

**UNEMPLOYMENT
AND TECHNOLOGICAL CHANGE**

WORK PROJECTS ADMINISTRATION
NATIONAL RESEARCH PROJECT

WPA NATIONAL RESEARCH PROJECT

Reports issued to date

General

- G-1 Unemployment and Increasing Productivity (*out of print*)
- G-2 The Research Program of the National Research Project
- G-3 Summary of Findings to Date, March 1938
- G-4 Effects of Current and Prospective Technological Developments Upon Capital Formation
- G-5 Industrial Change and Employment Opportunity—A Selected Bibliography (*Author index available*)
- G-6 Survey of Economic Theory on Technological Change and Employment (*in press*)
- G-7 Unemployment and Technological Change
- A-3 Selected References on Practices and Use of Labor on Farms (*out of print*)

Studies in Types and Rates of Technological Change

Manufacture

- M-1 Industrial Instruments and Changing Technology
- M-2 Mechanization in the Brick Industry
- M-3 Mechanization in the Cement Industry
- M-4 Industrial Research and Changing Technology
- M-5 Mechanization in the Lumber Industry
- B-2 Mechanical Changes in the Cotton-Textile Industry, 1910 to 1936 (*Summary*)
- B-3 Mechanical Changes in the Woolen and Worsted Industries, 1910 to 1936 (*Summary*)
- B-5 Systems of Shop Management in the Cotton-Garment Industry (*out of print*)

Mining

- E-1 Technology and the Mineral Industries (*out of print*)
 - E-3 Mechanization Trends in Metal and Nonmetal Mining as Indicated by Sales of Underground Loading Equipment
 - E-5 Fuel Efficiency in Cement Manufacture, 1909-1935 (*out of print*)
- Mineral Technology and Output per Man Studies:
- E-6 Grade of Ore (*out of print*)
 - E-11 Rock Drilling

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Changes in Farm Power and Equipment:

- A-2 Mechanical Cotton Picker
- A-9 Tractors, Trucks, and Automobiles (*out of print*)
- A-11 Field Implements

Studies in Production, Productivity, and Employment

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- S-1 Production, Employment, and Productivity in 59 Manufacturing Industries, 1919-36
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- B-1 Labor Productivity in the Leather Industry (*Summary*)
 - B-4 Effects of Mechanization in Cigar Manufacture (*Summary*)
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 - * Mechanization and Productivity of Labor in the Cigar Manufacturing Industry
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FEDERAL WORKS AGENCY
WORK PROJECTS ADMINISTRATION

F. C. HARRINGTON
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Assistant Commissioner

NATIONAL RESEARCH PROJECT

on

Reemployment Opportunities and Recent Changes
in Industrial Techniques

DAVID WEINTRAUB
Director

**THE WPA NATIONAL RESEARCH PROJECT
ON REEMPLOYMENT OPPORTUNITIES AND RECENT CHANGES
IN INDUSTRIAL TECHNIQUES**

Under the authority granted by the President in the Executive Order which created the Works Progress Administration, Administrator *Harry L. Hopkins* authorized the establishment of a research program for the purpose of collecting and analyzing data bearing on problems of employment, unemployment, and relief. Accordingly, the National Research Program was established in October 1935 under the supervision of *Corrington Gill*, Assistant Administrator of the WPA, who appointed the directors of the individual studies or projects.

The Project on Reemployment Opportunities and Recent Changes in Industrial Techniques was organized in December 1935 to inquire, with the cooperation of industry, labor, and governmental and private agencies, into the extent of recent changes in industrial techniques and to evaluate the effects of these changes on the volume of employment and unemployment. *David Weintraub* and *Irving Kaplan*, members of the research staff of the Division of Research, Statistics, and Finance were appointed, respectively, Director and Associate Director of the Project. The task set for them was to assemble and organize the existing data which bear on the problem and to augment these data by field surveys and analyses.

To this end, many governmental agencies which are the collectors and repositories of pertinent information were invited to cooperate. The cooperating agencies of the United States Government include the Department of Agriculture, the Bureau of Mines of the Department of the Interior, the Bureau of Labor Statistics of the Department of Labor, the Railroad Retirement Board, the Social Security Board, the Bureau of Internal Revenue of the Department of the Treasury, the Department of Commerce, the Federal Trade Commission, and the Tariff Commission.

The following private agencies joined with the National Research Project in conducting special studies: the Industrial Research Department of the University of Pennsylvania, the National Bureau of Economic Research, Inc., the Employment Stabilization Research Institute of the University of Minnesota, and the Agricultural Economics Departments in the Agricultural Experiment Stations of California, Illinois, Iowa, and New York.

Since September 1, 1939, the Project has been sponsored by the National Resources Planning Board, Executive Office of the President, Washington, D. C.

UNEMPLOYMENT AND TECHNOLOGICAL CHANGE

by

Corrington Gill

*Based on testimony by Corrington Gill
and David Weintraub given before the
TEMPORARY NATIONAL ECONOMIC COMMITTEE
in Washington, D. C., April 26, 1940*

WORK PROJECTS ADMINISTRATION, NATIONAL RESEARCH PROJECT

Report No. G-7

Philadelphia, Pennsylvania

April 1940

UNEMPLOYMENT AND TECHNOLOGICAL CHANGE

When the Works Progress Administration was established in 1935 we had had 2 years of recovery. Industrial production was substantially above the low point of the depression; industrial employment, however, had picked up much more slowly; the unemployed numbered 10 to 11 million or about a fifth of the Nation's manpower. The WPA, as a functioning part of the Administration's program directed essentially toward recovery, was vitally interested in the prospects for reemployment of this labor force. Since technological advance was obviously one of the important factors which affected these reemployment prospects, we initiated a group of studies of the role that technology played in current unemployment problems and long-run employment trends. This was the origin of the National Research Project on Reemployment Opportunities and Recent Changes in Industrial Techniques.

