UNITED STATES DEPARTMENT OF LABOR
FRANCES PERKINS, Secretary
WOMEN'S BUREAU
MARY ANDERSON, Director

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Employment of Women in the Machine-Tool Industry, 1942

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UNITED STATES DEPARTMENT OF LABOR,
WOMEN'S BUREAU,
Washington, May 15, 1943.

MADAM: The machine-tool industry is illustrative of an industry in which many women may be substituted for men. Until recently the industry has employed no women wage earners. Because machine-tool building was basic to the development of munitions industries, and because its previous methods of production called for highly skilled workmen in the first war years, united effort was exerted to keep the original skilled staff and to add thereto other skilled mechanics. Now even though the total amount of employment has reached a peak, there will be need for the replacement of men by women.

This survey of the machine-tool industry indicates that today there are many jobs in machine-tool building that are similar to those women are carrying on efficiently in other industries. That the industry also recognizes this fact is evidenced by monthly reports of increase in the employment of women wage earners since our technicians studied the industry.

The plant surveys were made by Martha J. Ziegler and Margaret Kay Anderson. The report has been written by Dorothy K. Newman and Miss Ziegler.

Respectfully submitted.

MARY ANDERSON, *Director.*

HON. FRANCES PERKINS,
Secretary of Labor.

—COURTESY BROWN & SHARPE

WOMAN PERFORMING OPERATION IN THE SKILLED ASSEMBLY OF A SURFACE-GRINDING MACHINE.

PROSPECT, MAY 1943

In the period it has taken for the data to be collected and this report to be prepared and published, machine-tool firms have made extensive progress in the employment of women. Some of the companies that at time of survey were resisting the hiring of women in the shop have already taken on hundreds. It is not at all uncommon today to find that in plants with 2,500 or more workers, from 12 to 20 percent are women.

The following analysis and the conclusions to which it points, however, are as valid now as before. The data continue to show that, even discounting plant differences in process and product, the occupations for which women are employed vary widely from company to company. Many plants employ men in jobs for which others are hiring women, and vice versa. This brings into relief two pertinent facts: (1) That, contrary to traditional notions, women can be trained under present conditions to handle successfully a wide variety of jobs in machine-tool manufacture, and (2) that opportunities for women in this industry are plentiful, assuming the interest and cooperation of management. The reason, in fact, that the pattern of women's occupational distribution in the industry continues so inconsistent and even haphazard is the extensive field over which women have been employed, no part of which has yet been fully exploited. For example, numbers of women were engaged in machine operations in some firms, but no women, or very few, were hired for similar work in others. Many jobs could be opened to women to perform various kinds of machining on machine tools and accessories. In a few plants women were doing a great deal of in-process inspection, but in most of the others they performed only a small proportion, if any. Subassembly work was women's chief job in one of the lathe factories, but this was considered unsuitable for women in several other firms where subassemblies were made.

Further illustration would only be redundant. It should be remembered, of course, that the employment of women, like that of inexperienced men, requires in many cases dilution of skills, involving also in some instances the introduction of handling conveniences. But it must not be forgotten that women, like boys and men employed now and in the past, become proficient with experience, and some are soon able to tackle more highly skilled and difficult operations.

In some quarters the employment problems of the industry that involve the necessity for extensive dilution of skills and the introduction of new and expensive equipment now appear less grave due to the threat of dwindling war orders. Though in the years before the war an annual machine-tool production worth $150,000,000 was considered good, in 1942 the industry's monthly output averaged practically three-fourths of this. However, from the very function of the business now, that of providing the basic tooling and retooling for the mass production of war material, output can hardly be ex-

pected to continue at such a remarkably high rate. The initial tooling-up has in many places been completed, and recent figures show that the industry is now catching up with its backlog. Not only are new orders no longer equal to shipments, but in addition there was an 11-percent reduction in output from December 1942 to January 1943. Production dropped again in February and was slightly lower in May.

This apparent trend has worried machine-tool manufacturers, since in many cases, even with extensive subcontracting, expansion in plant and other investment has been tremendous. They anticipate that soon they may have to convert all or part of their facilities to the manufacture of other wartime products. This uneasiness about the future doubtless has affected the attitude of some firms toward hiring women for the first time or adding to the numbers they already employ.

There is definite indication, however, that machine-tool orders will by no means cease when initial tooling has been completed. In the first place, it has been estimated that the backlog alone, if contracts are not cancelled, would keep the industry going at top speed into the summer of 1943. Actually, it may take even longer to clean up the backlog, since some of the largest companies with orders ahead are not now devoting all their energy to machine-tool production but have already taken on the manufacture of other products. Secondly, at the rate at which old and new machines have been used, thousands will have to be replaced. In many companies, furthermore, tooling for war production was done so hastily that old tools were accepted and new ones were designed in a hurry. Careful study of operations can now be gone into and designs made for better and more specialized tools, a great number of which will be needed as the war continues. The requirements of other countries remain high also.

On May 12, 1943, the War Production Board announced in a press release that "the United States at last has the machine tools * * * it needs to build production to defeat the Axis." This pronouncement, with its accompanying outline of a plan for pushing production of war material almost to the exclusion of facilities, makes more imminent the conversion of a large proportion of the industry.

As conversion occurs, however, the demand for women workers is likely to increase rather than decrease. Women can be absorbed in munitions manufacture in larger proportion than in machine-tool production, since the making of munitions involves straight mass production, in which women as inexperienced workers can participate much more readily and fully. Therefore, the possibility that a firm might have to convert later should not preclude the hiring of women now. The fact is that full utilization of the woman labor force in plants now devoted exclusively to machine-tool production has barely begun.

Employment of Women in the Machine-Tool Industry, 1942

SCOPE OF THE SURVEY

Machine tools are the basic tools of war production. Their use is essential in the manufacture, to very close tolerances, of the thousands of metal parts for guns, ships, tanks, planes, and countless other supplies and equipment upon which the armed forces of the United States depend. For this reason the production of machine tools had to be expanded rapidly before other production could get under way.

According to a statement released by the United States Department of Commerce in November 1942, the machine-tool builders of the country had produced more equipment in the previous 20 months than in 10 normally active years. The value of machine-tool output for the entire year 1942 reached the staggering sum of nearly 1 and a third billion dollars, or about 6 times the value of the 1939 output. Such a figure would have been almost inconceivable prior to the outbreak of war in Europe.

To meet the load of expanding production, employment also has increased until, according to a reliable estimate, the industry in 1943 has about 4 times as many workers as the average for 1939. The immediate employment problem, however, seems to be not so much a matter of finding the necessary labor for further expansion as of keeping what labor there is on the job and finding substitutes for men who enlist, are drafted, or move on to other war plants. To cope with this situation some employers already have taken on factory women in this traditionally male-employing industry, and top-flight executives are recommending that the practice be extended. The rapidity with which women have recently been absorbed into machine-tool plants may be judged from the fact that in 1939 they comprised less than half of 1 percent of the total wage earners in the approximately 200 plants engaged principally in making machine tools, whereas at time of writing the proportion is about 11 percent of a considerably expanded force.

In view of the industry's importance and recent expansion, the Women's Bureau of the United States Department of Labor made an investigation of machine-tool plants in the summer of 1942. This was in accordance with the Act of Congress creating the Bureau in 1920, which outlines its duties as follows: "It shall be the duty of said bureau to formulate standards and policies which shall promote the welfare of wage-earning women, improve their working conditions, increase their efficiency, and advance their opportunities for profitable employment. The said bureau shall have authority to investigate and report to the said department upon all matters pertaining to the welfare of women in industry."

As in its other war-industry surveys, the purpose of the Bureau in its study of the machine-tool industry was to find out to what extent and in what jobs women were or would be employed by some typical firms, and to be able, on the basis of the kinds of work they were known to be doing successfully elsewhere, to make recommendations concerning the jobs in which the employment of women could be introduced or extended. Trained field agents interviewed plant executives, production superintendents, shop foremen, and personnel workers, and made a careful tour of each of the factories surveyed. In those plants where women had not yet been placed on productive occupations the work in the factory was closely observed and the problems involved in its performance were noted. Where women were engaged in productive work, Women's Bureau agents paid special attention to their occupations. Data were secured from each firm concerning the numbers employed, hours, wages, and other conditions of work, and personnel policies and problems.

Fifteen well-known plants, situated in recognized centers of the industry in New England and the Middle West, were visited. These plants differ greatly in size and make the principal machine tools, that is, milling machines; drilling, reaming, and honing machines; gear-cutting machines; broaches; grinders; and engine, automatic, and turret lathes. The 15 plants are engaged primarily in machine-tool manufacturing, and so come within the 1939 Census of Manufactures definition of that industry, namely, "establishments primarily engaged in the manufacture of power-driven complete metal-working machines not portable by hand, having one or more tool and work-holding devices, used for progressively removing the metal in the form of chips." This definition is in general accord with that of the United States Bureau of the Budget in its Standard Industrial Classification Manual, and of the War Production Board.

In the industry as a whole the production of lathes (including screw machines) far exceeds that of any other type of machine tool made, being two-fifths of the total 1939 machine-tool output. Next are the drilling machines, comprising about one-fourth of the units made, and after these come grinding and milling machines, which together are but one-fifth of the 1939 production.

Firms making machines "for the shaping, pressing, or forging of metal, where the shaping action of such machines is not dependent upon a cutting tool" are not included in the machine-tool industry. This would be true, for example, of factories making forging or stamping machines, presses, or die-casting machines. Excluded also are the firms whose chief products are machine-tool accessories or attachments, precision measuring tools, or small portable power-driven cutting and shaping tools.

visited, and products and company systems of organization differed,

Equally complete plant figures were not available in all plants so in some cases proportions of workers employed in various occupations are only approximate.

The total number of employees in the plants surveyed, computed from figures available at the time of visit, was approximately 45,000, well over one-fourth of the currently estimated total force of the industry. Though the proportions varied somewhat from plant to plant, about 85 percent of the workers in the 15 plants taken as a whole were in the factory, the remainder in office or sales work. In

the 13 plants reporting employment by department, only about 1 in 4 of those in the factory were in such occupations as shop clerk, janitor, cafeteria worker, trucker, packer, tool-crib attendant, toolroom worker, maintenance worker, laboratory worker, designer, and the like, commonly called "nonproductive." The others had jobs directly connected with the preparation, machining, inspection, or assembling of the product.

Five of the companies manufactured nothing but machine tools; 9 made machine-tool accessories or machinists' tools in addition; and 8, including 7 of those making accessories, manufactured some miscellaneous products not considered within the metal-working-machinery industries. In some plants employees were expected to work on various products, so distinction between workers on the basis of the end products they help to make was not always possible, especially among the nonproductive personnel who ordinarily service the plant as a whole. In none of the 10 companies where other products were made were so many as two-fifths of the employees engaged primarily in other than machine-tool production, and in 4 plants fewer than 5 percent of the workers were employed exclusively on such products. The accessories departments had more workers than the departments making products not in the metal-working-machinery classification. Altogether about 9 percent of the workers were primarily on machinists' tools or machine-tool accessories at the time of visit and not quite 3 percent were on other than machine tools and accessories. The accessories included, among a variety of other things, chucks, collets, jigs, fixtures, broaches, milling-machine cutters, reamers, gear cutters, and measuring tools and instruments. Some companies made these tools or attachments primarily for use on the types of machine tools they manufactured, some for the general trade.

NUMBER AND OCCUPATIONAL DISTRIBUTION OF WOMEN

The machine-tool industry is traditionally a man's industry. Of the nearly 45,000 workers in the 15 plants surveyed, only 3,544, or not quite 8 percent, were women, and almost 3 in 4 of the women were employed in the plant offices. Though all the firms had women in the office, even here women by no means predominated, comprising only about two-fifths of the total office force in all the plants combined. In 3 cases women were less than one-fifth and in only 2 were they more than half those on the office pay roll.

Eight of the 15 plants employed women as factory workers. This was, in most instances, an innovation due to the emergency. At date of survey, the summer of 1942, 2½ percent of all the factory employees in the plants visited were women, and the proportion in the plants where women were working varied from 2 to as much as 8 percent of the factory total. These ratios undoubtedly have increased since the survey, since officials in all the plants employing women factory workers said they were planning to hire more of them and, in addition, 6 of the 7 with no women factory workers on the pay roll at the time of visit were giving serious thought to their employment.

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One company not then employing women in the factory had made a careful analysis of all the jobs on the factory floor and had designated the ones it was thought women could fill; it had let a contract for women's rest-room equipment, and was ready to go ahead with the hiring, pending only the settlement of certain raw-material and machinery shortages. Another had made an occupational analysis and had estimated the numbers that might be hired. Most of them could tell roughly about how high the proportion of women factory workers in the plant might become, should women eventually be taken on, and all were interested in discussing women's employment, indicating in every case that there was at least a possibility that women would be hired in the future.

Factory and office employment of men and women in 15 machine-tool plants

Place of work	All workers		Men—Number	Women		
	Number	Percent of total		Number	Percent of group total	Percent of women's total
Grand total	44,853	100.0	41,309	3,544	7.9	100.0
In factory	38,216	85.2	37,279	937	2.5	26.4
In office [1]	6,637	14.8	4,030	2,607	39.3	73.6

[1] Includes 58 men in sales force, and machine installation and service,.

