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TECHNOLOGICAL CHANGES IN
RELATION TO WOMEN'S EMPLOYMENT

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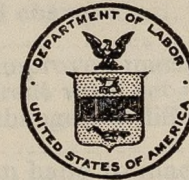
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TECHNOLOGICAL CHANGES IN RELATION TO WOMEN'S EMPLOYMENT

By
ETHEL L. BEST



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RELATION TO WOMEN'S EMPLOYMENT
TECHNOLOGICAL CHANGES IN



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ILLUSTRATIONS

Table of illustrations listing items like 'Air knives and other tests for transmittal', 'Flexible shaft power screw driver on assembly line', 'Assembling telephone receivers on conveyor', 'Inserting screws in blank-book covers', 'Feeding a soap-wrapping machine'.

LETTER OF TRANSMITTAL

UNITED STATES DEPARTMENT OF LABOR,
WOMEN'S BUREAU,
Washington, July 1, 1935.

MADAM: I have the honor to transmit a report based on inquiries by the Women's Bureau into technological changes involving the employment of women. Management in 115 factories, including some of the best-known in the United States, supplied descriptions of the changes that had taken place between 1921 and 1931—especially in the second half of such period—and their effects on numbers employed, on wages, on production, and on labor costs. More than 1,000 interviews were had with women affected by the changes, who supplied personal information, a comparison of the jobs before and after the changes, and the amounts of their earnings.

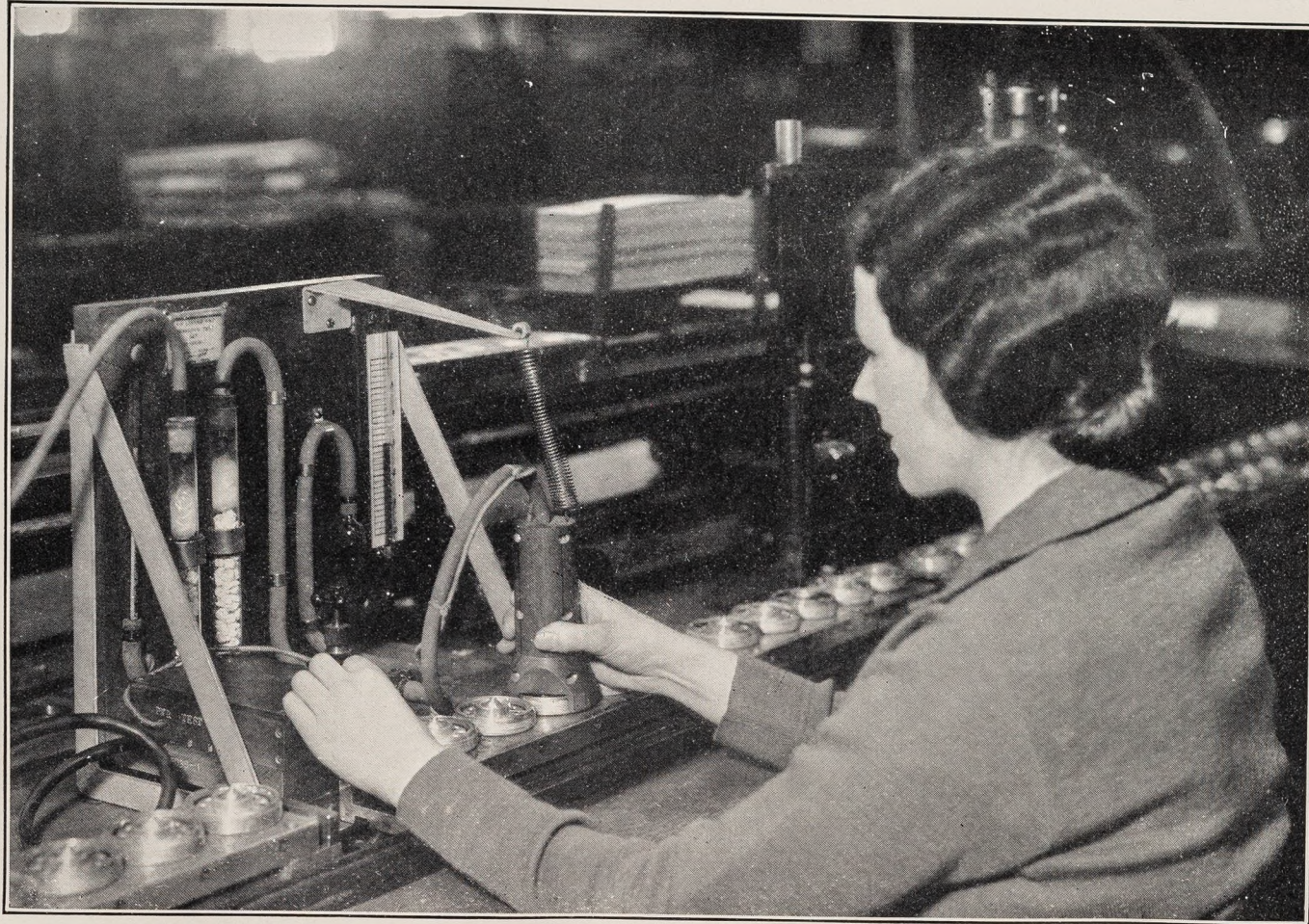
I greatly appreciate the courteous cooperation of employers and of employees in making this study possible.

The survey was conducted and the report has been written by Ethel L. Best, industrial supervisor. Caroline Manning, industrial supervisor, assisted in the field work.

Respectfully submitted.

MARY ANDERSON, *Director.*

Hon. FRANCES PERKINS,
Secretary of Labor.



AIR LEAKAGE AND OTHER TESTS FOR TRANSMITTERS.

TECHNOLOGICAL CHANGES IN RELATION TO WOMEN'S EMPLOYMENT

INTRODUCTION

The serious problem created by the rapidity of the process of technological improvement in American manufacturing is the increased capacity to produce and the inability of the public to buy enough goods to keep machines and workers steadily employed. An enormous supply of goods produced by fewer workers at a lower labor cost does not take into consideration the fact that the consumers' ability to purchase—and consumers are chiefly wage earners—must keep pace with production if there is to continue the unbroken round of wage earning and spending, consumption and demand, production and employment, wage earning and spending, and so on, that is necessary to prosperity.

The process of mechanization has been continuous since the first tool was created as an aid to man's work. For centuries the change was slow and spasmodic, but with the invention of power-driven machinery over 150 years ago the pace was greatly accelerated and one invention was quickly followed by another. This inventive process has been tremendously stimulated since the World War. Competition for both home and foreign markets has become keener with the increase of technical knowledge in all the countries of the world. The introduction of a new machine or a new method of operating may mean the life or death of a factory or even the substitution of the product of one industry for another.

Every effort is being made constantly to render costs lower and production more efficient by the introduction of new and improved machines, of more automatic devices, of better tools, and of more effective use of man power. The effect of these changes increases the productivity of the worker enormously and reduces the number of workers required, on some operations almost to the vanishing point. As a superintendent in a knitting mill expressed it, "Before long we won't need workers, the machines are so perfect; but unfortunately machines don't wear stockings."

According to indexes of production of the Federal Reserve Board the output per worker in manufacturing was approximately 45 percent greater in 1929 than in 1919 and this was accompanied by a decrease of 10 percent in the number of wage earners. This increase in efficiency at the expense of the number of available jobs is shown also by the fact that in every previous decade the workers employed in manufacturing had increased not only absolutely but relatively to the total population.¹

¹ Douglas, Paul H. Technological Unemployment. American Federationist, August 1930, vol. 37, p. 923.

Mr. Mentor Bouniatian, in an article in the *International Labor Review*, points out the fact that productivity per worker in manufacturing industries in the United States during the 14 years from 1899 to 1913 increased 16.3 percent, whereas in the 6 years from 1921 to 1927 it rose 40 percent.²

Improvements in machines and in operating have taken place in practically every industry. In the shoe industry the time required to make 100 pairs of shoes in 1916 was 142.7 hours; in 1923 it was 106.9 hours.³ In a cotton mill output per man hour increased 111 percent from 1919 to 1925.⁴ The labor cost of manufacturing pint milk bottles decreased from 75 cents to 10 cents a gross by the introduction of a new machine.⁵

Examples similar to the foregoing could be cited in every industry, but to obtain a definite picture of the many changes and their effects in even one industry is an almost impossible task. Miss Elizabeth Faulkner Baker, in her study of the displacement of men by machines in the printing industry, presents some of the difficulties of collecting information and what she says may be widely applied to all industry: "The present study, therefore, bears witness to the difficulties of looking in from the outside upon an industry in process of change."⁶ In her study the introduction of machines in single shops was gradual—men were transferred from job to job and there was an absence of records; several methods therefore were used, statistical, descriptive, and inferential.

Technological change is, in short, no finished process, the effects of which are being studied, but only part of a moving picture that is being examined as it goes by. The facts and statements obtained in this study give a picture of what has been going on for many years, is going on now, and will be for some time to come. The effect on industry and on the worker varies in proportion to the speed of the process, and because during the past 15 years the change has been so rapid its effects have been more widespread and severe than ever before.

There is a sentence in the report of President Hoover's Research Committee on Social Trends that reads, "More widely in the future than in the immediate past we may expect the growth of thinking about the meaning of the great masses of social data which we have become so expert and generous in assembling."⁷ The matter of technological changes in industry is one of the most important questions that the growing concern of the American people with industrial and labor problems must grapple with.

SCOPE AND METHOD

All efficiency changes in manufacturing are for the purpose of more efficient and cheaper production of goods, and they affect not only the cost at which these goods can be produced but the number of workers employed, their remuneration, and the conditions of their work.

² Bouniatian, Mentor. Technical Progress and Unemployment. In *International Labor Review*, March 1933, vol. 27, p. 328.

³ U. S. Bureau of Labor Statistics. *Monthly Labor Review*, November 1932, vol. 35, p. 1043.

⁴ *Ibid.*, October 1926, vol. 23, p. 28.

⁵ Barnett, George E. *Machinery and Labor*. In *Quarterly Journal of Economics*, August 1925, vol. 39, p. 546.

⁶ Baker, Elizabeth Faulkner. *Displacement of Men by Machines*. Columbia University Press, 1933, pp. vii-xi.

⁷ President's Research Committee on Social Trends. *Report. Recent Social Trends in the United States*. Vol. I, p. lxii. New York, McGraw-Hill Book Co., 1933.

Information on the different operating changes and their results, especially those to the workers, is relatively slight. There are many reasons for this absence of data. Technological changes usually are gradual and frequently are complicated, two or more taking place at the same time. Even with the best engineering skill, in many cases it is a matter of trial and error; the first plan is altered for a better one or additional changes are introduced. Accurate records are always difficult to keep and in time of change especially so. Afterward one can often see what comparisons should have been made and what pertinent records might have been kept, but at the time the foresight and even the personnel for this work is lacking in many cases. For these reasons the effect of changes on output and costs is difficult to obtain, and there is even greater difficulty in securing the results of technological change for the worker. As a rule studies on this subject have been made in as limited a field as possible, one change in one industry being selected for study, and little attention has been paid to the effect on the workers and their reaction to the change.

No attempt has been made in the present study by the Women's Bureau to investigate all changes that have occurred in any one industry nor to follow any single change through many industries. It was realized that thousands of technological improvements have been made and are now taking place that revolutionize methods of work. No one survey can do more than illumine one angle of the problem. The Women's Bureau is interested primarily in the effect of this continuous process of technological change on the women who work at the machine and at the bench in the many factories throughout the country. With 1,886,307 women in manufacturing and mechanical industries,⁸ it seemed worth while to collect not only examples from management of the many technological changes but from the women themselves the effect of these changes on them and their work. Neither time nor money was available for an exhaustive study, so the method used was to inquire into certain types of technological change and their effects on employment, production, and costs in factories visited by the Bureau over a period of years beginning in 1930. The various types of change reported on, occurring in many industries, at least indicate the principal kinds of changes in women's work and their results.