The other day Mr. Kettering spoke here about the cooperative nature of industrial research. Since the WPA was not the only organization which had an interest in these problems, we too sought and obtained the cooperation of other governmental and private agencies and of industry and labor. One series of the studies, for example, was conducted in cooperation with the Bureau of Labor Statistics; other studies were done in cooperation with the U. S. Bureau of Mines, the Railroad Retirement Board, the Department of Agriculture and various Agricultural Experiment Stations, the Department of Commerce, the Social Security Board, the Bureau of Internal Revenue, the Federal Trade Commission, and the Tariff Commission. Among the nongovernmental agencies were the Industrial Research Department of the Wharton School of Finance and Commerce of the University of Pennsylvania, the National Bureau of Economic Research, and the Employment Stabilization Research Institute of the University of Minnesota. The Project throughout, in collecting information has also enjoyed the cooperation of industry, of labor, and of farmers.

We feel that the National Research Project, directed by David Weintraub, is currently contributing the greatest amount of information on this question of the role of technology in production, employment, and unemployment. Thus far more than 60 published reports have resulted from the Project's work. I would like to submit as an exhibit a list of these studies.* The reports have been widely distributed and the value

*For a list of the Project's publications see inside cover of this report.

of the findings is well shown by the frequency with which material from the Project's reports has been used before this Committee during the past 3 weeks.

The two main subjects which I should like to discuss before this Committee are (1) the economic role which technological changes have played in recent years and (2) the impact of technological change on workers. I shall discuss these subjects primarily from the viewpoint of an agency charged with the responsibility of caring for the able-bodied unemployed.

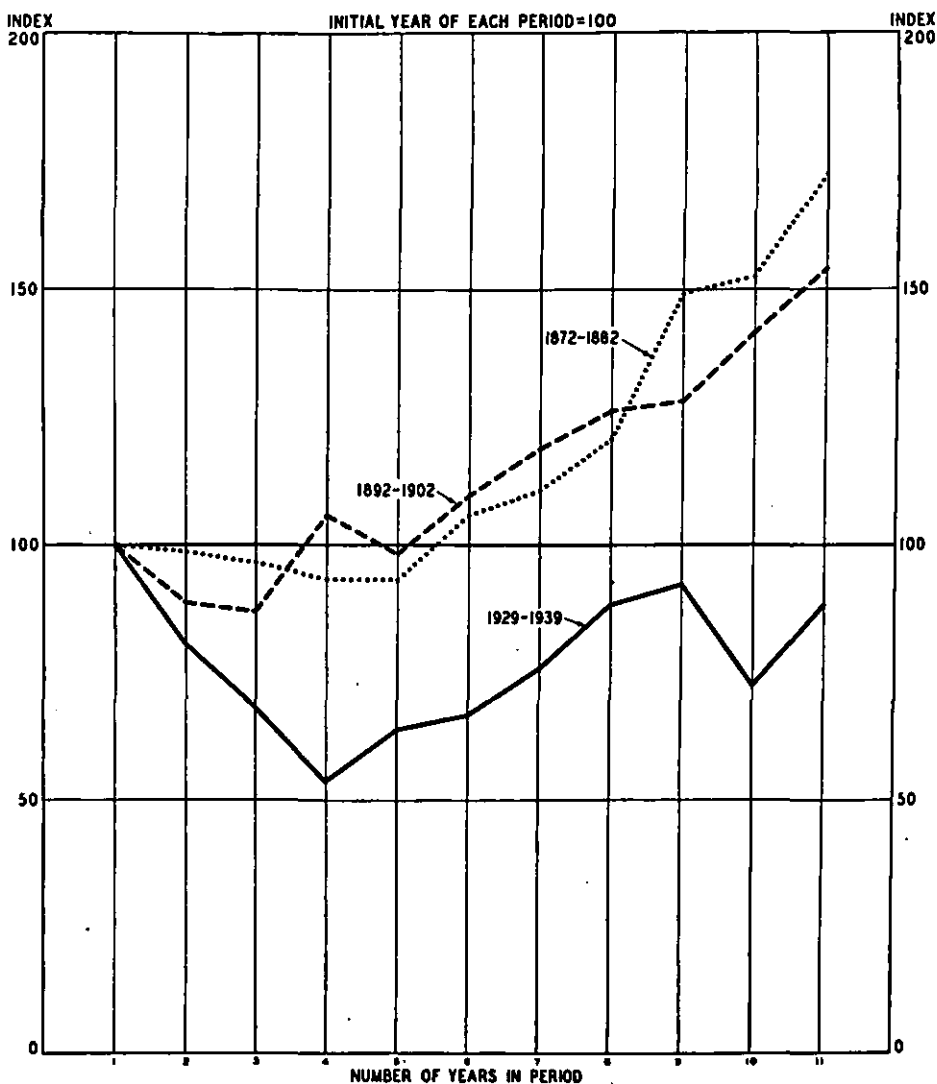
The decade that has just passed is unique in American economic history. It has been marked by the worst depression the country has ever known - a depression unparalleled both in severity and in persistence. At the end of the decade recovery is still far from providing normally full employment of the country's human and material resources.

Perhaps the best indication of how much worse the economic difficulties of the last 10 years have been than those of any previous period is afforded by a comparison with the so-called "great" depressions of the seventies and nineties. Production and employment are the most vital elements in economic well-being. Although it is only in comparatively recent years that employment figures have been gathered, reasonably satisfactory production data are available as far back as 1870. Indexes of general industrial production undoubtedly furnish the most satisfactory measures for a comparison of the course of the three depressions.

Chart 1 compares industrial production for the three decades, 1872-1882, 1892-1902, and 1929-1939. The peak year of the preceding prosperity is in each case taken as the base. The unique character of the decade that has just passed is immediately evident. The differences in severity and length between the depression of the 1930's and the two earlier depressions is so great as to suggest a difference in kind. From 1929 to 1932 industrial production declined by almost 50 percent, as compared with a maximum decline in the nineties of 13 percent, and in the seventies of 7 percent. The contrast in the three recovery periods is quite as striking. In 1939 production averaged somewhat below 1929. In each of the earlier periods it had far surpassed the previous prosperity peak. Eighteen eighty-two was 70 percent above 1872, and 1902 was 55 percent above 1892.

