

FEDERAL WORKS AGENCY
WORK PROJECTS ADMINISTRATION

F. C. HARRINGTON
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NATIONAL RESEARCH PROJECT

on

Reemployment Opportunities and Recent Changes
in Industrial Techniques

DAVID WEINTRAUB
Director

In cooperation with

EMPLOYMENT STABILIZATION RESEARCH INSTITUTE
UNIVERSITY OF MINNESOTA

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**CHANGES IN MACHINERY AND JOB REQUIREMENTS
IN MINNESOTA MANUFACTURING, 1931-36**

*A Second Survey of Production Work in Plants of the
Minneapolis-St. Paul Area*

by

Charles A. Koepke

with the assistance of

S. Theodore Woal

WORK PROJECTS ADMINISTRATION, NATIONAL RESEARCH PROJECT

In cooperation with

EMPLOYMENT STABILIZATION RESEARCH INSTITUTE

UNIVERSITY OF MINNESOTA

Report No. L-6

Philadelphia, Pennsylvania

July 1939

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

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

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

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

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

**FEDERAL WORKS AGENCY
WORK PROJECTS ADMINISTRATION
1734 NEW YORK AVENUE NW.
WASHINGTON, D. C.**

**F. C. HARRINGTON
COMMISSIONER OF WORK PROJECTS**

July 14, 1939

Colonel F. C. Harrington
Commissioner of Work Projects

Sir:

There is transmitted herewith a report on changes in machinery, methods of work, job requirements, and characteristics of workers in the Minneapolis-St. Paul area during the years 1931-36.

Many technological changes took place during this 5-year period. They were in part the result of installations of new equipment, but in the main these changes reflected minor improvements on old machines. Most of the improvements were designed to make the old machines more automatic and, depending on the need of the industry involved, either more specialized or more flexible. In any case, the efficiency of the machines was increased and fewer men were needed for the production of a given volume of output.

Moreover, these innovations changed the technical requirements of the work to be done and permitted changes in the character of the work forces employed. Outstanding was a tendency toward the reduction of the proportion of skilled and unskilled workers and an increase in the proportion of semiskilled workers. This tendency toward the leveling of skills was accompanied by a general shortening of the training time required for the various jobs. Automatically operated machines and machines that may be preset for a variety of standard operations reduced the need for special skills.

Workers who possess special skills used in a single industry are, however, also the ones who are particularly limited in their opportunities for adjustment even when employment is expanding. This difficulty becomes an especially serious matter to workers who are past

middle age, because the typical technological changes, discussed in this report, place a premium on speed, dexterity, and adaptability rather than on experience and skill. A technological basis is thus provided for industry's preference for younger workers to the detriment of the older workers with family responsibilities who, in increasing numbers, are forced to fall back on public aid.

Respectfully yours,

A handwritten signature in black ink that reads "Corrington Gill". The signature is written in a cursive style with a large, sweeping initial 'C'.

Corrington Gill
Assistant Commissioner

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PREFACE

Several reports of the National Research Project have dealt with types and rates of technological change from the viewpoint of the effects of these changes on the demand for capital goods and on the number of jobs. Aside from such effects, however, technological change also has an influence on the types of skill required by industry. Depending on the character of the change, its incidence differs with respect to occupation and variously affects the occupational composition of industry's work forces.

Based on the types of technological change observed in the Minneapolis-St. Paul area during the period 1931-36, this study presents quantitative data on the effects of these changes on job requirements and the worker. It is thus directed to questions on the degree to which the typical, current changes in industrial technique have, on the one hand, influenced the worker's responsibilities on the job, the type and duration of training required, and his working conditions and, on the other hand, altered the importance of such selective factors as skill, sex, age, previous experience, and transferability of skill in determining who in the labor supply gets the available jobs.

The fundamental changes in production processes that were characteristic of industries that were going through their early days of industrial revolution are relatively rare today, though they still occur and tend to be dramatized since their labor-displacement effects are usually spectacular. Rather, the rule

CHAPTER III

THE WORK

This chapter deals with the work performed in the factories surveyed in Minnesota. Here are presented analyses of the types of dexterity most in demand for industrial operations and summaries of the significant trends in job requirements, methods of compensation, and systems of performance. Particular attention is devoted to noteworthy modifications that occurred in identical plants during the period 1931-36, and the role of technological development in such changes is evaluated wherever possible.

Improvements in machinery have had far-reaching effects upon the qualifications which a worker must have if he is to obtain or hold a factory job. In changing work specifications, however, the part played by management has been equally and in some cases even more important than mechanization itself. Reorganization of the lay-out of the plant, increasing application of time and motion studies, continued refinements in the division of labor - all have had their repercussions upon the work to be done. Furthermore, there is usually an intimate connection between the introduction of a new machine, or the improvement of an old one, and a reallocation of tasks. Even where the machinery remains unchanged, industrial engineers seek to cut down waste of human energy, to simplify transportation of materials within the plant, and in general to reduce the item of labor costs.

One of the principal objectives of managerial policy has been the reduction of fatigue. Sometimes such an improvement has been effected simply by an adjustment of the machine, sometimes by a change in the organization of the work, but most frequently by a combination of both. Before the advent of mechanical handling equipment, conveyor systems, and the like, the lifting of heavy weights was an outstanding cause of fatigue in factory work. In recent years much of the heavy labor formerly assigned to the worker has been mechanized. Thus in 1936 few industries required their workers to lift weights by hand, and even in these the proportion of operations

which called for the lifting of units of 100 pounds or over was almost negligible. At present the most widespread cause of fatigue is the speed with which the worker must carry out his task and not the weight which he must lift or manipulate.

METHODS OF TRANSPORTATION WITHIN THE PLANT

Data on transportation within the plants surveyed were recorded in 1936, as in 1931, for the carrying of materials to the operation and from the operation.¹ Table 4 presents

Table 4.- METHOD OF TRANSPORTATION BETWEEN OPERATIONS,
1931 AND 1936^a

(Percentage of production operations)

| Industry | Material carried by - | | | | | |
|--------------|-----------------------|------|------------|------|----------------------------|------|
| | Hand | | Hand truck | | Mechanical handling device | |
| | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 |
| Baking | (b) | 55 | (b) | 25 | (b) | 20 |
| Candy | (b) | 64 | (b) | 15 | (b) | 21 |
| Carpet | (c) | 100 | (c) | 0 | (c) | 0 |
| Cigar | 74 | 90 | 20 | 10 | 6 | 0 |
| Clothing | 93 | 94 | 7 | 6 | 0 | 0 |
| Coke | 0 | 5 | 0 | 0 | 100 | 95 |
| Creamery | 26 | 37 | 17 | 13 | 57 | 50 |
| Dry cleaning | (b) | 63 | (b) | 26 | (b) | 11 |
| Flour | 23 | 33 | 5 | 3 | 72 | 64 |
| Food | (b) | 41 | (b) | 20 | (b) | 39 |
| Furniture | (b) | 69 | (b) | 25 | (b) | 6 |
| Laundry | 62 | 52 | 36 | 38 | 2 | 10 |
| Metalworking | 47 | 31 | 42 | 51 | 11 | 18 |
| Packing | (b) | 27 | (b) | 11 | (b) | 62 |
| Paint | (c) | 0 | (c) | 40 | (c) | 60 |
| Pottery | 58 | 40 | 36 | 60 | 6 | 0 |
| Printing | 72 | 80 | 19 | 20 | 9 | 0 |
| Shoe | (b) | 60 | (b) | 40 | (b) | 0 |
| Woodworking | 39 | 65 | 54 | 29 | 7 | 6 |
| Woolens | 39 | 22 | 39 | 53 | 22 | 25 |

^aBased on identical plants in industries in which 30 or more operations were surveyed in the given year.

^bComparable data not available.

^cLess than 30 operations surveyed.

¹In almost all cases the methods were found to be the same for materials moving in either direction.

the findings for both years for industries in which at least 30 operations were surveyed and in which the plants were identical. Six of the 23 industries surveyed in 1936 - carpet, cigar, clothing, pottery, printing, and shoe - employed no mechanical handling devices whatever. In all these, except carpet, the units carried were small and light in weight, and the distances covered were short. On the other hand, in the coke industry, where the material at most stages is too hot to be touched, the bulk of the operations, 95 percent, were fed by mechanical means. In general, it was the highly integrated, mass-production industries which employed mechanical transportation devices for a large percentage of their operations: Bottling for 100 percent, flour for 64 percent, packing for 62 percent; and paint for 60 percent.

Several of the industries in which identical plants were surveyed in the two years had revised their internal transportation systems with a view to cutting down the moving of materials by hand. In 1931 two-thirds of the transportation to and from operations in the bottling plant was mechanically performed; by 1936 this plant had completely eliminated both hand and hand-truck transportation. This plant, it will be recalled, was also outstanding for its high proportion of automatic equipment.

Metalworking had shifted from hand to both hand-truck and mechanical movement of materials. It had reduced the proportion of operations using hand transportation from 47 to 31 percent, raising that for hand-truck transportation from 42 to 51 percent and for mechanical devices from 11 to 18 percent.

In the laundry industry hand carrying was relied upon to a lesser degree than in 1931, although here the decrease was not so marked as in the industries just mentioned. The paint industry had done away with hand carrying altogether, whereas in 1931 hand transportation had accounted for one-fifth of its operations. Unlike transportation in bottling, however, that in the paint industry had not become completely mechanized, although mechanical handling showed a marked rise, from 46 to 60 percent, with hand trucking accounting for the remainder of the operations.

Both the pottery and the woolens industries had also decreased hand transportation, but in these two cases the shift was largely to the hand-truck method. Pottery had actually cut

the percentage of operations depending on mechanical handling devices from 6 to 0 percent, while the woolens industry showed only a slight rise in the mechanical category.

Some of the industries had, however, increased hand transportation. The carpet plant surveyed, despite the heavy weight of the units involved, was found to have augmented hand transportation from 77 to 100 percent of its operations. Although mechanical handling could well be used here, this plant appears to have adopted a policy of requiring that materials be moved by hand.

The cigar plant, despite the fact that it had introduced many advances in machinery, was found to have eliminated mechanical handling, which accounted for 6 percent of the operations in 1931, and to have raised the proportion of the operations relying on hand transportation from 74 to 90 percent. It should be noted, however, that in this industry, as in clothing, where 94 percent of the operations depend upon hand transportation, the units of material which must be moved are small and light in weight.

In the cigar, coke, creamery, flour, pottery, printing, and woodworking industries a somewhat smaller proportion of the operations was supplied by mechanical means in 1936 than in 1931. The apparent retrogression may be attributable in part to the fact that the number of operations in the given year served as the basis of the survey; in the absence of other changes, where a new machine had integrated several mechanically fed operations (including transportation from one to the next) into a single operation, the percentage of total operations fed by mechanical devices would have dropped.

Generally speaking, the factories surveyed are not large, a fact which may account somewhat for the rather slow adoption of mechanical handling devices. The size of the plant is not always the sole determining factor, however, for a number of small plants in the Twin Cities use mechanical handling devices for a large proportion of their operations. For example, in this survey one mechanized bread-baking plant (in the baking industry there is necessarily a great deal of handling) employed mechanical handling for about 80 percent of its operations; thanks to this equipment it could turn out an exceptionally large amount of bread with a minimum

number of workers. If other baking plants have not modernized their transportation methods, the failure cannot be ascribed wholly to their size. However, when the amount of material to be handled is small, its transportation by hand truck or even by hand may be found more economical than mechanical handling. This consideration may explain why some of the industries had decreased or eliminated mechanical devices in the period 1931-36.

TYPES OF DEXTERITY REQUIRED

The types of dexterity required for the various operations surveyed were classified as "finger", "hand", "arm", and "foot." These were noted for each task, with no reference to the potential dexterity of the worker engaged thereon. In many instances it was, of course, difficult to apply this classification rigidly, especially as between finger and hand dexterity. In general, operations were considered to demand finger dexterity when they depended almost exclusively upon digital manipulation. Hand dexterity was held to involve the use of the whole hand, from fingertips to wrist, and arm dexterity comprised hand, wrist, and the entire arm. Foot dexterity, in the few cases where it was found, most commonly required the pressing of a pedal or lever with the foot.

The 1936 data for 20 industries are summarized in table 5. It will be noted that hand dexterity was most frequently required. However, finger dexterity was a prominent requirement in all but one of these industries, and in three of them it was necessary on more than half the operations.

Unfortunately, it was impossible to record changes in all the industries surveyed in both 1931 and 1936 with respect to types of dexterity since in many cases this item was not noted in the earlier year. However, the seven industries for which comparable data were available (bag, baking, laundry, pottery, printing, woodworking, and woolens) clearly evidence a trend toward finger dexterity. This emphasis upon the fingers may be interpreted as reflecting the increasing simplification of operations, although it does not necessarily imply a decrease of fatigue, which in the case of small movements is conditioned primarily by the rate of performance. Greater speed is usually attained when motion is concentrated in fingers and hands than

Table 5.- KIND OF DEXTERITY REQUIRED, 1936^a

(Percentage of production operations)

| Industry | Finger | Hand | Arm | Foot |
|--------------|--------|------|-----|------|
| Baking | 32 | 53 | 15 | 0 |
| Candy | 40 | 44 | 15 | 1 |
| Carpet | 41 | 35 | 24 | 0 |
| Cigar | 62 | 31 | 4 | 3 |
| Clothing | 56 | 39 | 5 | 0 |
| Coke | 25 | 50 | 25 | 0 |
| Creamery | 21 | 54 | 25 | 0 |
| Dry cleaning | 31 | 40 | 29 | 0 |
| Flour | 29 | 68 | 3 | 0 |
| Food | 32 | 55 | 13 | 0 |
| Furniture | 33 | 50 | 13 | 4 |
| Laundry | 26 | 51 | 20 | 3 |
| Metalworking | 22 | 55 | 19 | 4 |
| Packing | 19 | 63 | 18 | 0 |
| Paint | 4 | 63 | 29 | 4 |
| Pottery | 24 | 71 | 5 | 0 |
| Printing | 60 | 34 | 6 | 0 |
| Shoe | 35 | 58 | 7 | 0 |
| Woodworking | 27 | 48 | 21 | 4 |
| Woolens | 44 | 46 | 10 | 0 |

^aBased on those industries in which 30 or more operations were surveyed.

when the arm is employed also, but the worker may tire even more quickly under such circumstances. Among the industries studied, a few had new machines which had been constructed with a view to increasing the productivity of the worker and at the same time decreasing his fatigue. For example, some of these machines have control levers in three or four places instead of in one, so that they can be operated with a minimum of walking to and from control stations.