The Women's Bureau, because of its interest in the working woman, considered it important to ascertain the types of technological changes taking place where women were most involved, and the effects of these various changes on them and their employment. Therefore all the changes selected for study were those in which women were principally concerned. The changes themselves were of widely different types and were found in many different industries, very few changes being peculiar to a single industry. There are certain changes, such as alteration in method of payment, in the substitution of one class of labor for another, and in the reduction of hours, that may not come under a strict definition of technological change, but they are included in this study because they were made to increase the efficiency of the plant and usually were based on engineering

⁸ U. S. Bureau of the Census. *Fifteenth Census: 1930. Population*, vol. IV, Occupations, p. 6.

studies. In a number of cases more than one change took place at the same time, and the results achieved were those from two types of change instead of from one.

Perhaps the most frequently found and widely distributed change was that of improved lay-out and better planning and routing of work. Conveyors or moving belts have been put into use in all industries wherever possible and often their introduction has occasioned considerable change in the work itself. The introduction of new and improved machinery also has been constantly carried on in all types of industry. The change might be from an old to a new machine, from a hand-feed machine to an automatic feed, from a single operating machine to a multiple, or from a less efficient to a more efficient type, but whatever the change there was frequently combined with it a change in personnel. Either the number employed was decreased, or women were substituted for men, or, more rarely, men for women. Altogether, these two changes alone, that involving a new set-up of the work and that bringing in new or improved machines, comprised well over one-half, 56.1 percent, of the 212 single examples of change and in addition were a part of each of the 38 double changes for which records were obtained. The change from hand to machine work was reported in 42 of the 212 and 9 of the 38 changes, respectively. (See summaries, pp. 7 and 8.) There were other changes, the principal one being the replacement of one class of workers by another (men by women in all but one case), usually termed substitution.

The substitution of women for men, combined with improved methods of operating, was the largest of the double groups, with 15 cases; the next largest, reported in 6 cases, also involved the substitution of women, but in this instance was combined with a change from hand to machine work.

It was found possible to obtain information as to effect on numbers of men and women employed in 241 of these technological changes; and though this is a fairly large number, it does not, of course, include all the changes in the areas covered but only the most frequent types of change and those for which records were available.

From management was obtained a description of the changes and their effects on numbers employed, on wages, on production, on labor costs, and on the comparative learning period on the old and on the new work. Effort was made to obtain the names and addresses and to visit as many as possible of the workers employed before the change, whether subsequent to the change their experience had been on the new work, on different work, or on no work at all. From these visits were obtained comparative earnings on the old and the new work, a comparison of the two jobs, and any comments regarding the change. More than 1,000 interviews (1,035), representing a fifth of the persons employed before the changes, were obtained. By far the largest proportion of the women interviewed had been employed on both the old and the new work; that is, both before and after the change. They constituted the largest group of women and were by far the easiest group to locate. Many of those not interviewed were no longer with the firm and could not be found; usually the only address obtainable was several years old, and many women had moved, some of them to other cities. Information on age, mari-

tal condition, and length of service also was obtained from the personal interview with the worker.

The material was collected over a considerable period and covered a wide geographic area. A total of 115 plants, in 32 cities in 9 States, were visited. They included some of the best-known firms in the United States. The cities were in the East and the Middle West and furnished a diversity of employment to women, except a few where employment revolved around a single industry. Records were obtained for 250 technological changes occurring in these establishments. Though it was not possible in every case to get all the information desired, for most of the changes the managements were able to state their effects on numbers employed, on production, and on labor costs. The information covered the period 1921 to 1931, but the great majority of the changes, 88 percent, were in the more recent 5-year period, 1927 to 1931.

There is every reason to suppose that the various technological changes reported in this study are indicative of the general character of the changes in which women are involved.

SUMMARY

Scope—115 plants visited in 32 cities in 9 States.

Period in which changes occurred—1921–31.

FIRM INTERVIEW DATA

Number of cases of change—250.

Types of change, single and combined:

- Improved machines.
- Operating changes.
- Hand to machine.
- Substitution of one class of workers for another.
- Different method of payment.
- Machine to hand.
- Shorter hours.

Employment on processes involved:

Before changes.....	6,401
After changes.....	3,604
Percent decrease (total).....	43.7
Women.....	42.0
Men.....	49.6

Type of change showing greatest decrease in employment was hand to machine with 70.5 percent.

Only change resulting in increased numbers was substitution, with 1.7 percent.

Numbers employed decreased in 53.4 percent of the changes reported.

Numbers increased in 8.6 percent of the changes.

Production:

An increase in production occurred in 69.6 percent of the changes reported.

A decrease occurred in 5.8 percent of the changes.

The amount of the increase was from 300 to over 1,000 percent in one-fifth of the cases reported.

Operating changes had the largest proportion of cases showing increased production.

Substitution was the change resulting in the least effect on production.

Labor costs:

Decreased labor costs resulted in 94.7 percent of the changes reported.

Increased labor costs resulted from only 2 changes, 1 where the change was from machine to hand and 1 where weekly hours were decreased.

Labor costs decreased at least 20 percent in 84 of the 106 changes where percent decrease was reported, at least 50 percent in 40 cases.

Where labor-saving devices such as conveyors, better tools, and different work set-up were introduced, labor costs decreased at least one-half in 45 percent of the changes reported.

HOME INTERVIEW DATA

Number of women interviewed.....	1,035
Percent transferred to new method.....	84.3
Percent on old method or transferred to other work.....	11.1
Percent laid off or quit (only a small number could be located).....	4.5

Earnings:

Earnings decreased after the change for 47.9 percent of the women reporting.

Earnings increased after the change for 30.7 percent of the women reporting.

Of the women earning less than \$16 previous to the change, 16.4 percent received less after the change and 51.4 percent more.

Of the women earning \$20 and more previous to the change, 59.3 percent received less after the change and 20.5 percent more.

An increase of at least 30 percent over previous earnings was shown for one-fifth (20.9 percent) of the women in the group earning less than \$16 and for less than 2 percent (1.8) of those earning \$20 and more.

A decrease of at least 30 percent under previous earnings was shown for 2.8 percent of the women earning less than \$16 and for 17 percent of those earning \$20 and more.

COMPOSITION OF GROUP INTERVIEWED

Nativity (1,033 women reporting):	<i>Percent</i>
Native born.....	79.3
Foreign born.....	20.7
From English-speaking countries.....	4.0
From non-English-speaking countries.....	16.7
Age (1,030 women reporting):	
Under 20 years.....	7.9
20, under 25 years.....	29.4
25, under 30 years.....	22.7
30, under 40 years.....	25.0
40, under 50 years.....	12.0
50 and over.....	2.9
Marital status (1,031 women reporting):	
Single.....	55.4
Married.....	37.6
Other.....	7.0



FLEXIBLE-SHAFT POWER SCREWDRIVER ON ASSEMBLY CONVEYOR.



ASSEMBLING TELEPHONE RECEIVERS ON ASSEMBLY CONVEYOR.

RESULTS OF TECHNOLOGICAL CHANGES

In a report of President Harding's Conference on Unemployment the following sentence appears: "Gradually the fact emerged during the course of this survey that the distinctive character of the years from 1922 to 1929 owes less to fundamental change than to intensified activity."⁹ Perhaps this "intensified activity" is best defined by Mr. P. W. Martin of the International Labor Office, who says, "Machines are made to run faster. One man is in charge of more machines. There has been a greater mechanization of the human factor itself."¹⁰ It might be added that together with these changes there has continued the replacement of hand processes by machines so that the product travels from one machine process to another, with little human aid. This is described by Prof. Rexford G. Tugwell as "the serialization of machines which tends to run the product through all the processes, from raw material to finished goods, without any, or very little, human intervention", and in which "the assembly line is the heart of the process, sets the pace, establishes the rhythm * * *." Another statement by Professor Tugwell is pertinent and is confirmed by the findings in this study: "* * * workers do not now, if they ever did, make or dominate the manner of work in which they are engaged. It is the machine, its serialization, the routine it establishes, which is the dominating condition."¹¹

In the survey with which this report is concerned many of the changes were of the character described by Professor Tugwell, namely, machine improvements and the operating changes or different work set-up. These two types, either as sole changes or accompanied by secondary changes, comprised three-fifths, 59.6 percent, of the total number of technological changes on which information was obtained.

The following classification of single changes is used in the report:

Total.....	212
Improved machines.....	78
Operating changes or different work set-up.....	41
Hand to machine.....	42
Substitution:	
Women for men.....	32
Men for women.....	1
Different method of payment.....	14
Machine to hand.....	3
Shorter hours.....	1

Of single changes, the first two listed cover a rather wide variety. Under the first, improved machines, are included the introduction of multiple machines, that is, where two or more units are turned out

⁹ President's Conference on Unemployment. Committee on Recent Economic Changes Report, Recent Economic Changes in the United States. Vol. I, p. ix. New York, McGraw-Hill Book Co., 1929.

¹⁰ Martin, P. W. The Technique of Balance: Its Place in American Prosperity. In International Labor Review, October 1929, vol. 20, p. 504.

¹¹ Tugwell, Rexford G. The Industrial Discipline and the Governmental Arts. Columbia University Press, 1933, pp. 57, 61.

in one operation; the installation of automatic feed attachments; of machines that combine two or more operations formerly performed by separate machines; and many improvements in machines so that more and better work can be turned out. Under the second, operating changes or different set-up, are included changes from departmental to line production, including the introduction of moving belts and conveyors; the breaking down of work to simpler operations; the combining of work to eliminate nonproductive labor; the more efficient routing of the work; the provision of better tools; and the spreading of the work through better operating methods.

Of the two other changes most frequently found, one was from hand to machine work and the other was from one class of workers to another, commonly termed substitution.

There were also, especially in the case of substitution, a number of instances where accompanying the major change was some other improvement, such as better routing, finer tools, or more efficient machines. These combination changes are as follows:

Total.....	38
Substitution of women for men and operating change or different work set-up.....	15
Substitution of women for men and hand to machine.....	6
Substitution of women for men and single to multiple machine.....	1
Substitution of men for women and operating change.....	1
Substitution of men for women and more efficient machine.....	2
Substitution of men for women and single to multiple machine.....	2
Substitution of men for women and hand to machine.....	2
Substitution of men for women and old to new machine.....	2
Hand to machine and single to multiple machine.....	1
Old to new machine and different work set-up.....	1
Hand feed to automatic and different work set-up.....	2
More efficient machine and different work set-up.....	1
Different method of payment and different work set-up.....	2

Labor costs

In all these changes, whether they consisted of a single improvement or of more than one, the principal objective was greater production per unit of cost. In every type of change, whether it involved a direct saving in labor or an indirect saving from more efficient operation, as in the case where hours were shortened or a higher rate of pay was introduced, the object was either increased production per worker or reduction in cost per unit of output. The different changes were successful, judged by the standard of lower labor costs, in all but 10 of the 187 cases reported; and of these 10, costs remained the same in 8 cases and were increased in only 2.

Of the two changes where labor costs increased, one was a change from machine to hand work and one a decrease in hours.

The most frequent method of decreasing costs was through the aid of a new or an improved machine, and when this was done labor costs were decreased in 93.3 percent of the cases and remained the same in the other instances.

Though in most of the changes in the following list a reduction in labor costs was achieved by the aid of better machines or more efficient operation, there were two changes where the savings effected

were solely through the effort of the workers, namely, where a different incentive system was introduced and where a substitution occurred of one work group for another. Decreased labor costs were reported for these two changes in every case but one, though the change consisted merely in a different basis of pay or in the substitution of women, usually at lower rates of pay, on work formerly done by men.