About four-fifths of the women found in factory work were in productive occupations such as machining, assembling, and inspecting. The others were primarily in shop clerical jobs such as timekeeping, stock chasing, production control, and the like, or were employed, to mention the more numerous, in service work and in the shipping and store rooms, the toolroom, and the tool crib. Three plants had more than 100 women each in production departments, and in one of these the women were more than 7½ percent of the productive employees.

Of the women in factory work, two-fifths were working primarily on machine-tool accessories or small tools and other products, rather than on the machine tools themselves. In fact, though women comprised less than 2 percent of the productive factory workers employed chiefly on machine tools, they constituted nearly 6 percent of the workers on accessories and 12 percent of those on other products. In four of the six plants where there were women working on other products they were half or more of the women factory workers employed. In the other two the women factory workers were engaged chiefly in making machine tools, most of them in such productive work as machining and inspection. It is significant also that two of the eight plants that reported women in factory work made nothing but machine tools, and, what is more, were among the first four companies in the proportion of women to total factory workers employed. The data prove, therefore, that women can be employed in substantial numbers in plants other than where accessories and other products are made. To be sure, differences in the kinds of machine tools they make affect the capacity of machine-tool firms to absorb women in their labor force. Consideration will be given this in the section of the report dealing primarily with occupations.

The foregoing discussion indicates in brief what will be brought out in more detail in a later section, that not only were women not employed to any great extent in the machine-tool industry at the time of the survey, especially in productive work, but where they were employed their occupational distribution showed little uniformity from firm to firm.

The reasons for this situation, besides differences in products and processes, are various. One of the most potent is the strength of tradition in the industry, heretofore a man's world. One personnel director stated, for example, that between the period of World War I and the present war emergency his company had made it a policy not to employ women in clerical jobs within the factory, that is, as department clerks, timekeepers, and the like. No women were permitted on the factory side of the wall, as it were. In fact, the bulk of all clerical jobs in the plants surveyed, whether in factory or office, still tended to be held by men at the time of visit, though this is work for which women have been employed elsewhere as a matter of course. Again, a plant reported specifically that one of the difficulties that had to be met there in connection with the employment of women was resistance from foremen. Where such traditions exist, not only is there the expected opposition on the part of workmen as well as supervisory personnel to efforts to introduce women, but also there are variations in the methods and speed with which the change is made. It is a curious thing that the amount of experience the management has had with women in factory work shows no discernible correlation with the degree to which the scope of women's employment has broadened as a result of the war emergency; three of the firms that have been most progressive in their employment policies in regard to women, opening to them a variety of productive jobs under liberal conditions for the acquisition of skill, had no women on production prior to the spring of 1942.

The adequacy of the male labor supply and the availability of women for factory work vary from area to area, so the different companies have not been affected equally by the generally tight labor market and some have felt less need to hire women. All those visited, however, had experienced a severe shortage of skilled male labor by the summer of 1942, and some were even having difficulty recruiting semiskilled and unskilled men. Many complained of high turn-over among their men, numbers of whom shopped around for other jobs, enlisted, or were drafted. Most believed the supply of woman labor adequate, even abundant. The fact is that when both men and women had to be trained for the job, though the turn-over among men was high, the tendency was to hire men if they could be had.

In some instances expansion in the labor force had occurred very early because of war orders from England, Russia, and France, and also because orders reached machine-tool plants before less basic industries. This gave some firms the opportunity to tap the labor market early for male employees. Some company executives said, for example, that several years ago their firms began taking on and training many young men. However, though these plants have been at an advantage for some time there is no guarantee that their men, still young, will not soon be transferred to the military services. Early in the emergency, when men were comparatively plentiful for the Army, local draft boards were willing to defer workers in machine-tool plants, but

in many cases this is no longer true. A number of the firms visited reported to Women's Bureau agents in the summer of 1942 that many of their men, even skilled workers, were being drafted, and an even larger proportion were expected to be called. Numbers were enlisting. This situation has been one of the chief reasons for employing women. One employment manager stated that the local draft board had urged him to begin hiring women.

In four of the States in which the machine-tool plants of the survey are located, Illinois, Massachusetts, Ohio, and Rhode Island, women's workweek is limited to 48 hours or less except by special permit. New Hampshire, also with a 48-hour law, licenses 54 hours during 8 weeks in any 6-month period, and in addition exempts the manufacture of munitions or supplies for the United States in wartime. One company in each of two States voiced the complaint that this restriction is an inconvenience when women are placed on men's jobs in productive factory work, since the men work longer hours, thereby necessitating two sets of work schedules and special synchronization of men and women with the jobs to be done and the machines available to do them. This complaint was made in response to a question concerning the possibility of extended employment of women. Several other firms visited, however—also in the States that limit women's workweek to 48 hours or less—all employ women in productive jobs. In each case the work schedule provides for a workweek of from 44 to 48 hours for women but from 52½ to 63 hours for men. One of these firms was planning at the time of visit eventually to place women on almost every type of work except where heavy lifting was required. This included the operation of a variety of machine tools. Furthermore, women were to be hired in this firm as replacements for men, and not to expand the labor force. In each of the five States where maximum hours are 48 or less, adult women, at least by special permit, may work at night, thus allowing several shifts.

Before women can be employed, toilet facilities must be provided for them. This can be a very real problem. In at least 5 of the 15 firms visited, plans to hire women were delayed or hindered because of difficulty in securing materials under priorities for the installation of the necessary equipment. One plant had to place a sizable proportion of its women machine-shop workers on the third shift because the office workers' facilities were the only ones women could use pending completion of the factory equipment. The crux of the situation, however, is not that materials cannot be secured at all, but that they are slow in being made available. Plans, therefore, for providing facilities for women must be made as long as possible before women are to be employed, so that the delays experienced will not handicap the organization unduly in its recruitment.

Though for various reasons, some of which have been discussed, certain firms have been more active than others in hiring women for factory work, most agree that the time has come when the woman labor supply must be tapped in earnest. Furthermore, several have expressed great satisfaction with the ability and efficiency of their women workers and their capacity to learn and to produce. These firms are planning to hire many more women. The question remains, then, how extensively can women be employed in the machine-tool industry when its basic production problems and processes are con-

sidered? The following pages will be devoted to a discussion of this general subject.

Department distribution of men and women in 13 machine-tool plants [1]

Department	All workers		Men—Number	Women		
	Number	Percent of total		Number	Percent of department total	Percent of women's total
Grand total	41,233	100.0	37,880	3,353	8.1	100.0
Total factory—productive	26,477	64.2	25,799	678	2.6	20.2
Foundry	1,880	4.6	1,880			
Raw steel; castings receiving and cleaning; painting	606	1.5	606			
Heat treating, blacksmith, forge, sheet metal and welding	718	1.7	706	12	1.7	.4
Inspection	1,777	4.3	1,614	163	9.2	4.9
Machining	13,132	31.8	12,876	256	1.9	7.6
Assembling	6,283	15.2	6,271	12	.2	.4
Supervisors, trainers, n. e. c.	116	.3	116			
Apprentices, n. e. c.	306	.7	275	[2] 31	10.1	.9
Miscellaneous, n. e. c.[3]	1,659	4.0	1,455	204	12.3	6.1
Total factory—nonproductive	8,327	20.2	8,187	140	1.7	4.2
Shop offices	1,124	2.7	1,068	56	5.0	1.7
Receiving, shipping, and finished stores	1,214	2.9	1,192	22	1.8	.7
Powerhouse and equipment and machine maintenance	975	2.4	975			
Service, laborers, truckers	1,845	4.5	1,826	19	1.0	.6
Tool crib (tool supply)	396	1.0	386	10	2.5	.3
Gage inspection, laboratory, metallurgy	18	(4)	17	1	(5)	(4)
Experimental, design, and pattern shop	402	1.0	400	2	.5	.1
Toolroom [6]	1,239	3.0	1,213	26	2.1	.8
Miscellaneous, n. e. c.	1,114	2.7	1,110	4	.4	.1
Total office [7]	6,429	15.6	3,894	2,535	39.4	75.6

[1] Covers all workers, whether engaged primarily in making machine tools, machine-tool accessories, or other products. All workers in 2 additional companies and 45 men in another could not be distributed by department because of lack of detailed data.
[2] In training in apprentice department but not apprentices.
[3] Includes all productive workers primarily on products other than machine tools and machine-tool accessories.
[4] Less than 0.05 percent.
[5] Not computed; base too small.
[6] Productive work may be done in the toolroom.
[7] Includes 58 men in sales force and machine installation and service.

CAPACITY OF THE INDUSTRY TO EMPLOY WOMEN

The machine tool is an intricate mechanism. The tool itself, the instrument that actually cuts into the metal, is one of the smaller parts of the machine, in fact, an accessory to it that may be easily and quickly replaced. There may be a ton or more of frame, ram, gears, racks, and other devices all coordinated to direct the small tool in its course through or against the metal to be worked. Machine tools may range in size from those small enough to mount on a bench and weighing only a hundred pounds to giants that stand as high as a three-story house and weigh several hundred tons.

The lathe was the first machine tool and retains its original principle of operation. It is a turning machine in which the tool remains stationary, the work revolving against it; in this way a cylindrical surface is generated. Drilling or horizontal boring machines and milling machines are the direct descendants of the lathe. The former

cut round holes by means of a rotating cutting tool; the latter primarily produce flat surfaces by means of a rotating tool with multiple cutting edges that take successive layers from the work. For other kinds of flat-surface work there is the shaper, in which the tool moves back and forth over the work, and the planer, in which the work reciprocates beneath the tool. There are many other devices for special purposes, such as slotting machines (really vertical shapers in which the ram carrying the tool moves vertically and thereby may machine flat surfaces at right angles to the main body of the work), broaching machines, gear cutters, thread cutters, automatic screw machines; for a final smooth finish, grinding, honing, and lapping machines.

Each machine may be built for either of two purposes: (1) to perform different operations on miscellaneous pieces or (2) to perform the same operation or operations on quantities of pieces of the same type. The first kind of machine is versatile, flexible, and adjustable. Ordinarily it is operated by a skilled machinist and with it can be constructed other machines, including those of the made-to-order variety. Machines of the second type are specialized. They often have a capacity for multiple tools—groups of drills or cutters working away simultaneously—and may be partly or fully automatic, so that once set up they require an operator only to load and unload and to start and stop them. It is such machines that more often than any others are "one of a kind" and reach gargantuan size. As masters of mass production they frequently present special problems brought to the attention of machine-tool builders' sales engineers who design them in conference with the customer.

Machine-tool factories make both kinds of mechanism, but in so doing use the former type of machine almost to the exclusion of the latter. This is because very seldom even in the present emergency are really large quantities of identical machine tools ordered at a time. There are few firms that specialize in only one kind of machine, the drill press for example, the grinder, the lathe, and so on, and even those that do are prepared to make a variety of sizes and types and frequently must turn out "tailor-made" models such as those already described to fill special orders. One well-known manufacturer, said to be engaged in the "mass production" of milling machines, in 1940 made over 140 varieties of the bed and knee type milling machine, all differing in principal characteristics. Even with the degree of efficiency in manufacture achieved by this plant, milling machines or their components do not leave the assembly line with anything like the speed of a standard make of automobile. The assembly of only one component of the machine, the knee, takes 8 hours.

A single machine tool may have several thousand parts. There are, for instance, over 3,000 parts in a turret lathe. Working three shifts, a turret-lathe manufacturer cannot build a lathe in less than 3 months. The building of some types of machine tools and the larger lathes requires a considerably longer time than that, sometimes 9 months or a year. Though the 1942 output of machine tools was about 308,000 units,[1] or nearly 4⅔ times the output of 1939, this scarcely constitutes mass production when compared with the manufacture

[1] Exclusive of low cost (under $350) units.

in 1939 of over 10,350,000 radio receiving sets, over 2,800,000 passenger cars, and nearly 1,800,000 electric refrigerators. It is clear that no degree of plant expansion, installation of new equipment, multiple-shift operation, subcontracting, or dilution of labor and breakdown of job operations can speed machine-tool building beyond a certain point.

This being the case, machine-tool manufacturers asserted, the lots of parts running through a machine at a given time tend to be smaller on the average in the machine-tool industry than in many others, especially industries engaged in mass production, and obviously this necessitates frequent set-up of the machine, usually done by the operator, and requires a degree of skill said to be unobtainable in inexperienced recruits. Company officials said also that many of the parts to be made must be machined to very close tolerances, some of them so accurately that a leeway of only a few ten-thousandths of an inch from the exact dimensions specified is permitted. Some commented that the parts that must be handled on any one machine may vary greatly in size and weight, thus requiring a muscularly strong person.

Objections to the hiring of women were raised with regard not only to machine operation but to other jobs also. For the most part they were based on the one hand on the extraordinary skill or technical knowledge required to do the work, and on the other on the degree of physical strength or endurance necessary. Experience of other industries has shown that neither of these factors, within limits, bars employment of women. It must be pointed out also that though the machine-tool industry is not in mass production it has been forced to make certain adjustments to its recent and rapid expansion that follow the pattern of mass-production techniques and thus allow at this time the extensive employment of semiskilled labor.

In recent years large numbers of inexperienced men have been trained in the industry within very short periods, and it has been estimated that most of the men making machine tools in January 1942 had never seen the inside of a machine-tool plant 2 years before that date. In many cases the regular 3- to 4-year apprenticeship course for training all-round machinists has been practically discontinued in favor of an 18-months learnership program or a few months or even weeks of instruction on one specific machine to be operated or job to be done. By 1941 the industry had trained thousands of new men, in from 6 weeks to 4 months, to operate even the more difficult machines such as boring mills and turret lathes. Training of this kind has been intensified and has already proved in many places the feasibility in the industry of breaking down an all-round machinist's skill into its component parts. In one plant this technique yielded enough skilled men to start a third shift, thereby doubling production within 3 months' time.