Five of the seven industries were found in 1936 to have substantially increased the proportion of their operations requiring finger dexterity and reduced hand operations at the same time. Outstanding among these was printing, which had raised finger operations to 60 percent as compared with only 8 percent in 1931 and lowered hand operations from 84 to 34 percent. The growing preponderance of finger operations here may be attributed partly to the introduction of several

PREFACE

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Based on the types of technological change observed in the Minneapolis-St. Paul area during the period 1931-36, this study presents quantitative data on the effects of these changes on job requirements and the worker. It is thus directed to questions on the degree to which the typical, current changes in industrial technique have, on the one hand, influenced the worker's responsibilities on the job, the type and duration of training required, and his working conditions and, on the other hand, altered the importance of such selective factors as skill, sex, age, previous experience, and transferability of skill in determining who in the labor supply gets the available jobs.

The fundamental changes in production processes that were characteristic of industries that were going through their early days of industrial revolution are relatively rare today, though they still occur and tend to be dramatized since their labor-displacement effects are usually spectacular. Rather, the rule is continuous, day-to-day change in minor steps of production processes. These changes are, however, extremely pervasive; in time they cut across the whole production process of an industry, spread from industry to industry, and cumulatively represent a far greater threat to the security of workers than the occasional revolutionary changes.

Thus the jobs of factory production workers are steadily becoming simplified and physically less strenuous as machinery is made more automatic or more specialized, as handling of materials is conveyORIZED, and as production methods are rationalized by management. Although the setting of machines has become more complicated, the actual set-up and the use of blueprints has become the responsibility of engineers and "set-up men" rather

than that of the individual workers who operate the machines. All these changes involve a general leveling of skills and a shortening of the necessary training time; they place an increasing emphasis on speed and dexterity and thereby impair the older worker's chances for jobs. They also increase industry's opportunities for using inexperienced personnel, and, thereby, industry's labor reserve and the number of workers who can compete for the same jobs.

Although these recent technological changes and their effects may not be entirely new in kind, they appear to be increasingly important in degree. So long as the economy of the country was rapidly moving toward ever-higher levels of employment, the displacement effects of technological change were being minimized by the ever-growing total of job openings and the opportunities which these openings offered for occupational adjustments. The decline of one industry was always more than matched by the expansion of others or by the appearance of new ones; the industrial decline of one area was more than balanced by the industrialization of other parts of the country. Although the transfer from one occupation, industry, or area to another frequently involved heavy sacrifices in earning power, social status, or personal ties, there was at least a place to go and the hope of rehabilitation.

The recent economic history of the United States, however, seems to indicate that such opportunities for adjustment have become fewer and fewer. Even the 50-percent increase in manufactured output during the 1920's left the average number of wage earners in the manufacturing industries stationary. Most of the other commodity-producing industries actually registered employment declines during the same period. Although the growth of employment in many service industries more than balanced the declines in the other branches of the economy, the job requirements of the service industries were usually such as to offer to workers from the declining industries even greater difficulties in occupational transfer than had existed when the commodity-producing industries were still expanding their job opportunities. The spotty character of the expansion of employment in the twenties was then, and the large volume of unemployment is now, creating reservoirs of workers who have been directly or indirectly displaced by such technological changes as are described in this report, difficult though it may be to segregate them from the general body of the unemployed.

PREFACE

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The Employment Stabilization Research Institute of the University of Minnesota cooperated in this study, which was conducted by Charles A. Koepke. Irving Kaplan, in his capacity as Associate Director of the Project, directed the study. S. Theodore Woal assisted in the preparation of the tables and the illustrations of particular technological developments. The manuscript was reviewed and revised by Edmund J. Stone, and the completed report was edited and prepared for publication under his supervision.

DAVID WEINTRAUB

PHILADELPHIA

July 10, 1939

CHAPTER I

SCOPE AND METHODS OF STUDY

This study of jobs and equipment in manufacturing industries covers a number of the more important factories in or near St. Paul and Minneapolis¹ and was undertaken with a view to ascertaining what changes in operations, in the characteristics of the workers, and in the machines themselves had taken place in the 5-year period 1931-36. In 1931 a study made under the auspices of the Employment Stabilization Research Institute of the University of Minnesota² presented a cross-sectional picture of the prevailing industrial conditions and a description of the mechanical operations performed in the same area, although not always for the same plants that have been included in the present study. The present study, made at the request of the National Research Project of the Works Progress Administration, has, in a sense, grown out of the earlier one, since the gathering of data, the methods of procedure, and the taking of records were originally so arranged as to facilitate a return to particular plants at a subsequent date.

The primary purpose of the job analysis made in 1931 was to obtain first-hand information concerning the mechanical operations performed in manufacturing plants. Thus attention was devoted principally to the operations, the machinery used, and the personnel requirements for such operations and machines.³ In addition to recording data obtained from the workers and their supervisors concerning their history and working conditions, the investigating staff took account of those variables of each job which related particularly to the worker and to his adaptation to the task assigned him. The chief interest of the earlier study, however, was the actual job or mechanical operation which the worker was called upon to perform.

¹The author wishes to express his gratitude to the many executives of Minnesota industries whose cooperation made this study possible and to the St. Paul Association of Commerce and the Minneapolis Civic and Commerce Association for their interest in the undertaking.

²Charles A. Koepke, *A Job Analysis of Manufacturing Plants in Minnesota* (Univ. Minn. Employment Stabilization Res. Inst. Bull., Vol. 15, No. 8, June 1934).

³Throughout the present report, explanations of procedures or standards and many definitions of terms have been taken from the 1931 study, in some cases verbatim. Data for 1931 are, similarly, taken either from the published report or from the files of the earlier study. Acknowledgment is herewith made of all such material.

The present job analysis is similar in nature to the first study in that its point of departure is likewise the strictly mechanical aspect of industrial processes. The 1936 survey has, however, an important objective which the earlier study did not have: to compare for the years 1931 and 1936 the characteristics of the personnel employed, the work performed, and the machinery utilized for the processes studied, and wherever feasible to indicate whether the changes are to be attributed to modifications in the methods of production or to other factors.

A staff of mechanical engineers trained in factory work conducted the survey,⁴ making every effort to obtain information as to actual conditions. Data were always gathered from operations actually in process. The longest period of time devoted by the staff to any single plant was 5 days. Except for a few items, the operation sheet (reproduced in appendix A) used in the field work for the present survey was the same as that employed in 1931. On this sheet the data were recorded under four headings: (1) The operation, (2) the worker, (3) the work, and (4) the machine. Under the first heading, the firm and the article manufactured were identified, and the actual work done in the process of manufacturing was described. Inasmuch as all information was received in confidence, it was necessary for the staff to designate each firm by a code number. The article manufactured was recorded under "Part Name", and the particular unit, or part of a "part", under "Part Number." Since several operations ordinarily are involved in the production of a finished article, the number of operations required was recorded, and each operation was enumerated. Thus an orderly sequence appeared on the production flow sheet, and missing operation sheets were easily detected.

In order to obtain a complete description of each operation, the staff, for each study, took photographs or made sketches - sometimes both - of the part before and after each operation as well as of the machinery, tools, and special equipment used therefor. The photographs and sketches made it possible for the staff to recall minute details of manufacturing procedure

⁴The author is indebted for the collection of data to Aldon Melzian and Roman F. Arnoldy, field supervisors; and to Arnold C. Matthies, Henry G. Lykken, John F. Peterson, Walter W. Pohl, Noel Crouch, Elmer C. Nelson, Wallace A. Lien, and Myron S. Sandberg, field agents. He wishes also to acknowledge the assistance of D. Jeanette Sweney, Hollerith Machine supervisor; of Kay S. Jue, who prepared the tables; and of Mrs. John Kuypers, principal statistical clerk.

even after a lapse of years. In the present study they were found to be invaluable for contrasting the industrial set-up of 1936 with that of 1931. The illustrations for both years may in turn serve as a basis of comparison for any future surveys of manufacturing processes in this area.

The second and third parts of the operation sheet are concerned mainly with data on the worker and descriptions of the work. Since it was difficult to estimate offhand the productive capacity of the various types of machines, the staff undertook a short "as is" time study (using decimal stop watches) of each operation. No time allowances were made while these studies were in progress (that is, there were neither fatigue nor comfort allowances for the workers), nor were any provisions made for the time consumed in oiling, repairing, or setting up the machinery. On the other hand, no attempt was made before the time study to reorganize the operations for better performance.

The fourth part of the sheet covers the machine, and it is here that changes in types of equipment were recorded. Indeed, it was with such possible changes in mind that the staff in 1931 collected data on which a future study might be based.

In this report it was possible not only to compare similar operations in different plants within an industry and to contrast types of operation in one industry with those prevailing in another, but also to gage the nature and extent of modifications in machines and operations for the period 1931-36. Since one of the chief interests of the National Research Project is "recent changes in industrial techniques", the following chapters place particular emphasis upon any effects which modifications in machines and in methods of production may have had upon the personnel requirements for the various operations.

The sample of schedules was collected in the same manner in 1931 and 1936. In each plant, schedules were obtained to represent all discrete production operations. If two persons performed the same operation, both were included in the survey through filling out on a second schedule the portions of the schedule relating to the characteristics of the worker. Not more than five schedules were thus filled out for different workers on the same operation. Only in the cigar, creamery, and woollens industries, however, did

this technique limit the number of workers included in the survey. In order to assure a representation of machines with different characteristics used on the same operation, schedule information on machines was taken in the same manner as that on workers. On the other hand, if a worker performed more than one operation, he was counted as one worker, and the operations were reckoned as two or three or whatever the number might be. Thus the total number of workers surveyed for this study was 2,026, while the number of operations was 2,388 and the number of machines was 1,334.

Though most of the plants surveyed in the 1931 study were examined again in 1936, changes in the industrial map of the Twin Cities area necessarily imposed upon the investigators some revisions of the earlier scope. In 1936, 67 plants, distributed over 23 industries, were covered. In both years the studies embraced a substantial number of the more important plants in the region.⁵

In order to increase the size of the sample, a few plants not surveyed in 1931 were included in the 1936 study. However, in all cases in which findings for the two years are compared in this report, data for identical plants only are used.

For purposes of analysis the plants have been grouped by industry. The number of plants surveyed in each industry in 1936 is given in the following tabulation:

| Industry | Number of plants ^a | Industry | Number of plants ^a |
|--------------|-------------------------------|--------------|-------------------------------|
| Total | 67 | Food | 3 |
| Bag | 1 | Furniture | 6 |
| Baking | 5 | Knitting | 1 |
| Bottling | 1 | Laundry | 3 |
| Candy | 4 | Metalworking | 10 |
| Carpet | 1 | Packing | 2 |
| Cigar | 1 | Paint | 2 |
| Clothing | 2 | Pottery | 1 |
| Coke | 1 | Printing | 6 |
| Creamery | 4 | Shoe | 1 |
| Dry cleaning | 3 | Woodworking | 5 |
| Flour | 2 | Woolens | 2 |

^aSixty-four different establishments were surveyed; 2 of these, however, because of the diversity of product manufactured, appear in more than one industry.

⁵All but five of the plants surveyed in 1936 were located in Minneapolis or St. Paul; these five plants were in other towns in Minnesota.

Except for laundry and dry cleaning, these are all manufacturing industries. For convenience, the samples will generally be referred to by the name of the industry in which they have been classified. Unless the contrary is clearly intended, then, in subsequent chapters statements about an individual industry refer only to the plant or plants included in the field survey.

CHAPTER II

THE MACHINE

Manufacturers in the Twin Cities area tended on the whole to avoid extensive purchases of new machinery during the depression; it was found, therefore, that in most cases the average age of equipment in use was greater in 1936 than it had been in 1931. This does not mean, however, that machine equipment underwent no modification during the years 1931-36. Machines did change both in speed and purpose, but these changes are to be attributed not so much to the installation of new machines as to the improvement, through the application of jigs and fixtures, of those already functioning. Appliances of this nature have frequently had far-reaching effects upon methods of manufacture, giving rise to marked revisions in the qualifications demanded of the worker for particular operations, sometimes indeed as noteworthy as the changes caused by the substitution of a new for an old machine.

AGE OF MACHINERY

The age of a machine is not a criterion of its usefulness. A machine over 21 years old is likely to be technically obsolete, but sometimes an old model is exceptionally good. On the whole, however, in any industry the plants with newer equipment have a strong competitive advantage. In this study wide variations were found in the age of equipment between plants in the same industry as well as between industries.

In 1936 a number of industries depended to a large extent upon machinery which at that time was 22 years old or over: In the plants surveyed in the paint, woolens, knitting, and shoe industries, from two- to three-fifths of the equipment surveyed was in this age group. In recent years there have been great technological advances in printing machines; yet in the printing plants studied, more than half the equipment was at least 10 years old, with machines in the 22-year and over category amounting to 20 percent (table 1). In metal-working, too, the plants studied had not taken full advantage of recent improvements. More than half the machines in this

industry likewise were 10 years old or over, with one-fifth being upwards of 21 years old.