Other indicators tell the same general story. No data exist on which to base a direct estimate of unemployment in either the seventies or nineties. However, some idea of the extent of unemployment in the ear-

Chart 1. - INDUSTRIAL PRODUCTION DURING THREE DEPRESSION PERIODS, 1872-1882, 1892-1902, AND 1929-1939



lier depressions, relative to the recent depression, can be formed from a study of production and labor-supply figures. The latter are available for census years. Eighteen seventy, 1880, 1890, and 1900 were all generally prosperous years. Hence, it is reasonable to assume that unemployment in each of them was at or near the practical minimum. The increase in labor supply can thus be taken as a rough measure of the increase in employment for the decades 1870-1880 and 1890-1900.

Chart 2 shows the trend of gainful workers, excluding those attached to agriculture, for each of the three decades, 1870-1880, 1890-1900, and

1929-1939. It also shows the course of industrial production in each of these periods. Detailed conclusions cannot be drawn because of the lack of refinements in the basic data. However, one central fact does stand out clearly. The increase in the severity of the decline in industrial production in the 1930's was so great as to leave no room for doubt that unemployment must also have been considerably more severe than in earlier depressions.

These facts are unmistakably clear. In every important respect the depression of the 1930's has been far more severe and far more persistent than any previous depression the country has seen. In 1939 we had 2 or 3 million fewer persons employed than in 1929 despite the fact that the volume of goods and services produced was almost the same. This unemployment was in addition to the 2 million persons who were unemployed in 1929 and was aggravated by the natural increase in population which resulted in over 6 million net new additions to the labor market. Consequently, despite recent attempts of some newspaper columnists to "write them off", there were 10 to 11 million unemployed in 1939. The major problem is thus one of fuller utilization of the productive forces of the Nation - natural resources, plant capacity, and labor.

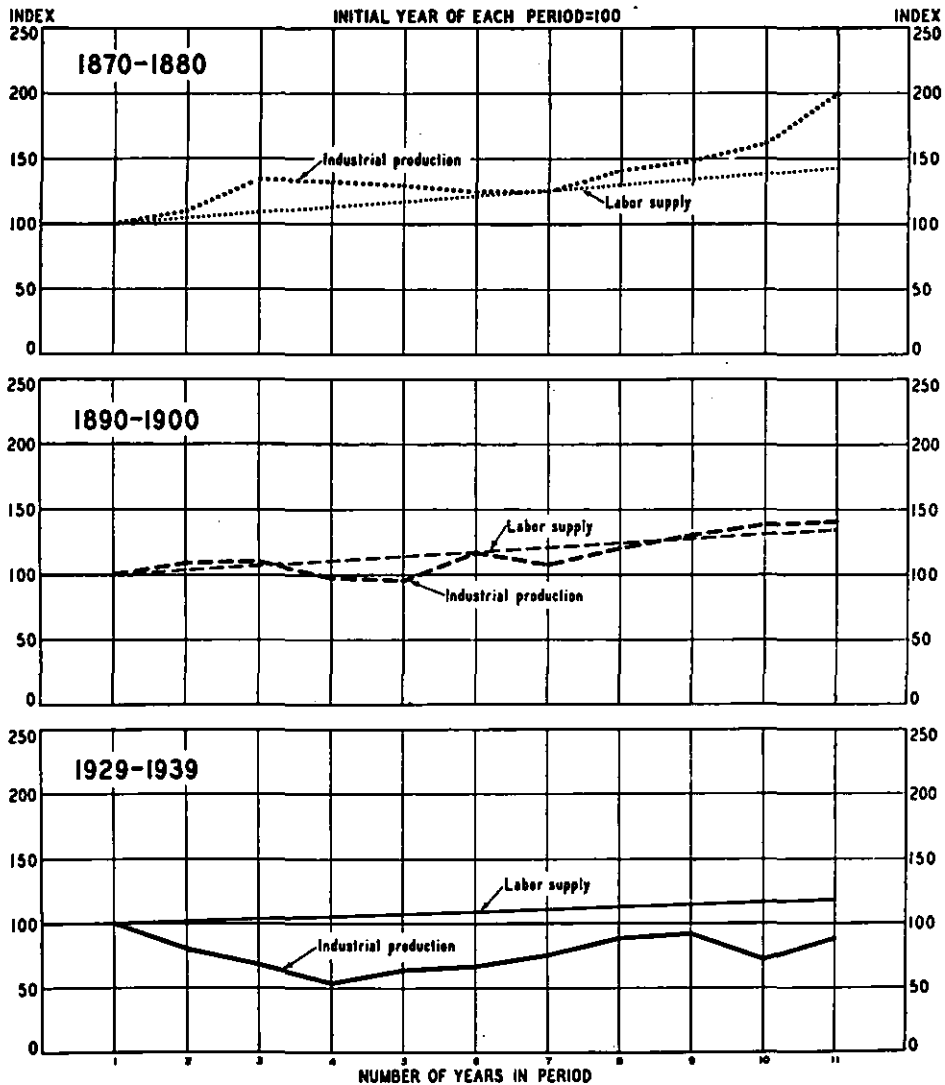
With respect to the subject matter of these hearings, the question arises, what were the effects of technological changes on recovery in recent years?

As your Chairman aptly put it the other day: "The measure of technological advance is the capacity of the masses to buy the products of technology." We are therefore interested not only in the physical aspects of changing industrial techniques, but also in the social and economic ways in which these techniques are used.

Traditionally, technological progress has contributed to a continually expanding economy by stimulating increases of production through the reduction of costs, by introducing new products and new industries, and by increasing the demand for capital goods. Hence, technological progress has, in the past, played an important role as a factor of recovery from depression.