This happened in an important company of Cleveland, where a learnership program lasting 2 to 5 months for each student has been in operation since 1935. Only men with technical-high-school training or a knowledge of blueprint reading and simple measuring tools were accepted. Soon, however, not even the meager background required of these learners could be counted on, and the rank and file of absolutely untrained individuals were taken in a newly organized vestibule training school, designed to give in 6 weeks general background and specialized instruction on one machine or one job. After

6 weeks the pupils in the vestibule school enter the learner course to receive advanced training that will make them skilled machine operators. In most places there is no class instruction, but all trainees learn directly on the job under the tutelage of an experienced worker. They stand beside veteran employees, watching them closely. Soon they are allowed to operate the simpler controls and then the entire mechanism, thereby advancing to the status of semiskilled operators. Within 60 to 90 days learners can be put on their own.

Women as well as men have been successfully introduced into such short-term training programs and have proved to be apt pupils. The data show that when processes are broken down sufficiently to admit on-the-job training and dilution of skill, there is no doubt of women's capacity to participate in machine-tool manufacture. The fact that larger quantities of parts are now going through machine-tool plants makes subdivision of work more practicable than ever before and allows the use of set-up men in many places, leaving the more routine work of machine operation to others. With larger lots, runs tend to be longer, so some of the machine tools used can be set up for repetitive operations for which men or women are quickly trained.

In some plants good tooling has replaced individual skill. In one case the inside chasing of threads was eliminated by standardizing the thread and size of hole and then buying four or five expensive taps by which the job could be done with much less skilled attention; in addition, automatic sizing equipment was put on lathes in the machine shop so that some operations involving fine-finish turning can be given virtually unskilled employees to do. The same plant reduced the number of models made to the extent that some were being scheduled in lots of over a thousand. This enabled still further subdivision of operations and still more job simplification; it justified retooling many jobs with improved jigs and fixtures for quantity operation. It meant, in fact, that new workers coming in could be taught one operation and kept on that operation continuously. Though an official of this company has stated that work simplification is something that can be undertaken in almost any plant, regardless of size, this doubtless cannot be accomplished to the same degree in all places. It has not been carried out to any appreciable extent in most of the machine-tool plants visited.

Whether or not work simplification has been undertaken in an endeavor to dilute skills, it is well known that the machine tool itself as it is made today is a well-designed instrument presenting the maximum of aid to the operator. As one executive has said, "Owing to development and design, the machine tool now does the physical work which formerly was done by the operator. The machine tool has within itself the precision and the power needed to get the job done. All that the operator has to do is to have the intelligence and the dexterity to operate the machine. * * * It seems natural that girls should be able to learn this craftsmanship just as well and as rapidly as boys, and so make good machine operators." In another machine-tool plant the executives in remarking that modern machine tools are either fully or partly automatic, said, "After a little practice any dependable man with common sense and the ability to learn should be able to acquire skill." Operating practices have been so standardized, in fact, that within a limited range the correct speed and feed for taking each cut is known. Enclosed and self-contained electrical

equipment is common and operated with push-button controls. Machines generally are equipped also with internal and self-lubrication.

Though inexperienced women can learn to do part, and in some places a considerable part, of the work in a machine-tool plant, a serious draw-back to their employment is the great size and weight of many of the pieces and the fact that large and small pieces may follow one another in the production process. This is not so serious, of course, where handling devices are provided. Further, men are no more capable than women of handling many of the major parts without the use of cranes, chain hoists, or other mechanical lifting devices and these very generally are part of the regular equipment in large modern machine shops. Women have been seen using lifting devices in connection with machining operations and operating both their hoists and their machines with no apparent difficulty. As a matter of fact, it appears that women can be employed more successfully on very heavy work when power chucks, lifting mechanisms, and other aids are provided than on parts that are beyond the lifting ability of the average woman but not that of the average man.

There are many instances in which the work, even with the use of handling devices, requires more strength and endurance than the average woman commands. In assembly operations, where this is very often the case, two of the firms visited had segregated the lighter from the heavier work and were employing a good many women on unit-assembly operations, and another was actively making plans for such a scheme. Rearrangement of work so that the lighter parts in machining departments can be handled separately from the larger and heavier ones appears possible also in sections where a number of machines of the same type are used. In fact, one official who was consulted about this said it could be done in his plant and probably would be done if women were hired. The rearrangement, however, would require reorganization of the prevailing scheme of manufacture, since all the pieces for one assembly are kept together and machined on the same machine. In his opinion the break-down of operations so that all the small parts for different assemblies could be handled on certain machines would decrease the efficiency of plant operation, in that more movemen and stock chasers would be necessary. In other plants the flow of production, not being arranged exactly in this fashion, allows more conveniently for the suggested division of work. In one of the firms visited the smaller tools in two machining departments were already separated from the medium and large, the lighter work being at one end of the room and the heavier at the other. The smaller parts were being routed separately in these two departments, yet no women were employed there nor was their employment anticipated, though the company had already begun to hire women operatives in other parts of the plant.

The weight of the work has nothing to do with the precision required of the worker. It should not be underemphasized here that in machine-tool manufacture a great many operations that command special skill and accuracy remain even where process simplification and dilution have been accomplished. Inexperienced men and women cannot be expected at the beginning to perform such operations, many of which need seasoned judgment as well as the skill that comes from aptitude tempered with experience. Yet, though they have been in

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the industry a relatively short time, women already are doing accurate work on jobs requiring, for example, machining to a tolerance of .0002″, or a fifteenth part of the diameter of a hair. It was said more than once that women had been found unusually conscientious about following instructions exactly. Further, where small lots are common some women already are learning the setting up of their own machines, generally considered skilled work. This was true in six of the eight plants visited in which women were on productive work. One of these, in fact, has no special set-up men, since women are expected to set up all the machines they operate.

Great Britain has been at war nearly 4 years and consequently is now suffering a much greater scarcity of manpower than is the United States. This is reflected in her machine-tool industry, in which the proportion of women to men very materially exceeds this country's and the jobs women are doing are much broader in scope. To be sure, most persons in the industry here would agree that in case of real need women could and would be employed in occupations no one now even dreams of suggesting. In this report the types of work proposed as feasible for women are those in which women can be employed conveniently and easily now. Consideration is given to the jobs women are already doing in the industry here and in Great Britain, to the work suggested by plant officials as suitable for women, and to their jobs and the types of machine tools women are operating in other industries.

OCCUPATIONS: CURRENT EMPLOYMENT OF WOMEN AND FUTURE POSSIBILITIES

Methods of production and systems of departmental organization differ in details within the industry, but in general the types of work are very similar throughout. Therefore the departments and occupations within each as they might be found in a "typical" plant make the framework of this discussion. It is recognized that no one company may have all the divisions outlined.

Work with raw stock: Foundry work, castings cleaning, forging, bar-stock storing and cut-off.

The kinds of raw iron and steel stock used in making machine tools are chiefly castings, forgings, and steel bars. The major components for the machines, such as beds, headstocks, and tailstocks, are made from castings prepared usually in outside foundries. Two of the firms visited, however, had foundries as integral parts of their operations. No women were employed in them, though women have been engaged in foundry work as core makers for many years. Cores weighing up to hundreds of pounds may be made by women if mechanical aids are provided, though in this country women are for the most part still making only the lighter cores.

The castings must be cleaned before they begin their trip through the machining departments. Some work of this kind was being done in each of the plants visited, though in a few cases most of it was completed in outside foundries before castings were delivered. The work generally requires a considerable amount of physical strength, since it involves the use of heavy hammers and chisels and portable

grinders and polishing equipment. Sandblasting equipment also may be used. No women were employed in the castings-cleaning departments, sometimes called snagging and chipping departments, nor were they being considered in future hiring plans. Though women are doing this work in Great Britain, it does not appear to be suitable for women here as it is now arranged. Further, since the total number of workers involved is relatively small, this is one of the last places women's employment might be recommended.

Forgings are used for parts that require great strength, such as shafts, levers, and gears. Some of the plants had small forge departments, but, as in the case of castings, at the time of visit most were buying their forgings. In any case, not only were few workers employed in machine-tool forging, but it did not appear likely that any significant number of women could be successfully inducted to the work.

Small parts such as spindles and small gears usually are made from steel bar stock. Bars of various lengths and diameters are stored in steel-stock rooms and, as needed, pieces are cut off with such equipment as power hacksaws, cold saws, and abrasive cut-off machines. No women were employed in this work. It is not highly skilled but involves the handling of heavy bars as they are received, storing them in some orderly system of arrangement, and, in addition, loading, unloading, and operating the cut-off equipment. Women could do some of the work on small light bar stock and even on the heavier stock if handling devices were provided. As the work was organized at the time of visit in the plants surveyed, however, most of it would be too heavy for women.

There are several departments in machine-tool production besides those just mentioned and the three major ones to be considered later i. e., machining, assembly, and inspection. They come in at different stages in the manufacturing process but will be discussed here without regard to logical order.

Painting.

Spray painting is the more common technique used in painting castings and finishing the completed machines, though some hand painting also was seen. All the work was done by men, though women could be employed to do some of it where the proper exhausts were provided for protection from paint and fumes. To be sure, the total number of men that could be released would be relatively small.

Sheet-metal work.

Sheet-metal departments were noted in some plants where guards and enclosures to cover moving parts and to keep dust and dirt from machinery were being made. Power shears, nibblers, bending machines, and the like were being used. Most of the work appeared to be too heavy for women, since the pieces of metal to be handled were large and of heavy gage. No women were employed, but women could handle small power presses and power shafts on the lighter types of work.

Welding.

Small groups of male welders were occasionally noted doing oxy-acetylene or electric arc welding work that women were known to be doing successfully in other industries.

Heat treating.

Heat treating is an essential process in machine-tool manufacture and was part of the plant operations in every firm visited. Various methods of heat treating, including hardening and annealing and tempering, carburizing, and case hardening, are used on different parts for different purposes. Heat treatment may be employed to relieve stresses and strains in forgings, to harden gears so they will stand up under strain and wear, and to produce wear-resistant surfaces on cutting tools. In all but one of the plants visited heat-treating work, whether on parts for machine tools or on cutters and other machine-tool accessories, was being done in one department. One plant had a separate heat-treating unit for its small tools.

Opportunities for women in heat-treating departments as they are now managed are limited; very few women were employed in them at time of survey and those employed were not engaged in actual heat-treat work, but in hardness testing. First, much of the work requires considerable background and experience and consequently cannot be handled by inexperienced recruits. Second, in some plants a great deal of heavy work is involved in the loading and unloading of furnaces and in plunging the heated pieces of metal into quenching tanks. And finally, some employers considered the work connected with heat treating unsuitable for women because the working conditions involve exposure to intense heat, possible burns, and chemical fumes. Adequate protection is of course required for both sexes under such conditions. An increase in the amount of handling equipment and the installation of automatic feeds for furnaces would make possible the introduction of women to the work in many places. In fact, at least one official stated that women could be employed immediately to work on the simpler heat-treating operations on small pieces of metal.

Rockwell and Brinell hardness testing is commonly done in heat-treating departments. One of the plants visited employed a few women for this work in which the use of gages also was involved. Women can do this type of inspection in other machine-tool plants also when, with or without mechanical handling devices, it is within their handling capacity.[2]

In one plant it was said that women might be employed on the straightening of light tools of the bar type. This involves placing under presses tools that are hot after passing through a heat-treating process. Women are heating and straightening small drills in the machine-tool-accessory industry, and consequently could do similar work on somewhat larger types of tools. One firm has solved the problem of the danger from hot metal pieces breaking on the application of pressure by providing a metal guard with a safety-glass window through which the operator watches her work.

MACHINING

Only 12 percent of all productive workers and less than 2 percent of the women on production in the machine-tool plants visited[3] were in the departments just discussed. Machining, on the other hand,

[2] See p. 40 for a discussion of weight lifting.
[3] Proportions based on data available in 13 of the 15 plants.

employs more personnel than any other division of work, using half of all the men and nearly two-fifths of all the women in production departments. Most of the employees in machining units are operating machine tools, though workers who burr and file, and foremen, supervisors, and general laborers, also are included in the totals.

Two plans of organization were encountered:

(1) Most common was the departmental system, in which machine tools of one kind, such as milling machines, turret lathes, or drills, were grouped together and parts were routed accordingly. Under this system, within each separate machine-tool department is one kind of machine in various sizes and makes, sometimes with a few machine tools for supplementary operations that differ from the predominating type.

The way in which such an arrangement operates may be illustrated by a description of the departments through which several components of a lathe pass in a firm making engine lathes and organized along these lines. The lathe-bed castings, after being cleaned and painted, are sent to the planers. Immediately following planing, they are subjected to heat treating and then move to a group of large bed-grinders. Finish planing comes next and then the drilling operation, which allows attachment of the legs of the machine to the bed. The bed moves on finally to the assembly department, where it meets other completed parts. Headstocks go through milling first, then drilling and boring-mill operations, after preliminary cleaning and painting as rough castings. From the boring mills they proceed to assembly. Tailstocks follow the same sequence, from painting to milling machine and drill departments, but from this point they are directed to machines where top and bottom sections are scraped to give a tight fit. A tailstock boring mill here takes care of the last machining operation prior to sending on the finished tailstocks to storage. Forgings to be made into gears are machined first on turret lathes, then gear cutters and drills (when gears are to have oil holes). They pass next through heat treating, and then go to internal grinders, a bushing operation, internal grinders again, gear-tooth grinders, and finally stock storage.