Type of change	Number of cases reported	Number of changes causing labor costs to—		
		Increase	Decrease	Remain same
Total.....	187	2	177	8
Improved machine.....	60		56	4
Operating change or different work set-up.....	28		25	3
Hand to machine.....	29		29	
Substitution ¹	32		32	
Different method of payment.....	8		7	1
Machine to hand.....	1	1		
Shorter hours.....	1	1		
Combination of changes.....	28		28	

¹ In all but 1 case women were substituted for men.

The savings effected by these methods—change in method of payment and substitution—were considerable: In only 2 of 22 cases with percent decrease reported was this less than 10 percent, while in 16 instances it ranged from 20 percent to as high as 50 to 60 percent. When, however, the change involved some labor-saving device (the 3 changes first listed) the percent saved on the former labor cost was considerably higher, with four-fifths showing savings of at least 20 percent, and well over two-fifths reporting savings of 50 percent and more. These findings illustrate the truth of J. A. Hobson's general statement that "Rationalization * * * is a reduction of the part which labor plays as a productive agent in respect of the output."¹²

Production

Increased productivity or increasing the rate of production within a given plant is a process that is being continuously experimented with in practically all manufacturing establishments. New machines replace old ones, conveyor systems are introduced, and any operation that slows down production is studied and the cause of retardation eliminated. Improvements to lower costs of production and to increase output per worker have been going on for centuries, but they are especially important in this twentieth century. As Graham A. Laing points out, the important thing is the speed of development. There are hundreds, if not thousands, of centuries between primitive man and the 18th century peasant. Steam power and electricity were discovered only a short century ago, and since these discoveries the rate of change has increased almost beyond belief.¹³ Most records of production per worker in manufacturing do not go back very far, but in considering the last 36 years, a comparatively recent period, the productivity per worker has increased greatly. From 1899 to 1913 the rate of increase in manufacturing industries was

¹² Hobson, J. A. Rationalization and Unemployment. London, George Allen & Unwin, Ltd., 1930 p. 73.

¹³ Laing, Graham A. Towards Technocracy. Los Angeles, The Angeles Press, 1933, p. 18.

16.3 percent.¹⁴ Between 1919 and 1929 production per worker increased about 45 percent, and in an estimate given by Charles A. Bliss in his article entitled Recent Changes in Production he gives an estimate, based on relative decreases in employment, hours, and physical production, that output per man-hour increased approximately 25 percent in the 4 years from 1929 to 1933.¹⁵ From these figures it would appear that David Weintraub probably is right when he says that output per man-hour in the manufacturing industries tends to increase in periods of depression.¹⁶

In the present study all the changes took place in the period from 1921 to 1931. Where production figures could be obtained, an increase in output was reported in 69.6 percent of the cases with the same number or fewer workers employed. In 13 instances of change there was a loss in production per worker, but this was compensated for either by decreased costs or by an improvement in product.

	Number of changes	Percent
Production increased.....	156	69.6
Production decreased.....	13	5.8
Production was the same.....	55	24.6

In the cases where production was increased the percent of increase varied from less than 10 percent, reported in 10 cases, to at least 1,000 percent in 6 cases. In one-fifth of the cases with percent increase in production reported, the increase ranged from 300 to over 1,000 percent. The following figures show the percent of cases in each type of change where an increase in production was reported, and it is interesting to note that for one-half the cases of increase in the change from hand to machine the gain was 300 percent or more.

Type of change	Percent of changes resulting in increased production
Improved machines.....	81.1
Operating changes or different work set-up.....	87.1
Hand to machine.....	82.1
Substitution ¹	10.7
Different method of payment.....	64.3
Machine to hand.....	0.0
Shorter hours.....	0.0
Combination of changes.....	73.5

¹ In all but 1 case women were substituted for men.

The effect of the change on production is least noticeable in the case of substitution. In this change nearly four-fifths of the cases reported no difference in output after the substitution.

¹⁴ Bouniatian, Mentor. Technical Progress and Unemployment. In International Labor Review, March 1933, vol. 27, p. 328.

¹⁵ Bliss, Charles A. Recent Changes in Production. Bul. 51 of National Bureau of Economic Research, Inc., New York, June 28, 1934, pp. 6, 7.

¹⁶ Weintraub, David. The Displacement of Workers Through Increases in Efficiency and Their Absorption by Industry, 1920-31. In Journal of American Statistical Association, December 1932, vol. 27, p. 398.

Employment

The effects on employment varied according to the character of the change, but when all changes are combined there appears a marked decrease in the number employed. As all the changes involved human beings and not merely automatic processes this result is not surprising. "The general effect of this type (technological) of improvement", according to Emil Lederer, "and in particular of rationalization measures, is to reduce the amount of labor required * * * to produce the same output as before."¹⁷ This is illustrated by the following figures: Compilations made from census figures show that in 1925 the number of wage earners per 1,000 population was 16.1 percent smaller than in 1919, in spite of the fact that there was a 25 percent increase in the quantity of goods produced, as shown by Federal Reserve Board figures.¹⁸ Since the depression that began in 1929 there has been a very marked decrease in the demand for goods and the need of workers. This has resulted in higher overhead costs and increased necessity for more efficient operating. Charles A. Bliss, in his study of recent changes in production, finds that "a period of depression is conducive to improvement in labor productivity."¹⁹

In the present study a comparison of the changes effected in employment and production shows that employment increased in less than one-tenth (8.6 percent) of the cases reported and decreased or remained stationary in a little over nine-tenths, while production increased in seven-tenths and decreased or remained stationary in three-tenths. Before the technological change 6,401 workers were employed, but 6 months or more after the change the number was only 3,604, a reduction of 43.7 percent. This decrease was reported by the management to be due in each case to improved technology, not to lessened factory output, and it includes only the groups of workers affected by the change.

A greater number of women than of men were affected by the changes included in this report, as would be expected when the selection of change was made on the basis of its importance to women. Before the changes women comprised more than three-fourths, 77.8 percent, of the total number, while after the changes they were an even larger proportion of the total, namely, 80.1 percent, the changes having eliminated a somewhat larger proportion of the men (49.6 percent) than of the women (42 percent).

There was considerable variation according to type of change both in the numbers involved and in the percent of decrease or increase occasioned by the change. The largest group of workers, over two-fifths (44.7 percent) of the total number employed before the changes, were in the group where a machine improvement occurred. The other three large groups were those where one group of workers was substituted for another; where improved operating change occurred, other than machine change; and where the work was changed from

¹⁷ Lederer, Emil. Technical Progress and Unemployment. In International Labor Review, July 1933, vol. 28, p. 4.

¹⁸ U. S. Bureau of Labor Statistics. Monthly Labor Review, May 1927, vol. 24, p. 17. Comparison of Employment and Productivity in Manufacturing Industries, 1919 to 1925.

¹⁹ Bliss, Charles A. Recent Changes in Production. Bul. 51 of National Bureau of Economic Research, Inc., New York, June 28, 1934, p. 6.

hand to machine operation. The proportional increase or decrease in numbers in each group was as follows:

Type of change	Percent decrease in employment of—		
	All employees	Men	Women
Total.....	43.7	49.6	42.0
Improved machines.....	50.3	22.0	54.5
Operating changes or different work set-up.....	39.3	47.4	38.8
Hand to machine.....	70.5	0.0	70.9
Substitution ¹	² 1.7	61.0	² 1,168.4
Other.....	44.5	56.6	41.3

¹ In all but 1 case women were substituted for men.
² Increase.

In all types of technological change except where substitution occurred there was a marked decrease in the numbers employed. The largest reduction was in the change from hand to machine work, where machines displaced 70.5 percent of the workers. Where substitution took place, the total number of workers increased slightly; though the men showed a marked decrease, the number of women rose from 38 to 482. Due to this large replacement number, the women did not suffer so much as men from the changes, but when this one type of change, substitution, is eliminated, the numbers of women are decreased by the other types of change to an even greater degree than are the numbers of men.²⁰

The actual number of changes showing a decrease in employment was 118, while in only 19 cases was an increase reported.

	Number of changes	Percent of total
Employment increased.....	19	8.6
Employment decreased.....	118	53.4
Employment was the same.....	84	38.0

Combination changes

When a single change is introduced in a plant it is often found that during its installation, or even in the planning, additional changes are necessary. Frequently, also, multiple types of change are included in those classed as single changes. For example, an operating change such as the introduction of a moving belt may transform the method of work from departmental to line production and some new tool or fixture may also be added. This type of change involving more than one modification would be classed as a single one in most cases, as the accompanying changes are dependent on and more or less incidental to the principal one, the introduction of the conveyor. However, when two changes distinct in type and of equal importance are introduced at the same time, and the results are the combined effect of these changes, they are classed in this report as "combination changes." For 36 of the total 38 such cases in the present study the

²⁰ However, as the changes were selected primarily because of their effect on women workers, the results cannot be considered typical of technological changes as a whole.

effects on employment are reported. The number of workers previous to the changes was 1,150. This total showed a reduction after the changes of about one-half (49.2 percent). In 15 of the combination changes there were fewer employees afterward, but in 17 there was no difference in numbers.

Total combination changes.....	36
Number of workers before.....	1,150
Number of workers after.....	584

Labor costs were lessened in all the combination changes reported, so that there was a saving by some other method even when the actual number of workers was not decreased. The better operating methods resulted in increased output per worker, for output was increased in three-fourths of the cases and in no instance was there a decrease.

	Combination changes			
	Number of cases	Percent of cases resulting in—		
		Increase	Decrease	No change
Employment.....	36	11.1	41.7	47.2
Labor costs.....	28		100.0	
Production.....	34	73.5		26.5

Technological changes by year of change

In earlier pages of this report figures have been given and authorities quoted showing the continual change and improvement in technological processes during the years 1921 to 1931. Stuart Chase, in his "Economy of Abundance", declares that this process has continued, uninterrupted, through periods of prosperity and of depression.²¹ The findings of the present study would at least indicate that no decline in the rate of change occurred during the period from 1927 to the early part of 1931.

Year	Number of changes	Number of women before changes	Percent decrease in number of women after changes
Total.....	250	5,109	40.4
Prior to 1927 ¹	30	547	58.7
1927.....	26	1,306	32.4
1928.....	39	465	41.5
1929.....	58	1,605	44.3
1930.....	65	827	48.6
1931 ²	32	359	² 4.5

¹ 6 years.
² Only part of the year.

There was a steady increase in the number of changes reported to have taken place from 1927 to and including 1930, but it is not possible to determine to what extent this is indicative of the existing rate of change or how much the increase is affected by the fact that records could more easily be obtained the nearer the changes occurred to

²¹ Chase, Stuart. The Economy of Abundance. New York, Macmillan Co., 1934, p. 220.

the time of the survey. It would appear, however, that there was at least no diminution in the number of changes during the period 1927 to 1930.

Earnings

Probably in any change of job or of method of work, by far the most vital point to the worker is the effect of the change on her pay envelop. This was realized at the outset of the study, and an attempt was made to obtain from factory pay rolls comparative records before and after the change. This information was obtained in some cases, but there were many plants where no fair comparison could be made, because of changes in methods of payment, in bookkeeping, in personnel, or in hours of work. It was decided, therefore, that a more complete picture could be obtained from the workers themselves concerning their average weekly pay and the number of hours in which it was earned under the old and the new method of work. Frequently these facts would be accompanied by illuminating comments such as the following:

I like machine work better because pay is better; work goes faster and therefore is more interesting.

The new machine is easier work—but the old job had the advantage of higher pay.

You work harder on the group bonus; if you don't work hard on the group you're cheating the others.

Do I work harder? I'll say I do. I work and earn 40 cents an hour and only get 27. They talk about lost hours, lost motion—all it is to me is lost money.

From such remarks by the women it is probably true that the change in earnings affected to a considerable degree their opinion of the increased difficulty or ease of the new work.

The report of the women of their earnings on all the changes combined showed nearly one-half to be earning less after the change than before, while about one-fifth experienced no change in earnings and three-tenths earned more. Of 835 women whose average hourly earnings on the old and the new work were obtainable, 404 (48.4 percent) had a lower average after the change, 257 (30.8 percent) a higher average, and 174 (20.8 percent) the same as before.

