, waterpower, and atomic energy. By retaining their markets, rail-

⁹ See Yale Brozen, *Automation: The Impact of Technological Change* (Washington: American Enterprise Institute, 1963) for examples of such types of automation. Also, Y. Brozen, "The Economics of Automation." *American Economic Review*, May 1957, for an analytical discussion of the many varieties of automation and of the consequences.

TABLE 3
WAGE AND SALARY RATES
(In Thousands)

	1955		1964	
	Increasing Employment Industries			
Manufacturing.	\$16,882		\$17,301	
Contract construction.. .	2,802		3,105	
Wholesale and retail trade.	10,535		12,184	
Finance, insurance, and real estate.	2,335		2,945	
Service and miscellaneous.	6,274		8,532	
Federal government.	2,187		2,348	
State and local government	4,727		7,153	
	Decreasing Employment Industries			
M i n i n g	792		636	
Transportation and public utilities.	4,141		3,974	
Agriculture*.	6,718		4,761	

* Total employment.

Source: Economic Report of the President (Washington: Government Printing Office, 1965). 1964 figures include Alaska and Hawaii.

roads and coal mines have been able to provide more jobs than would have been available if they had not been able to minimize through automation their rise in costs and prices. The Studebaker plant in South Bend might still be operating today if the company could have automated sufficiently to reduce costs to the level where the plant would be viable.

Causes of Unemployment

If automation creates jobs and raises the productivity of those with jobs sufficiently to make it possible for them to earn more, then why is unemployment among teen-agers now at the 14 per cent level, four times the unemployment rate of adults? Are we faced with a situation in which jobs for the unskilled and

the inexperienced are being wiped out by automation?

In this case, the primary cause of unemployment is the over-pricing of many jobs which would normally be filled by inexperienced, unskilled new entrants to the labor force. The unemployment among teen-agers is a consequence of arbitrarily determined wage rates for certain groups of jobs which have caused a contraction of employment opportunities for the unskilled, inexperienced worker.¹⁰

The situation of elevators in Chicago provides an example of unemployment caused by arbitrarily determined wage rates. There is a high incidence of unemployment among male juveniles in Chicago. Many of these boys would be happy to accept jobs as elevator operators at \$1.25 to \$1.50 an hour. The elevator operators' union, however, imposes a minimum wage rate of \$2.40 an hour for operators in downtown Chicago buildings. In this circumstance, owners of the buildings find it economic to spend \$40,000 per elevator to automate their lifts and make them self-operating. The tax, insurance, depreciation, maintenance, and interest costs of automating an elevator amount to \$8,000 per year. It did not pay to automate when two shifts of operators cost only \$5,000 per year. The union has driven the two-shift cost of operation to \$10,000 per year. The result in elevator automation, a drain of capital from expansion of production where it would provide more jobs, fewer jobs for elevator operators, and problems of unskilled teenagers finding tasks to keep themselves occupied. The decreased demand for unskilled teenagers resulting from the high minimum wage rates set in jobs which they might take forecloses the opportunity for the acquisition of personal charac-

¹⁰ See C. E. Silberman, "What Hit the Teenagers," *Fortune*, April 1965, for a somewhat different view of the problem.

teristics and skills which would equip them for more productive, better paying jobs in later years.

There is a growing concentration of unemployment among unskilled workers not only because of the high minimum wage rates for newly hired workers set by union-employer agreements, but also because of the successive increases in statutory minimum wage rates by Congressional amendment of the Fair Labor Standards Act. In 1949, the minimum wage rate set by federal statute was \$0.40 per hour. At this time, average earnings of manufacturing industry employees were \$1.38 an hour. The minimum wage has been increased several times since 1949, reaching \$1.25 in September, 1963. At that time, average earnings of manufacturing industry employees were \$2.47 per hour. Thus, compared with the hourly wage of workers in manufacturing, the minimum wage rose from 29 per cent in 1949 to 51 per cent in 1963.

It is hardly surprising that unemployment among the unskilled increased with this rapid rise in the minimum wage. In absolute terms, the statutory minimum wage has been more than tripled since 1949. In relative terms, it has been raised to 176 per cent of what it was in 1949. The growth in unemployment among teenagers from 595,000 in 1949 to 979,000 in 1963 or from 17 per cent of all the unemployed in 1949 to 25 per cent of the unemployed in 1963 should have been expected. To the extent that teenagers are inexperienced, unskilled workers, they are the ones who have been priced out of the labor market by the rise in the minimum wage rate.

Increasing the price of unskilled workers so greatly relative to that of skilled workers unduly penalizes the hiring of the unskilled. It is fortunate that the proportion of the work force which is unskilled has been diminishing (see Table 4). Otherwise, the unemployment

TABLE 4

EDUCATIONAL ATTAINMENT OF EMPLOYED PERSONS
18 YEARS OLD AND OVER, 1952-1962

YEARS OF SCHOOL COMPLETED	1952		1962		1964 (Per Cent)
	Thou- sands	%	Thou- sands	%	
Less than 8	11,612	19.7	8,494	13.3	
8-11.....	21,706	36.9	20,426	32.0	
Total-Less than 4 years of High School.....	33,318	56.5	28,290	45.3	42.8
High School 12.....	15,876	27.0	20,688	32.4	
College 13-15.....	4,950	8.4	6,981	10.9	
College 16+.	4,766	8.1	7,350	11.5	
Total 4 years of High School or more.....	25,592	43.5	35,019	54.8	57.3
Total employed	58,910		63,939		
Median school years completed.	10.9		12.1		12.2

Sources: D. F. Johnston, "Educational Attainment of Workers, March 1962," *Monthly Labor Review*, May 1963, p. 508; *Economic Report of the President* (Washington: Government Printing Office, 1965), p. 123.

problem would be more severe than it is, given the increases in minimum wage rates which have occurred.

