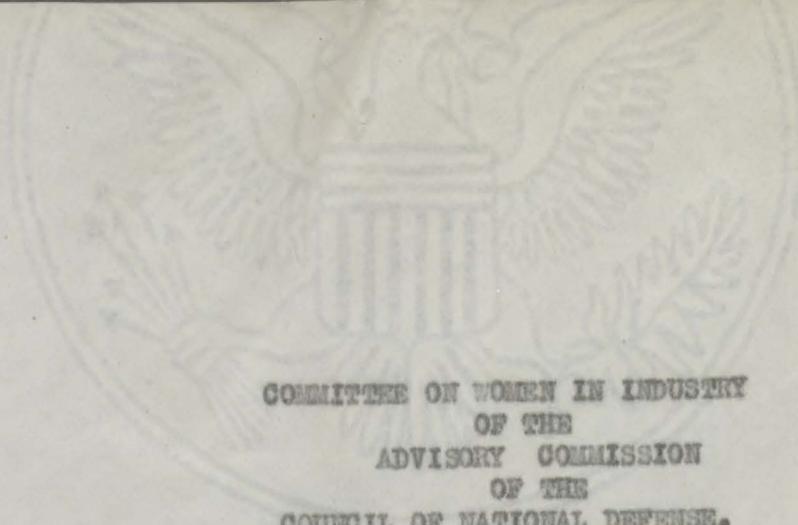


AIRCRAFT

88



COMMITTEE ON WOMEN IN INDUSTRY
OF THE
ADVISORY COMMISSION
OF THE
COUNCIL OF NATIONAL DEFENSE.

VALLEY PAPER CO

SUBSTITUTION OF WOMEN IN AIRCRAFT PRODUCTION.

Women in War Industries Series - No. 5

October, 1918.

RECOMMENDATIONS.

The substitution of women for men in the big war industries brings with it certain benefits - the establishment of better working conditions. Conditions of employment which are tolerated by the men when working alone become obviously unprofitable when women are brought into the factory and both the men and women receive the benefits of the improved working conditions.

Aircraft production offers many new and favorable opportunities for women, but suffers to a certain extent from its sudden mushroom-like growth. The pressure for airplanes and flying boats has been so great, that attention must first be concentrated upon output. But output is determined by many factors.

The spirit and morale of the workers are fundamental in securing large output. Adequate compensation, opportunities for advancement and promotion, good working conditions, opportunities for rest and relaxation from the strain of the ~~six-hour~~ working day, adequate provisions for cleanliness and comfort, health and good physical condition, and a minimum of difficulty and strain in getting to and from work are all important in determining the vim which the worker puts into the thing she is doing, and the amount of work she accomplished.

The stability of the working force on which production is so dependent, is largely determined by these factors.

The Curtiss Aeroplane and Motor Corporation recognizes the importance of good working conditions, as is shown in the splendid new Elmwood plant built on the outskirts of Buffalo; but production still continues in the old Churchill plant which is inadequately equipped to house the large number of women workers and the great variety of processes carried on under its roof.

And even in the new Elmwood plant more provisions for the comfort and relaxation of the women workers are needed. Space is at a premium in any factory engaged on war contracts, but setting aside adequate room for the needs of the workers has proven to be a paying investment.

As a result of the investigation of the Elmwood and Churchill plants of the Curtiss Corporation in Buffalo, the Committee makes the following recommendations believing that they will promote the welfare of the worker and at the same time increase the output of the plant.

1. The wage scale for women should be revised
in accordance with several well-established principles:
 - (a) the same pay for the same work for women and for men,
 - (b) wage rates based on the degree of skill required by the different occupations,
 - (c) wage rates comparable to those paid for similar work in other places
2. A careful analysis of the different occupations
should be made, and a definite scheme of promotion should be evolved, so the worker has the incentive of advancement to increasingly skilled occupations and to increasing compensation.
3. Workroom conditions in the Churchill plant should be improved by
 - (a) removing the doping of the wings to a separate workroom equipped to carry off the fumes of the dope,
 - (B) providing better lighted, better ventilated, and less crowded workrooms for the machine shop workers. of adequate size and
4. ~~larger~~ Cheerful restrooms/well equipped with tables, couches and chairs should be established in both plants where the girls can come from the workroom during the midday rest period for relaxation and rest.
5. More adequate coat-rooms and wash-rooms with plenty of hot water, soap and towels in both plants are nec-

essary. A half dozen wash basins for 225 girls in the Churchill plant and the assignment of 80 girls to one small wash room in the Elmwood plant is not sufficient and results in a crush or in neglect to go at all.