Table 1.- AGE OF MACHINES, 1931 AND 1936^a
(Percentage of machines)

| Industry | Age in years | | | | | | | |
|--------------------|--------------|------|------|------|-------|------|------------|------|
| | Up to 3 | | 4-9 | | 10-21 | | 22 or over | |
| | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 |
| Baking | 61 | 13 | 25 | 63 | 14 | 18 | 0 | 16 |
| Candy ^b | 27 | 21 | 23 | 9 | 18 | 49 | 2 | 21 |
| Creamery | 30 | 21 | 53 | 39 | 17 | 38 | 0 | 2 |
| Flour | 34 | 6 | 2 | 53 | 58 | 25 | 6 | 16 |
| Food ^b | 11 | 22 | 46 | 27 | 38 | 29 | 5 | 22 |
| Furniture | (c) | 9 | (c) | 22 | (c) | 38 | (c) | 31 |
| Laundry | 8 | 19 | 35 | 34 | 47 | 40 | 10 | 7 |
| Metalworking | 20 | 18 | 30 | 27 | 45 | 34 | 5 | 21 |
| Printing | 16 | 25 | 33 | 17 | 47 | 35 | 4 | 20 |
| Shoe | (d) | 7 | (d) | 16 | (d) | 38 | (d) | 39 |
| Woodworking | 15 | 6 | 45 | 27 | 35 | 35 | 5 | 32 |
| Woolens | 12 | 0 | 26 | 13 | 46 | 39 | 16 | 48 |

^aBased on identical plants in industries in which 40 or more machines were surveyed in the given year.

^bData for 1931 tabulated from files of the earlier study.

^cComparable data not available.

^dLess than 40 machines surveyed.

The majority of the plants covered in 1936 used chiefly machinery which was neither very new nor very old. It should not be assumed, however, even for industries which have relied for the most part on machines which are far from new, that there has been no installation of new equipment or no significant modification in their utilization of old machines.

In the bottling plant surveyed, half the machines in use were less than 3 years old, and much of the older equipment had been modified by the addition of special fixtures. The new equipment here effected a marked saving in labor. With the old bottling equipment, five men had been required: One to place the dirty bottles in the washing machine, one to remove the clean bottles from the latter and place them in the filling machine, one to remove the filled bottles and inspect them, one to place them in the labeling machine, and, finally, one to fill the cases. The more advanced combination machine used

in 1936 performed the washing, filling, and labeling, while an inspector watched for specks and imperfections through a large magnifying lens. Only two men were needed in addition to the inspector, one to feed the dirty bottles into the machine and another to stack the labeled bottles in cases at the other end.

A carpet plant likewise had installed considerable new equipment, most notably the automatic drier, a conveyor arrangement for removing moisture from the hair after it has been centrifuged. Two-fifths of the machines in carpet manufacture were 3 years old or less; on the other hand, a third of the machinery in this plant was over 21 years old at the time of the survey.

Plants in three other industries were noteworthy for the purchase of new machines. A third of the machines in the paint industry in 1936 were 3 years old or less; these consisted in the main of improved types of automatic paint grinding, mixing, and labeling equipment. More than a quarter of the machines in the six printing plants had been obtained within the previous 3 years. These included at least two linotype machines which had been in use less than a year at the time of the survey, a number of automatic color presses, and three folding machines which had been in use for less than a year. One-fifth of the machinery surveyed in the candy industry was bought in 1936. These latter purchases reflect the marked expansion of a single plant, which installed large and highly efficient cookers, several automatic molding and dipping machines, and an automatic wrapping machine.

Table 1 shows that there was a general tendency for the machinery in use in the plants surveyed to be much older in 1936 than in 1931. However, there are other means of reducing costs than through the purchase of new machinery. Manufacturers tend to seek ways of cutting down costs by a reorganization of the working force, by the improvement of machines already in use, and most frequently by a combination of both. Changes in the nature of the job itself - and consequently in the personnel requirements - commonly follow from the revitalizing of machinery. The application of a jig or a fixture has pushed many an operation out of the skilled into the semiskilled class; frequently it has also accelerated

production and thus has lowered labor costs on another count. Such modifications of existing equipment are reflected not in the relative ages of machines but in the design and level of automaticity of machines in operation.

GENERAL- AND SPECIAL-PURPOSE MACHINERY

Although for purposes of comparison it has been considered advisable to classify equipment either as "general" or as "special purpose", these terms must allow for considerable variation within each category. No machine, obviously, can be used for all purposes; the type of equipment discussed here as general-purpose equipment is that which can be employed for several different operations, as, for example, an engine lathe in machine-shop work. On the other hand, a machine which produces one particular article or part and no other is a special-purpose machine, such as the Bradford Breaker commonly used in the coke industry. Ordinarily, a special-purpose machine can perform a specified operation better or more rapidly than a general-purpose machine, and often a machine of the former type may replace several of the latter.

The survey disclosed that in some instances equipment originally intended to serve a general purpose had been modified by the addition of a fixture or device for the production of a particular article, so that it now functioned as a special-purpose machine. In a woodworking plant, for example, a series of levers and cams had been added to a wood shaper, with the result that it turned out only a special shape of ironing board. Incidentally, this modification of the machine not only increased labor productivity but also gave rise to significant changes in the nature of the task performed by the operator. Whereas formerly a moderately skilled worker had been required to manipulate a single ironing board around the cutting tool until the edges were smooth and even, now a less skilled operator had only to stack a number of boards, which were cut and shaped at one time by the machine; the worker then removed the cut boards and inserted others.¹

In the bottling plant surveyed, all the machines (as compared with four-fifths in 1931) were special-purpose. More than

¹In the skill classification shown in appendix B, the job had shifted from class C to class D. Skill of workers is discussed in chapter IV.

90 percent of the machinery in the coke plant was specialized in 1936 (table 2). The flour industry also was found to rely largely on this type of equipment: 70 percent of the machines were special-purpose in 1936 as compared with 60 percent in 1931. The three industries just mentioned are noted for the standard nature of their products.

**Table 2.- GENERAL-PURPOSE AND SPECIAL-PURPOSE MACHINES,
1931 AND 1936^a**

(Percentage of machines)

| Industry | General purpose | | Special purpose | |
|--------------|-----------------|------|-----------------|------|
| | 1931 | 1936 | 1931 | 1936 |
| Baking | 71 | 68 | 29 | 32 |
| Candy | (b) | 48 | (b) | 52 |
| Clothing | (c) | 89 | (c) | 11 |
| Coke | 11 | 7 | 89 | 93 |
| Creamery | 26 | 38 | 74 | 62 |
| Dry cleaning | (b) | 65 | (b) | 35 |
| Flour | 40 | 30 | 60 | 70 |
| Food | (b) | 55 | (b) | 45 |
| Furniture | (b) | 66 | (b) | 34 |
| Laundry | 77 | 67 | 23 | 33 |
| Metalworking | 86 | 84 | 14 | 16 |
| Packing | (b) | 46 | (b) | 54 |
| Paint | (c) | 52 | (c) | 48 |
| Printing | 76 | 62 | 24 | 38 |
| Shoe | (b) | 49 | (b) | 51 |
| Woodworking | 80 | 77 | 20 | 23 |
| Woolens | 35 | 45 | 65 | 55 |

^aBased on identical plants in industries in which 20 or more machines were surveyed in the given year.

^bComparable data not available.

^cLess than 20 machines surveyed.

Of the remaining industries which were resurveyed in 1936, the great majority had increased the percentage of special-purpose machines. This is shown in table 2 as well as by data from plants in which the number of machines surveyed was small. The cigar plant, for example, had introduced specially designed machines to replace hand labor formerly employed for the "making" operations - rolling, bunching, pressing, and wrapping. The installation of these machines, which

raised the proportion of special-purpose equipment from two-thirds in 1931 to four-fifths in 1936, involved in addition a shift from male to female labor.² A new special-purpose and automatic cellophane-wrapping machine had also been installed in this plant.

For identical plants surveyed in 17 industries, there was a marked increase (10 percent or more) between 1931 and 1936 in the proportion of special-purpose machines in 8 industries; in 6 others the change was slight but favored special-purpose equipment, and in the other 3 there was proportionally less special-purpose equipment in 1936.

AUTOMATICITY OF OPERATIONS

While a machine designed for a special purpose is likely to take over a skill for which a trained worker was formerly required, the automatic machine, whether general- or special-purpose, is responsible for even more far-reaching changes in the organization and make-up of the entire labor force, involving skilled, semiskilled, and even unskilled workers. In several of the plants covered in the present survey, the installation of automatic machines in large numbers or the rendering of old machines automatic or semiautomatic by the application of special fixtures has resulted in a corresponding revision of the entire process of production. Skilled labor has been reduced and in some cases virtually eliminated, and training periods for many semiskilled operations have been cut down.³ Thus, although a small group of highly skilled "machine setters" is always required to set up and adjust the equipment, in actual production semiskilled workers tend to predominate.

For the 1936 survey the investigators collected information on automaticity for all the plants studied, whereas in 1931 the staff had noted data on this topic for only part of the industries. Because comparable figures are available for so few industries, any attempt to draw specific conclusions as to the spread of automatic machinery in this area would be unjustified.

In table 3 percentages of production operations surveyed in 1936 are recorded by industries with respect to their

²For a study of what happens to displaced hand cigar workers see Daniel Creamer and Gladys V. Swackhamer, *Cigar Makers—After the Lay-off* (WPA National Research Project, Report No. L-1, Dec. 1937).

³For a discussion of this topic see chapter IV.

performance on automatic machines, on machines in which the tools have been preset, and by manual labor. Automatic machines are those which the operator merely starts and stops. Machines on which the tools have been preset are semiautomatic in operation; after the tools have been set in the machine, most commonly by a skilled machine setter, the motions necessary to complete the operation are performed by the production worker. In contrast to these two degrees of automaticity, manual operations require the production worker actually to handle and guide the machine, to use a tool, or to work only with his hands. This classification should not, however, be interpreted too literally. No machine is ever strictly automatic, because at fixed intervals a worker must place the stock in position. Furthermore, an operation listed as "tools preset" may require considerable skill for its completion or virtually no skill at all; thus in some cases the performance may approximate that on an automatic machine, while in others it may be more akin to an operation classed as manual.

Table 3.- AUTOMATICITY OF OPERATIONS, 1936^a

(Percentage of production operations)

| Industry | Automatic | Semiautomatic (tools preset) | Manual |
|--------------|-----------|---------------------------------|--------|
| Bag | 14 | 72 | 14 |
| Baking | 40 | 53 | 7 |
| Candy | 41 | 43 | 16 |
| Carpet | 44 | 56 | 0 |
| Cigar | 10 | 58 | 32 |
| Clothing | 12 | 71 | 17 |
| Coke | 88 | 12 | 0 |
| Creamery | 47 | 43 | 10 |
| Dry cleaning | 28 | 52 | 20 |
| Flour | 73 | 24 | 3 |
| Food | 49 | 27 | 24 |
| Furniture | 17 | 70 | 13 |
| Laundry | 37 | 40 | 23 |
| Metalworking | 19 | 60 | 21 |
| Packing | 42 | 44 | 14 |
| Paint | 70 | 20 | 10 |
| Printing | 45 | 47 | 8 |
| Shoe | 29 | 65 | 6 |
| Woodworking | 14 | 75 | 11 |
| Woolens | 63 | 35 | 2 |

^aBased on those industries in which 20 or more operations were surveyed.

It is nevertheless of interest to note that in none of the 23 industries studied in 1936 were more than one-third of the operations classified as "manual." In 19 of the industries, at least four-fifths of the operations were performed on automatic or semiautomatic machines. Foremost among the industries in which operations in 1936 were overwhelmingly automatic was coke manufacture, with almost 90 percent in that class. Plants surveyed in the bottling, flour, and paint industries reported at least 70 percent of their operations as automatic. These industries are all characterized by highly integrated continuous processes, and relatively few of their jobs require manual operation of tools or machinery.

The plants studied in the cigar, bag, clothing, and wood-working industries, on the other hand, performed only a small proportion of their operations on automatic machinery. Here the largest proportion was carried out on semiautomatic machinery requiring the attention of semiskilled operators.

Among the five industries for which the plant data are comparable for the years 1931 and 1936 (baking, laundry, printing, woodworking, and woollens), printing and baking were found to have increased substantially the proportion of operations on automatic equipment.⁴ In the printing industry, operations on automatic machinery rose from 25 percent in 1931 to 45 percent in 1936, while those on semiautomatic machines also increased slightly. Here at least two-thirds of the machines which were 3 years old or less fell within the automatic category. One firm had a new hand-feed folding machine with a capacity of 60,000 circulars in 8 hours, representing a marked advance as compared with the equipment used in 1931. Another printing firm had a new machine which automatically folded 16,000 pamphlets four times within 8 hours.

The increase of automatic operations in the baking industry, from 12 percent in 1931 to 40 percent in 1936, reflects the technological trend in the mechanized bakeries. Many of the operations previously assigned to hand labor, such as rolling dough and forming loaves of bread, had by 1936 been transferred to machines.

⁴In the laundries surveyed there was a slight increase in automatic operations as well as an increase in manual operations between 1931 and 1936. In the woollens mills there was some decrease in automatic operations and a corresponding increase in operations on machines that are tool preset. In woodworking there was a substantial decline in the proportion of operations performed on automatic machines and increase in semiautomatic operations.

All the new equipment on which operations were observed in the paint industry was automatic, sometimes representing a shift from manual operations and sometimes, as in the case of the grinder, introducing a striking increase in capacity. In one plant in this industry two types of automatic paint grinder were in use; one was over 21 years old, with a capacity of 200 gallons per 8-hour day, while the new machine turned out about twice as much in the same length of time. Other innovations were the automatic machine for inserting covers on the filled cans of paint and that for labeling the cans as they roll down the conveyor.

The laundry industry was found to have effected considerable saving in labor and in skills by the introduction of more speedy air driers and of semiautomatic shirt pressers. One press, with its several attachments, could now be used to iron a shirt completely.

Not only in the industries just mentioned but also in virtually all the others surveyed, the installation of a new machine has usually involved a rise in the level of automaticity. Nor is the movement toward automatic performance limited to these instances, for there has been a parallel trend in the Twin Cities area toward the automatization of older equipment by the application of special fixtures. One of the most significant effects of this technological advance has been the modification of the worker's task in factory production, a subject which will be treated in detail in the following chapter.

new automatic machines. Moreover, this is one of the industries whose executives have shown a special interest in motion study in recent years.

Another noteworthy illustration of the trend toward finger dexterity was found in the pottery industry, which in 1936 had 24 percent of its operations in that category as compared with none in 1931. This shift was accounted for largely by a drop in the proportion of hand operations, from 100 percent in 1931 to 71 percent in 1936.