Now, it has already been pointed out to you by several witnesses that technological changes in industry are continuous and cumulative in their effects. There is no way of telling what the technological changes of the future will be or precisely how they will affect employment and investment. Moreover, it is important to realize that the consequences of technological advance are by no means uniform.

Chart 2.- INDUSTRIAL PRODUCTION AND THE LABOR SUPPLY DURING THREE DEPRESSION PERIODS, 1870-1880, 1890-1900, AND 1929-1939



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The automobile industry, which has been discussed before you at some length, is a classic example of a technological innovation that, in the past, had created more jobs than it destroyed and also provided important indirect support to employment through its effect on investment and income. That such an effect of technological change is by no means universal can be seen by a glance at our industrial history since 1920. The country's manufacturing industries were, throughout that period, subject to continuous and cumulative technological changes. The effects of these changes on labor requirements are reflected in the measures

of increased labor productivity which are embodied in several of the National Research Project's reports. Many of these data have already been presented to you by Dr. Kreps and others. These increases in labor productivity were, during the 1920's, usually accompanied by increases in production. But in the face of the rate at which technological improvements were taking place, the increases in production were not great enough. The manufacturing industries, although their production increased by about 50 percent during the 1920's, showed virtually no increases in employment. Other industries which prior to the World War were relied on to provide an increasing number of jobs for our growing population not only failed to continue this traditional role but in many instances also failed to maintain their previous employment levels. Mining and the railroads registered substantial declines. Employment in agriculture declined during the war period and showed no increase during the twenties.

These increases in the productivity of labor represent continuations of past trends in our economy. The particular feature of recent developments is the important part played by a multitude of refinements and improvements which are a day-to-day outgrowth of developing science and technology. The revolutionary changes which are associated with the initial shift of an industry from a handicraft to a mass-production basis pave the way for a continuous chain of less spectacular changes which may be even more important with respect to their effects on labor productivity. Drastic changes which result in the direct displacement of workers are by no means a thing of the past, as you heard in the descriptions of the introduction of the continuous-strip mill by an earlier witness. Today, however, such changes rarely occur. The typical changes in industrial processes at the present time are the day-to-day improvements of already existing equipment; they are usually not spectacular, and many of them require relatively small capital outlays.

Thus the development of tungsten carbide steel has made it possible to increase the operating speeds on machine tools as much as thirtyfold without any important additional capital outlay. Metallurgists have also developed more easily machinable alloy steel which has enabled many manufacturers to increase the output per unit of labor time by 30 to 50 percent. The important part played by increased knowledge of chemical changes and its application to industrial processes is illustrated by the introduction of organic accelerators which reduced the time for curing rubber tires by one-half to two-thirds with only small attendant capital outlays. Thus, operating costs and labor requirements have been

significantly reduced by a series of refinements which create small or no investment opportunities.

Many of the improvements and refinements in machines are associated particularly with equipment of large capacity. Aside from improved design, size is frequently an advantage in and of itself. Large-capacity equipment frequently requires no greater operating labor per operating unit than smaller equipment. Furthermore, the cost of manufacturing a particular type of equipment does not usually increase proportionately as the capacity of the machine increases. Accordingly, the capital investment per unit of capacity usually decreases with an increase in the size of the equipment. In the petroleum-refining industry, for example, for one type of equipment operating costs per unit of capacity for the large units are only about one-third as great as for the small units. Similarly, investment per unit of capacity is only about one-third as great for the large as for the small units. These economies of large-capacity equipment are available principally to the large enterprises. This is a result of both the technical possibilities of large-scale production and the availability of funds for investment.

Other types of technological change which accrue principally to large enterprises are the mechanization of handling and the introduction of continuous processes. The most important economies associated with these changes follow the reorganization of plant lay-out to assure the continuous flow of materials and the necessary synchronization of one operation with another, that is, by improvements in the organization of production - an important phase of recent technical advances. I should like to illustrate this by reference to the conveyor assembly-line system of production which has effected spectacular economies in such mass-production industries as automobile and radio manufacture which involve the assembly of numerous parts. The elimination of handling labor by the conveyor is only a small part of the total economies effected. Labor productivity is increased principally through the reduction in stoppages and the increased intensity of labor whose speed is to a very large extent set by the speed at which the belt operates.

In large-scale industries working with homogeneous materials, the introduction of the continuous-process principle has effected equally great economies but has been accomplished somewhat differently. Previously distinct operations have been integrated either directly or through the use of mechanical conveying equipment. The necessary synchronization is accomplished largely with the aid of instruments, and much operating as well as handling and storage labor is eliminated. In many of these

industries, notably electric power, petroleum refining, steel, glass, paper and pulp, and chemicals, after two decades of such developments, entire departments and plants are now operated from central instrument panels at which a few operators are stationed.

Such recording and controlling instruments, employed in large, highly mechanized plants, are an example of the type of equipment, auxiliary to the principal production units, which has found extensive application in recent years. Such auxiliary devices have involved only small capital outlays in relation to the economies which they made possible. Numerous instances could be cited to show the reduction in operating costs effected through the precise regulation of processes with the aid of such instruments. According to one of the Project's studies, the expenditures for controlling and measuring instruments per \$1,000 of machinery rose from less than \$4 in 1919 to more than \$14 in 1939. The increase in the use of industrial instruments which automatically control the operation of machinery or processes has been especially notable. As a percentage of total sales, controlling instruments have risen from 8 in 1923 to more than 35 at the present time.

Not only are the larger enterprises the principal beneficiaries of the typical developments in industrial techniques, but they also possess the organization for systematic technical advance through organized industrial research. As one of the Project's reports has shown, the number of workers engaged in industrial research has increased fivefold during the past two decades. It is estimated that in 1940 close to 60,000 research workers are employed. This work has been concentrated in the hands of relatively few companies; one-half of the research personnel is employed by about 50 large corporations. Approximately 2,000 other concerns employ the other half of research personnel while more than 150,000 manufacturing companies do not maintain any organized research. In nine leading industries, one-fourth of the companies that operated laboratories in 1938 employed between 56 and 90 percent of the research workers in the respective industries.