6. A large lunchroom should be installed in each plant where the workers can get something warm to eat and drink outside of the workroom. There should be a proper place where lunch may be eaten.

7. Prohibition of lunching or remaining in the doping-room during the lunch hour is a Government regulation in Great Britain and would seem advisable in this country.

8. Periodic physical examination of the workers employed in doping, painting and varnishing should be made to see if the dope is ^{producing} any bad effects on the workers. This would be simple in the Elmwood plant as only a few girls have yet been introduced on the doping and resident doctors and nurses are stationed in the plant.

9. Careful consideration of the possibility of alternating the work of the women dopers to some other work during the day or during the week as the physical examination of the worker ~~so~~ ^{may} indicate the need for change.

10. A vigorous effort to secure from the municipal authorities better and more frequent transportation facilities to and from the factory.

CONTENTS.

	Pages
PREFACE	a
RECOMMENDATIONS	
<u>CHAPTER I- INTRODUCTORY</u>	1
Aircraft in the War Program	1
The Airplane.....	2
The Hydroplane and the Flying Boat.....	3
Government Production.....	5
<u>CHAPTER II - THE CURTISS AIRCRAFT FACTORIES</u>	6
Product	6
The Elmwood Plant.....	7
The Churchill Plant.....	8
Health and Welfare Arrangements.....	9
Ventilation.....	13
Doping.....	14
Washing Facilities.....	17
Uniforms.....	17
Wages.....	18
Hours.....	19
<u>CHAPTER III- PROCESSES OF MANUFACTURE</u>	20
Women's Work	20
Occupation Groups.....	22
Processes.....	22a
Description of Principal Processes.....	30
Inspection.....	30
Occupations in the Metal Working Shop.....	32
Occupations in the Woodworking Depart- ments.....	38
Varnishing and Finishing.....	45
Wing Covering.....	46
Doping and Painting.....	47
Light Final Assembly.....	48
Wrapping.....	48
Electric Truck Driving.....	49

SUBSTITUTION OF WOMEN IN AIRCRAFT
PRODUCTION.

PREFACE.

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for the U. S. Army
The second draft/in the middle of the second year of the war has brought the words "substitution" and "dilution" into every-day use. The replacement of men by women, we are told, must assume proportions little dreamed of when we first entered the war. Women must be trained to work on processes from which they have been rigidly excluded because of social custom or prejudice, or because the supply of men labor was adequate to meet the demand.

The aircraft industry presented many favorable openings for women and was one of the first of the big war industries to bring them inⁱⁿ/large numbers. The Curtiss Aeroplane and Motor Corporation, Buffalo, New York, the largest private firm holding Government contracts from both the Army and the Navy was one of the first to introduce women in large numbers on a great variety of occupations which had formerly been done by men.

The Curtiss factories were visited in May and again in August, 1918 by May Allinson, Executive Secretary of the Committee on Women in Industry, who prepared this report and submitted it to the Officer-in-Charge, October, 1918.

The Committee has had the most cordial co-operation and assistance from the Signal Corps of the United States Army and the officers in charge who gave every opportunity for observation and inspection in the plant.

This report supplements Bulletin Number 4, Women Workers in the Philadelphia Naval Aircraft Factory. The two reports read together are of interest in showing the extent to which women have been introduced into so-called men's occupations. The Philadelphia Naval Aircraft factory has gone further in putting women on woodworking occupations. The Curtiss plant has gone much further in putting women on metal-working processes, painting and doping,

Women have demonstrated their ability to work on most of the processes in the making of aircraft. This report aims especially to bring to the public who can not go into the factories, some conception of women's work in this great war industry.

Florence J. Harriman, Chairman,
Committee on Women in Industry.

October 1918.

SUBSTITUTION OF WOMEN IN AIRCRAFT PRODUCTION.

CHAPTER I.

INTRODUCTORY.