Of the 404 whose earnings declined—

- 22.0 percent declined less than 10 percent.
- 30.7 percent declined 10 and less than 20 percent.
- 24.3 percent declined 20 and less than 30 percent.
- 12.1 percent declined 30 and less than 40 percent.
- 6.2 percent declined 40 and less than 50 percent.
- 4.7 percent declined 50 percent or more.

That is, for almost half of the 404 women whose hourly earnings were lower than before, the decline was from 20 percent to 50 percent or more.

Whether earnings increased or decreased appears to be somewhat dependent on the amount of the original earnings. Of the 177 women who were receiving less than \$16 a week before the change, a little more than half reported an increase in average hourly earnings after the change and only 16.4 percent reported a decrease; the earnings of the remaining women did not change. The effect of the change was much less favorable to the women whose earnings before the change were \$16 or more. Of the group whose earnings

had been \$16 but less than \$20, nearly one-half (46.7 percent) earned less after the change; and of the group whose earnings had been \$20 and over, almost three-fifths (59.3 percent) reported lower earnings than before. Therefore the workers who before the change earned \$16 and up showed a larger proportion of their number earning less after the change than did the lower-paid group at less than \$16. Thus one result of the change was to establish wages nearer a normal or average, with a smaller number of workers at either end of the scale who received very low or very high pay. That this leveling process resulted in a considerable change for the lowest and highest paid women is shown by the following figures, which give the proportion of each wage group whose average hourly earnings decreased or increased 30 percent or more.

Weekly earnings before change	Percent of women in specified earnings group whose average hourly earnings—	
	Decreased 30 percent and more	Increased 30 percent and more
Less than \$16.....	2.8	20.9
\$16, less than \$20.....	6.6	6.6
\$20 and more.....	17.0	1.8

It is apparent that sharp increases in earnings occurred chiefly in the lowest wage group and pronounced decreases in the highest, thus concentrating earnings much more closely around an average wage than was the case before the change.

Interviews were had with 95 women whose work was affected by the change through a transfer to other work in the same plant. These women were included in the analysis because their work and earnings were changed by the introduction of the new method of work though they themselves were not employed on the changed job.

However, if the earnings of these women are considered separately, they show a smaller proportion of women with decreased earnings (42 percent) and a larger proportion receiving an increase (32.1 percent) than was found among the women who went on the new method, with 48.4 percent having a decrease and 30.8 percent an increase.

Learning period

The majority of changes reported in this study involved some technological improvement, such as more efficient machines, better tools, or other aids to the work. In most cases the job itself was simplified through these aids and less skill was required to perform the work. Information concerning the time required to learn the new work, as compared with the time required to learn the old, was difficult to obtain. In very few establishments had any records been kept, and the fact that many of the workers had been transferred directly from the old to the new work, bringing with them their acquired skill, made it especially hard to get even an estimate of the learning time required on the new work. Usually the question was referred to the foreman in charge of the work, and frequently he gave his opinion on the average learning period before the change

and the average after the change. In the majority of the 111 changes for which information was available, the learning time was the same before and after the change (63); in well over a third the learning time was shortened by the change (40), and in only 8 cases was the learning time lengthened. There was, therefore, a considerable saving effected through the shorter learning time required for much of the new work, and in comparatively few cases was there added expense from this cause.

Opinions of workers

The comments of the workers on the change were unfavorable in the majority of cases.

	Number	Percent
Total comments.....	944	100.0
Unfavorable.....	508	53.8
Favorable.....	226	23.9
Partly favorable.....	158	16.7
No preference.....	52	5.5

This preponderance of unfavorable opinion of the new work as compared to the old without doubt is due partly to a very general dislike of change. As one girl said, "You can't do a job for 4 years one way and then change your way of doing it"; and another remarked, "It was just like learning a new job."

It is difficult, therefore, to tell whether the new work was really harder for the majority of workers or its newness and unlikeness to the old work, combined in almost half the cases with a decrease in pay, were responsible for the large number of women who found the change unsatisfactory.

The proportion of women expressing an unfavorable opinion of the change was greater on some types of change than on others. Of the various changes (considering only those reported by 20 or more women) the one with the largest percent of unfavorable comments was the change in method of payment, with 73.6 percent disliking the change. The next most unpopular, though the total number of women reporting in this group was small, was the change from machine to hand work, with 69.6 percent reporting unfavorably. Comparing this with the change from hand to machine work, it is found that just one-half reported this change unfavorably, showing a considerably smaller proportion dissatisfied than on the machine-to-hand change.

Type of change ¹	Total comments	Percent of comments that were—			
		Favorable	Unfavorable	Partly favorable	No preference
Improved machines.....	234	33.3	43.6	16.2	6.8
Operating changes or different work set-up.....	237	22.8	54.0	16.0	7.2
Hand to machine.....	92	23.9	50.0	17.4	8.7
Substitution ²	23	21.7	39.1	34.8	4.3
Different method of payment.....	201	12.9	73.6	11.9	1.5
Machine to hand.....	23	69.6	21.7	8.7
Operating change and method of payment.....	75	26.7	46.7	21.3	5.3

¹ Includes only those changes with 20 or more women reporting.

² Women for men.

The change that received the most favorable comments was that from an old type of machine to a new. One-third of those experiencing this change were pleased by it. One girl said the new machine was much better and not so dangerous; another reported, "The new machine is ten times better; it goes much lighter; you don't get tired. I'd never go back to the old machine." And still another said, "At first none of us liked the new machines—now we wouldn't change them." Some of the unfavorable comments on the improved-machine change as well as the improved-operating change were that the speed of work had been much increased, that there was less time to rest, and that the work was steadier and more monotonous. The increased steadiness of the work was complained of also when the change was from hand to machine work. There was considerable mention in these three types of change of the strain of "keeping up" with the machine. "I'd rather have hand work; with the machines you've got to keep up no matter how fast they set the machines." The other side of the picture was shown by a girl who found the machine a great relief; of her old work she said, "Turning an arm crank all day is a steady pull—not heavy but hard work." And another said: "We used to be on our own power, now its machine power: I'm not so tired at the end of the day as I used to be."

With the many modifications included under "operating changes" the principal complaint was of the steadiness of the work with no minute to rest. This was especially frequent when a conveyor had been introduced or the work spread.

On the conveyor we must stay all day, whereas the table group could leave when the ticket was finished.

Must just work and work, no time to rest.

No time even to sit down, and before found a little time to do that.

But the picture had another side:

Putting in the conveyors saved all that running and carrying boxes, so it was a great help to us.

I like the conveyor better; it is more fun to be with all the girls and I don't mind the speed.

Differences of opinion were found also about the change from individual to group work.

Work is much harder because you've got to keep up, for the whole group is affected if you take time off.

I like working in a group; it is interesting because we change around on the belt and take turns at different jobs.

The change that involved a substitution of women for men resulted, as did some of the others, in new work for the women. Where it differed most from the other changes was in a transfer to an entirely new job. The women may or may not have done similar work previously, but they had not been employed on that specific work. For this reason a comparison of their work before and after the change was dependent to a great extent on their previous work, and the comparison may have been between two distinct jobs and not between a change of method on the same work.

The new work on which they took men's places was considered an improvement over their former work by 5 of the 23 women reporting and was thought not so desirable by 9. Thus, as in other groups, a larger proportion preferred their old work to the new, but unfavorable opinions constituted a smaller percentage in this case than in any of

the other major changes. Drawbacks to the jobs, such as the heaviness of the work, were mentioned frequently.

The motors weigh 8 or 9 pounds and we average 200 a day. The work comes along and you've got to keep right at it. It's really a man's job.

This work is pretty hard for girls. (This girl had to carry big boxes and handle heavy parts.)

The work was not always hard, and some preferred it to their former jobs:

I like this job—you only put in two screws. It's not heavy—we can stand or sit.

The job is easy; we just move a handle back and forth. (This girl preferred the new job to her former work where she used an acid that made her sick.)

From the different statements made by the workers, it would seem that the jobs on which women were substituted for men varied a great deal in the physical strength required, and also that more care was taken in some plants than in others to select workers best fitted to the job.

The only change on which there was no wholly favorable comment from the women reporting was the change from machine to hand work. Five of the 23 women reporting on this change found some things they liked and some they disliked, but none gave unqualified approval, while the majority (16) would have preferred returning to their old work on the machine:

I like the machine. It was less work and easier—not so hard on your eyes.

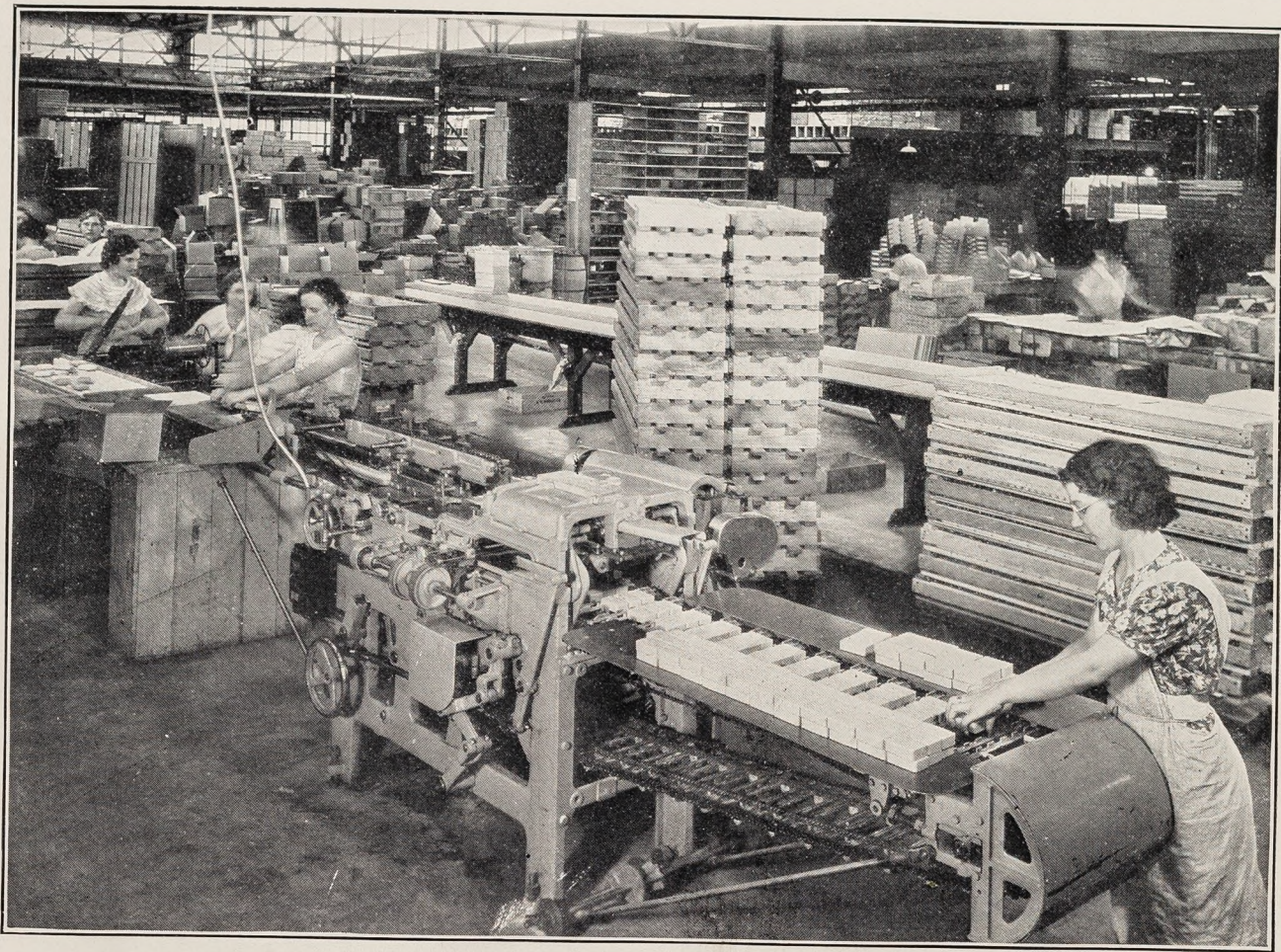
The work on the machine was easier and better paid. Now it is tedious and we work like dogs.