(2) In contrast with this routing of parts to the various operations, some of the plants visited were organized on a unit system of operation in which wherever possible all the machining equipment necessary for the manufacture of a unit of a machine is grouped in one department. Some drilling, grinding, milling departments may be maintained for the manufacture of small pieces, but the major components, such as spindles, gears, shafts, columns, knees, and saddles, for the most part are made complete each in its separate place.

In one milling-machine factory the knee department covered more than 40 separate operations on the knee casting, which arrived there directly from the cleaning and priming department. Included in the knee department were two types of planers, three types of milling machines, radial drills, and three types of boring bars. Another component, the column, underwent 37 separate operations, 24 of which were performed directly in the column department by the use of 7 different types of machine tools. These included medium and large planers, boring bars, Kearney & Tracker special duplex and multiple bars, horizontal knee-type milling machines, and radial drills.

For purposes of this report it seems best to discuss the machines women operate or can operate without regard to a particular system of plant organization. For this reason each major variety of machine tool is considered separately and without reference to plant process except as this affects the employment of women.

Lathe operation.

Lathes (including screw machines), drilling, grinding, and milling machines, in that order, were the tools used in largest numbers in the plants visited.

Engine lathes.—Lathes are the most versatile of all machine tools. This explains why so many more of them are made and used. In addition to ordinary turning operations, they can drill, bore, ream, and tap straight or tapered holes, file, polish, lap, or wind springs and electrical coils. With the use of adapters and attachments they can perform milling and grinding operations also. The ordinary engine lathe is made in a number of modified forms, such as turret lathes, automatic lathes, and single-spindle automatic screw machines. The two last mentioned are used extensively for the rapid production of duplicate parts.

For years women have been operating engine lathes in many industries. Less than half the machine-tool plants surveyed, however, were employing women on engine lathes at time of visit, and some of these employed women on lathes only in the fabrication of products other than the machine tool. Where women were operating engine lathes in the production of machine tools they were on such models as the LeBlond Regal and the Monarch model W. Some had been employed only 2 or 3 weeks at time of visit, yet they were learning to read blueprints and to do simple set-ups. Lots ranged from 100 to 1,000 pieces and required the greater part of a day for completion. Women on the Monarch model W lathes were performing turning operations on small rods and gear blanks. One woman was using a Monarch to cut lead screw threads.

Most of the women operating lathes in accessories or other departments were using only small bench lathes. Several women in one company, however, were operating specially constructed South Bend engine lathes of fairly large size with which they were cutting the teeth on broaches. They were required to read blueprints and mark out their own work. Each type of cutter on which the women were engaged had a different pitch of teeth, so they had to be able to mark out numerous kinds of work.

Though the employment of women on engine lathes was not general, in practically every firm visited the men interviewed agreed that there were lathe operations in their plant to which women could be successfully introduced. One company, not then employing women for lathe work on machine tools, had employed a number during the First World War, many of whom learned to do their own setting up. Officials in another company, where women were soon to be placed on production for the first time, were planning to introduce them from the beginning to the small engine lathes, such as the Hendey 4Cx54 inches and Hendey Head lathe. The women will work on small parts, and though men will do the set-up in the beginning, the plan is gradually to teach the women to take this over. Various ad-

ditional types of lathe suitable for operation by women were seen in the plants visited. These include among others,

Pratt & Whitney engine lathes 16 x 60 inches and 16 x 54 inches.
American engine lathe 16 x 60 inches.
American Pacemaker lathe.
Sidney engine lathe with 18-inch swing.
Reed-Prentice engine lathes (in small sizes).

Turret lathes.—Much of the work done on turret lathes in the plants surveyed is heavy, so opportunities for women operators on these machines appear to be limited. At time of visit only one woman in all 15 plants was actually operating a turret lathe. This machine was a Jones & Lamson of small size.

Four other firms, however, had made plans to employ women on turret-lathe work. In one of these women would be expected to operate the smaller Jones & Lamson machine and the Potter & Johnston chucking lathe, and automatic chucking machines. Another company was planning to have women operate Warner & Swasey ram-type machines. Two others expected to hire women to work on some of the Warner & Swasey saddle-type models, after introduction of air chucks or handling equipment.

Where the work is heavy and handling equipment is not available, rearrangement of the parts to be machined is often possible, the lighter being routed to machines to be manned by women. Such a plan was thought feasible in two plants in which several of the smaller Gisholt, Jones & Lamson, and Warner & Swasey turret lathes were seen. Special set-up men would have to be employed at first, however, since runs are short.

A number of the men interviewed agreed generally that the ram type of machine is suitable for women machine operators. This kind of turret lathe is designed for smaller work and has a shorter stroke than the larger saddle type of machine. It is easier to operate also, since the turret is more easily moved on the ram than on the saddle. But though the saddle type of machine is larger and somewhat more difficult to operate, women could do the work on some of the models with the use of power chucks to avoid the necessity for exerting great physical strength in tightening the pieces, and with the aid of hoists and handling equipment to move and lift the parts to be machined.

In Great Britain women are successfully operating turret lathes adapted for chucking and bar operations even when processes are varied and runs are short. It is significant further that women operated turret lathes in World War I in at least two of the firms visited, yet no women were employed on such machines by these companies at the time of the 1942 survey.

Hand screw machines and automatics.—No women were employed on screw machines in the machine-tool plants visited, though hand screw machines, closely related to turret lathes, and small automatic screw machines have been operated by women in other industries for some time, particularly on quantity production of identical screws or other small parts.

The setting up of automatic machines is really the most difficult part of their operation. After the set-up has been made, such machines are, as the name implies, largely automatic. Inexperienced workers are less easily broken in on machines of this type unless the runs are long enough to make it feasible to employ a set-up man who

can be assigned to the care of several machines, the operator being left only with the job of loading, unloading, and watching the machine. Many of the automatics seen in the plants visited, moreover, were very large, and the bar stock used was large and heavy. These considerations, and the fact that in machine-tool work the set-up is often quite complicated, preclude the employment of women on the larger machines and of inexperienced women on some of the smaller ones.

Nevertheless, several of the plants visited had small machines of the hand and automatic types which women could operate under the conditions then observed, and in two the employment of women was contemplated. In one of the latter, women were to be hired to operate a small hand screw machine used for turning, forming, centering, drilling, reaming, and tapping. In the other, women will be employed on small automatics. A production supervisor in a plant not planning to employ women on screw machines made the statement that women could be trained to do their own set-up on small automatics and that the hiring of women on such machines was limited largely by the size of the bar stock that must be handled.

Milling operations.

Milling, the machining of metal by bringing it into contact with a multiple-edged rotating cutter, includes the hobbing, cutting, and finishing of gears and the milling of threads. Under this definition are included both general-purpose milling machines on which various kinds of work can be done and those restricted to the performance of specific operations, such as gear cutting. Machines used in thread milling or in keyway, cam, or clutch milling were seen frequently in milling or gear-cutting departments.

Milling machines vary considerably in size as well as type. There are small hand millers, different sizes of automatic machines, horizontal and vertical machines and, finally, huge planer-type milling machines used for work on very large parts. In the plants visited, the planer-type machines usually were grouped with such machines as ordinary planers, great boring mills, vertical turret lathes, and radial drills, employed on the heaviest types of work.

It is agreed generally that women can operate easily hand milling machines and the small- and medium-size power mills. A recent survey by the Women's Bureau [4] of the employment of women in the manufacture of small arms found more women working on milling machines than on any other one type of machine. In Canadian small-arms firms visited in an earlier survey as many as 60 percent of the milling-machine operators were women and this proportion was to be increased. The United States small-arms plant surveyed that employed the largest proportion of women in factory work had no men on hand mills, small milling machines, and medium-size mills, except in the case of a very few operations on large parts too heavy for women to handle. The manufacture of arms, however, is a mass-production industry.

Few women were operating milling machines in the 15 machine-tool plants surveyed. Some were on such machines in each of 6 plants, and in at least 2 of these plants the proportion was expected to

[4] Women's Bureau Bul. 192–3, Employment of Women in the Manufacture of Cannon and Small Arms in 1942. 1943.

increase. In some cases many of the machines used and the operations performed were suitable for women but the employment of women was not then anticipated.

For example, the cutter-manufacturing department of one plant had men on Brown & Sharpe machines of the Nos. 2 and .000 types that women are known to be operating successfully elsewhere. The work to be done was not too heavy nor too highly skilled. In another plant the smaller steel parts and castings were being milled by men on, among others, Brown & Sharpe Nos. 1 and 2 machines and a United States hand miller, all operated easily by women. The men on these machines do their own set-up. About 75 percent of the work in this all-male department probably could be done by women if they were taught the set-up work. An earlier study made by the Women's Bureau shows that Canadian women milling antiaircraft-gun parts set up their own machines.

In another machine-tool plant visited in the 1942 survey, a proportion of the work in the milling of collets could be done by women. Some operators on milling machines were young boys who had had but 1 year of experience. Still another company had employed women to operate milling machines in the earlier war. At time of survey many of the machines in its milling department were of medium size and it was said that women would be hired again if the labor situation warranted.

These are but examples chosen at random. They show that many more women could operate milling machines in the machine-tool industry. Some plants without women on such machines at time of survey had made plans to hire them. One already using some women on milling machines expected to employ women for Jones & Lamson cam milling machines and small Nichols & Kempsmith hand mills. The work would involve die manufacturing rather than milling on machine-tool parts. Another company, one that had made a job analysis, planned to employ women to do face, slab, straddle, slot, and keyway milling on both vertical and horizontal milling machines.

In a number of plants much of the work to be done on milling machines was heavy, involving the handling of heavy castings and parts. A good deal of the work was beyond the strength of men also, and chain hoists were being used. Women would be handicapped further where considerable force is necessary in the use of wrenches, mallets, and other tools for tightening and releasing work on the machines. It is very important that work be secured so that it will not be sprung in clamping and will be correctly alined. Some persons interviewed suggested, nevertheless, that women might operate rather large milling machines (of the No. 4 size Cincinnati type, for example) if good handling equipment were provided and if power chucks were placed on the machines, thus making it easy for women to load and unload the work.

This has not been suggested in the case of the huge planer type of milling machine. It is interesting, however, that the March 1942 issue of the *Engineering Bulletin* published by the British Ministry of Labor and National Service pictures a British woman working on a multiple-type planer-miller with which she is milling the bed of a thread-milling machine. Doubtless this woman had mechanical and other assistance in placing this large casting on the machine, but the

picture indicates that it is not impossible to employ women on milling work even of this very heavy type.

Among women milling-machine operators in the machine-tool plants visited were some on Kent-Owens and Nichols hand mills. They had been on this work only 2 weeks at time of survey, yet they were already setting up some jobs. The number of pieces per lot varied a great deal. Some might be large enough to allow the same set-up to be kept for as long as 2 days, but other numbers were small. The women's supervisor said he was well satisfied with their work. They were employed to perform milling operations on a great variety of bolts, nuts, rods, and other small parts. One of the women had worked on five different jobs, ranging from 1 to 1,000 pieces per lot, on the day before the field agent's visit. This woman had received 158 hours of training in a defense course prior to employment.

Other women were milling gears and shafts. The employment of women on milling machines in the department where they were working was limited only by the weight of the gears and shafts women could handle. The gears weighed from 1 to 110 pounds and some of the shafts weighed 60 to 70 pounds as forgings.

A few women here and there were seen operating some of the more specialized types of milling machines. A woman was doing keyway milling on a Taylor & Fenn spline-milling machine in one plant, and in two others women were operating Lees-Bradner and Pratt & Whitney thread-milling machines. Foremen and production men in several other places agreed that women could be employed in their plants on work of this kind.

Among still other milling machines women were operating in the plants visited were—

Cincinnati milling machine Nos. 0–8, 1–12, 2.
Milwaukee milling machine Model H.
Brown & Sharpe milling machine Nos. .0, .000, 2.

Gear cutting.

Frequently there is a special department for gear-cutting operations in machine-tool plants. Gear shapers and gear hobbers were the machines most commonly seen in such departments, though gear grinders, gear finishers, and some miscellaneous machines of other kinds often were segregated there also.

Though only two plants were employing women to operate gear cutters at the time of visit, several others were expecting to put women on this kind of work. In fact, one company was considering filling most of the jobs in the gear-cutting department with women. Set-up men would be employed, but each woman would be expected to tend a number of machines. The machines it was planned they would operate included gear cutters or shapers made by Brown & Sharpe, Fellows, Barber-Colman, Cincinnati Milling, and Newark. According to the analysis of a supervisor in another plant, if women were employed they could operate, among several others, the Fellows gear shaper No. 7 and the Gleason bevel gear rougher No. 12. In still another place the Barber-Colman Model S bench-type hobbing machine was soon to be operated by women. The women would not do the set-up work. There were several other companies with gear-cutting work on which women could be employed; ordinarily, however, set-up men would be considered necessary.

It is interesting in this connection that in one of the two plants visited where women were employed on gear cutters, each woman, in addition to operating two to five machines, did her own set-up work. This firm planned to hire more women for gear cutting. Those employed at the time were operating Fellows gear shapers of the 6A type and, in addition, several gear shavers of sizes 12 to 18 inches.