Aircraft in the War Program.

The making of airplanes and flying boats was only in its infancy in the United States when we entered the war. The importance of aircraft in the war program had not become apparent to us even during the three years of war abroad. We found ourselves suddenly involved in the great world struggle even less prepared ^{to push a vigorous air program} than a land campaign.

Airplanes and hydroplanes had been built in small numbers in several plants in the middle west and on the Atlantic coast.

The interest previous to the war, however, had been mostly in scientific invention or in exhibitions of the remarkable feats of the "flying machines."

The war brought aircraft into the essential industries group. Aircraft production was a new industry, suddenly developed just as men were being called out of the industries into war service. The great demand for labor must be met by introducing women workers.

Aircraft production offered particularly good

opportunities for women workers since the airplanes and the flying boats are made of the lightest materials consistent with maximum strength.

The Airplane.

The airplane has a wooden skeleton of the lightest spruce wood, which looks not unlike the skeleton of a huge bird. The skeleton of the body or "fuselage" of the airplane is built of the lightest beams and spruce slats supported with wire cables stretched back and forth between the four longitudinal beams. It is covered over with the lightest wooden veneer of spruce or cedar and linen is used in the upper parts wherever possible.

The skeleton wings or panels, as they are called, are covered with a strong linen covering and are "doped" (or varnished) and painted to make the cloth taut, smooth, and water-proof.

These wooden parts are held together by many small metal parts, which are cut, filed and welded in the airplane factory and by steel ropes which are looped at the ends for greater strength and flexibility.

On all these processes women workers were soon introduced and found satisfactory.

The Hydroplane and the Flying Boat.

The hydroplane had been developed several years before the war, but was produced in even smaller numbers than the airplane. It was similar to, but larger, than the airplane, and had large pontoons or boats underneath the wings which rested on the water and kept it afloat when it came down to rest.

A newer seaplane or flying boat has since been developed and is now being built almost exclusively for the Navy. The body of the flying boat is somewhat similar to that of a motor boat with walls, a flat roof or deck and even windows in some of the larger boats. The front end of the boat is broad and rounded but the rear end of the boat curves upward like that of a gondola, ending in a tail fin which is painted red, white and blue and which is supported by a similar stabilizer on each side. In fact, the body of the flying boat reminds one of a big whale.

The wings of the flying boat are built high above the body or hull of the boat. Pontoons underneath the wings support them when the boat is on the water. The motors in the flying boat are built in beneath the upper wing to protect them from the water instead of inside the body as in the airplane.

The propeller of the flying boat therefore is also high above the body of the boat, attached to the engines beneath the upper wing. In the airplane, the propeller is attached to the front of the body or fuselage and connects with the engines inside the body of the plane. The propeller looks like a large wooden fan of two blades about five feet in length crossed at right angles at the center and made of the finest and hardest mahogany.

The flying boat is made of practically the same materials as the airplanes and women's work on both is very similar. The chief difference between the two, from the standpoint of women's occupations is in the body. The airplane body is a skeleton framework built of the lightest wooden beams of struts and covered with a thin wooden veneer.

↗ The body of the flying boat resembles the hull of a boat and is necessarily much heavier since the boat sets on the water when at rest. The hull of the boat is built of strong boards which girls rivet and nail on the framework of the boat side by ^{side with} the men in the Philadelphia Naval Aircraft factory, but not in the Curtiss factories.

The Army has depended on private plants for the production of airplanes. The Signal Corps of the U. S. Army had charge of the program of aircraft production for the Army until May 21, 1918, when the Bureau of Aircraft Production was created for this purpose.

The Navy which has charge of the production of seaplanes lets contracts to private plants for the making of flying boats but also has a large assembling plant in the Philadelphia Navy Yard.

In some plants such as the Vurtiss Aeroplane and Motor Corporation, Buffalo, New York, airplanes are being made for the army and flying boats are being made for the Navy in the same factory.

CHAPTER II.

THE CURTISS AIRCRAFT FACTORIES.

Product.