It is interesting to find that one of the chief complaints of hand work was monotony, which was also expressed frequently of machine work.

As previously stated, the large majority of the women visited were still in the employ of the firm in which they had experienced the technological change. This overweighting was unavoidable, as in many cases women who had been laid off in earlier years could not be found after such a lapse of time. Therefore, only a small number of those interviewed, 4.5 percent, had been laid off or had quit because of the change in their work. The great majority, 84.3 percent, were on the work in which the change had taken place; the remainder who were still with the firm had been transferred to other work, or in a few cases remained on the old job.



INSERTING SCREWS IN BLANK-BOOK COVERS.



TENDING A SOAP-WRAPPING MACHINE.

PRINCIPAL TYPES OF TECHNOLOGICAL CHANGE

IMPROVED MACHINES

One of the most constantly occurring technological changes is that of improved machines. In some cases a new attachment may be added to an old model or an entire new machine may be introduced, frequently including features of the older one, while still another machine may combine several operations formerly done on two or more separate machines. However, a general change that prevails in most of the new machines regardless of the character of the improvement is an increase in the automatic performance of the machine and a decrease in the need for human labor. Such changes form the largest group in this study with 77 cases reporting number of employees affected. In these cases 2,861 workers were employed before the change, 1,421 after.

SUMMARY OF FINDINGS ON IMPROVED-MACHINE CHANGES

Number of changes.....	78
Number of workers:	
Before.....	2,861
After.....	1,421
Percent decrease (total).....	50.3
Women.....	54.5
Men.....	22.0
Employment decreased in nearly two-thirds, 64.4 percent, of the changes.	
Production increased in 81.1 percent.	
Labor costs decreased in 93.3 percent.	
Of the women reporting, 33.7 percent had decreased earnings after the change and 32.1 percent had increased earnings.	
Unfavorable comments on the change were expressed by 40.8 percent of the women; favorable comments by 37 percent.	

The following descriptions illustrate the types and effects of machine improvements and combinations.

The installation of hoppers or batteries on machines eliminates hand feeding and the strain of keeping pace with the machine as well as the danger frequently involved.

In a printing shop the girls formerly gathered the sheets by dropping a double sheet across a saddle or rod as it came by. It was important never to miss, for if one were skipped that copy of the magazine would be incomplete when published. In the new machines the girls filled the hoppers with sheets, which were automatically dropped on the saddle and were carried along to the stitcher. Not so much skill was required to keep the hopper full as to keep in rhythm on the old method. On the old machines it took 9 girls to gather and place the sheets; on the new machines 3 girls could keep the hoppers full. A girl was substituted for the man on the stitching machine, at a lower rate of pay.

The production of each girl on the gathering process trebled on the new machines, and as their pay remained the same and fewer girls were needed, labor costs were reduced. In this shop business was growing, so it was possible to keep all the workers that this change otherwise might have displaced. It also was the practice to introduce changes slowly and only as the demand required, so that no reduction of numbers was necessary even temporarily.

In a plant where formerly 20 women fed and operated punch presses, machines were introduced with a dial feed and compressed air chucks that threw out the finished pieces. The pieces were fed into the hopper by the man who formerly assisted around the machines and who was able to add other duties to this. The 20 women operators were eliminated, but as the 5 new presses were introduced gradually over a 6-month period, only a few at a time had to be laid off. Production per machine increased from 2,500 parts a day on the old presses to 20,000 on the new, so that 5 machines with the part-time work of one man replaced 20 machines with 20 women operators and the part time of one man, and turned out twice the production.

With the many goods now sold in package form, such as cereals, soap flakes, and so forth, the demand for cheap methods of filling and wrapping has increased. For many years these packages had been filled by machine, the operator opening and feeding the box into the machine, where it was glued and filled, the operator then inserting a slip, and the package being sealed by the machine.

In the plant reporting on this, there is now in operation a machine that requires only the filling of the hopper with the flat unformed boxes. The machine forms the box, fills it, inserts the slip, seals the box, and finally pushes it onto a moving belt that carries it to the packing room, without the aid of hands after the placing of the flat cartons in the hopper. Five new machines do the work of 24 of the old type. Only 1 girl is needed on each new machine compared to 2 on the old. Two mechanics look after all machines and 2 girls were given jobs inspecting and preparing boxes, respectively. Twenty girls are now employed on the new machines, whereas 48 operated the old ones.

In another plant the women formerly operated large punch presses that cut sheet metal, one woman to each press. Now the machines have been timed to work in unison, a magazine with automatic feed has been installed, and conveyors connect the machines so that 1 woman can operate 3. This change yielded about the same production, but as fewer workers were employed labor costs were decreased 66½ percent. Of the 9 women who originally operated the machines, 3 went on the new machines, 2 were laid off, and 4 were transferred to work in other departments.

Whenever it is necessary in the course of a change to lay off some of the workers or to shift them to less desirable work it very naturally affects the opinion of the change even of workers not immediately concerned, as there is always the fear that further change may eliminate their jobs. There appears to be a normal antagonism to change, which is increased by fear of loss of job. Where a wage cut is involved in addition, there may be expected—as was found in the case of the punch-press change—the opinion that “The old machine was better because I could earn more and more people were employed. It is

also necessary to watch 3 machines now instead of 1, and that means running backward and forward.”

A change that is found frequently and in many different kinds of work is that from a single machine—one producing but one piece at a time—to a multiple machine that turns out a number of identical parts at the same time.

In a plant doing engraving on metal, the work was done formerly by a single-spindle machine with one operator. A new machine with 8 spindles was introduced. At the time of interview 1 man operated 3 of these 8-spindle machines. The new machine also did more of the work than the old, such as changing the characters and indexing the wheel automatically, so fewer operations were performed by the worker than on the old single-spindle machine. Production per operator increased from 6 wheels per hour on the old machine to 86 per hour on the new, or 1,300 percent. Total labor costs decreased by 89.6 percent. The single operator's earnings on the new machines averaged 72 cents an hour, compared to an average of 48 cents an hour for the 16 operators on the old machines.

There is another element in any machine change on which there was great difficulty in obtaining accurate information, that is, the increased cost of the new machine over the old. In the case of the engraving machines just cited the management emphasized this fact and declared that while 16 of the single-spindle machines cost \$1,200, the 3 new multiple machines cost \$6,600, over five times as much, and though it was difficult to estimate obsolescence, without doubt the additional machine cost must be considered as well as the increased production and decreased labor costs. No lay-offs were involved in the change described, as the factory was a large one and well organized and the extra workers either remained on the single-spindle machines, some of which were still in use for special kinds of work, or were transferred to other departments. Among the women interviewed, who were put on the new machines at first but displaced by a man, there was a difference of opinion about the machines: “It is easy work”, according to the statement of one woman, and several agreed that the new machines were more interesting than the old and “turned out such pretty work”, while another side was presented by a slender woman who found the new machines heavier than the old and when she tried to “pull” it would nearly turn her over in her chair. This wide difference of opinion of the heaviness or difficulty of the same work was found frequently and emphasized the need of careful selection of workers to meet the demands of the work.

Results of change to improved machines

The introduction of an improved machine or one that combined the operations of two or more machines did not result in the displacement of nearly so great a proportion of workers as did the change from hand to machine work. In the first named only one-half as many workers were needed on the new machines as on the old, and the numbers decreased from 2,861 to 1,421. Women, employed in much larger numbers, were affected to a greater extent than were men. The number of women employed after the change showed a decrease of 54.5 percent, while the men decreased by only 22 percent.

Records on labor costs were obtained for 60 of the changes, and all but 4 showed a decrease; none showed an increase, and in 4 cases there was no change in costs. Production increased after the change in 60 out of 74 instances where production figures were furnished, and in only two cases was there a decrease.

	Number of cases resulting in—		
	Increase	Decrease	No change
Employment.....	3	47	23
Labor costs.....	0	56	4
Production.....	60	2	12

The earnings of the women who were shifted from the old to the improved machines and who reported in the interviews increased in slightly over one-third of the cases, were the same as before in slightly under one-third, and decreased in the remaining cases.

There were, however, among the women who reported, a slightly larger number who preferred the work on the old machines to work on the new:

	<i>Percent</i>
Old work preferred by.....	40.8
New work preferred by.....	37.0
No decided preference expressed by.....	22.3

OPERATING CHANGES OR DIFFERENT WORK SET-UP

In a bulletin on the manufacturing of electric-light bulbs published by the United States Bureau of Labor Statistics in 1933 the following statement appears: "Technological changes are perhaps most commonly associated with machines. Processes not primarily mechanical in nature should, however, also be included. Methods of economizing space, material, and time are also essentially technological, even though there is no mechanical innovation." To this is added, "Scientific management' is often more effective than scientific mechanism."²²

The group of changes next discussed are those of management, and though in some an improved machine may be involved, nevertheless the improvements were primarily in the arrangement and routing of the work and the better adjustment of the worker to the job. A large number of the changes were concerned with the way that the work was done, such as the introduction of a conveyor, a moving belt, or long connected tables, so that work traveled along a line with one process following another. This method saved the time and labor of trucking materials from one department to another and eliminated some inspecting and checking.

Other types of change included in this section are the introduction of bench fixtures that held the work in place, leaving both hands free for the work; the combining of one or more operations so that trucking and ticketing were decreased or eliminated; the breaking down of a complicated job so that workers less highly skilled could be used and the learning time greatly reduced; the introduction of a

²² U. S. Bureau of Labor Statistics. Technological Changes and Employment in the Electric-Lamp Industry. Bul. 593, 1933, p. 36.

new tool that simplified the work. All these different types of change were studied, as were many others that illustrated various methods used to increase production, lower labor costs, and render the finished product more perfect and uniform.

SUMMARY OF FINDINGS ON OPERATING CHANGES OR DIFFERENT WORK SET-UP

Number of changes.....	41
Number of workers:	
Before.....	708
After.....	430
Percent decrease (total).....	39.3
Women.....	38.8
Men.....	47.4

Employment decreased in 66.6 percent of the changes.

Production increased in 87.1 percent.

Labor costs decreased in 89.3 percent.

Earnings decreased for 52.3 percent of the women reporting.

Earnings increased for 21.3 percent.

Unfavorable comments on the change were expressed by 53.8 percent of the women reporting; favorable comments by 22.7 percent.

Increased efficiency through the introduction of a moving belt, a very frequent improvement, was found in the packing department of a candy factory. In the old days each girl had before her on a table the different varieties of candy from which she packed her boxes. After the change a moving belt down the middle of a narrow table carried the boxes past a line of girls, and as they passed each girl put in four or five pieces of candy. In this way of packing on the belt the daily production per girl was about 190 boxes, whereas when each girl packed her own box directly from the table the output per girl averaged 100 boxes a day. Though production was almost doubled by the change, no women were laid off, as there were many other packing jobs in the plant and it was possible to transfer them to similar work.

The elimination or reduction of handling the product made possible by the use of conveyors is important not only for the saving in labor but because frequently it eases the load of the worker.