Now, there are certain points which I should like to stress with respect to the characteristics of recent technological developments.

First, the establishment of the basic machine techniques which was accomplished in the bulk of manufacturing industries before 1920 has multiplied rather than restricted the opportunities for technological change. There is therefore no reason to expect any cessation in the rate of increase of labor productivity since it can be expected that as

mechanization continues fresh opportunities for improvement will unfold themselves.

Second, while revolutionary changes in technique are still occurring, the emphasis in the recent period has been on detailed improvements in established techniques. These latter changes are, however, extremely pervasive; in time they cut across the whole production processes of an industry and spread from industry to industry. Their cumulative effect on labor productivity and their threat to the security of workers has been far greater than the occasional, spectacular, revolutionary changes.

Third, it is important to note that technological advances may be reflected in a reduction in labor requirements outside of the establishment in which they occur. Illustrative of this is the reduction in the demand for coal as a result of improvements in the efficiency with which coal is burned. One of the Project's studies shows that fuel consumption per unit of output was reduced by almost 80 percent at central power stations between 1899 and 1936, by 32 percent on steam locomotives between 1917 and 1936, and by 16 percent at cement plants between 1914 and 1935. The difficulties of the coal miners are in no small degree ascribable to this technological development outside of their own industry.

Fourth, the nature of recent technological changes has been such that significant increases in labor productivity have been accomplished in many instances without important additions to capital investments. The studies of the National Research Project present a mass of information covering changes in technology and productivity during the last two decades or more. During the last decade the emphasis has been on technological changes of a labor-saving rather than plant-expansion character. This is reflected in the Project's findings on recent types of changes and on productivity in mining, manufacturing, transportation, communication, and power production. Notwithstanding the fact that many factors operate to reduce productivity when production is curtailed, the findings show that productivity continued to increase in most industries even during the decline of the early thirties.

In many instances, old and fully depreciated machines are replaced by improved machines which are capable of much higher outputs but which do not involve an increase in investment. The economies effected through the use of auxiliary equipment are frequently accomplished with only small capital outlays. In many cases, moreover, the smaller capital outlays involved in the use of auxiliary equipment are a substitute for

the larger capital outlays involved in the construction or in the equipping of new plants for additional production capacity. Although the introduction of handling and conveying equipment involves considerable investment, there is frequently no increase in investment per unit of output, since the initial outlays are offset by savings in space, the fuller utilization of equipment, and the reduction of raw-material inventories and storage.

The fifth point I want to make with respect to recent technological developments is that they are obtainable principally by the larger concerns. There is evidence that in many industries the small concerns are being forced out of business because they cannot keep abreast of new technological developments. In testimony presented to you by an earlier witness, the elimination of many small steel mills was attributed to their inability to employ the new processes. In the bulk of American industry, the trend toward the elimination of small enterprises and the concentration of production in large corporations is an observed fact. Our studies have shown that this trend has a technological basis in the advantages in production costs gained by the organization of production in large plants, by equipment of large capacity, and by many types of special-purpose equipment which aid in economies of production while they add little to capital requirements. The economic advantage possessed by large enterprises with respect to the utilization of labor has been reflected in most of the manufacturing industries studied by the Project. In mining operations, also, the benefits of mechanization tend to accrue to the larger enterprises, and mechanization in agriculture favors production on larger farm units.

One more point. The strengthening of large enterprises through technological changes has its basis not only in the characteristics of their production techniques but also in the concentration of research. This concentration tends to widen the technical and economic advantages of large enterprises over smaller ones that are without research facilities and cannot keep pace with new scientific developments. This factor is important in any evaluation of the prospects for the development of new industries and new products on a scale sufficiently great to constitute a demand for capital goods substantial enough to stimulate general recovery. In considering the prospects for new industries developing out of current industrial research, it must be remembered that though the companies which finance this research are interested in the development of new products they are also concerned with the safeguarding and improvement of their existing investment in plant and equipment.

I have earlier referred to recent types of technological changes which find application typically where production is organized on a large scale. This is doubtless in part ascribable to the fact that most research is done by large enterprises which naturally concentrate on their own problems. The characteristic technological advances which they develop cannot usually be applied in small enterprises, either because finances are wanting or because the techniques cannot be employed on the production scale of such enterprises. Yet this is not a necessary development in all industries. Efficient production does not necessarily exclude small-scale operation, provided the technological base is studied specifically with a view to improving it; I am certain that in some cases, at least, research can fruitfully be redirected to problems of the small enterprise.

Some means should be developed for making the results of scientific research more generally available to small as well as large enterprises. Greater emphasis should be given to industrial research directed toward the development of new products or industries and to those technical problems which are peculiar to the small and medium-size producers now without adequate research facilities. Such a development, encouraged and perhaps in part supported by government, may make it possible not only to employ all of our trained scientific personnel but also to stimulate capital investment.

Up to this point I have sketched the economic role which technological change has played in recent years. I come now to the second subject, namely, the effects of technological changes on workers.

The process of industrial change is by its very nature accompanied by a constant displacement and reabsorption of labor. New occupations, plants, and industries come into existence while old ones decline, new areas become industrialized while old ones become "stranded", a technological change results in a new product or process that displaces an old product or process, job requirements are altered, fewer workers are needed to meet the requirements of production, and as a result workers lose their jobs. Under these circumstances, even when such changes are accompanied by an absolute increase in the total amount of employment offered, unemployment of individuals and groups of individuals is continually being created because of changes in the location of activity, transformations in the nature of the employment offered, or changes in the types of persons hired.