The Curtiss Aeroplane and Motor Corporation is ^{one of} the largest private firms holding government contracts from the United States Army and the Navy. It is housed in five large plants in and adjoining Buffalo and employed about 15,000 workers in May at the time of the first visit. ~~Contracts for airplanes were also let to factories in Cleveland and other cities.~~ Battle planes and training planes are made for the Signal Corps of the War Department and flying boats for the Navy Department. The working force was much reduced at the time of the second visit in August because of the decision of the Government to abandon the production of the Bristol ^{fighting} plane which the Curtiss plant had been making.

— An English airplane, S E 5 had been adopted but was not yet being produced on capacity basis.

Both the Signal Corps of the Army and the Navy have a number of Government inspectors in the plant, to inspect the parts which go into the planes before they are assembled; again inspecting parts of the plant in the different stages of production, and testing the completed plane on the adjoining flying field, before it is packed up and sent to its destination.

The Elmwood Plant.

Description.

The Elmwood plant is the newest and largest of the five factories. It covers about 27 acres of land and is housed in two adjoining buildings separated by a fire-proof brick wall. It is built entirely of glass and looks something like a huge green house. In one building is housed the production departments and in the other, the assembly departments. The Elmwood plant began production about one year ago in August, 1917. Battle planes for the Signal Corps and flying boats for the Navy are manufactured in this plant.

Several low wooden buildings front on the street, one occupied by the Signal Corps Inspection force, one by the administrative offices of the plant and another containing a cafeteria lunch-room, employment offices, etc. The big manufacturing plant lies just behind these office buildings, separated by a large open yard covered with cinders in which are packed many automobiles. Visitors must go through the main office building to enter the factory.

Transportation.

The factory is built on the outskirts of the City

of Buffalo just beyond the park system and it is surrounded by open country and green fields. It is reached by a single car line which runs from the center of the city through one of the most beautiful residential sections and is about one-half hour's ride from the center of the city. The transportation of thousands of employees every morning and evening to and from the city proved to be a most serious and difficult problem during the winter. This congestion was still further intensified by the large numbers of employees working in the Pierce Arrow and other large plants just a few blocks away. The workers of all these big plants must reach these factories by the same car line and at about the same time. The Elmwood plant, therefore, arranged three schedules of hours with a half hour's difference for opening and closing to lessen the congestion and those in charge report that traveling conditions are much improved. Even so, the transportation problem, as is the case with many of the big Government plants and factories engaged in the war industries, is serious.

The Churchill Plant.

The Churchill plant, in the City of Buffalo, was the original Curtiss Airplane factory in this city and is an old brick building much smaller and less modern and well-equipped than the Elmwood plant.

Training planes are made in this plant. The factory consists of one big long room with a balcony at one end and extending along one side and an adjoining wing opening off the main room. The balcony houses the web department, the training school, the lavatories, and the welfare director's room. About 400 girls were employed, 225 in the manufacturing department and almost an equal number in the clerical department at the time of the visit in May. Each factory maintains a separate organization and system of manufacture. The employment department, pay roll department, and business management are kept distinct. Because of the comparatively small number employed, some of the processes are different from those in the Elmwood plant where more and larger mechanical devices have been introduced to handle the larger output.

Health and Welfare Arrangements.

The Elmwood Factory. The Elmwood factory is housed in two huge modern factory buildings built entirely of glass, and with only one - the ground - floor. Balconies

210

are built in several parts of the factory and swung over
the panel department, the punch,^{and} drill and press department,
and other departments where the work does not require
great height, to secure additional space for the training
school and for lavatories and rest-rooms. The training
school for the women industrial workers and for the sailors
who are being trained in airplane construction and repair
occupies a balcony 50 by 500 feet. It is reached by a
long, wooden stairway from the main floor. The bal-
conies for the lavatories and cloak-rooms are built at
regular intervals in the machine room and each is reached by
a single stairway. Each balcony contains two small rooms-
one room contains eight or ten toilets and a double row
of six wash bowls running down the center, the adjoining
cloak room has several couches and chairs to rest on.
Coats, hats, and street clothes are hung on nails or hooks
in the walls. Each lavatory is supposed to accommodate
about 80 girls. About 1500 girls were employed in the
Elmwood plant in May.