A similar substitution of finger for hand dexterity was apparent in the bag plant, which had raised its proportion of finger operations from 10 to 31 percent and lowered that of hand operations from 76 to 46 percent. The laundry industry, likewise, was found to be requiring more finger and less hand dexterity, having increased finger operations from 15 to 26 percent and decreased hand operations from 75 to 51 percent. Finally, the woodworking industry had increased the percentage of operations requiring finger dexterity from 0 to 27 percent and had reduced operations using hand dexterity from 100 to 48 percent.

In the woolens industry the change between 1931 and 1936 was smaller but was in the direction of increased finger dexterity at the expense of arm and hand dexterity. Baking was the only one of the industries which was found to have raised markedly the proportion of finger operations (from 10 to 32 percent) without cutting that for hand operations to any appreciable degree. These increases were counterbalanced by the drop in foot dexterity from 15 percent of the operations in 1931 to 0 in 1936 and by the decline of arm dexterity from 20 to 15 percent.

It might have been expected that these industries would show a rise in the percentage of operations calling for foot dexterity since the latter is coming into increasing favor among industrial engineers throughout the country. This was not the case, however. Woodworking and laundry alone raised the proportion of foot operations, from 0 percent to 4 and 3 percent, respectively. On the other hand, all of the seven industries, except baking and woolens, showed an increase in the proportion of operations requiring arm dexterity - bag from 14 to 23 percent, laundry from 10 to 20 percent, pottery from

0 to 5 percent, printing from 0 to 6 percent, and woodworking from 0 to 21 percent.

TYPES OF RESPONSIBILITY

Machine set-ups have become more complicated in the movement toward automaticity, but the task of mastering this complexity has been allocated on the whole to the engineer or to the experienced machine setter. In the industries of Minnesota, as in the rest of the country, the production worker has had less and less brainwork to do in the performance of his job. Particularly in recent years has the distinction between the semiskilled machine tender and the highly skilled set-up man become strongly marked. As a result, even where in 1931 an operator may have had to know something about the construction of the machine he used, by 1936 such knowledge was no longer required of him except in rare instances.

Machine Set-ups and Blueprints

In the present survey it was found that only in high-class color printing - and here largely because of union control and precedent - were the operators themselves expected to set up the presses. In all the other industries, with the possible exception of the woolens mills where the production workers occasionally adjust the machines, complicated set-ups were taken care of by machine setters.

The same trend was apparent in the matter of blueprint reading. Blueprints were being used more widely in 1936 than in 1931; many of the concerns surveyed which did not use them in the earlier year had by 1936 substituted them for models and sketches. They usually were read and interpreted, however, not by the production workers but by tool designers and by methods and standards men or, in some shops, by the foremen.

The employment of production engineers was far more widespread in 1936 than it had been in 1931, although even then the trend in this direction was clearly marked. Today, with blueprints and instruction sheets drawn up by experts, the worker rarely needs to do more than follow meticulously the course laid out for him. As the size of factories continues to grow, it may be expected that industrial engineering will acquire increasing control over the various operations involved

in the manufacture of the finished product, while less and less initiative will be expected of the individual worker.

Accuracy Measurements

The term "accuracy", when applied to factory operation, necessarily varies with the special standards which the product must meet. Operations were examined in the present survey with regard to the degree of accuracy they required of the worker as indicated by the terms "gage", "micrometer", "scale", and "rule."² These criteria were employed in the 1931 study also, but only with reference to linear measurements. In 1936, however, operations such as the careful weighing of material on a chemical balance, found principally in the creamery and flour industries, were recorded as well.

In 1936 operations requiring gage or micrometer accuracy of the worker were very infrequently found. The requirement of scale or rule accuracy was common in a few industries but was by no means generally found. Although the vast majority of operations required no measurements whatsoever, this does not mean that the products were not made to close tolerance. Accuracy had been largely built into the machine and its attachments, so that the operator was not primarily responsible for it. The few operations for which gage or micrometer accuracy had to be controlled by the worker were found chiefly in the metalworking plants, where for some machines there were not enough jobs to warrant the application of special jigs and fixtures. Among the industries in which the operator had to apply the simpler scale or rule measurements, clothing and printing ranked highest.

Calculations

Only a very few of all the operations studied in 1936 required a knowledge of addition, and a similarly small proportion called for a knowledge of multiplication or division. In the baking industry 9 percent of the operations required a knowledge of percentage. In no industry were production operations found that required a knowledge of trigonometry or calculus. A worker's ability to make calculations is becoming

²"Gage" and "micrometer" signify that measurements are made in thousandths and ten-thousandths of an inch; "scale" and "rule", that a lesser but positive degree of accuracy is required. Accuracy requirements not controlled by the worker were not, however, recorded.

less and less of an asset in modern industry, with its current tendency to preplan the entire process of manufacture.

CONDITIONS OF WORK

Side by side with the trend toward a simplification of the production worker's task there has been a movement directed toward securing optimum performance on the part of the worker. This movement is exemplified by changes in methods of paying the workers, organization of the work itself, and the length of the workweek.

Methods of Compensation

For some years there has been a tendency throughout the country to replace systems of straight-time payments with various types of incentive wage plans which seek to reward the worker for extra effort through the granting of bonuses, premiums, company stock, or vacations with pay. The National Industrial Conference Board reported that in 1928 not more than 15 percent of the employees in a sample of factories employing up to 1,500 workers received their wages on a straight-time basis.³

In recent years there has been another shift in methods of compensation, this time in the direction of rationalized hourly rates. The reasons for this general movement are to be found in the changing nature of industry itself. After bonus or piece-rate systems had prevailed for many years, rates and standards could be set for most operations on the basis of careful time and motion studies. Moreover, with continuing technological advance and refinement, speed of performance became less and less a matter of choice for the individual worker. Thus, once a definite measure of a day's work on a particular operation had been established, management found that a flat hourly rate would eliminate costly bookkeeping, as well as tension on the part of the worker, without in any way decreasing the speed or quality of the work. According to Frank J. Oliver, "in making the change-over to the flat hourly rate, the manufacturers have made no changes in standard

³The straight-time basis was used in 33 percent of these plants. *Systems of Wage Payment* (New York: National Industrial Conference Board, Inc., 1930), pp. 6-7. Small establishments were underrepresented in the study (*ibid.*, p. 5).

times or in standard costs It is expected that the same efficiencies will be maintained."⁴ Mr. Oliver's statement refers only to the Detroit automobile industry, but it is also applicable to other industrial situations and other parts of the country.

With regard to the use of accurate time and motion studies in the plants surveyed, there was a noteworthy advance in this direction in the period since 1931. Recently the mechanical-engineering department of the University of Minnesota has been unable to meet the demands of local plants for men adequately trained in this field. When time and motion studies are instituted, time rates based on production over a standard period are often adopted. One of the paint firms surveyed had adopted a wage scale derived in this manner; and one of the packing plants, after setting a weekly wage based on annual production, reported that its workers were able to complete their daily quota of tasks much more expeditiously than before.

The data collected for this study show only whether a time basis or an incentive device was used in determining wage payments, so the degree to which time rates represent rationalized rates cannot be tested. However, incentive wage plans seem to have diminished in number since 1931 in the few industries for which comparable data are available for the two years. The laundry industry reported incentive payment on 34 percent of its operations in 1931 but on only 3 percent in 1936. The bag plant reported incentive wage plans covering 58 percent of operations in 1936 as against 91 percent in 1931. Pottery in 1931 paid for 13 percent of its operations according to a wage-incentive scheme; in 1936 workers on all the operations received compensation in time rates. The baking industry decreased incentive wage payments slightly, from 8 to 5 percent of operations; in the woollens industry they were increased somewhat, from 6 to 11 percent of operations.

In the present survey all the industries, except bag, clothing, and shoe, were using time rates for the bulk of their operations, and in several industries no production workers were paid on the basis of wage-incentive schemes (table 6). The food industry, on the other hand, had introduced incentive

⁴"It's 'Hour Rates' in Detroit," *Factory Management and Maintenance*, January 1935, p. 10.

Table 6.- BASIS FOR WAGE PAYMENTS, 1936^a

(Percentage of production operations)

| Industry | Time basis | Incentive wage plans |
|--------------|------------|----------------------|
| Bag | 42 | 58 |
| Baking | 95 | 5 |
| Candy | 91 | 9 |
| Carpet | 70 | 30 |
| Cigar | 56 | 44 |
| Clothing | 36 | 64 |
| Coke | 88 | 12 |
| Creamery | 100 | 0 |
| Dry cleaning | 100 | 0 |
| Flour | 96 | 4 |
| Food | 81 | 19 |
| Furniture | 72 | 28 |
| Laundry | 97 | 3 |
| Metalworking | 92 | 8 |
| Packing | 97 | 3 |
| Paint | 98 | 2 |
| Pottery | 100 | 0 |
| Printing | 99 | 1 |
| Shoe | 4 | 96 |
| Woodworking | 92 | 8 |
| Woolens | 89 | 11 |

^aBased on those industries in which 20 or more operations were surveyed.

payment for some of its operations since 1931, when all operations had been paid for on a time basis.⁵

Methods of Performance

Teamwork.- In some cases in which wage-incentive plans have been introduced, there has also been a shift to teamwork. Management found that if men worked in groups rather than singly where this was technically feasible, production was almost always increased, particularly when a bonus or some other incentive was offered for augmented productivity. Even after incentives had been discarded, teamwork retained many of its advantages, so that it tended to survive in some of the plants which reverted to time rates of payment. Working in groups builds up a certain rhythm which, when properly

⁵In this industry some plants surveyed in 1931 were not resurveyed in 1936, but all plants surveyed in 1936 were also included in the earlier year.

controlled, enables the men to perform their tasks more rapidly without becoming more fatigued. This is especially true in assembly work.

In the five industries for which comparable data are available for both 1931 and 1936, there was little change in the percentage of operations performed by teamwork except in the baking industry. Here 92 percent of the operations in 1931 were carried on in teams; this figure had dropped to 27 percent by 1936.⁶

Excepting the baking industry, the industry in which the highest proportion of operations was performed in teams in 1936 was bottling, although even here only one-quarter were

Table 7.- TEAMWORK AND PACING OF WORKERS, 1936^a

(Percentage of production operations)

| Industry | Work performed - | | Workers - | |
|--------------|------------------|----------|------------|-------|
| | Individually | In teams | Self-paced | Paced |
| Bag | 95 | 5 | 39 | 61 |
| Baking | 73 | 27 | 67 | 33 |
| Candy | 86 | 14 | 53 | 47 |
| Carpet | 96 | 4 | 56 | 44 |
| Cigar | 81 | 19 | 89 | 11 |
| Clothing | 97 | 3 | 100 | 0 |
| Coke | 78 | 22 | 22 | 78 |
| Creamery | 93 | 7 | 75 | 25 |
| Dry cleaning | 100 | 0 | 87 | 13 |
| Flour | 98 | 2 | 55 | 45 |
| Food | 92 | 8 | 53 | 47 |
| Furniture | 96 | 4 | 88 | 12 |
| Laundry | 88 | 12 | 70 | 30 |
| Metalworking | 93 | 7 | 84 | 16 |
| Packing | 81 | 19 | 15 | 85 |
| Paint | 90 | 10 | 70 | 30 |
| Pottery | 89 | 11 | 74 | 26 |
| Printing | 94 | 6 | 80 | 20 |
| Shoe | 100 | 0 | 95 | 5 |
| Woodworking | 87 | 13 | 70 | 30 |
| Woolens | 85 | 15 | 64 | 36 |

^aBased on those industries in which 20 or more operations were surveyed.

⁶In the other industries the changes in teamwork were from 14 to 12 percent in laundry, from 19 to 15 percent in woolens, from 10 to 11 percent in pottery, and from 0 to 5 percent in bag.

in this category. In plants surveyed in the cigar, coke, and packing industries, about 20 percent of the operations involved teamwork in 1936 (table 7). The shoe and dry-cleaning industries, on the other hand, had no teamwork at all.

Pacing.— Far more important as a method of increasing productivity on the part of the worker is the device of pacing, that is, the establishment of regular time limits for the performance of an operation. Such limits are set most commonly by the conveyor belt, which, as it moves, allows so many seconds or minutes for each operation, and by machines which run automatically in time intervals. The speed of a worker who feeds a printing press, for instance, is controlled by the machine. On the other hand, workers who operate machines whose speed can be varied set their own pace, as do those who are not engaged on machines at all.

Table 7 shows that in the industries covered in this study, pacing was applied much more widely than was teamwork, a fact which reflects the use of conveyors and other automatic equipment. In the packing industry in 1936, 85 percent of the operations were paced, in coke 78 percent, and in creamery 75 percent.

Pacing was found to have risen in the woolens industry from 3 to 36 percent, in the laundry industry from 20 to 30 percent, and in the bag plant from 23 to 61 percent. Of the two remaining industries for which there are comparable data for the two years, both baking and pottery dropped their proportion of paced operations, the former from 72 percent to 33, and the latter from 39 percent to 26.

Hours of Work

Although comparable figures on standard hours of work per week are available for only a few of the industries covered in both 1931 and 1936, those for which such data can be presented show a decided trend toward the shorter workweek (table 8). In printing, for example, hours were reduced to 40 or less for 96 percent of the operations, whereas in 1931 the hours for all operations in this industry were from 41 to 45. In 1931 standard hours were over 40 on all operations reported in the five industries, but by 1936 a substantial portion were 40 or under, and few were above 45 in any industry except laundry.

Table 8.- STANDARD HOURS WORKED PER WEEK, 1931 AND 1936^a

(Percentage of production operations)

| Industry | Number of hours per week | | | | | | | |
|-------------|--------------------------|------|-------|------|-------|------|-------|------|
| | 40 or under | | 41-45 | | 46-50 | | 51-55 | |
| | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 |
| Baking | 0 | 35 | 0 | 64 | 0 | 1 | 100 | 0 |
| Laundry | 0 | 32 | 0 | 57 | 49 | 11 | 51 | 0 |
| Printing | 0 | 96 | 100 | 4 | 0 | 0 | 0 | 0 |
| Woodworking | 0 | 62 | 0 | 37 | 100 | 1 | 0 | 0 |
| Woolens | 0 | 64 | 3 | 32 | 97 | 4 | 0 | 0 |

^aBased on identical plants in industries in which 50 or more operations were surveyed in both years.