In the enameling of parts in a stove factory, under the old method the pieces to be sprayed were trucked to each worker, who sprayed the part in her own booth, first scraping off rough places and seeing that it was smooth for spraying. Afterward she placed the part on a rack for drying. These racks were trucked to the furnaces, where the baking was done. Men took the sheets off after baking and trucked them to the brushers, where they were lifted off the trucks, brushed, and again trucked to the assembly department. Under the new method all sheets are prepared by men for spraying. Girls take the sheets from the table and place them on a moving belt which carries them past the sprayer (a girl), after which they are hung by girls on a conveyor that carries them through the ovens. When baked they are transferred by girls to a revolving table, on one side of which sit the brushers. After brushing the pieces these men lay them on a truck to be wheeled to the assembly department. The work of spraying on the conveyor is hard, as the gun must be held steadily and continuously to spray the pieces as they pass by,

while on hand spraying the work of scraping and handling the pieces gave some relief from constant spraying. Because of the steadiness of the work, the girls on the conveyor line change off, one girl spraying for a while, then feeding, and then taking off and hanging. The frequency of this shifting was experimented with, until finally half an hour on each job was arrived at as the desirable length of the work spell. Production averaged for the 6-month period following the change showed an increase of 60 percent over the average production for a similar period a year earlier. One of the workers who had been a sprayer in a booth found the spraying on the conveyor easier because "you work in a team on a conveyor; this rests you and relieves you from the strain of spraying constantly."

The introduction of a bench fixture or improved tool frequently results in increased output and easier work. In the assembling of locks, formerly a girl sat at a bench, held a lock in her left hand, and dropped in the springs and tumblers with her right. By the introduction of a small fixture on the bench which held the lock, the worker was able to drop in the springs and tumblers with both hands, as she no longer had to use one hand to hold the lock in position. Her production increased with the use of the fixture from an average of 800 an hour to 1,200. Earnings were the same under the two methods.

A change in the job itself, either through simplification or breaking down of the work, or through the opposite of this—the combining of two or more operations—was found frequently. An example of the breaking-down of the work was found in the spinning department of a cotton mill. The spinner's job consisted formerly in piecing up broken ends, keeping the roving full, and cleaning and oiling the rolls. She tended from 960 to 1,440 spindles, depending on her ability and the quality and count of yarn. Under the new method this work was divided between the spinner and a cleaner. The spinner pieced up the ends and attended to the roving, while the cleaner took care of the frames from the roller beam up. The average number of spindles tended by a spinner varied from 1,921 to 2,098, depending on the yarn. Efficiency based on production increased from 90 percent to 96 and labor costs decreased by 17 percent. Earnings were higher by 7.6 percent for the spinners, and lower by 13.4 percent for the cleaners, who formerly were spinners.

As in most cases where the work is changed, some employees found the new way easier and some found it harder. One spinner declared that she did not work nearly so hard on the new work as on the old, where she had had everything to do. Now the cleaning and oiling being done for her made the work easier. Another found it harder because of the increased speed of the machine, with "plenty of breakage now" and never a minute to sit down where formerly there was a little time occasionally to rest. Though a careful study had been made before the change of the quality of cotton and speed of machine in relation to thread breakage, and the load planned accordingly, there was a fairly unanimous feeling among the workers visited that the number of end breakages had not been decreased. Naturally, the lack of a definite route that the worker must follow in piecing ends necessitated their "running here and there", probably adding not only to the actual labor involved but to the strain of "keeping up", which is nearly always present in machine-tending jobs.

An entire reorganization of the work in a department of a hosiery mill combined several types of change. On some operations the work was broken down, on others two separate jobs were combined; group work in small units was introduced for some work, while other jobs were changed from a group to an individual basis.

The job next described illustrates some of the differences resulting from the change. Formerly a girl whose work on women's hose was mating and pairing performed these operations: Inspecting, measuring for length and pairing, mating seconds, folding hosiery three times, counting number of dozens finished and marking down the number. Under the new method the work was much simplified: Measuring for length, matching hosiery for color thread in heel and toe, matching for shape of foot, and inspecting a little if anything gets by the inspector.

The inspecting, mating, and pairing formerly were done at long tables by groups of girls. This was changed to two processes—inspecting and sorting, and pairing. Two operators worked together but were paid individually. Trimming, labeling, folding, etc., and packing in boxes with final inspection, were operations performed by two groups, paid on the group plan.

The change resulted in increased output for the department, and average hourly earnings as shown by pay rolls taken before and after the change showed an increase from 38.2 cents before the change to 43.7 cents after. The average number of workers decreased from 266 to 202, while total production increased and labor costs were lowered.

There was a variety of opinion among the workers regarding the change. One girl (a pairer) liked the new method better because, as she said, "It is easier work, not so hard on the eyes, and there is no carrying work and usually no waiting around for it." She also felt that the quality of the work was improved, "because each girl more or less checks up on the girl she works with." The opposite of this opinion was expressed by another woman pairer who did not like the new method because of "the speed and feeling of strain." Each pairer had an inspector and they had to keep up with each other; also, if the pairer allowed the work from the inspector to pile up, the folders and packers did not like it. But, she added, "Under the new system the same amount of work is finished in less time." As is found in most line work the pressure to keep up is hard on the slower worker.

The opposite of breaking down the job was found in a factory making shirts and collars. In this plant the work of joining the collar to the band was done formerly in two operations: One worker stitched the band and was called a bander; the other inserted the collar into the band and stitched it in place, and she was termed the inserter. It was necessary to truck the bands and collars to the assembling department and from there to the inserters. Production records also had to be kept of both banders and inserters. The pay for these tasks was on a piecework basis. These two operations, making the band and inserting the collar, were combined and were performed by one operator. Production per hour decreased slightly but not enough to offset the savings effected by the elimination of the assembly department (which had collected the bands and the collars and tied them in bundles), the abolition of the trucking from

one operation to another, and the decrease in clerical work. After the change the earnings of the inserters showed a decrease and those of the banders an increase. The change was effected during the slack season so that the workers would have time to learn the new operation before a high rate of production would be required. Further, it was installed slowly, so the elimination of workers was gradual, except in the assembly department, which employed 6 men and 16 women at the time it was shut down.

There was a difference of opinion among the women concerning the work before and after the change. Nearly all agreed that the work itself was more difficult, but some preferred the double job because "it is easier to insert in your own well-made bands than to have to make someone else's bands fit. You can make a much better job of it." Others had difficulty in learning the new work. As one girl said, "After learning a job one way you don't like to learn it over again." According to a former inserter, it was much harder to do the bands than to insert; "turning the corners stuck most of us." But according to a former band maker, inserting was the harder work. It would seem, therefore, that the newness of the job was the stumbling block rather than its character.

Results of operating changes or different work set-up

Improved methods of operating, other than those where the introduction of a new machine was the principal factor, were reported in 41 cases. They occurred in a wide variety of industries; for example: Metal goods, hosiery, cotton cloth, candy, electric bulbs, electrical supplies, automobiles and accessories, shirts and collars, soap, paper goods, food products, drugs and pharmaceutical products, and stoves. Without doubt they are very important changes and probably it is true that there is not a single industry that would not show, on investigation, some changes of this nature.

The decrease of employment due to operating changes was not so great as in machine changes. Numbers decreased after the change by about two-fifths (39.3 percent). The number of men involved in the changes was small, only 38, compared to 670 women. Of the cases where effect on employment was reported, 22 showed a decrease, 10 no change, and 1 an increase. With smaller numbers employed it is not surprising to find a decrease in labor costs in all but 3 instances, and in no case was there an increase. As the changes were made primarily in an effort to obtain more efficient production—that is, more goods at less cost—it is not surprising to find a record of increased production after the change in 27 out of the 31 cases where this was reported.

	Number of cases resulting in—		
	Increase	Decrease	No change
Employment.....	1	22	10
Labor costs.....	0	25	3
Production.....	27	1	3

In many of the operating changes the work was simplified; in others the work formerly done by hand was accomplished by mechan-

ical aid; while in still others some tasks were eliminated. Naturally, these types of change would result, as has been found, in lower labor costs. They would not, however, necessarily result in decreased earnings. Nevertheless, this happened in many cases. Of 235 women who reported their earnings on the new method, a little over one-half, 52.3 percent, earned less after the change, slightly over one-fourth earned the same as before, and a little over one-fifth experienced an increase.

The comments of 225 workers on the new method, expressed a month or two after the change, were unfavorable in considerably more than one-half the cases; favorable in well over one-fifth; partly unfavorable and partly favorable in one-sixth; and indifferent to the change in the remainder of the cases.

HAND TO MACHINE

Though not so common at the present time as some other types of modification, the change from hand to machine operation is continually going on. In some cases where this transfer is made the work is lightened for the operator; in others there may be an added strain from the necessity of adapting the human pace to that of the machine or from the increased monotony of watching an automatic machine all day. Whether these strains are equal to or greater than the old hand method, where often considerable muscular effort was needed, depends to a great extent on the operation and on the temperament and physique of the worker, together with the care with which she has been selected in relation to the work.

SUMMARY OF FINDINGS ON HAND TO MACHINE CHANGES

Number of changes.....	42
Number of workers:	
Before.....	624
After.....	184
Percent decrease (total).....	70.5
Women.....	70.9
Men (only 3 affected).....	0.0

Employment decreased in 77.1 percent of the changes.

Production increased in 82.1 percent.

Labor costs decreased in every change.

Of the women reporting, 55 percent had lower earnings after the change and 29 percent had higher earnings.

Unfavorable comments on the change were expressed by 50.7 percent of the women reporting; favorable comments by 24.7 percent.

The following example, according to the women themselves, shows a decrease in strain with the introduction of the machine. In checking electric units the girls who were testing sat at tables and measured the resistance of electric units on a small calibrating machine. They had to watch the readings closely and throw those that measured correctly into one box, those that measured higher than the desired measurement into another box, and those that were lower into still another. With the introduction of the mechanical process, a girl sits by the machine and feeds in units, which are automatically measured and thrown into the correct boxes. Five units are measured

at one time, thus enabling the girl feeding the machine to do as much work as five girls did on the hand-measuring job. It was possible in this case to transfer the extra girls to other work in the factory, as the volume of business was increasing. A comparison of the two methods of calibrating, hand and machine, was made by a woman who had experienced both. She declared in favor of the machine: "It is easier, and not nearly so hard on your eyes as where you have to watch the figures when you are hand checking. You make more mistakes on hand checking."

Another example where the introduction of a machine appears to have benefited the worker was found in the cutting and counting of paper napkins. Formerly girls unwound the paper roll with the left hand, the foot operated the cutting treadle, and with the right hand the cut napkins were taken off and the counting was done as they were bundled. Now a machine, operated by a man, cuts and counts the napkins and the girls take off and bundle. Daily production increased from 22,000 packages per person under the hand method to 40,000 per person with the machine. Labor cost decreased from 28 cents per 1,000 packages to 14 cents per 1,000. Machines were introduced gradually so that it was possible to transfer the women to other departments. The women were divided in their opinion of the change. One said, "We had to count and band them. By having to count all day you could never talk. Now we are freer. We change jobs throughout the day; it gives you a chance to stretch your legs a little. Each of us stands about 1 hour out of every 3. We used to be on our own power; now it's machine power and I'm not so tired at the end of the day as I used to be. This doesn't take so much out of your bones." In short, the machine made the work easier for this girl. Another felt differently, however: "Work used to run better by hand. Working on the machine makes me nervous. It's terrible, it goes so fast. By hand the strain was on the eyes, watching for the dot to cut by; now the strain is on the whole body trying to keep up." For this girl keeping to the pace of the machine made the work harder even though the former job strained her eyes.

Again, in a plant where the labeling and wrapping of bottles were done by hand a machine was introduced. This machine took the bottles after they had been washed and filled by machine, labeled and wrapped them, dropping in a little corkscrew. From the machine they were carried along on a moving belt to be packed in large containers. The machine requires 1 girl to supply the bottles, 1 to operate the machine, 1 to furnish the corks, 1 box maker, 1 packer, and 1 stripper (putting gummed tape around 1 dozen boxes), 6 girls in all to work with the machine. The labeling and wrapping formerly were done at tables and required 15 girls, or 2½ times as many as are needed on the machine. The output increased from 2,016 a day on hand labeling and wrapping to 26,000 a day on the machine. Some of the displaced girls were given temporary work on hand wrapping and some were transferred to other jobs, but all, whether transferred to the new machine or to other work, received a cut in pay, amounting in the majority of cases to 25 percent. In the interviews with the women this decrease in pay naturally was a

source of dissatisfaction and may have influenced their reaction to the new work itself. One girl said: "The work is much harder now; the steadiness of the machines is more tiring than working even harder at some other job; you have to keep right at it every minute." This girl voiced the opinions of the other workers, who referred in their interviews to the "steadiness" of the machine. "Hand wrapping was easiest; I didn't like the steadiness of the machine."