A woman welfare manager has general charge of
the welfare of all the girls employed by the company.
Each plant also has its own woman welfare manager who
reports directly to the Plant Manager. The Elmwood

plant also has several floorwomen or forewomen distributed through the building. One has charge of the new workers as they come from the employment office and has general supervision over them during their training period in the balcony school. The others have general oversight of the workers on the factory floor, and over the lavatories and rest-rooms of their section of the factory.

There is a Red Cross Station in the center of the Elmwood plant consisting of a consultation room, two rooms containing several beds, one for women and one for men employees, and a supply room with medical supplies, apparatus, sterilizing equipment, etc. Three doctors and two nurses and several first aid men were employed at the time of the visit, but plans were completed for the introduction of a large corps of nurses.

Lunch counters are distributed through the different parts of the plant where the workers line up at noon and buy food or sweets. An excellent cafeteria in a separate building is patronized by the clerical and administrative force, but the industrial workers sit about in their workrooms and eat lunches brought from home, supplemented by what they buy at the small counters in the factory.

The Churchill Plant.

A woman welfare manager, who is a trained nurse, looks after the health and welfare of the workers in this plant.

She has a small office in which she has a few first-aid remedies, a desk, a couch, and a chair or two, but has not adequate facilities to care for the girls who need treatment, nor has she an assistant to leave in the office when she is out in the factory. No doctor is stationed in this plant. Much less provision is made for the health and comfort of the employees in this plant than in the new Elmwood plant.

One small room on the balcony contains a coat room filled with long racks on which are hung coats, hats, street clothes, and along one wall are six wash basins. An adjoining room contains several toilets. The rooms are small and crowded and quite inadequate for the 225 girls who must use them. No arrangements are provided for a warm lunch.

Ventilation.

The making of airplanes is, on the whole, a very clean industry. In the machine shops, the brazing, welding and soldering departments and in the varnishing and the doping room the women work on processes that involve grease and oil, heat or fumes. Only in the machine shop do women sit or work close together. In general the workers are employed on large parts so there is a great deal of floor space all around as well as air space above for each worker.

The Elmwood plant is so large, the ceilings so high, and the workers so scattered in most parts of the factory that the air is fresh and ventilation does not seem to be a problem. Many of the big doors are open and the panes of glass in the sides of the building can be adjusted to let in air. The doping is done in a separate room and the doors leading into the other work rooms are kept tightly closed so the fumes of banana oil do not spread through the factory.

In the Churchill plant, conditions are much less favorable. The building

is old and inadequately lighted and ventilated. In some parts of the machine rooms, the girls work close together in rows with scarcely room to pass down the small aisles between them. In the main workroom the doping is done right in the middle of the room, so all the workers on the other processes must breathe the fumes. No exhaust system is provided to carry off the heavy air, and the few windows do not solve the problem.

Doping.

Adequate ventilation in the doping room is a real problem. While good ventilation is a most important factor in securing efficient production in any department, it is especially important in those occupations carried on in the midst of heavy fumes and odors. Windows and doors are not supposed to be open in the doping room as currents of air carry dust and are said to make white spots on the drying wings.

The "dope" looks like a thick varnish which is spread over the linen covered wings to tighten the cloth and make it water-proof. It has the strong odor of banana oil. It consists of a cellulose compound, either acetate or nitrate which are not poisonous but which must be dissolved in a volatile compound. These solvents have proven in the European countries to be more or less poisonous and have shown bad physical effects on the nervous system, on the liver, kidneys or heart muscle, or on the blood. ^{1/}

^{1/} See Dr. Alice Hamilton's description of the various dopes used in covering airplane wings in Dope Poisoning in the Making of Airplanes, U. S. Bureau of Labor Statistics, Bulletin February 1918, n. 37.

The tetrachlorethane, similar to but more powerful than chloroform, which was first used as a solvent has been abandoned and acetone, alcohols, and benzols are now used. Dr. Alice Hamilton reports that there is little reason to expect serious poisoning among the users of these dopes, but the slow chronic effects of long continued exposure to effects of these solvents should be mitigated in every way possible. British experience led to a series of recommendations for the control of doping in airplane factories, which were issued by the Factory Inspection Department of the British Home Office in February, 1916.^{1/}

Although these recommendations were framed for the users of tetrachlorethane dopes, they have continued to be applied since safer dopes have been substituted.