Table 9.- STANDARD HOURS WORKED PER WEEK, 1936^a

(Percentage of production operations)

| Industry | Number of hours per week | |
|--------------|--------------------------|---------|
| | 40 or under | Over 40 |
| Bag | 92 | 8 |
| Baking | 35 | 65 |
| Candy | 79 | 21 |
| Carpet | 10 | 90 |
| Cigar | 30 | 70 |
| Clothing | 79 | 21 |
| Coke | 100 | 0 |
| Creamery | 2 | 98 |
| Dry cleaning | 56 | 44 |
| Flour | 9 | 91 |
| Food | 75 | 25 |
| Furniture | 57 | 43 |
| Laundry | 32 | 68 |
| Metalworking | 65 | 35 |
| Packing | 70 | 30 |
| Paint | 74 | 26 |
| Pottery | 0 | 100 |
| Printing | 96 | 4 |
| Shoe | 61 | 39 |
| Woodworking | 62 | 38 |
| Woolens | 64 | 36 |

^aBased on those industries in which 20 or more operations were surveyed.

Even where no comparisons can be made with 1931, the list of industries in which the bulk of the operations were performed in 1936 on a weekly basis of less than 40 hours is decidedly impressive (table 9). In 14 of 21 industries the standard hours reported were 40 or less for at least half of the operations.

CHAPTER IV

THE WORKER

One of the objectives of this study was to determine whether in the period 1931-36 any noteworthy changes had occurred in the proportions of men and women employed and, if so, in which industries such shifts were most marked. Another objective was to record significant modifications in the skill requirements for factory jobs and the type of training received by workers and to note whether any general tendencies were observable in these data. This chapter presents the findings of the survey with respect to changes in the composition of the working force and embraces such topics as sex, age, length of training periods required and methods of instruction, mobility of the workers, and shifts in skills found among workers. The basic unit of observation here was the worker himself, and the data represent, for the most part, the responses made to the investigators by the individual employees questioned.¹

SEX AND AGE

Table 10 shows the composition of the 23 industries covered in 1936 both as to age and sex of the 2,026 workers surveyed. Six of the industries - clothing, cigar, knitting, dry-cleaning, laundry, and food - reported a majority of women workers. Among the industries which relied mostly or exclusively on male workers were metalworking, woodworking, furniture, packing, and printing.

It will be noted in table 11 that between 1931 and 1936 the proportion of female workers was substantially increased in two industries, while in almost all others the changes in either direction were small.² The employment of women in industry is one expedient in the widespread drive on the part of employers to lower costs of production. A shift to female labor may be facilitated by the substitution of machines for hand operation, the automatization of machines, the revision of plant lay-out,

¹It is to be remembered (see chapter I) that the data do not represent all production workers in the cigar, creamery, and woolens plants surveyed.

²Sharp decreases in the proportion of women workers were recorded in the bag and pottery industries. For both of these, however, the field sample was small.

Table 10.- AGE AND SEX OF WORKERS, 1936

(Production workers)

| Industry | Total surveyed in each industry | Men | | | | | Women | | | | | | |
|--------------|---------------------------------|-------|--------------|-------|-------|-------|---------|-------|--------------|-------|-------|-------|---------|
| | | Total | Age in years | | | | | Total | Age in years | | | | |
| | | | 10-19 | 20-24 | 25-34 | 35-44 | Over 44 | | 10-19 | 20-24 | 25-34 | 35-44 | Over 44 |
| Bag | 18 | 15 | 0 | 1 | 1 | 6 | 7 | 3 | 0 | 1 | 1 | 1 | 0 |
| Baking | 153 | 83 | 1 | 14 | 46 | 17 | 5 | 70 | 6 | 33 | 24 | 3 | 4 |
| Bottling | 10 | 10 | 0 | 4 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Candy | 95 | 49 | 5 | 19 | 14 | 7 | 4 | 46 | 1 | 22 | 13 | 7 | 3 |
| Carpet | 24 | 21 | 1 | 5 | 8 | 5 | 2 | 3 | 0 | 0 | 1 | 0 | 2 |
| Cigar | 43 | 9 | 0 | 0 | 1 | 2 | 6 | 34 | 1 | 11 | 11 | 9 | 2 |
| Clothing | 32 | 4 | 0 | 0 | 0 | 3 | 1 | 28 | 0 | 7 | 9 | 6 | 6 |
| Coke | 25 | 25 | 0 | 0 | 4 | 6 | 15 | 0 | 0 | 0 | 0 | 0 | 0 |
| Creamery | 90 | 71 | 0 | 8 | 19 | 20 | 24 | 19 | 1 | 5 | 11 | 1 | 1 |
| Dry cleaning | 55 | 18 | 0 | 1 | 6 | 9 | 2 | 37 | 2 | 8 | 6 | 14 | 7 |
| Flour | 23 | 21 | 0 | 2 | 9 | 3 | 7 | 2 | 0 | 0 | 0 | 1 | 1 |
| Food | 56 | 23 | 0 | 3 | 6 | 6 | 8 | 33 | 2 | 15 | 10 | 5 | 1 |
| Furniture | 228 | 195 | 6 | 35 | 67 | 45 | 42 | 33 | 3 | 13 | 10 | 3 | 4 |
| Knitting | 8 | 3 | 0 | 0 | 1 | 1 | 1 | 5 | 0 | 0 | 4 | 0 | 1 |
| Laundry | 85 | 27 | 1 | 5 | 7 | 10 | 4 | 58 | 0 | 5 | 22 | 17 | 14 |
| Metalworking | 308 | 293 | 11 | 41 | 98 | 82 | 61 | 15 | 1 | 7 | 4 | 3 | 0 |
| Packing | 219 | 188 | 4 | 38 | 91 | 38 | 17 | 31 | 4 | 17 | 4 | 4 | 2 |
| Paint | 39 | 37 | 0 | 3 | 13 | 10 | 11 | 2 | 0 | 1 | 1 | 0 | 0 |
| Pottery | 20 | 17 | 0 | 3 | 7 | 1 | 6 | 3 | 1 | 1 | 1 | 0 | 0 |
| Printing | 151 | 120 | 0 | 10 | 48 | 37 | 27 | 31 | 0 | 5 | 12 | 7 | 7 |
| Shoe | 42 | 29 | 0 | 1 | 14 | 8 | 6 | 13 | 0 | 0 | 7 | 6 | 0 |
| Woodworking | 231 | 231 | 10 | 38 | 55 | 43 | 85 | 0 | 0 | 0 | 0 | 0 | 0 |
| Woolens | 71 | 54 | 1 | 7 | 16 | 19 | 11 | 17 | 0 | 5 | 7 | 5 | 0 |

further division of labor, integration of machinery, or a combination of several of these factors.

In the cigar plant, which raised the proportion of women workers from 58 to 79 percent, far-reaching technological changes had taken place between 1931 and 1936. Special-purpose, semiautomatic, and automatic equipment had been introduced, reducing the amount of skill required of the worker so that it was now feasible to employ semiskilled or unskilled women rather than highly skilled men to regulate and feed the new machines (see chapter II). In this plant there was a sharp decrease in the proportion of all workers who were men over 44 and a sharp increase in the proportion who were women between 20 and 34 years of age.

In one of the industries for which the plant constituency is not the same in the two years, there had been a series of strikes, during which many women were hired at low wages to replace men who were demanding an increase in pay.

In one candy plant, production and the proportion of female workers expanded markedly during this period. In the earlier

Table 11.- SEX OF WORKERS, 1931 AND 1936^a

(Production workers)

| Industry | Total number surveyed | | Percentage distribution | | | |
|--------------|-----------------------|------|-------------------------|------|-------|------|
| | | | Men | | Women | |
| | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 |
| Bag | 34 | 18 | 62 | 83 | 38 | 17 |
| Baking | 230 | 153 | 70 | 54 | 30 | 46 |
| Carpet | 26 | 24 | 81 | 87 | 19 | 13 |
| Cigar | 36 | 43 | 42 | 21 | 58 | 79 |
| Clothing | 89 | 32 | 18 | 13 | 82 | 87 |
| Creamery | 173 | 90 | 78 | 79 | 22 | 21 |
| Flour | 92 | 23 | 93 | 91 | 7 | 9 |
| Laundry | 161 | 85 | 26 | 32 | 74 | 68 |
| Metalworking | 240 | 308 | 98 | 95 | 2 | 5 |
| Paint | 17 | 39 | 94 | 95 | 6 | 5 |
| Pottery | 30 | 20 | 83 | 85 | 37 | 15 |
| Printing | 181 | 151 | 83 | 79 | 17 | 21 |
| Woodworking | 237 | 231 | 98 | 100 | 2 | 0 |
| Woolens | 100 | 71 | 68 | 76 | 32 | 24 |

^aBased on identical plants.

year, when the plant was small, men made the candy and women were employed as dippers and packers. Upon its expansion, although the same division of labor was retained, the installation of cookers of increased capacity and efficiency made unnecessary the addition of an appreciable number of men. New automatic molding and dipping machines, however, were tended by women, and because of the augmented volume of production more women were taken on in the packing department.

In the baking industry female workers increased from 30 to 46 percent of the total. Those plants which still maintained handicraft conditions had further subdivided the work and employed many women on the simpler operations, while the mechanized plants had augmented the proportion of machine operations performed by women.

According to table 10, male production workers in the industries surveyed were concentrated in the ages 25 to 34. In general, there were more men 35 to 44 years old than 20 to 24. On the other hand, in most industries the women were chiefly between 20 and 34 years old. There were, in general, about as many women in the age group 20 to 24 as in the group 25 to 34.

A few female workers 45 years old or over were found in most of the industries, but, except in the clothing, dry-cleaning, laundry, and printing industries, they were a very small proportion either of all women or of all workers surveyed. Men over 44 years old were much more frequently found and in 7 of the 23 industries accounted for 20 percent or more of all workers surveyed. The manner in which male and female workers are distributed over the various age groups indicates that women enter industry at an earlier age than men and drop out sooner, a tendency which was apparent in the 1931 study as well.

The relative absence, both in 1931 and 1936, of workers under 20 years of age reflects the functioning of the minimum-wage law in Minnesota, which has been amended since 1931 to protect girls under 21 years of age as well as boys. Formerly it applied to boys under 21 and to girls under 18. The law still contains a loophole for the hiring of workers between the ages of 16 and 18 through three graduated learners' rates, but no child under 16 years of age may be employed in the State, unless a special work permit is issued by the Industrial Commission. Neither in 1931 nor in 1936 was any worker under 16 found in any plant surveyed, and in the latter year only four were between 16 and 18 - two boys in the metalworking industry, one in furniture, and one in the woolens industry.

For a few of the industries in which identical plants were surveyed there are sufficient data for the tabulation of changes in the age group and sex of workers. Table 12 shows that in the metalworking industry between 1931 and 1936 there was a substantial decline, from 44 to 26 percent, in the proportion of workers who were men and 35 to 44 years old and a rise from 34 to 45 percent in the 20 to 34 year old male category. In the baking industry the proportion of women 20 to 34 years old increased at the expense of men of the same age group, while in the laundry industry a drop in the proportion of women 20 to 34 years old was accompanied by an increase of men 35 to 44 years old. There was a substantial rise in the proportion of men over 34 in the creamery industry and of men over 44 in the woodworking industry. Smaller increases in the proportion of older men and women were recorded for the printing industry.

Even in these cases, of course, the age composition cannot be considered as typical for the industries which these identical

Table 12.- AGE AND SEX OF WORKERS, 1931 AND 1936^a

(Percentage of production workers)

| Sex and industry | Age in years | | | | | | | |
|------------------|--------------|------|-------|------|-------|------|---------|------|
| | 10-19 | | 20-34 | | 35-44 | | Over 44 | |
| | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 |
| Men | | | | | | | | |
| Baking | 4 | 1 | 52 | 39 | 11 | 11 | 3 | 3 |
| Creamery | 1 | 0 | 54 | 30 | 13 | 22 | 10 | 27 |
| Laundry | 4 | 1 | 15 | 14 | 2 | 12 | 4 | 5 |
| Metalworking | 1 | 4 | 34 | 45 | 44 | 26 | 19 | 20 |
| Printing | 3 | 0 | 41 | 37 | 22 | 25 | 17 | 18 |
| Woodworking | 4 | 4 | 40 | 40 | 27 | 19 | 27 | 37 |
| Women | | | | | | | | |
| Baking | 2 | 4 | 22 | 37 | 6 | 2 | 0 | 3 |
| Creamery | 1 | 1 | 19 | 18 | 2 | 1 | 0 | 1 |
| Laundry | 2 | 0 | 36 | 32 | 23 | 20 | 14 | 16 |
| Metalworking | 0 | 1 | 2 | 3 | 0 | 1 | 0 | 0 |
| Printing | 1 | 0 | 14 | 11 | 2 | 5 | 0 | 4 |
| Woodworking | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |

^aBased on identical plants in industries in which 85 or more workers were surveyed in both years.

plants represent, since new plants or plants which have undergone a change of management may be expected in general to obtain a labor force which is younger than that of plants which have been established for a period of years. This is illustrated by one of the industries whose plant composition was different for the two surveys, shoe manufacture, which in 1931 provided a notable source of jobs for women over 44. One of the shoe plants which employed older women in 1931 had moved out of the State in the intervening period; a second plant went through bankruptcy, closed down entirely for a time, and finally reopened under new management, with all its female employees between the ages of 25 and 44.

Age Limits

In the present study, as in the earlier one, the staff sought to obtain information as to the establishment of age limits for factory operations. From the responses vouchsafed by most executives of the plants covered, it would appear that very few maintain a definite policy with regard to this question.

However, it is beyond doubt that there is a conspiracy of silence on the part of industry about the entire subject of age restrictions. The personnel manager of a large production plant in the East, who must necessarily remain anonymous, writes informally as follows:

Industry will not discuss age limits. In this country any industry of any worth or size, in competition with other industries, must of necessity set an age limit at which workers are employed. I would not like to be a man over 40 years of age who is without a special trade or special experience and without a job. There are exceptions, but I know definitely that the hiring age in industry is not much over 40. In one concern where I worked we were told to say that no age limits were set, that only ability was considered, but if we hired anyone of 40 or over without an extremely good reason our own jobs were worth nothing. No industry will admit these facts; from a social viewpoint it seems wrong, but from a purely business standpoint it is absolutely necessary to meet the demands of efficiency and competition.