Gear-cutting work was limited, of course, in firms where the machines manufactured were hydraulic rather than mechanical in operation. In fact, hydraulic machines have fewer small parts than others have, thereby placing certain general limitations on the employment of women.

Grinding.

Much shaping of metal parts is done by bringing them in contact with rotating abrasive wheels mounted on various types of grinding machines. There are several grinding techniques. Grinding a hole involves internal grinding; shaping the outside of a rotating piece, external cylindrical grinding; and finishing a flat surface, surface grinding. The grinding process also includes polishing, buffing, and lapping operations that are performed by means of specially dressed rotating wheels.

Numerous types and sizes of internal, external cylindrical, and surface grinders were being used in the machine-tool plants visited. In addition, there were many specialized types of grinding machines such as disk grinders, thread grinders, and gear grinders, as well as a variety of tool and cutter grinders and sharpening machines for grinding and sharpening drills, milling cutters, reamers, and other tools.

Rough-grinding operations may be done on certain machine-tool parts during the early or intermediate stages of manufacture, but a great deal of grinding is done as a finishing operation. Finishing is precision work that must be done to very close tolerances. Ineptness in such work may cause great waste of material, time, and effort. Nevertheless, in the plants visited women were employed to a greater extent in grinding operations than in any other kind of machining. In addition to various lapping and polishing devices, some typical grinding machines women were using include:

Arter rotary surface grinder.
Brown & Sharpe external grinder No. 5.
Brown & Sharpe surface grinder No. 2.
Cincinnati cutter and tool grinder No. 2.
Ex-Cell-O thread grinder.
Heald rotary surface grinder No. 22.
Norton cylindrical grinders 10 x 36 inches and 10 x 48 inches.
Norton surface grinder 10 x 60 inches.

In one plant more than 30 women were grinding involute cutters and gears. They operated two machines each on both dry and wet grinding, performed their own set-ups, and dressed their wheels. The work done by women on the day shift was performed by men at night. It had taken the women about 2 months on the job to learn the set-up work. The same firm employed a woman to grind tapers on shanks with a Brown & Sharpe No. 5 external grinder. She was doing her own set-up and was allowed practically no tolerance, according to the plant official interviewed. In another plant several women who were form grinding also set up their own

work. Each new set-up had at least to be checked for every tool ground and the tolerance allowed was but .0002 inch. Women doing wet grinding on machine-tool parts by means of small Arter rotary surface grinders were performing their own set-up work also. In another company women on Norton 10 x 60-inch surface grinders were at first allowed a tolerance of .0005 inch, but later were upgraded to more difficult work on which they were permitted only .0002 inch leeway. One of them, employed only 10 weeks at time of survey, was already performing a complicated set-up involving compound angles and requiring the use of sine bars and Jo blocks.

Other women were doing various types of internal, face, and form grinding on small cylindrical, internal, or surface grinders and on tool-sharpening machines, while a few were performing lapping, polishing, and buffing operations.

In addition to the work they were already doing and the jobs soon to be opened to them women could take over a great many more of the grinding operations performed in the machine-tool plants visited. There was much tool- and cutter-grinding and grinding on small parts to be done with the use of such machines as small Rivett internal grinders, Landis external grinders, Brown & Sharpe external grinders, small Thompson and Heald machines, and the like, work of the sort that women were doing already in some of the plants. One firm was employing men on a Brown & Sharpe No. 5 plain grinder, a machine specially built for women to operate while seated. Additional opportunities for the employment of women on the lighter work appeared so numerous, in fact, that it hardly seems worth while to note also that some heavier kinds of jobs being done in the plants surveyed are not beyond women's capacity to perform. For example, in one firm where many small parts were ground at once on large Blanchard grinders, the work can be done by women. In another, large surface, external, and internal grinders could be operated by women with the installation of certain handling equipment. Some types of precision work, however, would have to wait till women had experience and were ready for upgrading. It is of interest in this connection that women are already doing such heavy and skilled work as surface grinding on turret-lathe saddles in Great Britain. One woman on such a job is pictured in a recent issue of the *Engineering Bulletin*. Her work requires absolute parallelism, the limit of error being .0005 inch. The application of cut must be delicate so that distortion due to increased temperature is avoided.

Grinding is an extremely hazardous occupation unless precautions are taken to protect the operator from the dust that is generated or from other flying particles. The hoods now generally provided, especially on the newer machines, help to prevent injury from pieces flying out or from possible breakage of the wheel. Danger from the metallic dust is prevented by wet grinding, in which the cutting takes place under a stream of water or oil. Some but not all of the grinding in machine-tool plants is done by the wet process. Where there is dry grinding, adequate exhaust systems should be provided. Satisfactory standards for such systems have been set up in various State codes. Those of Ohio and Illinois affect a considerable proportion of the machine-tool firms.[5]

[5] *See also American* Engineering Standards, *Safety Code for the Use, Care and Protection of Abrasive Wheels.* Approved by the American Standards Association. New York, 1935, 36 pp.

Until recently the employment of women on dry grinding has been prohibited in Ohio except for occasional tool grinding. Since the law forbids the hiring of women to operate, specifically, emery and corundum wheels and belts coated with emery or corundum, it has been ruled, in the interest of the war effort, that women may now be employed on aloxite, carborundum, alundum, or any type of wheel other than emery or corundum. This modified interpretation of the law, however, does not permit hiring women to do snagging or heavy grinding, or grinding operations requiring constant standing. The operation of buffing or polishing wheels is still forbidden. Actually, investigation by the Women's Bureau of occupations suitable for women in war production reveals that in plants with good dust-collection methods and other adequate protection the occupations of grinding, polishing, and buffing are among the most desirable jobs for women.[6]

Drilling.

Drilling and other types of boring operations such as reaming, tapping, countersinking, and counterboring on single- and multiple-spindle drill presses are occupations women commonly have held in industry.

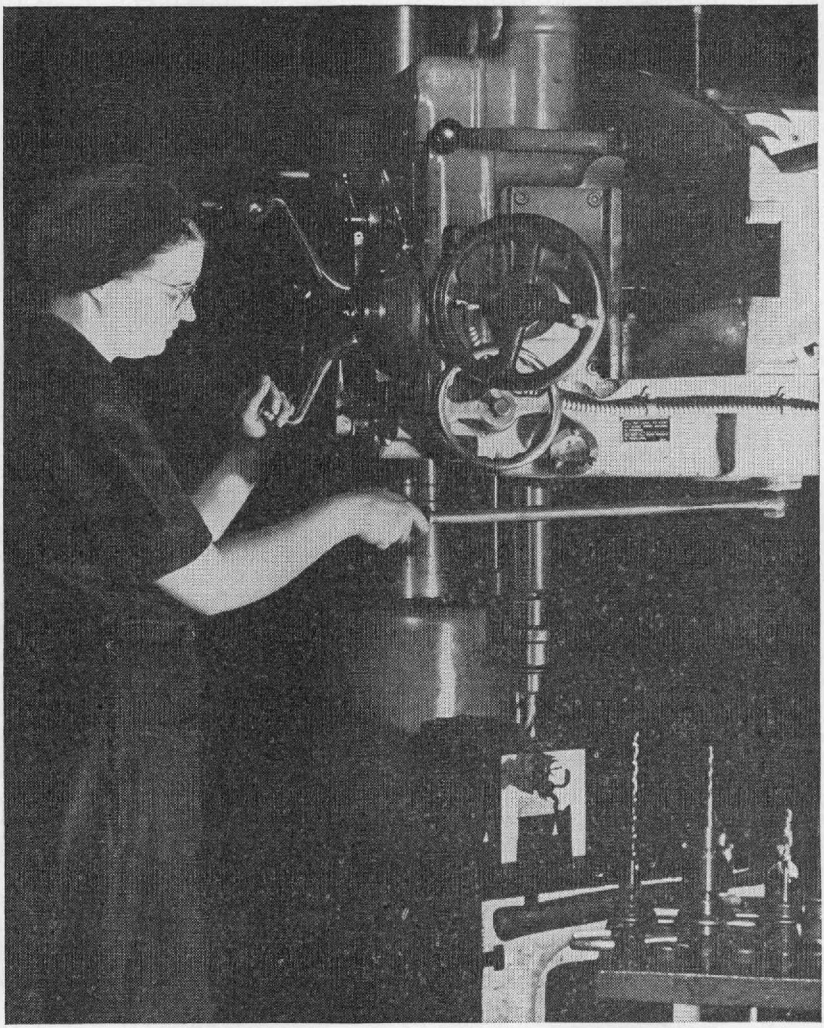
Though many of the drills in machine-tool plants are large machines principally of the radial type, there are numerous drills of other kinds that women could operate before it would be necessary to hire them for the larger radial drills. Some women were operating single- and multiple-spindle drill presses in six of the eight plants where women were on productive work. More women could have been employed on drill presses in these plants. Four companies with no women on drilling operations were planning to hire them. In one of these women were to operate multiple-spindle drills and would be trained gradually to set up the machines and sharpen the cutting tools. In another, they were to be hired for drilling operations, including jig drilling and counterboring on an upright Prentice drill and for light work on sensitive drill presses at which they might be seated. On the machines last named women were to perform jig drilling or their work would be laid out for them. The same company was planning to employ some women for lay-out work also. This work involves a knowledge of mathematics, the reading of blueprints, and the use of scribers, dividers, squares, surface gages, and the like.

In addition, examples were noted of drill work altogether suitable for women in plants where women were not then employed in such work or no plans had been made for the introduction of women. One firm had a department in which small and large parts were being routed separately to drill presses allocated by size on the factory floor. There were small and medium-size drills in this department that women could have operated easily. Another firm had a division set aside for work on the smaller parts and castings in which drill presses that women could operate were located. All the machine workers in the department did their own set-up, work for which women could be trained. Still another plant had multiple-

[6] Women's Bureau Special Bul. 7, Hazards to Women Employed in War Plants on Abrasive-Wheel Jobs. 1942.

spindle drills on which a considerable amount of small work was being done, such as the drilling and counterboring of taper screws. Much of the work was jig drilling and some of the lots consisted of several hundred pieces.

It is evident that the employment of women in machine-tool plants to operate sensitive drills and other small and medium types of



—COURTESY LODGE & SHIPLEY

WOMAN OPERATING SMALLER TYPE OF RADIAL DRILL. WORK FOR WHICH VERY FEW WOMEN HAVE BEEN EMPLOYED IN AMERICAN MACHINE-TOOL INDUSTRY.

single- and multiple-spindle table drills could be considerably extended, though these types of machines are not so numerous in the industry as the heavier models. Women could be hired later to operate radial and heavy single- and multiple-spindle drills on larger parts with the aid of handling equipment. Officials in two plants

agreed at time of visit that women could operate the smaller radials with 3- to 4-foot beam. British women already are operating the heavy radial drills.

Planing.

Planers are used widely in the machine-tool industry for heavy work on major castings such as the beds of machines. Sometimes many castings of smaller size are set up on large planers to be machined all at the same time, a process known as gang planing. To do such work, many of the planers are very large. One planer was seen that had a work capacity of 84 x 84 inches x 40 feet. Castings to be placed on such a machine may weigh thousands of pounds.

Because of the size of the planers and the parts to be machined on them, most of the firms visited were giving no consideration to the employment of women on planer work. Yet the director of the NYA machine-shop training school in Cincinnati was already, at the time of visit to machine-tool firms in the vicinity, training women to operate planers after boys had done the heavy lifting and set-up. In addition, an official of one of the plants surveyed stated that since one man cannot load the planers alone, two men and one woman could conveniently be employed as a team. His company already was having to train boys, so the fact that women were inexperienced would make no difference. One objection that has been raised to the employment of women on planers is that it requires skill to see that the bed of the machine is not twisted. The same company official was convinced that this is a matter not so much of skill as of supervision.

The superintendent of another plant said that some planing jobs in his company last one or two full days. He saw no reason why women could not tend the planers after men had set up the work. The women's part of the job would include also the use of calipers, verniers, scales, and the like for taking measurements, and enough knowledge of the work to be able to detect when the tool had become dull. The planers in the perishable-tools division of one of the machine-tool plants visited were only of moderate size. Here too the plant superintendent thought that women could be employed with the aid of set-up men to do the heavy work of getting the pieces into a level position and properly set into the machine. Even with the aid of handling equipment, this may involve much manual labor and the use of heavy wrenches and hand tools.

Women are already operating and setting up the smaller planers in British machine-tool plants, and in one of the factories visited in this country by Women's Bureau agents a woman had been employed as a planer operator in the First World War.

Miscellaneous work in machining departments.

Shaping is like planing except that in the former the tool moves over a stationary piece of work and in the latter the work moves back and forth beneath the tool. Shapers are generally much smaller than planers, being made more for small and medium-size work. Shaping machines on which the cutting tool moves vertically rather than horizontally are known as slotters. Shaping can generally be done by women, but except in two cases the few shapers and slotters in the machine-tool plants visited were operated by men. The women

employed were operating and setting up small Hendey shapers in a machine-tool-accessory department. At time of visit one of the firms with no women productive workers was considering the employment of women on both small and large slotters or vertical shapers.

The boring mills seen in the plants surveyed were heavy-duty machines usually placed in the same department as the planers or other large machines on which various operations on major castings or heavy forgings were being performed. The work to be done on these machines generally was considered too heavy and highly skilled for women. It should be mentioned, however, that women are operating horizontal boring mills in the British iron and steel industry. There are, of course, very many opportunities for women on lighter work for which they are not currently or generally employed in the machine-tool industry in the United States. These should be explored first.