The recommendations provide for

1. Exclusion of other work from the doping room;
2. Alternation of employment- every two days or

^{1/} See extract from Government Regulations in Monthly Review of the Bureau of Labor Statistics; February 1916, p.29.

every week. One factory, however, is reported to alternate the women's work after two hours on doping.

3. Fortnightly medical examinations.

4. Prohibition of eating in the doping room or remaining in the work room during the time allowed for meals.

The Navy Department prescribes^d a dope for the wings of its hydroplanes of two coats acetate and two coats nitrate. The Army requires four coats acetate for the battle planes, since the nitrate is inflammable. For training planes which are made in the Churchill plant the Army also uses two coats of acetate and two of

nitrate. The acetate is much more expensive than nitrate.

All the doping in the Elmwood plant was done in the big separate doping room which was so large that one could scarcely recognize people at the opposite end. Two sides and the roof were made of glass, and the room was shut off from the rest of the factory by a brick wall and by heavy sliding doors which were kept closed. Slotted openings about 18 inches square in the floor are supposed to carry off the fumes of the dope by suction from under the floor, but they are filled with dust and thread and seemed to have no suction. Large pipes also open into the room near the ceiling to provide circulation of air.

At the time of both visits to the Elmwood plant, several large windows and double doors opening outdoors were wide open. The atmosphere of the room was not oppressive but the dopers inhaled the fumes more than a visitor as they worked on the wings.

In the Churchill plant, the doping was done right in the midst of the other operations in

the center of the big main workroom. No special arrangement was made for carrying off the heavy air or odor of banana oil.

Washing facilities.

Some of the workers of the doping room gathered in small groups at the noon period and ate their lunch in the doping room, apparently without washing hands or face.

No facilities for washing were observed in the doping room though these girls had access to wash-rooms in other parts of the building. But the wash-rooms are on the balconies at the top of a long flight of stairs and about 80 girls are assigned to one small wash-room which may have explained their negligence.

At the time of the first visit, the dopers did not wear gloves and probably had to use turpentine to get the dope off their hands, but in August the majority wore large cotton gloves. Several of the dopers and painters were young girls of 20 or so who worked on the smaller parts of the wings.

Uniforms.

In both factories the girls wear cotton khaki uniforms, full bloomers and a waist with open neck and sailor collar. The plan is to provide each worker with a uniform, after which she must supply her own. In the

doping room, the management plans to provide a new uniform every two weeks and also to provide sneakers for their feet, as the workers are soon covered with the varnish which cokes on their clothes and is most unpleasant. One of the dopers, however, said she has been wearing her uniform a month.

The shoes are the most difficult part of the girls' dress to adapt to the new conditions. Most of the girls insist on wearing light-weight kid shoes with high French heels and some of the machine operators even wear white shoes. These are not only very bad for the girls' feet if she stands all day, but positively dangerous where she is operating machines and climbing over the airplanes. All plants introducing women workers into the mechanical departments are having this difficulty.

Wages.

Three wage rates are established on an hourly basis for the industrial women workers. Beginners start on the initial rate of 25 cents an hour, are advanced to $27\frac{1}{2}$ cents an hour and the average rate for experienced workers is 30 cents an hour, few receiving more than this.

The factory was running on a nine-hour day and 50 hour week at the time of both visits in May and in

August 1918, which would net a weekly wage of \$13.00 for beginners and \$15.75 for experienced workers. Access to the payrolls was not given the investigator but it is obvious that this hourly rate and weekly income is very low and is much lower than that paid in the Philadelphia Aircraft Factory under the Civil Service wage schedule.

Hours.

Three shifts of workers begin and end their nine-hour day half an hour apart- one set beginning at 6:30 A. M. and closing at 4:30 P. M., another beginning at 7:30 A. M. and closing at 4:30 P. M., and the third set beginning at 7:30 A. M. and ending at 5:00 P. M. Office and clerical workers begin work at 7:45 A. M. and close at 4:45 P. M. making an eight and one-half hours day. There is a half-hour noon recess from 12:00 to 12:30.

Early in the spring of 1918, the Curtiss plant was granted exemption from the six day week requirement of the New York State law and allowed to employ men seven days a week. This exemption did not apply to women.