A negligible percentage of the operations resurveyed in 1936 was subject to admitted, fixed age limits. It is perhaps worth noting that those operations for which a limit of under 30 years had been set - a few in the bag, baking, candy, food, and knitting industries - generally entailed neither the handling of heavy weights nor the exercise of any particularly high grade of skill on the part of the worker, and that the workers on a number of them were already older than the specified age limit. The exception was the bag industry, where most of the operations for which age limits had been established necessitated the handling of weights of 100 pounds or more.

TRAINING THE WORKER

How much and what sort of training does a worker need to function without direction? Was there any discernible modification in these requirements between 1931 and 1936? The data presented here tend to support the contention put forward in the 1931 study that advances in production technique have not only drastically cut down the time necessary for training but have also given rise to significant changes in the qualifications demanded of the worker. There is a strong indication, more-

over, that the process of increasing division of labor through increased mechanization is still running its course. That course may not now be so rapid or so revolutionary as before, but it is still causing important developments in industry and is showing a tendency to continue in that direction.

Length of Training Periods

The training time necessary for a job is one of the main elements in the skill classification of the job. The time needed for training varies a great deal with the nature of the industry, and, in general, jobs in hand-operated plants demand longer training than those in mechanized factories even within the same industry. In this study, however, it was apparent that the movement to curtail periods of training had not been limited to mechanized establishments and that, where hand operations prevailed, many of the jobs had been so modified as to require less training than formerly.

The baking industry affords a good example. Table 13 shows that in 1931 the mechanized bakeries required a training period of less than 9 months for 86 percent of the workers surveyed, whereas in the hand-operated bakeries this period was sufficient for only 38 percent. Five years later, a training time of less than 9 months was found satisfactory for 88 percent of the workers in the hand-operated bakeries and for 89 percent in the mechanized bakeries. In the hand-operated bakeries, moreover, the proportion of workers requiring a training time of less than half a month increased from 8 percent in 1931 to 45 in 1936, and jobs with a training period of from half a month to 2 months rose from 15 to 27 percent; on the other hand, the proportion requiring from 2 to 4 years decreased from 32 to 5 percent. In their competitive struggle with the mechanized plants, hand-operated bakeries obviously passed through a major adjustment during the years from 1931 to 1936, drastically cutting the time necessary for training workers. This curtailment of training periods is to be attributed largely to further division of labor and more efficient management. In some of the hand-operated bakeries where formerly one baker had made a complete product, there had been introduced a sort of assembly line, with each worker performing one simple operation.

Table 13.-- LENGTH OF TRAINING PERIOD REQUIRED, 1931 AND 1936^a

(Percentage of production workers)

| Industry | Less than $\frac{1}{2}$ month | | $\frac{1}{2}$ to 2 months | | 3 to 9 months | | 10 months to 2 years | | 2 years to 4 years | | Over 4 years | |
|------------------------|----------------------------------|------|------------------------------|------|------------------|------|-------------------------|------|-----------------------|------|-----------------|------|
| | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 |
| Baking | | | | | | | | | | | | |
| Hand-operated | 8 | 45 | 15 | 27 | 15 | 16 | 30 | 7 | 32 | 5 | 0 | 0 |
| Mechanized | 53 | 38 | 27 | 36 | 6 | 15 | 14 | 10 | 0 | 1 | 0 | 0 |
| Candy | (b) | 32 | (b) | 22 | (b) | 12 | (b) | 18 | (b) | 15 | (b) | 1 |
| Creamery | 44 | 43 | 13 | 19 | 0 | 20 | 37 | 12 | 4 | 0 | 2 | 6 |
| Furniture | (b) | 41 | (b) | 32 | (b) | 12 | (b) | 9 | (b) | 5 | (b) | 1 |
| Laundry | 20 | 39 | 38 | 43 | 32 | 9 | 9 | 9 | 1 | 0 | 0 | 0 |
| Metalworking | 4 | 20 | 22 | 30 | 11 | 16 | 20 | 23 | 42 | 7 | 1 | 4 |
| Packing ^c | 45 | 35 | 37 | 47 | 15 | 11 | 2 | 4 | 1 | 3 | 0 | 0 |
| Printing | | | | | | | | | | | | |
| Engraving ^d | 6 | 14 | 2 | 11 | 6 | 6 | 9 | 6 | 32 | 28 | 45 | 35 |
| Simple | 0 | 8 | 48 | 14 | 20 | 10 | 8 | 24 | 20 | 18 | 4 | 26 |
| Woodworking | (b) | 24 | (b) | 21 | (b) | 9 | (b) | 37 | (b) | 9 | (b) | 0 |

^aBased on identical plants in industries in which 85 or more workers were surveyed in the given year.^bComparable data not available.^cData for 1931 tabulated from files of the earlier study.^dIncludes high-class printing and newspaper printing.

The reduction in training time was found to have affected also the type of job the hand-operated bakeries now offered to their employees. In 1931, 32 percent of the workers in these bakeries had jobs in class B,³ or the second grade of skilled workers; 40 percent in class C, or the first grade of semi-skilled operators; 26 percent in class D; and 2 percent in class E or unskilled labor (table 15). In 1936 there were 6 percent in class B, 22 percent in class C, 68 percent in class D, and 4 percent in class E.

In the printing industry the differences between the training periods required for simple printing jobs and those for high-class color printing and the better grade of black and white work had been virtually eliminated. In 1931, 68 percent of the workers surveyed in simple printing but only 14 percent in high-class work had had a training period of 9 months or less; in 1936 these percentages in the same plants were 32 and 31, respectively. There was not such a close approximation between the two branches of the printing industry with regard to the longer periods; yet here, too, much of the difference had been wiped out. The decline of extensive training for high-class work is to be credited to the installation of new automatic

³See appendix B for "Skill Classification of Industrial Jobs."

and semiautomatic equipment, which explains also the increase in jobs capable of being learned in a few months. The rise in the proportion of jobs in the simple printing industry for which more extended training periods were prescribed does not indicate a reversion to more difficult production methods but reflects the recent adoption of an apprenticeship system in one of the large plants.

In each of the industries for which data are presented in table 13, except in the laundries, there was a considerable increase in the proportion of workers whose training period was 9 months or less. This tendency was also clear in the other industries in which the same plants were covered in 1931 and 1936 but where the number of workers surveyed was small.⁴ In most of the industries, moreover, there were appreciable increases in the percentage of jobs requiring a training time of less than half a month. In several industries, indeed, it was found that there were a number of jobs for which the worker needed no training whatever (see table 14).

The widespread reductions in training time are attributable largely to improved methods of production and to better machine lay-outs; in some cases they were brought about through mechanization alone and in others through mechanization in conjunction with the two factors just mentioned. In the cigar industry, the installation of machines not only displaced skilled male workers but also made unnecessary any prolonged training of the women brought in to replace them. In the specialized woodworking and metalworking plants, the application of jigs, fixtures, and other devices served to cut down the degree of skill, and therefore of training, required for many jobs. During the period 1931-36, a number of the plants studied had set up industrial-engineering departments composed of men trained in production methods and factory management who were to determine how manufacturing costs might be lowered. In one plant surveyed they designed new equipment, improved production techniques, arranged machine lay-outs more effectively, and eliminated considerable waste of materials.⁵

⁴The proportion of workers surveyed requiring a training period of 9 months or less increased in the bag, carpet, cigar, coke, creamery, flour, paint, and woolens industries; was unchanged in the bottling plant; and decreased in the clothing and pottery industries.

⁵In this plant they were able to effect a saving of \$15,000 a year on one operation alone by eliminating overruns. Whereas formerly for an order of 20 pieces, say 30 or 40 pieces had been cut, now for an order of 20 pieces, exactly 20 were cut. In part the rate of pay was based on the worker's ability to produce 20 perfect pieces when 20 had been ordered.

The shortened training time affects employer as well as employee. If highly skilled workers were necessary for his business, the manufacturer would have more difficulty in obtaining an adequate working force and, having once selected his men, would hesitate to lay them off in slack times despite the high wages he had to pay. With advances in production methods and shorter training periods, he can quickly expand or reduce his force according to the changing demand for his product without losing a disproportionate amount of time and money in training new workers. The employee, on the other hand, is able to reach the peak of his productive capacity sooner and thus to attain the maximum pay for his work in a shorter time. The maximum pay for quickly learned jobs, however, is less than that for jobs requiring a higher degree of skill.

Methods of Training

With the changes in production technique, semiskilled operators have come to supplant most of the highly skilled workers. Nevertheless, some industries will always require some skilled workers, and many have recently learned to their cost that their former lack of interest in the availability of this type of worker has been responsible in large measure for a shortage of workers with special skills.

It is significant, therefore, that the number of industries which used the apprenticeship method for training some of their employees was greater in 1936 than in 1931, a development which may reflect management's concern in 1936 with the problems of scarcity and cost of skilled workers. As table 14 shows, the baking industry, which reported no apprentice training in 1931, had introduced it for 12 percent of the workers surveyed in 1936. The metalworking industry had adopted apprenticeship for 8 percent of its jobs, and the furniture industry for 5 percent. The chief concentration of apprenticeship was found in the printing industry, as it had been in 1931. Some shifts had occurred within this industry, however. In 1931 simple printing had no apprentices, whereas high-class printing trained workers for 61 percent of its jobs in this manner; by 1936 the proportion in simple printing had jumped to 55 percent, while that in fine printing had declined to 43 percent.

Table 14.- TYPE OF TRAINING REQUIRED, 1931 AND 1936^a

(Percentage of production workers)

| Industry | No training | | By foreman | | By experienced operator | | Special-training institute | | Vocational school | | Apprenticeship | | College | |
|------------------------|-------------|------|------------|------|-------------------------|------|----------------------------|------|-------------------|------|----------------|------|---------|------|
| | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 | 1931 | 1936 |
| Baking | 0 | 7 | 50 | 44 | 50 | 31 | 0 | 3 | 0 | 3 | 0 | 12 | 0 | 0 |
| Candy ^b | 0 | 12 | 79 | 60 | 3 | 26 | 0 | 1 | 0 | 1 | 18 | 0 | 0 | 0 |
| Creamery | (c) | 13 | (c) | 48 | (c) | 35 | (c) | 6 | (c) | 1 | (c) | 1 | (c) | 1 |
| Food ^b | 0 | 8 | 43 | 50 | 55 | 39 | 0 | 3 | 0 | 0 | 1 | 0 | 1 | 0 |
| Furniture | (c) | 5 | (c) | 55 | (c) | 32 | (c) | 1 | (c) | 1 | (c) | 5 | (c) | 1 |
| Laundry | 0 | 7 | 44 | 42 | 56 | 49 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| Metalworking | 0 | 4 | 39 | 47 | 61 | 31 | 0 | 4 | 0 | 6 | 0 | 6 | 0 | 0 |
| Packing ^b | 0 | 6 | 94 | 55 | 6 | 34 | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 0 |
| Printing | | | | | | | | | | | | | | |
| Engraving ^d | 1 | 4 | 19 | 20 | 15 | 27 | 3 | 4 | 1 | 2 | 61 | 43 | 0 | 0 |
| Simple | 0 | 2 | 10 | 12 | 90 | 19 | 0 | 7 | 0 | 3 | 0 | 55 | 0 | 2 |
| Woodworking | 5 | 12 | 51 | 45 | 41 | 28 | 0 | 2 | 0 | 2 | 3 | 11 | 0 | 0 |
| Woolens | 0 | 1 | 90 | 46 | 10 | 47 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 0 |

^aBased on identical plants in industries in which 50 or more workers were surveyed in the given years.^bData for 1931 tabulated from files of the earlier study.^cComparable data not available.^dIncludes high-class printing and newspaper printing.

Special-training institutes also had a wider representation among the industries resurveyed in 1936. In 1931 workers trained in this manner were employed in very few of the operations studied, and those were in a very few industries. In 1936, although the proportions were extremely small in all cases, special-training institutes had prepared some workers in a majority of the industries covered.

For the bulk of the workers surveyed, training in the factory itself was the sole type of preparation in 1936 as it had been in 1931. There was a considerable rise, moreover, in jobs requiring no training at all.

Factory training, while it might appear at first glance to be the most desirable type of instruction, has certain serious disadvantages. If a plant is not operated with maximum efficiency, its development is likely to be still further retarded if it trains its workers in methods which more successful plants have already discarded. Furthermore, it does not make for operating economy to impose upon foremen and highly trained workers the task of teaching the inexperienced at the cost of their own productivity.

Personnel requirements have changed with the technological advance of industry. Detailed knowledge of the functioning of

a particular machine is less necessary to the production worker now than formerly when jobs were more complicated and less quickly learned.⁶ More and more attention is being devoted to conserving materials, time, and energy. Thanks to the simplification of individual operations, the primary qualification expected of a worker is no longer mastery of a machine or process. Management is tending increasingly to recognize that a high development of dexterity and bimanuifiability (the ability to use both hands at the same time but in different motions) is a far more valuable asset.⁷ Operations in mass-production industries are becoming basically more and more similar, and a shift of emphasis from training in particular skills, in which vocational schools have heretofore specialized, to instruction in the general principles and processes of contemporary industry might well be indicated. At the present time, however, very few vocational schools have begun to work out course material for the production worker.

SKILL OF WORKERS

In order to determine the extent and incidence of shifts in skills, workers were classified in 1936, as they had been in 1931, according to the degree of skill demanded by the operations upon which they were engaged. Since the classification followed is somewhat unusual, a brief explanation is here presented of the manner in which the term "skill" has been used as well as of the basis upon which the workers surveyed have been graded.⁸ As defined in technical literature, "skill" includes varying degrees of judgment and manipulative dexterity. While "skilled", "semiskilled", and "unskilled" were recognized as satisfactory terms for a broad indication of a worker's status, it was found advisable, for the type of survey undertaken in this instance, to set up more or less arbitrary divisions within those categories. Of two men generally

⁶ However, because of the very nature of the movement toward mechanization, some generally skilled machinists, tool makers, and other mechanics are and always will be required to build, adjust, and maintain the production equipment.