The decreasing number of unskilled workers available and increasing demand for them has caused a rise in their money wage rates by 66 per cent in occupations not covered by the wage law between 1949 and 1963. The rise would have been greater but for the fact that the increase in the statutory minimum wage (and the minima set by union-employer agreements) foreclosed many jobs to the unskilled workers and increased the number seeking work in the exempt occupations. This increased the supply of workers competing for the exempt jobs and held down the wage rise

which would otherwise have been greater for these people.¹¹

It is fortunate that exempt jobs have been available for many of the unskilled who were foreclosed from covered jobs by the rise in the minimum wage rate. The number of exempt jobs was greatly decreased in 1961, however, by a broadening of the coverage of the Fair Labor Standards Act. It is notable that a jump in the proportion of the unemployed who are teenagers has taken place since the recent increases in the minimum wage and the narrowing of the number of exempt jobs.

The doom criers who are alarmed about automation say that "a permanently depressed class is developing in the United States."¹² If there is such a class, it is caused by legislation such as the Fair Labor Standards Act, not by automation. However, the data on income received by the poorest 20 per cent of the population do not indicate that they are becoming worse off. From 1949 to 1962, average family income of the poorest 20 per cent of the population rose by 60 per cent in current dollars or by 28 per cent measured in constant dollars.

Conclusion

If no technological change had occurred in the past decade, the number of jobs available could have grown as it has from 63 million to 71 million only at the price of restricting increases in wage rates. Wage rates could have

¹¹ Y. Brozen, "Minimum Wage Rates and Household Workers," *The Journal of Law and Economics*, October 1962; D. E. Kaun, *Economics of the Minimum Wage: The Effects Of the Fair Labor Standard-s Act* (Ph.D. Dissertation, Stanford University, 1964); J. M. Peterson, "Employment Effects of Minimum Wages, 1938-1950," *Journal of Political Economy*, October 1957.

¹² R. Theobald, "The Threat and the Promise of Cybernation," *Main Currents*, September-October 1964, p. 5. For an objective analysis of the trend, see Rose D. Friedman, *Poverty: Definition and Perspective* (Washington: American Enterprise Institute, 1965).

been increased by only 30 cents per hour or \$600 per year instead of \$1,000 a year. With this restricted wage increase and automation, the number of jobs would have grown to 91 million instead of 71 million (see Chart II and compare the number of jobs at \$2.30 on Curve A and Curve 1965). In effect, technological change created 20 million jobs in the past decade.

Since employers could not find 20 million additional people to fill these jobs, they bid against each other for the available work force. The net result, then, was an additional rise in annual earnings of the typical worker of \$400 in the past decade above what he would otherwise be receiving if no new inventions had been applied.

Instead of castigating automation for causing unemployment, we should be inviting more automation to help solve the present unemployment problem. The over-pricing of labor in industries such as coal mining and the setting of high minimum wage rates by statute for unskilled labor have caused unemployment because many are not productive enough to be employed at these wage rates. With more technological advance, productivity would be increased. The men presently priced out of the market would be employable if their productivity were increased, and it would be by technical progress.

At present, employers are tending to hire fewer of the less skilled, less experienced people because of the high minimum wage rates set by laws, by governmental administrators (under the discretionary authority granted by the Walsh-Healy Act, the Davis-Bacon Act, and the various prevailing wage laws passed by state legislators), and by agreements between unions and employers. At these rates, inexperienced personnel are not sufficiently productive to be employable in the covered jobs. Adaptation to automation would

be easier if the wage structure were less rigid. It could take place, then, by the acceptance of lower wage jobs by some individuals as well as by attaining higher skill levels.

Individuals are doing much of the adapting required within our present wage and tax structure by staying in school longer. The proportion of 16 and 17 year old youths in school has increased from 75 per cent to 88 per cent in the past ten years. The median level of education has risen from 10.9 years to 12.1 years in the past decade (see Table 4). Also, people are acquiring the special skills in demand. Further, employers are providing retraining for a majority of their own employees directly affected by automation. They are minimizing displacement by letting attrition of their work force take place through retirements and quits rather than layoff when the number of employees must be reduced. The amount of reduction would be minimized, however, if wage rate increases were less precipitate.¹³

In short, the unemployment problem with which we are faced is not a result of automation and will not be worsened by automation. Automation should be welcomed as the means of alleviating poverty and undoing the damage done by bad wage laws and improper union-employer agreements. It should not be feared as a job destroyer. It is a job creator.

¹³ For an analysis of the employment constricting effects of unduly large wage rate increases, see L. E. Galloway, "Labor Mobility, Resource Allocation, and Structural Unemployment," *American Economic Review*, September 1963.