A change found rather frequently was from a hand process to a machine one where, as in the case of dial feeding, with the job itself easier and safer, the keeping up may have equaled the fatigue involved in the earlier method. Girls wrapping lollipops formerly stood at tables covered with the candy. At the edge of the tables were stacks of waxed paper. Each lollipop was picked up, wrapped in the paper, and a little twist given to the paper to hold it in place. The wrapped lollipops were thrown into a bin, from which they were taken to be packed in boxes. With the introduction of the wrapping machine one girl placed the lollipops in a little slot on a moving belt that carried them to the machine. Here they were wrapped and thrown out on a table for another girl to pack into boxes. The girl who feeds must see that the machine runs properly and the girl who packs must keep the hopper full of wrapping paper. In this change the worker no longer has the fatigue of standing all day in one spot, reaching for lollipops and twisting the papers in the wrapping of each piece, but has the steadiness of the work in feeding the machine and in keeping up with the lollipops as they are thrown out. There was little diminution in numbers due to the change, as the machines were installed gradually according to the growth of the business. However, the potential employment, or the number of workers that would have been needed with the increase in business had machines not been introduced, was considerably less. By hand one girl could wrap 80 boxes a day, and the packer could pack for two wrappers (160 boxes a day), while on a single machine two girls could wrap and pack 500 boxes a day. Earnings were higher on the machine work, but as the method of pay was changed as well as the method of work it was impossible to obtain a significant comparison.

Results of change from hand to machine work

The change from hand to machine work involved a greater decrease in numbers than any other single change. Where 624 workers had been employed before the introduction of the machine, after the change the number decreased to 184, only 29.5 percent of the earlier number. Only 3 men were employed on the operations affected and they remained after the change. The number of workers—as stated, practically all women—decreased in 27 cases and in no case was their number increased.

In this change, more perhaps than in any other type, the economy effected was essentially a saving of human labor. All the firms that reported labor costs declared a saving and in no case did the labor costs remain as high as before the introduction of the machine.

Production increased in over four-fifths of the cases reporting. It decreased in only one instance, and here, though the change did not increase the output, it did lower the cost of production.

	Number of cases resulting in—		
	Increase	Decrease	No change
Employment.....	0	27	8
Labor costs.....	0	29	0
Production.....	32	1	6

When earnings of all women are compared according to the women's statements, in most cases they were not so good after the change as before. Well over one-half of the women (55.2 percent) reported a decrease, considerably less than one-third (29.2 percent) an increase, just under one-sixth (15.6 percent) no change in earnings.

When only the earnings of women placed on machines are compared the result is slightly more favorable, with only a little more than one-half (52 percent) reporting decreased earnings and about one-third (32 percent) an increase.

It is not surprising that favorable and unfavorable comments followed rather closely the proportions with increased and decreased earnings. One-half of those transferred to the new method reported unfavorably and almost one-fourth either were partly in favor and partly against the change or were indifferent. Not quite one-fourth of the women were favorable to the change though nearly one-third earned more on the new work.

SUBSTITUTION OF ONE CLASS OF WORKERS FOR ANOTHER

In the search for economies of operating, one of the methods frequently employed is that of substituting one class of help for another. The change may be to a less skilled group, to more recent arrivals in the industrial field, or to those whose wage scale normally is lower. In past years the newer immigrant replaced, on less skilled work, the older immigrant. During and after the World War many Negroes went north and were employed on jobs formerly done by white workers. Where a job is simplified through the introduction of a machine or a labor-saving device, less skilled workers may supplant those more skilled. On these types of work, especially if great physical strength is not required, women have replaced men on many jobs during the past 70 years. This replacement increased rapidly during the World War as men were more and more withdrawn from industry. With the return of men after the war they were reemployed on the work on which women had not proved satisfactory, but on many jobs women were retained as being more efficient or less expensive. Though the amount paid in wages should be based on the task performed, and in some industries, notably textiles and clothing, it is so based, yet in much of the work where women replace men they receive a lower rate of pay largely because of the idea, based on physical labor, that they are worth less because possessed of less muscular strength. In some cases of substitution an adaptation of the work may accompany it, but more frequently it is only a change in the pay envelop and not in the work done.

SUMMARY OF FINDINGS ON SUBSTITUTION OF ONE CLASS OF WORKERS FOR ANOTHER

Number of changes.....	33
Number of workers:	
Before.....	744
After.....	757
Percent increase (total).....	1.7
Women.....	1,168.4
Men (decrease).....	61.0

Employment remained the same in 71.9 percent of the changes.

Production remained the same in 78.6 percent.

Labor costs decreased in all the changes.

An increase in earnings was reported by 50 percent of the women reporting.

A decrease in earnings was reported by 35 percent.

Unfavorable comments on the substitution were expressed by 36.4 percent of the women reporting; favorable comments by 22.7 percent.

The following examples give some idea of the process of substitution and the types of work on which it is occurring today.

Women were introduced on a number of operations in the assembling of electric refrigerators. They learned to screw hinges on the doors, to fit the copper tube line to dryer pipes and screw them on securely, to "peg" the food-compartment linings and fasten on the front coil shield. The superintendent was satisfied with the change, and, though it probably did not increase production, a saving was effected in costs because of the lower rates paid the women. Where base rates for the men had been 42 cents, 47 cents, and 50 cents an hour, those paid the women were 25 cents, 30 cents, and 33 cents an hour. The women were hired especially for the work, and in order to turn out the same amount as had been done by men the number of workers was increased slightly. The men displaced were transferred to heavier work in the department.

Sometimes when the work is especially well fitted for women, the change results in increased production as well as in decreased labor costs. On a punch-press operation where women took the place of men, actual production increased 15 percent for the entire department, largely, according to the management, because the women handled the work faster. The punch presses were well guarded, whether operated by men or by women, so the operators could work without any thought of danger to themselves. Labor costs decreased after the change, as the hourly rate for the women was 35 cents and for the men it had been 50. The men were replaced by the same number of women, but as the change was made gradually it was possible to transfer the men to other jobs so that they were satisfied with the change.

When in the course of the work it is necessary to use hand tools, women in the beginning are at a disadvantage, though they may become equally proficient after a time. In a certain plant making springs for auto cushions, it was necessary to use pliers to assemble the links. Women took the place of young men on the assembling of smaller springs. It took them longer than the boys to learn the job, but after 3 months their speed equaled that of the boys. The piece rates paid the women were lower, so where the labor cost per

unit had been 5.62 cents with the men, it fell to 4.48 cents with the women. A further saving resulted from the fact that labor turnover was less with the women than with the men.

In a knit-goods factory where women replaced men at the cutting table, it took a little time for them to become proficient in the work, but after they had learned their output was as great as the men's had been and with less waste. Labor costs were reduced considerably, as the men received 35 cents per unit of production and the women 25 cents—a reduction of nearly 30 percent.

In all the changes described here, as is generally the case where women replace men on the same work, the economy effected was largely through the lower wages paid the women. In only one instance where women replaced men with no accompanying change were the wages of the women the same as those formerly paid to men.

Where together with a labor change there was added a new machine or a new tool, production increased in almost every case and labor costs decreased.

A tube-forming job had been done by men, each of whom stood at a bench in front of a fixture; he inserted the tube in a vise, turned the forming lever to bend the tube (which required considerable strength), released the vise, and removed the tube. With the introduction of a machine to bend the tube girls were put on the job. The girl inserted the rods into the machine, turned on the power with a hand lever, the machine bent the tube, and as she released the power the bent tube dropped into a bin. The work of the girl therefore consisted in turning the power on and off and seeing that the rods were properly fed to the machine. None of the work involved strength. This change increased production greatly, as a girl with a machine could turn out as much as four men with the hand lever. Labor costs decreased from \$35.10 a day to \$5.84, or somewhat over 80 percent, for not only were fewer workers needed but the earnings of a woman operating the machine were only two-thirds as much as that of a man producing less work under the old method.

Very much the same result of increased production with less skill required was accomplished by the introduction of a tool and a change from men to women in the striping of automobile bodies. Formerly the decorative lines on automobiles were drawn free-hand by a highly skilled body of men, "super-painters." As the industry grew it was difficult to obtain in the busy season enough men who were skilled at striping and so the work would jam at this point. A small barrel container was invented with a gear-fed nozzle attachment for forcing paint out through the narrow needle at the end. With a little practice this could be operated by anyone, and it entirely supplanted the free-hand method of striping. By hand it used to average about an hour and 12 minutes to stripe a single car. With the gun the time averaged 12 minutes a car, including the time allowed for cleaning the gun, changing colors, or relief. This shorter period needed to do the job naturally resulted in fewer workers. Where formerly 22 men were employed on striping, the force decreased to 1 man and 4 girls; and where the wages paid to the skilled painters had been from \$1.50 to \$1.75 an hour, or about \$1.77 for the work on one automobile, the cost of striping one car decreased under the new method to 12 cents, with average earnings for the girls of 60 cents an hour when work was steady. When the change was made the painters were laid off and

the women were transferred to the striping job from other work in the factory.

When the substitution of one class of labor for another is done in order to obtain more efficient production this does not necessarily involve a change from a higher- to a lower-paid group, though without doubt this is the more common form of change. In the present study, facts were obtained in 10 cases where men replaced women. The change was combined, in most instances, with some alteration in the work; either a new and heavier machine was introduced or helpers were eliminated so that the work required more heavy lifting and handling. In the winding of large stator coils girls were employed on a semi-automatic machine. They sat at their machines, one girl to each. Her duties were to insert the wire, start the power, guide the wire, and watch the indicator to see when the machine must be stopped and the wire cut. She must then tie the coil, fasten on the plate, and repeat the operations until the winding of four or five coils was completed, the number necessary for a single stator. The girl must watch carefully and wind as evenly as possible. Nevertheless, by this method a good many uneven coils were wound. An automatic machine was introduced. On this new machine a man brings up and inserts the heavy wire rolls at the rear of the machine, turns on the power by a foot treadle, and watches to see that the machine runs smoothly. The machine stops automatically when the winding is completed. He must then cut the wire and remove the coils. Each man operates two machines, and the winding is more even on the automatics and the hourly production a little greater. Though the men's rates are higher, labor costs are somewhat less, as the men tend to operate two machines instead of one.

In the finishing department of a paper mill the final finish was obtained by passing sheets through a calendar roll, one girl feeding, another taking off. A machine was introduced that was fed with heavy rolls of paper instead of sheets, and these required men to do the lifting as the rolls were too heavy for women. Formerly there were 13 of the sheet-fed calendar rolls and 26 women fed and took off. With the larger machines fed from a paper roll only 3 machines were needed, and these required 6 men to operate, the 6 men replacing the 26 girls formerly employed. The daily production of the 13 old calendars was 3 tons, while on the 3 new calendars it was 6 tons, a 100 percent increase. The hourly rate of the men was 60 cents and that of the women 35 cents, but as fewer workers were necessary the labor costs on the machines decreased 80 percent.

In a plant where no machine change accompanied the substitution of men for women in the cutting of cloth, the change was made in order to eliminate nonproductive labor. Before the change the women cut the cloth, but as the rolls were heavy men did the trucking, lifting, and spreading. By the introduction of men to do the cutting, these helpers were eliminated, as the men cutters served themselves. The group before the change consisted of 5 cutters (girls), 1 subforeman, 1 stencil man, and 2 truckers. This group was replaced by 5 men cutters who performed all these tasks. The rate of production remained the same after the change but labor costs were reduced, in spite of higher rates paid the men cutters, because of the elimination of the nonproductive labor.