One of the most important factors in changing the location of economic activity has been the persistent relative decline of agriculture as an

employer of our Nation's labor. As the technique of production in agriculture has been steadily altered and improved, it has been possible to produce food and raw materials for a growing population and an expanding economy with an ever-dwindling proportion of the Nation's workers. In 1870, for example, more than half the working population was engaged in agriculture. Today only a fifth of the population is so engaged, and a large share of this fifth is no longer necessary to produce the volume of agricultural products which we consume. One result of this marked decline in opportunities on the land has been the migration of approximately 2 million persons annually from the land to the cities in search of industrial employment. Industry, however, even in the 1920's, was unable to absorb this tremendous extra supply of labor that was "released" from agriculture. This is reflected in the fact that the twenties saw annually an average of $1\frac{1}{2}$ million persons leave the cities to return to the land. That is to say, some $3\frac{1}{2}$ million migrations took place annually in this country as a part of the search for jobs.

The accumulation of people unable to secure employment and unable to maintain themselves on the land is continuing. Although there has been some reduction in the amount of migration from the land, this slackening is not caused by a lessening of the problem conditions on the land but by the development of severe depression conditions in the cities. As a result, there are uncounted persons dammed up on the land who in recent years would have moved to the cities had conditions there warranted the hope that they might find employment. They constitute an unemployed reserve for industry that has not even been tapped, and one which is growing steadily. The continuation of technological changes in agriculture impels them to move, but in the current industrial situation there is no place for them to go.

Another broad industrial change which has been constantly creating unemployed workers, even in periods of generally rising activity, is that which results in the transfer of the location of industrial activity. America is dotted with cities and towns which have declined from the days when they were flourishing commercial or industrial centers. As methods of transportation and communication have changed, many a canal and river town lost its locational advantage. As automobiles, trucks, and improved roads made large cities more easily accessible, many a rural shopping and marketing center has lost most of its trade. Stranded towns abound in areas where once rich deposits of coal, or timber stands, or bonanzas of ore have been exhausted, or where industries have lost out in the competitive struggle with industries in other areas. Thousands

of skilled textile workers have been left stranded in New England towns when mills either moved southward or went out of existence because of their inability to compete with southern manufacturers. Over 200,000 coal miners lost their jobs between 1923 and 1929 when 3,000 commercial coal mines closed down. The better utilization of coal and the increased use of other fuels cut into the market, and what demand was left went to the technologically more advanced mines.

In a true sense the populations that are left behind represent a group stranded through the operation of industrial and technological change. Their situation represents a pressing phase of our general unemployment problem which will continue to exist short of an extraordinary expansion of productive activity.

As examples in this connection, I would like to refer to some studies made by the WPA in various localities.

In 1935, the year in which the great Amoskeag mills of Manchester, New Hampshire, were shut down, more than 17,000 different persons had had employment in these mills. After the shut-down, there were few other jobs to which the displaced workers could turn. In a field survey conducted late in 1936 only two-fifths of the men interviewed and one-fifth of the women had had any work since their last Amoskeag job in 1935. Only one-third of the men and one-sixth of the women were employed at the time of the interview. Of the total man-months elapsed between the last Amoskeag job and October 1936, only 15 percent were spent in employment. Under these circumstances the need for relief became acute and continued to be so through the ensuing years. About one-quarter of Manchester families were receiving general assistance or WPA work in 1937. In 1938 the average rose to the level of almost 29 percent.

Somewhat similar situations prevail in several of the declining Massachusetts textile centers. New Bedford is a good example. It had 31 cotton-textile mills running in 1920 and employed 34,000 textile workers. While new plants in the South have flourished, New Bedford has slipped backward. By 1937 the number of cotton mills had been cut to 17, and the 34,000 millworkers employed had shrunk to 14,000. Between 1937 and 1938 another 6,000 cotton-mill workers were thrown out of work. During the two decades since the World War, New Bedford cotton textiles have lost almost four-fifths of their workers.

In spite of some new industry, New Bedford is clearly a chronically depressed community. About a year ago, 30 percent of all the available workers were jobless. Among workers whose last job was in the cotton

mills, 37 percent were unemployed, and their average duration of unemployment was a year and a half.

Brazil, Indiana, presents a similarly drastic situation affecting a somewhat smaller population. As a result of the general decline of coal-mining operations in the region and the collapse of the clay-products industry in the early thirties, more than a third of the employables in the community were unemployed in 1936. During the 3 years preceding 1936, the number of different persons who had received public assistance of some kind was equal to 71 percent of the 1930 population.

A block of counties in southern Illinois where coal mining is the major industry presents another clear-cut example of a depressed area with a large stranded population. The decline of activity in these counties (Franklin, Saline, and Williamson) began well before 1929 and had, by 1939, reached the point where two-fifths to one-half of the available labor force was without private employment.

The peak year of employment was in 1923 when 36,000 workers were employed in 105 shipping mines. By 1937 the number of these mines had declined to 40. With mechanization, the man-day output of the surviving mines had risen from 4.9 tons in 1923 to 8.8 tons in 1938, and at the same time approximately 5,000 additional men were displaced. In all, mine abandonment and technological advances had reduced employment opportunities by about two-thirds - from 36,000 workers in 1923 to 12,500 in 1937.

The cumulative effects of these developments on the community are shown by an unemployment census conducted in these counties about a year ago. At that time approximately 42 percent of the total labor force was unemployed, and about three out of five unemployed workers were dependent upon the WPA.

With respect to changes in the nature of jobs as distinct from their location, there can be no doubt that technological changes markedly influence the quality of labor requirements. Whatever may be the trends in production and employment at any time, the first effects of changes in techniques are the displacement of workers, changes in the kind of labor required, and, as Mr. Murray's human exhibit so tellingly illustrated the other day, the obsolescence of particular skills and occupations. These often result in the need for unemployment relief even though, eventually, there may be increased demand for another type of labor somewhere else. The effect has been different in different occupations. Technological changes have favored semiskilled jobs at the expense of both the highly skilled and the unskilled workers. In many

cases new skills must be learned. Frequently the new jobs are lower in the occupational scale. Often it is a matter of months and sometimes several years before reemployment takes place. For the older worker it frequently means permanent unemployment.