Simple operations involving burnishing and polishing, burring, and filing are among such opportunities. Though a few of the firms visited had women on these types of work, several were employing men. Some of the men, to be sure, were older workers who were no longer able to do the heavier tasks. This shows good use of the available manpower. But many were able-bodied men and boys.

TOOLROOMS

A variety of work may be done in toolrooms, including tool repair on plant equipment, experimental work, and the manufacture of jigs, fixtures, and other tools for machines used in the plant and for machines sold to customers. Usually there are machines of all kinds because of the diversity of the work.

Many of the toolroom employees are highly skilled men, able to operate more than one machine on jobs requiring the closest of tolerance and most intricate of set-up. For this reason a number of the machine-tool plants visited reported that women could not be employed. Not all the work in toolrooms, however, requires considerable skill. In one of the machine-tool plants visited two women were operating small lathes. One of them sometimes laid out locators for holes to be drilled. The company was planning to employ more women in the toolroom, some to be taken from a group then in a training course consisting of special instruction on one type of machine. The all-round toolroom work requiring the use of a variety of machines would continue to be done by men. In another plant one woman assisted a man in checking lead screws on a Carl Zeiss machine. Another in the same firm assisted in making sketches of tools that required repairing. Other women in this toolroom operated single machines including cylindrical grinders, tool and cutter grinders, a heavy-duty miller, and engine lathes. The men operated all types of machines, some of them the same as those operated by the women. In a third plant four women were working to very close tolerances on single machines; they performed their own set-up. Two were on Landis Universal cylindrical grinders, type C, one on a Brown & Sharpe surface grinder No. 2, and one on an Abrasive wet-surface grinder No. 3B.

In the three companies in which these cases were cited it has evidently been possible to organize toolroom work so that some employees need operate only one machine. Where such an arrangement can be made, the employment of relatively inexperienced workers, men or women, is possible. As a matter of fact, a fourth company was planning at the time of visit to employ a considerable number of women in the toolroom as a result of an occupational analysis of the work and plans for dilution consisting in large part of providing set-up men. Some of the women to be hired would rough-grind on flat-form and cut-off tools and spacers with a surface grinder having a magnetic chuck. Some would use a surface grinder on tool posts, wedges, and ratchets. Others would mill knurls, form tools, dovetail tools, and the like. These are but a few of the toolroom operations it was expected women would perform in this plant. In another, boys with only trade-school experience had been started on cutter grinding in the toolroom; women could easily do this work.

Women could take over not only the easier and less-skilled jobs in toolrooms if the work is adjusted to their limitation as machinists, but they could be upgraded to perform toolroom operations requiring considerable skill. They have been doing such work in Great Britain at least since 1941.

INSPECTION

The organization and arrangement of inspection work differs from plant to plant. Some companies employ floor inspectors who go through the departments and inspect any work that appears to need checking. These and others may provide also for the inspection of the first piece of each lot. Some firms have inspection centers where the work done in certain departments is thoroughly inspected before it is sent on for further processing in others. A combination of any of these methods may prevail and, in addition, final inspection of all parts may be made before delivery to the stockroom.

All companies provide for the final inspection of completed machines. Ordinarily this is handled by a separate inspection force working on the erecting floor. The work often involves also test running after assembly. It requires special skill and experience and therefore is kept in the hands of experienced men. None of the machine-tool plants visited were considering women to do this kind of inspection. It was being contemplated, however, by an official in one Ordnance District at the time of visit and it is said of one of the machine-tool plants that newcomers are showing such surprising aptitude that they will soon qualify for this work.

Plants with subcontractors usually have a force assigned to the inspection of incoming parts. Sometimes, however, it has been found necessary to set up field inspection at the place of manufacture.

Women inspectors were employed in most of the plants visited in which women were engaged in productive work. None were employed as line or general inspectors, usually highly skilled workmen who can perform any kind of inspection work. The women were doing in-process inspection; a few, final inspection of small parts. Most read blueprints and used such precision instruments as micrometers, calipers, scales, dial indicators, and various types of gages.

Gears were inspected by means of such devices as microscopes, comparators, checking gages, cone machines, and Red Liner machines.

Though a few plants put much of the responsibility for certain kinds of inspection on department foremen or group leaders, most employed a considerable group devoted exclusively to inspection work. Where this was true, there were many operations on which men were employed for which women could have been hired. In one plant a good deal of gear checking was necessary. The work was done with a Red Ring gear checker and Red Liner gear recorder, machines a woman could operate easily. There were men detail inspectors also whose place women could have taken. In another plant women could have been trained to do a considerable proportion of the inspection work, much of which took place in numerous inspection centers and some in the gear-cutting department. Since the Women's Bureau visit to this plant women have been put on this work and several other firms have planned to employ women for inspection, mostly of small parts, some of it to be performed on subcontracted goods. Where women already are working as inspectors, their numbers could in most cases be greatly increased.

Detailed and careful inspection is a field in which women have long excelled in many industries. Women have been found exceedingly conscientious, painstaking, and accurate in inspection work. This is the kind of employment in which they are said frequently to surpass men. The foremen in one of the machine-tool companies where they were employed as inspectors reported that women picked up the work faster than men, followed instructions better, and were more careful in making precision measurements and checks. The total number of experienced male inspectors needed by many firms could be reduced considerably if women were employed generally to check all the small parts in inspection centers. Women could check heavier parts also when lifting is not required and later could be upgraded to the more highly skilled branches of the work.

Inspectors' training is easily acquired and can be taken conveniently in defense training classes. Instruction in the use of measuring instruments, the reading of blueprints, and shop mathematics was available in several machine-tool centers at the time of visit through various types of public vocational schools, or schools operated under private auspices. A complete course specially set up for inspectors' training was being given in Worcester, Mass., by two trade schools. Such instruction is effective not only in presenting the needed material to the student, but in giving her ease and familiarity with the instruments. One must have practice in the use of a micrometer, for example, as well as knowledge of how to read it, since accuracy depends in part on getting the "feel" of the instrument. One of the firms visited had introduced an inspection course within the plant for those who qualified after one week of vestibule-school training. The trainees were taught the use of gages and measuring instruments, shop mathematics, and blueprint reading, and learned on the job also. They were put to work inspecting parts made in outside shops. These usually were received in large lots and so gave the new inspector practice on repetitive work. After a few inspection operations on a single part were explained, the newcomers could work for a considerable time, thus acquiring skill while being productively employed.

ASSEMBLY

Assembling of the many parts, large and small, that go into the complete precision instrument, the machine tool, is an extremely important part of its manufacture and one that claims a large proportion of the workers in the plant. In the machine-tool firms visited, assembly work occupied more employees than any other part of the manufacturing process except machining. It accounted for 15 percent of all those employed in the 13 plants reported and nearly 24 percent of the productive workers.

The fit of the many small parts and major units of the machine tool must be so carefully and expertly produced that the tool functions smoothly and to the required close tolerances. If this is not the case, all the previous labor is lost. The assembly process demands precise leveling of the machine on the assembly floor, the exact alinement of various units with each other, and then many fitting operations involving scraping, filing, tapping, and other hand and machine processes.

As assembly is customarily organized, one man does a considerable variety of the work. Because of the skill required under such an arrangement and also because of the heavy parts to be handled, plant officials interviewed generally considered it unlikely that women could be employed in final assembly or erecting departments and, in many cases, on subassembly work also.

In most plants some units are assembled separately and then attached to the machines during final assembly. Among the subassemblies being made in some of the firms visited were gear boxes, headstocks, tailstocks, taper attachments, aprons, feed shafts, spindle heads, and control levers. When one man assembles an entire unit, he must have considerable skill and experience, proficiency with a good many hand tools, ability to do a variety of bench operations, and in addition a certain amount of physical strength, since some of the parts to be handled are much heavier than others.

But in many cases it is unnecessary that so many operations be performed by one person. The all-round job of the skilled assembler may be broken down into components, and when this is done, especially in the case of subassembly, many inexperienced women may be employed. Women were already working as assemblers in two of the plants visited by Women's Bureau agents and in both the number was to be increased. Another plant had made plans to employ women on subassembly very shortly. Some of the women already employed were filing, burring, and polishing with emery cloth, and they were using hand drills and small arbor presses on such units as the feed shaft, feed box, apron, and head-cover unit. The lighter work had been separated from the heavier in one plant so that women could be employed; in fact, the work had been so arranged that women were not required to handle any parts weighing more than 18 pounds. Men were working on heavier pieces and on operations requiring greater skill. In another plant women assemblers were doing not only the kinds of simple and light operations already mentioned, but in addition some had been given the responsibility of assembling parts of subassemblies. For example, they were assembling the cross-feed screw nuts, "building" the taper attachment shoes,

making the lever and hand assemblies, and, in connection with the gear box, fitting the gears on small shafts, assembling shoes, hand reaming and hand tapping, filing, and painting the inside of the box. Women assemblers had proved so satisfactory here that a large proportion of the women to be taken on in the future were to be placed in the assembly department. At the time of survey, 7 in every 10 women productive workers in this plant were on assembly jobs.

The few companies that acknowledged that women could assist in subassembly operations were not the only ones where a considerable amount of light assembly work requiring only moderate, little, or no skill was observed. In one plant 6 men were employed in the subassembly department doing nothing but filing and burring. Women could take over this work on the lighter pieces. In another, where attachments were being assembled by men, much of the filing and polishing and the lighter assembly work could be done by women. Men were drilling holes and putting in bushings as part of the subassembly work in another firm; women could do this. One company had an entire department devoted to tool assembly in which there was a considerable amount of light work women could do, especially if some of the operations were broken down. In the same plant there were a great many small and light bench jobs in connection with machine-tool subassembly on which women could be employed immediately. As the work was then arranged, one man might handle some jobs during the course of a day which would be too heavy or too difficult for a woman, but simple planning would permit the release of numbers of men and the employment of women in their places. The foregoing are but a few examples taken at random.

Unless the work is greatly diluted, there is admittedly little that the average woman can do at present in the final assembly or erecting departments, except on the smaller machines. The work is generally too heavy and too highly skilled. Women can put in oil lines, however, and, as they already are doing in one plant, they can clean and polish the completed machines. In some cases there may be full-time bench work that women could do in connection with final assembly. One of the companies visited was planning to employ women final assemblers on the smallest machines they manufacture, to do light fitting as well as polishing and cleaning. Some consideration was being given there also to hiring women as part of a group to perform certain additional operations. It was suggested that one woman and two men might work together. This is similar to the plan in a large machine-tool factory in the Midlands of England where, working with men in gangs, women help to assemble the machines by fitting keys, tapping holes, and even scraping surfaces and bearings.

Considerable hand scraping is necessary in machine-tool assembly in order to "true up" flat surfaces or prevent "rock" between two parts that are to be attached. When red lead is smeared on the surfaces to be scraped and the two surfaces are rubbed together, the "high spots" on the metal can be detected. These are then removed by applying pressure with a hand scraping tool. The process of smearing red lead over the surface and of scraping off the high spots may have to be repeated many times. Scraping large surfaces is very hard work and too strenuous for the average woman, but women can

scrape smaller pieces. As a matter of fact, one of the firms visited that employed women to do scraping in the earlier war has placed the job of "light scraping on small parts" on its summary of occupations for which women may be employed, when finally taken on, in the present war. Another company also has suggested light scraping as a possible job for women. An instance was cited in each of two plants, however, of a woman who tried scraping but found it too difficult. In one case the woman had to lift a surface plate to rub it over the surface to be scraped. The plate was too heavy for her to lift as often as was necessary in the performance of her work. If a hoist had been available, the actual scraping might not have proved too difficult.

Women are doing heavy as well as light scraping in Great Britain. Reports from one British machine-tool plant show women doing the majority of the scraping; four women divide the job on the 30-foot bed of a planer-miller. In another British plant women scrape lathe beds and bed-in the saddle, cross slide, and other movable parts of the machine. The operations on the cross slide are particularly difficult in that two pairs of flat surfaces and one oblique pair have to make contact on each side at the same time. After 8 months on the job one woman was able to grind and stone her own scrapers and had trained eight other women in the work.

Assembly operations involve, in addition to scraping and fitting, a certain amount of electrical work, such as wiring and the installation of motors and switch boxes. In some plants maintenance electricians do this work, but in others the electrical assembly is handled by a separate group of workers. The wiring of switch boxes and other light electrical operations noticed in several firms were said to require more skill than the average inexperienced woman would have.

Actually, however, two companies already were employing women on electrical assembly work at the time of visit and one other was preparing to take on a number of women for electric-panel wiring. In both plants where they were already employed, the women were doing typical electrical assembly bench work consisting of wiring panel boxes, soldering, cutting wires, attaching wires to terminals, and the like. One of the companies had employed women in this work for more than 2 years. The other was intending to employ more women on electrical work as the men in the department were drafted. The company where women were soon to begin panel wiring had already constructed the work tables, which contained pigeon holes for the various parts to be used. It was planned to have the women follow numbered diagrams that had been broken down and simplified by the plant's engineering department. Several factories were visited in which much the same technique could be used or special supervision could be provided for women, thereby releasing a number of men for more skilled or heavier work. In two of these, young boys were doing the electric-panel wiring. In contrast, one plant in Great Britain is reported to employ women to do the complete wiring job on two sizes of turret lathes. The operation includes wiring a 4-speed motor and speed change gear and it entails also soldering lugs to the wires and fitting conduits. The women work from diagrams.