⁷ It is true that not all authorities agree that these qualities can be taught or learned. One psychologist, Dr. Walter Bingham of the Stevens Institute in Hoboken, New Jersey, is at present engaged in research to determine whether such training would be fruitful. Although he has not yet reached definitive conclusions, his findings seem to indicate that both dexterity and bimanuifiability may be acquired by instruction.

⁸ A more complete description of the qualifications of the various classes, together with a list of the principal jobs in each, is to be found in appendix B. The skill rating was determined by the field staff, not by the worker.

considered as semiskilled, one may perform an operation requiring not only more manipulative dexterity but also more judgment than the other. In order to further a more precise evaluation of a worker's services, therefore, skilled operators were listed in this study under classes A and B, semiskilled under classes C and D, and the unskilled under class E.

Within the factories themselves the workers were not actually classified as in this survey, although they were paid their wages according to the type of appraisal described here. Not many generations ago the majority of workers were masters of a trade, and the semiskilled were scarcely recognized as such. Today, with the exception of the tool maker and the comparatively new machine setter, the highly skilled are yielding place to the intermediate groups, as are also the totally unskilled. This tendency may be expected to advance as labor is further subdivided, training time cut down, and automatic machinery more widely applied.

A comparison for 1931 and 1936 of the data on class A and class B jobs in table 15 offers some evidence in support of the contention that the highest skills are still losing ground in many industries. Much more spectacular, however, was the decline in class E jobs. In 1931 virtually all the industries covered had some production workers so classified; in 1936 the proportions had dropped in the majority of industries surveyed, and in several plants this type of job had disappeared altogether. The same tendency was observable in the other resurveyed plants not shown in table 15.⁹ Few of the plants resurveyed had many class A jobs, whereas in every industry the plants had a substantial proportion of jobs in classes C and D; these had increased at the expense of occupations in classes A or E in most cases.

Today in the few skilled trades surviving in production work in manufacturing industries, every effort is being made to reduce the importance of human labor through the use of machinery and the adoption of cheaper methods of production. For example, in one of the metalworking plants surveyed, hand-operated punch presses were formerly used in the manufacture of heating and ventilating equipment, and the parts were

⁹In the bag and carpet industries there was a decline in both skilled and unskilled jobs; in bottling and clothing, an increase in skilled but a greater decline in unskilled; in coke and flour, an increase in skilled and a slightly smaller decline in unskilled; in pottery, a slight increase in both skilled and unskilled jobs.

Table 15.- SKILL OF WORKERS, 1931 AND 1936^a

(Percentage of production workers)

| Industry | 1931 | | | | | 1936 | | | | |
|------------------------|-----------------------------|-----|--------------|------------|-----|-----------------------------|----|--------------|------------|----|
| | Classification ^b | | | | | Classification ^b | | | | |
| | Skilled | | Semi-skilled | Un-skilled | | Skilled | | Semi-skilled | Un-skilled | |
| | A | B | C | D | E | A | B | C | D | E |
| Baking | | | | | | | | | | |
| Hand-operated | 0 | 32 | 40 | 26 | 2 | 0 | 6 | 22 | 68 | 4 |
| Mechanized | 0 | 2 | 20 | 63 | 15 | 0 | 19 | 13 | 63 | 5 |
| Candy ^c | 0 | 17 | 24 | 52 | 7 | 0 | 11 | 26 | 46 | 17 |
| Cigar | (d) | (d) | (d) | (d) | (d) | 0 | 21 | 20 | 53 | 6 |
| Creamery | 1 | 3 | 25 | 40 | 31 | 1 | 16 | 25 | 47 | 11 |
| Dry cleaning | (e) | (e) | (e) | (e) | (e) | 1 | 5 | 49 | 42 | 3 |
| Food ^c | 0 | 3 | 23 | 45 | 29 | 2 | 6 | 29 | 61 | 2 |
| Furniture | (e) | (e) | (e) | (e) | (e) | 3 | 14 | 34 | 48 | 1 |
| Laundry | 0 | 2 | 30 | 58 | 10 | 0 | 6 | 40 | 50 | 4 |
| Metalworking | 2 | 20 | 39 | 27 | 12 | 7 | 23 | 36 | 28 | 6 |
| Packing | (e) | (e) | (e) | (e) | (e) | 1 | 5 | 28 | 61 | 5 |
| Printing | | | | | | | | | | |
| Engraving ^f | 26 | 23 | 19 | 22 | 10 | 14 | 44 | 10 | 32 | 0 |
| Simple | 0 | 19 | 55 | 26 | 0 | 12 | 38 | 20 | 27 | 3 |
| Shoe ^c | 0 | 1 | 80 | 17 | 2 | 0 | 1 | 68 | 31 | 0 |
| Woodworking | 0 | 5 | 46 | 47 | 2 | 1 | 20 | 29 | 38 | 12 |
| Woolens | 0 | 15 | 37 | 33 | 15 | 0 | 9 | 35 | 50 | 6 |

^aBased on identical plants in industries in which 40 or more workers were surveyed in the given year.^bSee appendix B for explanation of skill classification.^cData for 1931 tabulated from files of the earlier study.^dLess than 40 workers surveyed.^eComparable data not available.^fIncludes high-class printing and newspaper printing.

assembled by hand. Now machinery not only manufactures the parts but assembles them as well. Among the many instances of the obsolescence of the trades may be cited also the furniture industry, where highly skilled wood carvers were at one time employed as decorators. These wood carvers have been largely replaced by wood-carving machines, which can produce up to 24 identical carvings from a master form. The new "carver" is merely a semiskilled worker who is probably incapable of carving with hand tools, while only a few of the craftsmen are retained - and these only in the very large furniture factories - to make the original master forms. In the pottery industry, too, artistic craftsmanship is all but obliterated. The potter's wheel is rarely used; instead a plaster-of-paris

mold is filled with fluid clay, and later the comparatively unskilled worker breaks open the mold to discharge the ware.

Since it is unlikely that industry's striving for independence from the skilled trades will cease, compensations other than those which might follow a revival of former techniques must be sought for many of these trades. It is perhaps some such realization of the situation that prompts the current trend away from unionization along trade lines and toward organization by large industrial units.

MOBILITY OF WORKERS

Closely bound up with the developments discussed above has been the tendency on the part of industry to shift workers from one operation to another, to lay off part or all of the working force when production is slack, and largely to disregard the factors of skill and training in hiring workers when production is resumed or augmented.

This shifting of workers from one industry or occupation to another is here discussed as the "mobility of the worker." From the worker's point of view, although his mobility is subject to less and less restriction with regard to technical requirements, his opportunity to shift his industrial or occupational affiliation is conditioned by a number of other factors, chief among them being the availability of jobs. The fact is that while workers are capable of adapting themselves to new occupations, thanks to the leveling of skills and the increasing simplification of operations, their actual mobility in no way approximates their potential mobility. For example, 29 percent of the workers surveyed in 1936 in dry-cleaning establishments in the Minneapolis area had come into the industry from another field since 1931, but it does not follow that only 29 percent could have done the work without previous experience. In 1931 it was found that 88 percent of the workers in the dry-cleaning plants surveyed in that year had at one time or another entered from an unrelated industry. Furthermore, in view of the type of work performed and the short training periods for the majority of the operations in the dry-cleaning industry, it may be assumed that even more than 88 percent could have done the work without previous experience.

JOB REQUIREMENTS IN MANUFACTURING

Table 16, compiled from statements of the workers surveyed as to their previous industrial affiliation, shows the proportion of employees in the industries covered who had shifted from an unrelated industry during the period 1931-36. Actual industrial mobility, as the data indicate, varied widely between plants and industries.

**Table 16.- SHIFTING BY WORKERS BETWEEN INDUSTRIES
DURING 1931-36^a**

(Percentage of production workers)

| Industry of employment in 1936 | Percent who - | |
|-----------------------------------|---------------|---------------|
| | Shifted | Did not shift |
| Baking | 43 | 57 |
| Candy | 54 | 46 |
| Cigar | 31 | 69 |
| Creamery | 36 | 64 |
| Dry cleaning | 29 | 71 |
| Food | 48 | 52 |
| Furniture | 40 | 60 |
| Laundry | 34 | 66 |
| Metalworking | 41 | 59 |
| Packing | 39 | 61 |
| Printing | 21 | 79 |
| Shoe | 61 | 39 |
| Woodworking | 52 | 48 |
| Woolens | 44 | 56 |

^aBased on those industries in which 40 or more workers were surveyed. Workers hired after 1931 who had never held a job before were considered as not having shifted.

The candy industry offers an illustration of the tie-up between advanced mechanization and large-scale shifts in labor. Here 54 percent of the workers surveyed had come in from other industries between 1931 and 1936. This high proportion of workers new to the industry is to be attributed in large measure to the expansion of one plant which hired a substantial number of workers, mostly women, for the less skilled occupations. In 1936, 89 percent of the workers surveyed in the candy industry were semiskilled or totally unskilled, while 84 percent of the operations were performed on automatic or semiautomatic machinery and required, on the whole, extremely

short training periods. Some of the previous occupations of the workers in one of the candy plants may be noted here, since they point emphatically to the inexperienced operator's adaptability to the simple tasks characteristic of the industry; among the employees who had entered the plant in the years 1931-36 there were a grocery clerk, a foundry worker, a farm laborer, a furniture worker, a manager of a refrigerator factory, a machinist, and a piano salesman.

In the woodworking industry, which, unlike the candy industry, is dependent upon a comparatively large group of operators in the higher skill brackets, the proportion of workers who had shifted their industrial affiliations was nevertheless as high as 52 percent. Here the chief cause of the influx of new workers was the recurrence of long periods of low activity; after each lay-off, men inexperienced in the industry were taken on for many of the less skilled operations.

The carpet industry, in which half of the workers had come in from other industries, owes its high mobility to an expansion in production during the period 1931-36. In this plant nine-tenths of the production employees surveyed were unskilled and semiskilled workers, and almost one-quarter were between the ages of 18 and 24.

The food plants drew upon outside sources for 48 percent of their labor force between 1931 and 1936. Here a majority of the workers surveyed in 1936 were women, and half of these were under 25 years of age. In one of the food plants surveyed, it was the policy of the management to employ young female workers whose tenure is characteristically short. Another plant had reduced its labor force with every decline in production and had taken on new workers upon resumption of activity. Still another establishment, after instituting a series of changes in machinery and equipment, had so altered the nature of the work, and consequently the requirements for the bulk of the operations, that it was able to substitute inexperienced female labor for male labor.

In the baking industry the workers who had entered in 1931-36 from unrelated occupations accounted for 43 percent of those surveyed. It has already been noted that the hand-operated bakeries underwent drastic reorganization during the period and that they reduced training time for a high percentage of their

workers and substituted women for men on a number of jobs. As for the mechanized plants, they had long since eliminated the old-time master baker and with each technological advance found it feasible to cut training periods and to employ women for many tasks previously assigned to men.

A number of the industries surveyed, on the other hand, were outstanding for the slight amount of shifting in the period under observation. The coke industry, which headed this group, had not taken on any workers from other industries in the years 1931-36. The establishment surveyed was characterized by great stability of operation and by a relatively high rate of pay. Its workers, moreover, had been granted substantial wage increases since 1931.

The plants of the paint industry are likewise notable for relative stability in this respect. The low mobility here may be attributed in part also to the policy of one plant which had established a yearly wage rate and offered its employees other incentives as well - including Christmas bonuses and a system of profit sharing.

Only 21 percent of the workers surveyed in printing had entered in the years 1931-36 without previous experience in the industry. Despite the advances in mechanization in this industry, skilled workers are still needed to set up work on the presses and to operate linotype machines. Inexperienced workers have been kept out, furthermore, through the influence of the union and through the apprenticeship system of training which applies to many printing operations.

SPECIAL REQUIREMENTS

The field staff noted also such special requirements for workers as ambidexterity; left-handedness; keener-than-average sense of smell, taste, hearing, and touch; and clerical ability. Although the sample was too small to offer conclusive evidence, it may be noted that the requirement of ambidexterity had increased somewhat, a fact which partly explains the rise that also occurred in jobs demanding the use of the left hand. In the packing industry, for example, a left-handed worker is needed for dismembering carcasses; here a worker stands on either side, the right-handed man on the left, the left-handed man on the right.

There was no increase in the demand for workers with an exceptionally keen sense of smell, taste, or touch. Some candy factories still did not use thermometers, so that the liquid candy had to be tested by the fingers, but the ordinary sense of touch appeared satisfactory for this purpose. A keener-than-average sense of hearing was shown to be required for some operations in the metalworking industry; here the workers, when cutting a blind hole, must listen to the noise of the machine to perceive the progress of the cutting tool and also to detect its dullness.

CHAPTER V

SUMMARY

This study of plants in 23 industries in the Minneapolis-St. Paul area covers changes in machinery, methods of working, and job requirements during the period 1931-36. Based on a field investigation of factory operations, it presents a picture of some important aspects of industrial development in a short period characterized by fluctuating economic conditions.

CHANGES IN THE MACHINERY

Although almost all the industries studied had installed some new machines between 1931 and 1936, the equipment in use was in general older in 1936 than in 1931. A more widespread mechanical change than the purchase of new equipment was modification in the performance of the machines, effected chiefly through the addition of jigs, fixtures, and other special appliances to machines already functioning. In the industries surveyed there was in most cases an increase between 1931 and 1936 in the proportion of machines classed as special-purpose, that is, designed or modified so that they produced but one particular article or part. In a number of cases machines originally used as general-purpose had been converted to a special purpose.

It was also observed that in the plants of 10 of 17 industries in 1936, two-fifths or more of the operations were performed on automatic machines, while in none of these industries were more than one-fourth of the operations manually performed. The proportion of semiautomatic operations varied from 12 percent in the coke industry to 75 percent in woodworking. Among the five industries for which comparable 1931 data were available (baking, laundry, printing, woodworking, and woolens), printing and baking had increased substantially the proportion of operations performed on automatic machines.