The National Research Project's studies have shown that the jobs of factory production workers are steadily becoming more simplified as machinery is made more automatic or more specialized, and as production methods are otherwise improved by management. Where an entire process is rendered highly automatic and continuous, both unskilled and skilled workers are eliminated. On the other hand, where auxiliary devices, such as recording or controlling instruments, simplify the method of work by eliminating operations which formerly required long training and great dexterity, semiskilled labor may be substituted for highly skilled workers. This reduction in skill requirements is naturally a prime objective of management, since the wages of unskilled workers are lower than those of the skilled, and unit labor costs are consequently reduced by the change.

While stranded communities present a spectacular type of problem because of the concentration and isolation of the unemployed group, our studies have indicated that industrial changes which alter the nature or volume of demand for certain types of labor can create special groups of workers who are as effectively stranded in a highly diversified industrial community as those residing around the tipples of shut-down coal mines.

The textile industry provides examples of a number of such occupations. Weaving and loom fixing in the woolen and worsted, carpet and rug, and upholstery-goods industries require a high degree of skill which cannot be used in other industries. These occupations have been declining since the early 1920's as a result of the introduction of more automatic looms and also because of a decline in the demand for the product of these industries. In Philadelphia, the center of these branches of the textile industry, 29 percent of the weavers and loom fixers were unemployed in May 1936. One-fifth of these unemployed had lost their last regular job earlier in that year. Twenty-eight percent had lost their jobs in the previous year, 1935, 13 percent in 1934, 12 percent in 1933, 7 percent in 1932, and 20 percent prior to 1932. That is, one-fifth had been unemployed continuously for more than 5 years.

A sample study of the work experience of a group of unemployed railroad workers indicates that there also, because of the limited transferability of their skill to other industries, displaced workers were

able to find little work in other industries. Moreover, the longer the attachment to the railroad industry, the more difficult it was to find work outside of this industry. The proportion of workers finding other work during periods of interruption of railroad employment ranged between a high of 63 percent for those with less than 5 years' service to less than 10 percent for those with service records of 30 years and more. The factor of age is, of course, partially responsible for inability to find work in other industries, and long years of attachment to an industry coincide with advancing age. Thus, when such workers are displaced, they are at a double disadvantage in finding work in other industries or occupations.

The effect of changing skill requirements as a result of mechanization is illustrated by our study of cigar makers after the process was converted from a system employing hand workers to one utilizing machinery and machine operators. One of the major results is the fact that the skill of the hand cigar maker is not needed at the new process, and women are generally substituted for men. In our study, 5 years after the lay-off, 13 percent of the men were self-employed cigar makers and another 17 percent were employed by others in the cigar industry. Though many of them searched for work as cigar makers, the majority did not find it, and 25 percent of them found no work at all during the 5 years.

With these and other economic factors constantly augmenting the labor reserve, the size of which has been swollen to tremendous proportions as a result of the long continuation of depression conditions, certain special problems have developed within the general unemployment problem. Because of their age, their sex, their race, their skill or lack of skill, the nature of their previous experience, or even because of the length of time they have been unemployed, certain workers face particular difficulties in securing jobs. In a labor market crowded with aspirants for whatever job openings arise, they are passed over in favor of other job seekers who appear more desirable to the employers.

One of the most tragic of such special problems is that of the youth entering a labor market already crowded with experienced job seekers. The young people on the farms face perhaps the most desperate situation. They are growing up in a situation where, with advancing technology, agriculture is unable to provide a livelihood even for those who were formerly associated with it. In the cities also, particularly where opportunity has been declining or stagnating, the youths unable to secure even a first job in industry have been a most important element in the general unemployment situation. In Philadelphia, for example, 7 percent

of the total unemployed in 1933 were workers who had never secured a first job; by 1936 this proportion had reached 20 percent of the unemployed and by 1937, 21 percent.

While it may be impossible to designate the unemployed youth of this country as technologically displaced, it is nevertheless true that our production activity has failed to keep pace with productivity advances, that in spite of production levels almost equal to those of 1929 there were no jobs for them in 1939, and that as a result this important group is losing valuable years in which it might be fruitfully employed and contributing to our economic life. Practically the only attempt made to meet this problem was that of the Federal Government, through the WPA, the NYA, and the CCC.

The older worker also faces a situation of increasing difficulty. Studies made by the National Research Project and others have shown that while the older worker may have some advantage in maintaining his job because of the value of his experience, once he is displaced he is less likely to regain his job and far less likely to secure another job. The result of this and other tendencies to pass over certain workers in filling jobs from a crowded labor market has been the creation of a group of chronically unemployed, who constitute one of the most serious aspects of our unemployment situation. For the passage of time itself proves to be an important factor in the distribution of employment opportunity, and those longest unemployed are likely to have the least chances for jobs for that reason alone. Such evidence as there is points to an increasing seriousness of this problem - an increasing number of able and willing workers who, in an economic setting characterized by a persistently large volume of unemployment, are chronically unemployed.

I would like to make a particular point with reference to these long-term unemployed. In Philadelphia, a diversified metropolitan labor market, we made a special study of this problem in 1936. The group we studied not only had suffered unemployment of long duration but they had also been continuously on relief or the Works Program for at least 2 years. They were, then, one of the groups hardest hit by the depression. Over 30 percent of them had not had a private job for more than 5 years. These long-term unemployed numbered 20,000, or one-fifth of Philadelphia's relief load at the time of the study. They were an unwanted part of the labor market, but they were certainly not an undesirable part. By every available test these people were employable. They were out of work only because, relative to other job seekers, they had some disadvantages of age, sex, race, or type of occupational experience. The

disadvantages affected not their ability to work but only their ability to get jobs.

In all, the situation that has developed, the widespread unemployment and underemployment, the inability of the younger workers to find a place in our crowded labor markets, and the increasing chronic unemployment, particularly of our older workers, presents a wide variety of problems for which a solution must be found.