MISCELLANEOUS NONPRODUCTIVE OCCUPATIONS

There were several nonproductive departments in the machine-tool plants visited in which women could have been much more extensively employed. These include the general and shop offices and the tool cribs. In the plants visited women comprised only 4 in 10 of all the workers in the central office. The proportion varied, however, from 13 percent in one plant to 64 percent in another. In every plant the proportion could have been greater. This is a sphere in which women's competence usually is unquestioned and one in which there are women who can immediately qualify for the more responsible as well as the routine jobs, thus making it possible to replace numerous men who could be employed more advantageously in the armed services or in technical or skilled work.

In the machine-tool factories visited, few women were employed as timekeepers, clerks in production departments, tracers, stock clerks, and the like. In some companies the claim was made that stock chasing in particular is a man's job because it requires intimate acquaintance with the business, enabling the employee to find parts and take them to the proper departments on his own initiative. It is true, of course, that stock chasing may be a much more responsible job and, especially when combined with other work, a heavier job, in some plants than in others. Certainly, however, with planning and direction, in almost every plant some women could participate in it. Without question women could take over most of the other factory clerical jobs, including timekeeping.

Only three of the firms surveyed employed women as tool-crib attendants. In one of these the women were known as tool dispatchers, since in connection with their tool-supply work they took the tools to the machine operators so that the latter need not leave their machines. Where heavy jigs and fixtures must be lifted from the shelves, some men would have to be employed, but women could do most of the work as all that it requires is acquaintance with the tools and their places in the crib. Women have been very apt in learning this job in other industries. The many tool cribs in a large airplane-engine plant recently visited by Women's Bureau agents are manned almost entirely by women.

The three lines of work just discussed—general office, shop office, and tool crib—claimed in the 13 plants reported about 8,000 workers, of whom not quite one-third were women. Yet women could have filled well over half and perhaps the great majority of the jobs, thus freeing many hundreds of men in these plants alone.

There are considerably fewer workers employed in gage inspection, laboratory work, experimental design, pattern making, or factory supervision in machine-tool plants. Further, most of the occupations involved in such work ordinarily require extensive background, skill, and experience, thereby precluding the immediate employment of women in most cases. Some women are adequately qualified to take over gage inspection and certain kinds of laboratory work, but practically none were employed. To be sure, the total number of employees affected would be very small. In connection with pattern making, women could serve as helpers and after a while as plain pattern makers. In Great Britain they are disk sanding, band

sawing, shellacking and painting patterns, and putting in the many screws and nails required. It is interesting that in one of the American machine-tool plants visited in which a schedule of jobs to be opened to women had been drawn up, the occupation of plain pattern maker was included in the original list. Women will not be employed in this work at first, however.

With so few women employed in the plants visited even in unskilled and semiskilled productive jobs, it is perhaps visionary at this juncture to suggest foremanship as a possible job for women. But where sizable groups of women are already working, as in small-tools departments and inspection centers, women supervisors are by no means out of the question, and as women gain in numbers in machine-tool production it is all the more feasible that some be upgraded to supervisory work. As a matter of fact, according to one plant superintendent there are some supervisory jobs that do not require a great deal of technical knowledge. He said women could start in such work and, as they proved capable, be advanced to supervision requiring more background and ability. British factories have had very favorable experience with women "charge hands." They have found supervision of women by women in many cases more successful than male supervision, for several reasons: Charges of male favoritism then disappear; the worker gains confidence from seeing that another woman has become expert on the work she is asked to perform; and the woman supervisor remembers where her difficulties lay in her comparatively recent experience as a learner.

Factory maintenance, receiving and shipping, service and stock work claim a not inconsiderable proportion of the total personnel, but few of the jobs could be taken over by women. The maintenance work demands highly skilled millwrights, electricians, carpenters, tinsmiths, and the like, usually older men. Receiving and shipping involves packing and crating the finished machines and other work too heavy for women. Women could be employed, however, to pack and ship the smaller accessories in companies where these are made in addition to the machine tools. At the time of visit one company was planning to employ women for this work. Women could also be hired for the clerical work in receiving and shipping departments and as counters and checkers. Two of the firms in the survey employed several women to keep stock records and in two companies women were handling the lighter types of stores.

Service work includes factory housekeeping and, in addition, such jobs as trucking and crane operating. Women could be employed in all three capacities, though very few were seen and in only two firms, where they served as janitresses. Another company was considering the possibility of taking women on for light cleaning. Certainly women could serve generally as chipmen, collecting the metal scraps that come from the machines as they operate. The boxes used to hold the chips should not require lifting, but should be transported from place to place on wheels or rollers. Women could drive small electric trucks within the plant if seats were provided for the operators, and they could handle many of the cranes used in machine-tool plants. They are driving cranes in other industries in this country and women in Great Britain are known to be operating cranes with a lifting power of 10 to 40 tons. In fact, crane driving is now virtually a woman's job there.

CONDITIONS OF WORK AND PERSONNEL PROBLEMS AND PRACTICES

Hours.

Factory employees in machine-tool manufacture are working longer hours than those in almost any other war industry. The average workweek over the period October 1942 to February 1943 was between 53 and 54 hours.

This situation stemmed from the tremendous speed-up that took place in the industry when war began in Europe, making it difficult to secure workers and to set up a second and especially a third shift. A number of firms, therefore, operated 2 long shifts instead of 3 shorter ones. But even in plants with 3 shifts, the hours tended to be long. About half the companies visited operated 3 shifts, but in only one of those was a 48-hour week scheduled for men at time of visit. The weekly hours of men in the remaining 3-shift plants ranged from 52 to 60. In most cases hours for men exceeded those for women; in all but one plant at least 52 hours a week, and in several plants a scheduled week of 60 hours or more, was customary. Women, on the other hand, were employed 48 hours or less in 6 of the 8 plants in which they were engaged in factory work. In the other 2 firms the hours were the same for women as for men, 11 hours a day and 55 hours a week on the first shift, 11½ hours daily and 57½ hours weekly on the second. (Only one of these firms employed women on the second shift.) Two weeks in eight all workers were on a 6-day instead of a 5-day week, the daily hours remaining the same; the averages over the year thus became respectively almost 58 hours and just over 60 hours. Exemption from their State hour law providing that women be employed no longer than 50 hours weekly or 9 daily had been allowed these firms.

Except for the two cases just cited and an 8½-hour schedule on one second shift, women were working 7½ or 8 hours daily, but in few cases were men on the 8-hour day. Furthermore, in most plants where men worked but 7½ or 8 hours a day they were expected to put in a 7-day week. In some instances the men were assigned 7½ or 8 hours one or more days in the week, but 10, 11½, or 12 hours the remaining days.

These hours are long in comparison with the recommended 40-hour week for peacetime and the 8-hour day and 48-hour week recommended for sustained efficiency in wartime by the War and Navy Departments, the Maritime Commission, Public Health Service, War Manpower Commission, and other interested Federal agencies. The consensus is that though hours in excess of 48 a week have been necessary in some instances because of a limited supply of supervisory and skilled manpower, there has been a tendency to continue the longer schedules after sufficient opportunity has been afforded to train additional workers. A committee representing eight Government agencies interested in maximum production recommends that plants employing workers longer than 48 hours weekly analyze their situation with respect to output and time lost because of absenteeism, acknowledged to be due chiefly to accidents, illness, and fatigue. The 8-hour day and 48-hour week does not prevent round-the-clock and 7-day operation.

Most of the plants visited approximated the goal of 24-hour production with a variety of shift schedules organized on the basis of

either 2 or 3 shifts. Long daily hours were in two instances tempered by 2 days off after 6 days on the job. In one plant where women were employed 11 hours daily, they worked 3 days and were then off 1 day. In some cases, as already stated, there were 4 or 5 long days combined with 1 or 2 short days. Two plants scheduled the first shift for 2 days of 12 hours and 4 days of 8 hours in a 6-day week. These are but a few examples from a wide assortment of shift schedules and practices, most of them directed toward production for all or most of the 24 hours, combined with adequate maintenance time, and, where women were employed, adjustment to the statutory requirements of the various States regarding women's hours. However, though the plants were generally operating round the clock, the great majority of the men as well as the women were on the first shift, illustrating that full utilization of plant facilities had not been achieved at the time of the Women's Bureau visit. Over half (52½ percent) of all the men and 84 percent of all the women in the plants reporting were on the first shift and only about 17 percent of the men and 8 percent of the women were on the third. Rotation was not generally practiced.

A weekly day of rest was the rule in most of the companies. In several, 2 days were customary after 5 long days of work. Though in no instance were women required to work more than 6 days in 7, in three plants men were on a full 7-day workweek. In one of these the men were given one day off every 3 weeks, the time being made up on that day by each of the other shifts working 4 extra hours. In another, an 8-hour day was considered sufficient offset for the day of rest. Some of the men in the third company were on 9-, 10-, and 11-hour shifts and in addition worked a 7-day week. The War and Navy Departments recommend that "Only in extreme emergencies and for a limited period of time should workers or supervisors forego the weekly day of rest." They assert, with other Government departments interested in maximum output, that the 7-day workweek is injurious to health, morale, and production.

At least a 30-minute meal period, a necessity from the standpoint of the worker's health and efficiency, was customarily allowed men as well as women in most of the companies in the survey. In a few cases, however, men were required to eat their lunch in 10, 15, or 20 minutes, or as time permitted on the job. Some plants provided, in addition to meal periods, regularly scheduled rest periods of 10 or 15 minutes morning and afternoon. These are particularly helpful in preventing excessive fatigue and thereby increasing efficiency.

Methods and rates of pay.

The principle of equal pay to women who are doing similar or the same work as men was not generally in force in the machine-tool firms visited, at least as far as entrance rates were concerned. Only one of the eight firms in which women were employed on productive work operated under this principle. In the others, women entered at 5 or 10 cents less per hour than men. Women's entrance rates ranged from 40 to 60 cents, men's from 50 to 65 cents in the firms hiring both men and women. Furthermore, because of their very recent accession to the labor force, women in most cases had not advanced beyond their starting rates.

The reasons given for the sex differential varied. Some firm officials said that women required more supervision—that they had no

background or experience in mechanical work; others that they did not work so long a shift as men because of State maximum-hours provisions; some that they must prove their efficiency first; and so on. One company had in the beginning given women the same entrance rate as men, but the men complained, and as a result the men's beginning rate was raised 5 cents.

It is the considered stand of the National War Labor Board and the Women's Bureau that to maintain all-round industrial efficiency and industrial democracy women should be paid the rate for the job and that rate should be set without regard to whether a man or a woman will perform it.[7] It is significant in this connection that one of the machine-tool companies showing a differential in the summer of 1942 was, early in the fall, directed by the War Labor Board to standardize and simplify its wage schedules and to include in its agreement with the International Association of Machinists, A. F. L., a clause adopting the principle of the same pay to women who, "in comparable jobs, produce work of the same quantity and quality as that performed by men." In its written opinion the Board stated specifically that to be specially guarded against is the procedure of cutting women's rates when the extra labor introduced for heavy work, setting up, and so forth, does not increase the unit cost of production. It has often been found that the hiring of a special set-up man or moveman for a group of workers may actually reduce unit costs of operation, even though hourly rates are maintained.

Most of the machine-tool plants visited operated under wage plans involving a base rate plus some form of individual or group incentive scheme or production bonus. In 5 of the 15 companies a straight time rate only was paid, and in 1 a straight piece rate, the rate being guaranteed for the job in all factory occupations except inspection and stock-chasing. Where piece rates were set in connection with a production bonus, they generally were computed on the basis of job classification and requirements, the same rate being paid regardless of the sex of the worker. But since the base rates were not alike, the sex differential remained.

A regular wage-advancement policy was in effect in 7 of the 15 plants surveyed and in 3 of those reporting women operatives. In general, the scheduled raises were given in 5-cent intervals until the job rate was reached. The total advancement amounted in most cases to 10 cents an hour. In two plants where the entrance rates for men and women differed, only the women were raised until they reached the starting rate for men. After the job rate was reached, in plants where regular pay raises were made and in companies where no regular advancement was provided for, increases were given usually on an individual basis, depending on foremen's recommendations with regard to efficiency and merit, length of service, and the like.

Special wage differentials generally were paid all those employed on the evening and night shifts. In two plants this amounted to as much as 20 percent above the worker's regular rate. In most cases, however, it was a matter of 10 percent or 5 cents an hour, the bonus being generally the same for the third shift as for the second. Only 1 of the 15 firms visited did not pay a shift differential.

[7] See Women's Bureau Bul. 196, "Equal Pay" for Women in War Industries. 1942.

Recruiting, training, upgrading.

The machine-tool plants employing women in the shop did not make very rigid requirements of women recruits. None of them insisted on previous shop experience. Furthermore, though defense training courses were available to women in each of the towns where the plants visited are situated and many women already hired had attended them, preemployment training was not generally required. All the plants accepted married as well as single women. One, however, reported a preference for single women and another would not hire the wives of their men employees. Half the firms would not accept women under 21 and half set 18 years as the minimum age limit. Only two stipulated a maximum age; one set 40 years, the other 50.

At time of visit a large proportion of the hiring was done at the plant gate. Four factories in which women operatives were employed secured most of their personnel in this way. Several, however, were making extensive use of the United States Employment Service facilities. One plant made new hires exclusively, and one almost exclusively, through the U. S. E. S.; even when applicants came to the gate, the company first named sent them to the U. S. E. S. before granting them an interview.