In general, the mechanical changes which had been inaugurated in the 5-year period resulted not only in increased capacity, improved product, or lower costs, but also in marked economies in the utilization of labor. Thus in a woodworking plant the addition of special fixtures to a wood shaper made possible

the substitution of a comparatively unskilled operator for one of superior skill and training and at the same time vastly increased the number of boards that could be cut and shaped at one time. The integrated bottling machine reduced the number of men required to tend it from five to three. The installation of large-capacity cookers in a single candy plant multiplied output but involved only a slight addition to the force of skilled male cooks. In the cigar industry the new machines facilitated the displacement of skilled men hand workers by semiskilled women.

CHANGES IN THE WORK PERFORMED

The nature of factory jobs was found to have changed in several respects in the industries resurveyed in 1936 after a lapse of 5 years. Such changes are to be attributed both to improvements in machinery and to the increasing rationalization of production methods. Even more marked than in 1931 was the trend toward simplifying the factory worker's job. The production worker often was required merely to perform his repetitive task without exercising judgment. The machine had become more complicated, but this complexity was now largely the province of the skilled set-up man. Although blueprints were being used more widely than ever before, they were read and interpreted by production engineers, tool designers, and foremen. Calculations on the job were confined largely to the metalworking industry, and for operations in most of the industries observed accuracy had been built into the machine itself. Time and motion studies likewise were being applied more extensively than in 1931.

No clear tendency was discerned in the method of transporting materials between operations. Several plants had revised their internal transportation system with a view to reducing the carrying of materials by hand. This involved a shift either to mechanical handling devices or to hand trucks. However, there also were quite a few industries which reported hand transportation on a larger proportion of operations in 1936 than in 1931.

In a number of industries, emphasis had shifted from hand operations to finger manipulation, which makes for more rapid performance although it may increase the fatigue of the worker. For the most part, this trend toward small motions reflects

changes in the construction of the machine and the simplification of operations. In 1936 hand dexterity was most frequently required in the industries surveyed, but finger dexterity was prominent in most industries and predominant in some.

It was found that the great majority of industries used a time rather than wage-incentive basis for wage payments, and in the few cases in which comparable data were available, it appeared that wage-incentive plans had decreased somewhat in popularity since 1931.

In most industries in 1936 employees worked in teams on some of the operations, but in only one industry were as many as one-quarter of the operations performed in teams. Pacing, on the other hand, was more generally used, with speed of working commonly controlled by a conveyor belt or by automatization of machine speed. Thus the work on as high as 85 percent of the operations in the various industries was found to be paced, and in only 7 of 21 industries were less than one-quarter of the operations paced.

The tendency toward a shorter workweek was clear in the few industries for which comparable data were available in 1931 and 1936. In the latter year the standard hours of work were 40 or less for at least half the operations in 14 of 21 industries.

CHANGES IN THE CHARACTERISTICS OF THE WORKERS

There were some shifts in the proportions of men and women in the industries surveyed, but the changes were not great, except in the cigar and baking industries where there were substantial increases in the proportion of female production workers. In the cigar plant the shift was related to the mechanization of cigar making. In the baking industry it was accompanied by increased division of labor and simplification of operations in hand-operated plants and by increased use of women on machine work in mechanized plants.

The female workers were in general younger than the male; they were more highly concentrated in the age group 20 to 24 years and infrequently were over 44 years old. On the other hand, in 7 of 23 industries men over 44 years old accounted for 20 percent or more of all workers surveyed. In very few of the plants studied did the management admit that age

limits, beyond which an applicant was considered ineligible for employment, had been established for any of the operations.

The increasing simplification of factory jobs was reflected in the data on length of training periods, which had been drastically curtailed in a majority of the industries in the period 1931-36. Several, indeed, had a number of operations in 1936 for which no training was necessary. Although it is true that jobs in nonmechanized plants generally require more extended training than those in highly mechanized establishments, the survey disclosed that reduction of training time took place in nonmechanized plants as well as in others.

The number of industries in which apprenticeship was used to train employees for some operations was found to have increased after 1931, although the proportions were small in almost all cases. In 1936, as in 1931, training for the great majority of operations was received in the factory itself.

Improved methods of production, new equipment, and better lay-out also tended to level off the degree of skill required of production workers in the various industries resurveyed in 1936. As a result, in most of the industries there was a rise in the proportion of workers in classes C and D, the categories of the intermediate or semiskilled, and the increase was more uniform in class D than in class C. The proportion of workers having class A and B (skilled) jobs dropped in some of the industries which had maintained them in 1931, although they increased in others. There was a general falling off in the proportion of class E (unskilled) jobs. Most of the industries had had some class E jobs in 1931; by 1936 these had been reduced in a great majority of the industries and in some had virtually disappeared.

The changes in production and management methods, resulting in the curtailment of training periods and in industry's growing independence of skills for the bulk of factory jobs, have made it feasible for enterprises increasingly to substitute completely untrained workers for experienced employees upon resumption of activity after a shut-down, plant expansion, or change in processes, or in pursuance of a particular personnel policy. This is reflected in the extent to which the workers surveyed had shifted between industries in the years 1931-36. In 11 of 14 industries more than a third of the workers in 1936 had come in from another industry after 1931.

APPENDIXES

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APPENDIX A

OPERATION SHEET FOR FIELD WORK

EMPLOYMENT STABILIZATION RESEARCH INSTITUTE UNIVERSITY OF MINNESOTA OPERATION SHEET FOR JOB ANALYSIS

Firm No.
 Part Name Part No. Number of Op. on this part
 Operation No. Operation Name
 Description of work done during operation (see over for pictorial representation)

Actually From Worker on This Operation

1. Sex—M F 2* Age—Use code
- 3.* Actual disabilities
4. Major previous occupation, length of service, and where
5. Length of service on this operation

Characteristics of Worker On This Operation

1. Age limits for hiring—Under 30 30 to 45 Over 45
2. Special requirements — Smell Taste Clerical
Hearing Touch Ambidextrous Left Hand
3. Tools worker should own Kit
Incidental tools None toolmakers, carpenters, etc.
4. Tools worker must use
5. Training time necessary to work undirected on this operation
- 6.* How is training received (use code)
7. What other operations has this operator performed satisfactorily in this plant
- 8.* Classification of worker—A B C D E
9. Calculate on job—Yes No If so specify type of calculation

THE WORK

1. Weight—100 lbs. and up 10 lbs. to 100 lbs. 1 lb. to 10 lbs. 1 oz. to 1 lb.
2. Strength needed most—Back Legs Arms and hands
3. Dexterity—Finger Hand Arm Foot
4. Position—Stand Sit Stoop Reach Walk
5. Transportation } to operation
of material } from operation
- 6.* Machine set-up—Complicated Simple Done by others
7. Accuracy—Gage or mike Scale or rule None
8. Does operation require reading of blue prints—Yes No
9. Continuous production Job production (few only)
10. Working conditions—Good Hot Cold Humid
Fumes Dusty Dirty Oils Acids Poor ventilation
11. Location of job—Inside Outside
12. Sanitation—Common drinking cup St. jet An. jet
Dirty fountain Individual toilets Trough toilets
Dirty toilets
13. Lighting (ft. candles)—Natural Artificial
14. Hazards and safety precautions
15. No. of pieces, lbs., etc. per hour (av. from time on 10 units "as is")
16. Method of pay.—D.W. P.W. Premium Std. T.
Group
17. Are time studies used to set rates? Yes No
18. Team work Individual work Paced Set own pace
19. Normal number of hours per week
20. Rate of pay translated to 44-hour week \$
21. No. of men on this op. No. of pieces per unit
22. Type of fixture used
23. Material used
24. Cutting tool material F.P.M.
25. Average production per 8 hrs. in normal times
26. Ultimate product

The Machine On This Operation

1. Type of machine, name and size General purpose Special purpose
2. Machine—Strictly automatic Tools preset, but manually operated Strictly manual
- 3.* Age of machine (use code) Condition of machine—Excellent Good Poor
4. Are better machines or methods available
5. Would better machines or methods be economical on this operation with above average production. Yes No
6. Remarks

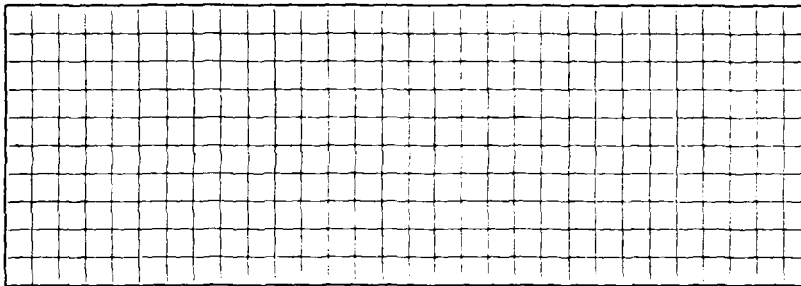
Observer
Name in full

EXPLANATORY DATA

Photographs of part after operation

Photographs of fixtures used

Explanatory sketches



Definitions

- Code for Training Received**
- 0. No training
 - 1. Instruction by foreman
 - 2. Working with experienced operator
 - 3. Special training instruction
 - 4. Vestibule school
 - 5. Vocational school
 - 6. Apprenticeship
 - 7. High school
 - 8. College
 - 9.

- Machine Set-up**
- Check type of set-up and whether done by others:
- Actual Disability**
- Loss of arm, hand, fingers, speech, sight, hearing, leg, foot.

- Code for Age of Machines**
- 0. Less than 1 year
 - 1. 1 to 3 years
 - 2. 4 to 9 years
 - 3. 10 to 15 years
 - 4. 16 to 21 years
 - 5. Over 21 years

- Code for Employee's Age**
- 0. 10-17
 - 1. 18-19
 - 2. 20-24
 - 3. 25-34
 - 4. 35-44
 - 5. 45-54
 - 6. 55-64
 - 7. 65-74
 - 8. 75-over

APPENDIX B

SKILL CLASSIFICATION OF INDUSTRIAL JOBS

The following classification was used in grouping workers by skill for this study (see especially chapter IV and table 15):

Class A: Skilled Mechanics, Grade 1

The jobs in this class require men who are masters of their trade, who understand their work thoroughly and comprehensively, and who are competent to work without immediate supervision. They necessitate the exercise of considerable judgment, accuracy without the use of jigs or other special equipment, and considerable initiative within the limits of the particular trade. Involved experimental work and high-grade production or tool work for which a general knowledge of all machines, tools, and materials of construction is necessary belong in this class. A list of jobs included in class A follows:

- Art stonecutters
- Assemblers of delicate precision equipment
- Die sinkers
- Electrotypers
- Engravers
- Filers on dies and gages
- Goldsmiths
- Head flour millers
- Lapidaries
- Master paper makers
- Pattern and model makers
- Printers of high-class color or offset work
- Silversmiths
- Tool makers
- Watchmakers

Class B: Skilled Mechanics, Grade 2

The jobs in this class differ from those in class A largely in that they are repetitive. Whatever difficulties an operation in this class presents are for the most part solved after

it has been performed several times. It may or may not continue to require the same degree of manipulative dexterity, but it does not continue to require as much exercise of judgment. The skill necessary for the jobs in class B is definitely less, therefore, than that in class A.

Class B jobs are partly preplanned, and they require more supervision than jobs in class A. In general, heavy jobs which must be accurate and smaller jobs which require accuracy without the use of special fixtures but which are nevertheless somewhat repetitive belong in this class. Workers on such jobs must know machines, speeds, and construction materials; they must also know how to read blueprints and how to use precision instruments.

This class also includes a large group of jobs not usually performed by factory labor - bricklaying, general baking, plastering, plumbing, paperhanging, etc. A list of jobs included under class B follows:

- Bakers in general bread bakeries
- Beverage compounders
- Blacksmiths
- Boilermakers
- Butchers
- Butter makers
- Cabinetmakers
- Carpenters, all round
- Carpenters, finish
- Casters in foundries
- Cigar makers, hand
- Compositors
- Coppersmiths
- Custom job assemblers on operations that require fitting and adjusting (as on locomotive and gas engines)
- Custom machine grinders
- Dyers
- Electricians
- Founders in type foundries
- Gas and steam fitters
- Glaziers on building work
- Heat treaters
- Linotypers
- Machinists, general tool and railroad

Metal buffers and polishers
Milliners on custom work
Millwrights on high-class machines
Molders
Paperhangers
Plasterers
Plumbers
Saw filers
Screw-machine setters
Sheet-metal workers
Stonecutters
Stonemasons
Tile layers
Tinsmiths
Toolsmiths
Typesetters
Upholsterers
Weavers

Class C: Semiskilled Operators, Grade 1

The jobs in this class require machine operators rather than mechanics. The operations are highly repetitive; day after day and week after week the worker repeats the same operation, whether by hand or by machine. For these jobs, however, he must still have considerable ability in the use of gages and in other methods of control. The work is preplanned, and the tools are usually preset, but the operator knows the machine and is able to make adjustments on it. A list of jobs included under class C follows:

Annealers
Carpenters, rough
Cement finishers
Coopers
Cutters in packing plants
Dressmakers in factories
Drop-forgers
Forgemen
Furnace men in metal industries
Glass blowers in factories
Glaziers in factories
Hammermen in metal industries

Hand painters on building work
Loom fixers
Machine carvers
Machine cigar makers
Machine knitters
Marble polishers
Millwrights on general repairs (handy men)
Mule spinners
Pasteurizers
Pottery decorators
Pottery-machine operators
Pourers in metal industries
Puddlers in metal industries
Rollers and roll hands in metal industries
Roofers
Repetitive line assemblers for accurate fitting work
Sawyers
Slaters
Smeltermen
Spray painters
Stationary engineers
Structural-iron workers
Textile nappers
Wool card tenders

Class D: Semiskilled Operators, Grade 2

The operations in this class are extremely simple and highly repetitive, and they need only a short training period - 3 weeks or less. They require little exercise of judgment on the part of the worker; ordinary dexterity or the ability to load and unload machines and to perform simple hand operations are the main qualifications. A list of jobs included under class D follows:

Assemblers on simple line assembly
Bakery-machine operators
Bag-factory operators
Book gatherers
Bottle washers
Bottlers
Cigar-factory strippers
Cranemen

NO CODE
ENTERED