Results of substitution

There were 33 cases where the only change was a substitution of workers of the other sex so as to bring about economies of operation. In 32 instances women took the places of men and in 1 instance men replaced women. The effect on employment was the opposite of that produced by most technological changes. Instead of a decrease in numbers there was a slight increase in the total number employed and a marked growth in the number of women. In the 32 cases the number of women increased from 33 to 482, while the opposite occurred with the men, who showed a decrease from 702 to 270. In the single case where men replaced women, described in the foregoing text, the number in the group changed from 4 men and 5 women to 5 men.

In the 32 cases of substitution where labor costs were reported they were decreased. Output showed less change, as it remained the same in 22 of the 28 instances reported, increased in 3, and decreased in 3.

	Number of cases resulting in—		
	Increase	Decrease	No change
Employment.....	7	2	23
Labor costs.....	0	32	0
Production.....	3	3	22

The result of substitution when it was combined with machine or other operating changes, as was frequently the case, presented a rather different picture from that caused by substitution only. When the substitution of men for women was combined with another change, numbers employed decreased 55.8 percent. This decrease affected women only, the men increasing from 8 to 47. In the other type of substitution, where women replaced men, when combined with a secondary change numbers decreased 45.6 percent, both men and women being affected. The proportion of decrease was nearly three-fourths, or 72.8 percent, for the men, but was only 19.3 percent for the women.

The results in the cases of substitution of men for women combined with another change, and in the cases of substitution of women for men also so combined, are presented in the summary following:

SUBSTITUTION OF MEN FOR WOMEN, WITH ANOTHER CHANGE

	Number of cases resulting in—		
	Increase	Decrease	No change
Employment.....	0	8	1
Labor costs.....	0	6	0
Production.....	8	0	1

SUBSTITUTION OF WOMEN FOR MEN, WITH ANOTHER CHANGE

	Number of cases resulting in—		
	Increase	Decrease	No change
Employment.....	3	4	14
Labor costs.....	0	19	0
Production.....	11	0	7

Home visits with women who had displaced men showed that as a result of this change average hourly earnings had increased for half the 20 women reporting, remained the same for 3, but had decreased for 7. No women affected only by the replacement of women by men were visited, but of 21 cases where this was part of a combination of changes earnings showed an increase for 5 women, a decrease for 7, and no change for 9. The substitution of women for men combined with some other change resulted in increased earnings in 2 cases, a decrease in 3, and no change in 1.

The opinions of the women after the substitution varied according to the nature of the work. One woman who was placed on striping an automobile said it was the best job that she had ever had and that the work was easy and clean. A woman put on spring assembling found the work difficult and also complained about the difference in rate of pay from that formerly earned by the men, as she was doing the same work. This last comment was very frequently heard, especially where the work was unchanged. Unfavorable comments on substitution of women for men were expressed by about one-third of the women reporting. Slightly more than one-fifth expressed themselves in favor of the new arrangement and about one-third were partly favorable to it.

CHANGE IN METHOD OF PAYMENT

The change from time or piece rate to a method of payment designed to promote cheaper production probably should not, strictly speaking, be classed as technological. It is included as such a change in this report for two reasons: It is installed usually after scientific study and it is a change that is supposed to increase the efficiency of operating. Further, the result of this change is similar to that of strictly technological changes and it is introduced with the same end in view, lower production costs. It differs from other so-called technological changes in that the extra efficiency is the direct result of the effort of the workers, in most cases without the introduction of any improved machinery or better methods of work. The cost to the management usually consists of an engineering study previous to the introduction of the new system and in some cases increased book-keeping after the change. This additional cost is supposed to be covered by the extra effort on the part of the workers.

During the period from 1900 to 1920, more and more jobs were changed from a method of time payment to one based on actual amount produced, or piecework. This resulted not only in an increase of speed, as the worker wished to make all she possibly could, but the elimination for the manufacturer of payment for waiting time and for imperfect work. In the present study the change in method of pay found most frequently was a change from piecework payment to some other form of incentive payment. One very significant change was to a task-and-bonus system. A task—that is, a certain output—is required, and for this a definite hourly rate is paid; for all production of more than the required amount an extra sum, or bonus, is paid. Another change that occurred with considerable frequency was from an individual method of incentive payment to a group method of payment. Sometimes these changes involved operating changes as well. In most cases a time study was

made of actual performance, of routing, waiting time, and so forth, and minor improvements were introduced. An example of this found frequently was when the change from individual to group payment was accompanied by line production or better methods of bringing up and taking away the work.

In all incentive methods of payment other than straight piecework the fairness of the task set is the crucial point. If the change is made from a piecework method of payment where the worker is already doing her best to earn as much as possible, there is great danger of overstrain if the task requirement is set too high. A pieceworker has her good and bad days. As one girl said, "You can't go at a certain speed every day"; and she added: "The man that timed us only did it for a few minutes—anybody could work fast for a few minutes, but it's all day every week for us and we can't do it." The need of allowing for this variability is too seldom considered in the setting of tasks.

SUMMARY OF FINDINGS ON DIFFERENT METHOD OF PAYMENT

Number of changes.....	14
Number of workers:	
Before.....	305
After.....	198
Percent decrease (total).....	35.1
Women.....	35.1
Men.....	No men affected
Employment decreased in 5 out of 9 changes.	
Production increased in 9 out of 14.	
Labor costs decreased in 7 out of 8.	
Earnings decreased under the new method for 57.5 percent of the women reporting.	
Unfavorable comments on the change were expressed by 74.7 percent of the women reporting; favorable comments by 12.6 percent.	

The strain involved in trying to make the task is especially marked when the operation is performed by hand. In one plant the change was made from individual piecework to individual task-and-bonus system with no change in the method of work. The girls worked standing. It was a distinctly hand job and although the work was not heavy it involved considerable reaching. The result of the change may have been satisfactory from the viewpoint of the management, for production per operator almost doubled and labor costs declined to an even greater degree as the unit of pay was lower. The workers, however, considered the result in quite a different light. "They don't keep you unless you make the bonus. It is not an easy job; you stand and reach all day." "If too many mistakes, you go out and stay out forever." The girls who were interviewed were practically unanimous in their opinion of the tremendous speed necessary "to make your task." "It'll just wear you out in 2 years", one girl said.

Another frequent form of change was from payment based on individual performance to the output of the group. Such a change was made on a wrapping and packing operation. One girl inspected and wrapped, the second girl boxed the wrapped product, and the third sealed the box. The pay was changed from individual to group piecework but no change was made in the method of work. Production was increased about 10 percent by the change, as the girls on

group payment would help each other so that the slowest girl would not hold back the others. Costs were cut because less supervision and bookkeeping were required. Earnings decreased slightly as the premiums were lowered, though the base rates remained the same. It was felt also by the management that the group system might increase cooperation among the girls and eliminate disputes over the work. It seems doubtful whether this hope would be realized in view of comments made by the women where a similar change took place. The results for the management in this second plant were much the same as in the one just reviewed. Production per worker increased about 10 percent and average hourly earnings increased by 2 percent, while the numbers employed decreased from 48 women to 42. According to the management, the poorer workers left "automatically", either of their own accord or at the request of the other workers because they slowed down production. The workers themselves in the majority of cases did not like the change. "One girl can hold up a whole group." "The slow workers are carried by the group", and there are "some who will not and some who cannot work fast." "One unfair thing is that when a new girl comes into the factory they give her 3 days to learn the job in and then she goes on a group. She can't really learn in less than a month. It means the group is carrying the company's burden of teaching beginners, and that's not fair."

In an optical factory a change was made from the individual piecework system to a task-and-bonus system. On the new method a fixed hourly rate based on average hourly production was given to each worker and for all output above that a bonus was given. The standard hourly output required was valued at 60 points and for all production above this amount a bonus, figured in points, was given. The entire department went on the new system of pay and the foreman was paid his bonus according to the hourly output of the department; that is, as the workers' efficiency increased, the pay of the foreman also increased. The principal operations on which the women were engaged were grinding and polishing, cleaning blocks, and washing lenses. The girls, with one exception, stood at their work and seemed rarely to glance up. All worked tensely, and all but two on work requiring great care. The management in setting the rates, which had been done after careful time study, had set an allowance of 15 percent of the work time for rest and personal needs. This, according to the workers, was seldom taken. One said "We never have a rest period," and another "Haven't time to sit or even take a drink at the bubbler." Production increased approximately 10 percent and the number of employees remained the same. If, due to the increased speed, the work was finished more quickly than formerly, fewer hours were worked. Therefore, though average hourly earnings for the department increased by 2½ cents (5½ percent), there was a division of opinion as to the effect of the change on weekly earnings, some declaring that they earned more and some less. All were agreed, however, that the work was harder. "We work much faster now. Before the bonus I had 6 machines; they gave us a cut and added 2 machines—I tend 8 now." Another said: "Before we had to change our grinders every hour and a half; they would get dull by that time. Now we have to change every three-quarters of

an hour, and changing means you lose a lot of time. Before, I did 354 lenses a day, now I do 460. I feel much more tired at night." In spite of such speeding the average hourly production for the group at this time was only 10 points above the base of 60, and though according to the management an average operator should have an output registering an efficiency of 80 points, not one of the efficiency ratings posted on the bulletin board reached that figure.

On piecework and all other forms of incentive payment, the tendency is for the worker to drive herself so that earnings may be as high as possible. When the system of payment includes a bonus to the foreman or superintendent based on the production of the department or factory, there is additional pressure from above to work to the limit.

In a knitting mill where all but the general help had been paid on a straight piecework basis, a new method of pay was introduced where an hourly rate for standard production was given and all output in excess of the standard was paid by the piece. A standard of production was set for the entire department and for all production above the standard the foreman received a bonus; further, if the production of the whole mill was above, the superintendent also received a bonus. Some routing changes that saved time and labor were introduced. Work was brought to all the stitchers but the seamers, who still fetched their own work, and was then passed along from one worker to the next. The cost of trucking and waiting time was saved.

Actual production increased by 5 percent after the change and labor costs decreased by 25 percent. The number of workers was 89 before the change and 64 afterward, but the average efficiency of the workers increased from 80 percent to 112 percent, as only the better workers remained. According to the management, average hourly earnings increased by 2 cents or almost 7 percent, but this increase in earnings was not reported by the workers visited, who complained of harder work and less pay. "They talk about lost hours, lost motion—all it is to me is lost money." Another woman said: "The changes are not made for the people. Our boss gets a part of what we make, so he wants us to work every minute we are there." "We used to go to a truck for work; now girls back of me throw it in a bin beside me; when I finish it I throw it in a bin in front. We don't save so much by that and it was a little change from work to get up and walk across the floor."

Results of change in method of payment

The decline in numbers was not so great as in changes that involved the introduction of new and better machines or of new methods of work. Nevertheless, the number of workers decreased a little over a third without such aids to production as better machines or other improved equipment. No men were affected by this change, as the operations selected were those employing only women. Labor costs decreased in all but 1 of the 8 cases where costs were reported, and in the 1 instance where there was no decrease the costs were the same before and after the change. Output increased in 9 of the 14 cases reporting production, was less in 2, and the same in 3 cases.

	Number of cases resulting in—		
	Increase	Decrease	No change
Employment.....	1	5	3
Labor costs.....	0	7	1
Production.....	9	2	3

Earnings after the change in method of payment were less for almost three-fifths (57.5 percent) of the 200 women who reported their earnings before and after. About one-third reported an increase and the remaining 8 percent reported no change. The comments of the women showed more dissatisfaction with this change than with any other of the principal ones, and three-fourths complained of harder work or lessened earnings after the change. A marked feature of this change was a speeding up of the work combined with a lack of adequate rest periods.

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