It must be emphasized that both the general and the special problems which have been indicated here are by no means temporary. The process of rapid technological and industrial change will continue to raise problems through prosperity and depression, as the process of displacement and reabsorption of workers continues. They are aggravated during periods of depression, particularly as in the present situation, when widespread and long-continued unemployment adds new considerations and raises new questions as to reemployment prospects of the persons affected. Any attempt to gain full employment of our manpower must take into account technological change and its action in continually jeopardizing the job security of workers.

I should now like to draw some conclusions.

The effects of technological change on employment and unemployment present two distinct sets of problems. We have, on the one hand, the situations where particular groups of workers, in specific industries or localities, have been reduced to a condition of unemployment as a direct effect of technological changes. Such situations exist even at times when business is prosperous and employment opportunities are plentiful. We need only to recall the situation which prevailed, even at the height of prosperity in the late twenties, in some of our agricultural areas, in sections of our textile industries, and in some of the coal-mining districts. Such situations will be recurring even at the best of times. The adjustment, whether through migration, retraining, or development of new employment opportunities, may be a long process, much too long to be taken care of by present systems of unemployment insurance. A permanent work program would be well suited to meet such situations. It would help maintain the work habits and morale of the displaced workers and would aid them in the acquisition of new skills in a manner that would yield returns not only to the individuals concerned but to the community as well through the execution of socially useful projects.

A different type of situation confronts us in times of declining business. The groups of workers who are unemployed directly or indirectly

as a result of technological changes are many and varied. There are, first, those directly displaced by labor-saving devices introduced during the depression. But in addition to these there are others whose unemployment reflects the previous course of technological progress, although not always in a directly traceable manner. They are the ones whose previous employment was in technically backward or temporarily revived plants, and those whose employment was contingent upon equipment installations during prosperity when technological change went hand in hand with plant expansion but who were dispensed with once the construction was completed.

In periods of depression, with widespread general unemployment, these displaced workers became one additional element of an excessive labor supply. Although their existence in the labor market tends to reduce the general chances for reemployment, they are not necessarily the ones whose opportunities are lowest. In the general scramble for jobs they are not necessarily the ones doomed to constitute the "hard core of unemployment." They do, however, tend to make the core harder and heavier and to make the criteria of selection on the part of the employers more stringent.

The incidence of displacement of labor through technical improvements in a depression is thus not limited to any particular group of workers, but its effects are diffused through the labor community. Remedial measures can therefore not be viewed as a matter of mere readjustment of any concrete group or groups. The maintenance of a flexible work program becomes a matter of necessity under such conditions, but the fundamental problem is that of remedy against unemployment, the problem of recovery.

In the comparative recovery achieved since 1932-33 the main drawback has been the lag of the capital-goods industries. Technological improvements introduced in recent years have been many and they have had very substantial effects on the productivity of labor and on reducing costs of production. But, as I have pointed out, those effects have in many instances been achieved without incurring capital outlays large enough to develop that cumulative demand for capital goods which is necessary for recovery. As a result of the available technical improvements, not only cost reduction but also the expansion of productive capacity can be, and in many instances has been, effected with comparatively small capital outlays.

As long as technical trends of this nature continue to prevail, a growth of demand for capital goods in a volume requisite to make the re-

recovery cumulative can be expected only from a flow of investments that is directed at quantitative expansion of production on a vast scale. The failure of private capital expansion in the thirties not only resulted in the lack of employment in the capital-goods industries but contributed to a further reduction in purchasing power by withdrawal of savings from the economy which were not reinvested. This failure of private capital expansion and the increasing productivity during the thirties had to be offset to provide employment. This necessitated the large-scale works programs as measures for the relief not only of the unemployed but also of the capital-goods industries.

The problem of income distribution is, of course, an important part of the problem of full employment. The increases in wage rates as a result of the spread of collective bargaining and minimum-wage and maximum-hour laws, the expenditure of funds for public works, emergency work projects, unemployment insurance, and other forms of social legislation and relief have contributed to the removal of some of the deficiencies of the distribution of income during depression years. But, with a view to bringing about full utilization of our resources, we need, in addition to the public policy of strengthening the purchasing power of the mass of consumers, a policy of directly promoting an expansion of demand for capital goods by direct investments by public bodies in large-scale undertakings and by stimulating private investment in other directions.

Public capital investment has, of course, and of necessity, always been a contributing factor in developing opportunities for private investment - notably in transportation facilities. The public development of streets is a necessary condition for the growth of cities and the development of local construction; the development of harbors and navigable rivers was a necessary condition for the growth of national and international commerce; use and development of railroads were necessary conditions for the growth of domestic commerce; Federal land grants and subsidies were a necessary condition for development of the railroads; the development of hard-surfaced highways was a necessary condition for the growth of the automobile industry; and the construction of airports for the growth of air transportation.

Capital requirements for the phenomenal expansion of the use of the automobile are not limited to the planned facilities required for their production, for the replacement of parts, and for providing the fuel for automobile operation. The expansion and use of the passenger car, the truck, and the bus depended upon Federal, State, and local cooperation in building roads. Total expenditures on streets, roads and highways,

and bridges and tunnels thereby rose in rank second only to education in total public expenditures. Among other transportation agencies, aid to the new aviation industry was provided as early as 1926 by the Air Commerce Act, and the successive emergency work programs have established airways and constructed airports and landing fields. More recently a legislative provision has been made to aid in the construction of ships for a Merchant Marine.

Federal, State, and local outlays for all types of construction formed a substantial proportion of the demand for capital-goods production during the 1920's. This public investment, in addition to supplying the needs of private industry, aids the expansion of the capital-goods industries, and therefore multiplies the amount of employment created and thereby expands the purchasing power of the Nation for more consumers' goods.

Reductions in hours of work would help to maintain employment; increases in wage rates would increase consumption and employment; special programs have been developed and are required to meet the special problems of youth and the aged. But the solution of the major serious problem of unemployment necessarily depends upon full utilization of our resources and manpower - the problem defined by the President, by the Committee, and by the witnesses appearing before the Committee as idle men, idle machines, and idle money.

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