Though women who have attended defense training classes find jobs in machine-tool plants, personnel was not customarily secured directly from the schools except by two companies. These are in the same New England town, where a special cooperative training school under public-high-school authority has been sponsored for nearly 25 years by the local industries. The high-school machine-shop classes were held in space provided on the property of one of the companies and with machinery donated by several affiliated firms. The same machine shop was being used as a National defense training school in the summer of 1942, with both men and women enrolled. One of the cooperating machine-tool firms was getting most of its women employees from this school. Another used this school and in addition canvassed defense schools in other parts of the State and adjoining sections.

Trainees in the New England school just mentioned were being taught first the use of the micrometer and of all types of precision measuring instruments such as calipers, vernier gages, plug gages, dial indicators, and the like. Next they were taught to read blueprints and to set up machines from blueprints. In addition the students were trained in the operation and set-up of an unusually diversified and complete array of machines. The course required about 160 hours over a period of 6 to 8 weeks. Classes were held 24 hours a day and 7 days a week. The school admitted women in April of 1942, and when visited in July, 85 women had completed the course. Most of them were employed in three machine-tool plants. The supervisor of training reported that the women listened more carefully than men to instructions and were more painstaking in their work. They were slower than men at first, but their spoilage was less. The supervisor stated also that the women were able to work to close tolerances in a very short time.

In Cincinnati, often called the machine-tool center of the United States, approximately 72 percent of the vocational training sponsored by the U. S. E. S. was in machine-shop work. There were 12 machine

shops and 98 machine-shop classes, all open to women since February 1942. In August of that year fully one-third of the total enrollment were women and it was estimated that one-fourth of those already trained had been placed. The schools stressed production and actually turned out numerous machine-tool accessories and various machines and machine tools for use in their shops. At the time of visit one well-equipped school shop was making or planning to make 100 3-horsepower motors, 12 centering machines, 250 milling-machine vises, 25 complete hand-operated milling machines, and 500 drill-press vises. Besides the machine-shop work, related instruction in blueprint reading, shop mathematics, and the use of precision measuring instruments was given. The courses required 300 hours to complete, but most of the trainees secured jobs and left before finishing.

The NYA school in Cincinnati, devoted almost entirely to training Negroes, operated three 8-hour shifts a day. Classes were coeducational. All the work in the school shop was production work for which orders had been received. According to the instructor, machine-tool firms would not take down a set-up for small jobs, so the training school got such orders. The usual related training was given also. The difficulty was that Negro women, in spite of this training, were not accepted for productive work in this area.

A course in inspection sponsored by the Ordnance Department and providing training in mathematics, blueprint reading, mechanical drawing, the use of precision measuring instruments, and metallurgy completed the training picture in Cincinnati.

Machine-shop and inspection courses, most of them under public auspices, were open to both Negro and white women in other machine-tool centers. In one important area a course for women supervisors had been started as an experiment.

The demand for women workers in the various war industries has been so great that many leave the training schools before they have completed their course. Many others do not enter training because they can secure paying jobs without benefit of preemployment instruction. The attitudes of the machine-tool firms visited varied considerably toward the defense-training-school work. Some reported at time of survey that they took students from the schools whenever possible and considered the preemployment instruction valuable. Others in the same area with access to the same schools preferred to train their own workers. They complained of lack of success with the school trainees. Still others appeared to be indifferent; in fact, seemed to do their hiring without regard to whether or not the applicant had school work that would serve to familiarize her with shop procedures and terms.

This doubtless arose from the fact that machine-tool plants were in many cases training their new women workers themselves either directly on the job under experienced workmen or in their own vestibule schools. In at least one instance, however, where a vestibule school for women was in operation, the time that trainees had to spend in classes depended in large part on whether or not they had had previous training in a defense school.

The instruction given women in vestibule schools varied in its thoroughness. In one plant, foremen gave 3 days of training to all new women employees. The instruction consisted of blueprint read-

ing and the use of the micrometer and other measuring tools. After this, the women were assigned to a machine with a man worker and trained on the job. A company representative said that inexperienced women could be trained by the plant in 3 days to use measuring tools as well as if they had previously attended defense classes. A more elaborate training program was in operation in a second plant where the women remained in school an average of from 3 weeks to a month. Some were there 7 weeks, and others a day or so. Some women did not have to enter the school at all if they had received sufficient preemployment training in the defense school. The firm's vestibule training comprised 1 to 1½ hours of classroom work each day and instruction in the use of measuring instruments, in assembly work, and in machine operations. The girls were started on scrap material, but as they became more efficient were put on production work. At the time of visit women were learning to set up work, though special set-up men might be hired for some of the machines on which women eventually would be placed.

An even longer and more elaborate training program was in operation in a third plant. Here all women employed were given, first, one week of classroom instruction during which they learned the fundamentals of blueprint reading and the use of measuring instruments. In this period, also, they were lectured concerning health, dress, company policies, safety, and the like. For another week in the plant's trade school the women were taught to identify the machines and from here they went into the shop, where they were given a 12-week learnership course. They were paid while in training.

No additional or supplementary training was being offered women in the plant after induction, but in every center where the firms were located ample opportunity existed for taking additional work in defense classes. Women were not being considered for apprenticeship training and in fact this type of training was practically discontinued for men in favor of short-term learnership programs or on-the-job instruction.

The firms hiring women operatives reported that they included them in their upgrading program. Several stated that women were already being upgraded to set up their own machines. In one plant one or two women had been advanced to more difficult machines.

Turn-over.

The consensus was that women's turn-over was low, men's high, mostly because of the draft and enlistments. In fact, at least 2 plants began to take on women principally because of the high turn-over among men. One employment director said that the turn-over in his plant would decrease as more women were employed.

Medical services and related problems.

Industry has for some time been aware not only of its responsibility to the worker to provide adequate treatment in case of illness or accident while on the job, but of the dividends good medical facilities pay in factory morale and reduced absenteeism. Most of the machine-tool plants visited had a well-appointed medical department in which first aid was administered or minor treatment given. A nurse generally was on duty at all times and a doctor was on call. In a few cases one or more doctors were in attendance at the plant for

all or part of the day. One firm provided home-visiting service. The smallest company, on the other hand, had only a first-aid station tended by a worker with some training; a doctor was on call in case of accident.

The medical service in a good many of the plants included also a thorough preemployment physical examination. Some companies had X-ray equipment. Most gave blood tests, took the blood pressure, and examined eyes, ears, nose, throat, heart, and lungs. Men were examined for hernia. A number of the companies that gave preemployment physical examinations employed women operatives. These companies had several advantages over those also employing women but giving no physical examination. Not only could their personnel managers on the basis of the medical information weed out women totally unable to do factory work or for whom physical exertion would be dangerous, but they were able to allocate more wisely those women who were hired. This is especially important where the women's work may involve lifting or other strenuous physical activity. Providing the best possible arrangement of the work and as many handling conveniences as possible eliminates a large part of the problem, but proper choice of the woman for the job is essential also. Women who will have to lift heavy materials or perform other work requiring a good deal of strength should have a physique enabling them to do the work and should be informed concerning the proper methods of doing it with least exertion and danger to themselves.

The question is raised frequently as to the maximum weight women should be asked to lift. According to the research division of the Women's Bureau, "the scientific establishment of a maximum that would apply to all women is impossible. All the elements in weight lifting, such as compactness of load, levels of lifting, and so forth, must be considered as well as the physical characteristics of the individual who is to do the work." [8]

In ordinary times women workers in this country are seldom required to lift over 25 pounds. Wartime employment, however, may involve lifting much heavier loads. A recent study by the Division of Labor Standards of the United States Department of Labor suggests as over-all limits for employees in general a 25-pound maximum for women, a 50-pound maximum for men.[9] The British allow a maximum for women that is twice as great, 50 pounds for continuous work, 65 pounds for intermittent work. American authorities feel that if specific limits are set, this is too high.

Uniforms and safety-clothing regulations.

Safe, convenient, comfortable, and attractive work clothing for women war workers is widely recommended.[10] The clothing need not be uniform, but uniform or not it must be safe. Proper factory garb can make all the difference between freedom from accident and disfigurement or even death.

[8] See Women's Bureau Special Bul. 2, Lifting Heavy Weights in Defense Industries: Methods for conserving health of women workers. 1941. This report summarizes the problems involved in weight lifting and methods of protecting women employed in such work.

[9] U. S. Department of Labor. Division of Labor Standards, Guide to the Prevention of Weight-Lifting Injuries. Special Bul. II. 1943. p. 13.

[10] Recommendations of the Women's Bureau in this field are summarized in its Special Bul. 3, Safety Clothing for Women in Industry. 1941.

All machine-tool plants visited in which women operatives were already employed were safety-clothing conscious. Most of them had adopted a uniform and cap for plant wear. One company furnished the uniforms to their women workers; the others asked the women to buy them. The cost, reported in only two instances, was around $3 an outfit. In one plant the women were said to have 2 or 3 each. In one of the companies women operatives were not required but were advised to wear the adopted uniform, since special clothing was not required of the men. The women who did not wear the uniform were requested to wear a suitable substitute for it in the way of a coverall or slacks. Women engaged in machine work were generally required to wear special headgear. Sometimes a hairnet or kerchief was specified. Kerchiefs, however, may expose the hair, or machines may catch loose ends of cloth. A hairnet alone is not safe either, but worn fully under a cap it may help. Height, stiffness, and generous headsize are essential in a safety cap, so that it will cover all the hair, give warning of dangerous approach to the machine, and be quickly lifted or knocked off in case of necessity. Above all, the hair should not be allowed to show beyond the cap. This seems to be one of the most difficult plant rules to enforce, but it is extremely important because of the many serious injuries that have resulted from exposure of women's hair near moving machinery.[11]

Low-heeled shoes were generally required; in one company most of the women had purchased safety shoes at a cost of from $4.50 to $5.50. Goggles and shields for work involving danger to the eyes and face were provided as needed.

Food service.

Hot food generally was available for purchase by the workers on all shifts, except in a few plants where sandwiches and light refreshments only were provided or where the workers had to carry their lunch or go out to eat. Of 15 plants, 7 had a cafeteria, 5 of the 7 being firms where women operatives were employed. In some places lunch carts carried hot or cold food to the workers on each shift. One plant allowed a caterer to come in at lunchtime with sandwiches, hot soup, and coffee. Where lunching facilities were not available many carried food to work and ate it at their workplaces or in rest rooms. One plant provided lunch-room space for this purpose. A company having a cafeteria also sent a cart through the plant morning and afternoon with hot coffee, milk, orange juice, soft drinks, and ice cream. Employees were allowed a reasonable time off for refreshments.

In the machine-tool plants visited, the most usual lunch period was 30 minutes. This is sufficient only if washing facilities and lunchrooms are conveniently located so that the worker has enough time to leave the workroom, wash, eat a well-balanced meal, and have a few minutes for leisure afterward. If the cafeteria or lunchroom is inadequate to serve an expanding force without delay, or if it is distant from the workroom, additional time should be allowed or provision made for carts with hot food to serve lunches at convenient points outside of workrooms.[12]

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[11] See Women's Bureau Special Bul. 9, Safety Caps for Women in War Factories. 1942.
[12] Women's Bureau Special Bul. 5, Women's Effective War Work Requires Time for Meals and Rest. 1942.

Tool kits.

It is customary in the machine-tool industry for workers to furnish a good many of their own hand tools, such as micrometers, scales, and other miscellaneous equipment. The tools needed vary with the job. In one plant it was said that the cost to women is generally between $10 and $20, the higher in the toolroom. Another company planning soon to employ women would furnish the more expensive tools such as Johansson Blocks, but would require the purchase of others. The latter would be bought by the firm and resold to the women, who would pay for them in installments. Since most women in the industry probably will be employed only for the duration or not long after, this expense must be kept low.

Personnel work: Selecting and counseling versus policing.

Women matrons, counselors, or personnel officers had been introduced into all but two of the plants in which women operatives were employed. Their functions varied extensively. In one plant matrons were employed expressly to "control" the women and keep them from soldiering on the job by too frequent visits to the rest rooms. Not far above these women in status and effectiveness were the matrons in two firms who, in addition to their duty of seeing that the charwomen or janitors kept the women's rest rooms clean, were expected to handle problems brought to them by the factory women and act as go-between to the personnel department.

The woman personnel officer in another company had still different functions. She was employed before any women operatives were taken on to try various jobs in the plant herself and then advise the personnel office concerning those she thought women could do successfully. This continued to be her main function as more and more women were employed. She had no authority in the selection of women nor in counseling them, but once they were hired she familiarized them with plant facilities and regulations.

More professional and well-defined were the functions of the woman personnel officer in each of two companies. These women interviewed women applicants, hired them, and acted as women's counselors. One of the women, in addition, lectured trainees on such topics as health, dress, and safety. These personnel officers had an important function in the plant and because their function was well-defined and well-implemented they, as women, could give valuable service, especially if they had the proper qualifications for the job.[13] These capabilities should include varied industrial experience in addition to a good education and a personality and manner that preclude prejudice and inspire confidence. A woman personnel officer, furthermore, should be interested in her fellow women workers and their capabilities. She should have detailed knowledge of the jobs to be filled, conditions in the plant, and the types of work which women are fitted to do. When aptitude tests are given, she should be competent in their interpretation. A woman personnel officer equipped in this way can be of great service in an industrial organization where large numbers of women are being employed for the first time.

[13] See Women's Bureau Special Bul. 12, Choosing Women for War-Industry Jobs. 1943.