The women workers are however sometimes required to work longer than the nine-hour day and 50 hour week for which they are paid time and one-half. No detailed study of the amount of overtime could be made.

CHAPTER III

PROCESSES OF MANUFACTURE.

Women's Work.

Fifteen hundred women, about 10 per cent of the working force were employed in May, in the North Elmwood plant, and 224 in the Churchill plant.

The Curtiss factory and the Philadelphia Naval Aircraft Factory have ^{each} introduced women on some processes which the other has not. In the Philadelphia Naval Aircraft Factory, the policy has been to increase the number of women on the woodworking processes where they were first found to be successful, and to which the training school has given special emphasis. They are now employed in building the boat, they are being introduced on the band saws, and do the larger part of the wing assembly. In the Curtiss factory, the tendency has been to try them on practically every department, so many more women are found on metal working machines and metal processes than in the Naval Aircraft plant. (More men are working on the assembly of the wings, and they are building the boat body entirely in the Curtiss Plant.)

The final assembly of the airplane, installing the engines and tanks, putting on the guns, bomb thrower,

fan pump, controls, etc., attaching the propeller, wings, tail unit and elevators, - is still done entirely by men. Mechanical knowledge, skill, experience and strength, which the women have not yet acquired, are the fundamental requisites for this final stage of assembling the airplane.

Much of the metal work is concerned with making and preparing the small metal parts either by hand or on comparatively simple metal working machines which women can operate as well as men. The heavier metal processes are done by men. ~~Assembling the panels or wings, covering the wings, except for pulling and stretching the linen covering over the largest wings, can be easily done by men.~~ Assembling the panels or wings, covering the wings, except for pulling and stretching the linen covering over the largest wings, can be easily done by women. The varnishing and even the doping of the smaller parts of the wing made no special demands on the physical strength of the workers. The painting and wrapping of the wires and metal parts are also done by women. Inspection of the small parts seems also to be well done by women.

The fundamental characteristics of women's work in the production departments of the airplane factory are much what they have been in the older industries - processes which can be explained, taught and followed with increasing skill and ease, but in a fairly mechanical way and without any special physical or

intellectual requirement.

The making of airplanes is so new and unstandardized and the organization has had to be developed under such pressure for speed and output, that the casual visitor, as well as the management, can see many things which might be changed or improved. Certain processes are done by hand, or by crude mechanical means, which in an older and more established industry would be done by machine. But the parts of the airplane are so little standardized and new styles and new methods are being developed so rapidly that mechanical tools for some of the small metal parts could scarcely be made before something new would have been substituted.

Occupation Groups.

The processes on which women work in the Curtiss plants may be grouped roughly in nine main divisions:

(1) Inspection of small parts and continuous inspection through the progressive stages of assembly.

(2) Metal Work, including the operation of a great variety of machines; bench work; wirework; filing; soldering; welding and brazing; copper-

cutting, tipping and riveting, and most of the processes dealing with small metal parts.

(3) Woodwork, including the operation of woodworking machines; bench work, glueing together the wooden parts, preparing the webs; finishing and tipping the propeller; assembling the panels; making the wing float and the fuselage of the plane.

(4) Varnishing and finishing the wooden parts.

(5) Wing covering, hand and machine sewing, tacking, taping, fraying and glueing;

(6) Doping and painting the wings, ailerons, elevators, etc.

(7) Light final assembly- attaching metal fittings to the wings, wiring the wings with wireless and electric light installation, etc.

(8) Shipping, greasing and wrapping all metal parts;

(9) Electric truck driving.

Processes.

The Elmwood plant, employing 1500 women had no record of the number of women employed in the various occupations, nor does the occupation appear on the payroll. The following list prepared by the educational director shows the various occupations on which men and women were employed in the plant, but does not give the number on each occupation.

TABLE I SHOWING OCCUPATIONS ON WHICH
MEN AND WOMEN WERE EMPLOYED IN PRODUCTIVE DEPARTMENTS
IN THE CURTISS PLANT JULY 1918.

<u>METAL</u>	Men	Women
Machine		
Chopper Hands	M	
Drill Press Operators		W
Lathe Hands	M	
Milling Machine Oper. (Hand)	M	W
Milling Machine Oper. (Machine)	M	W
Punch Press Oper.		
Profiling	M	
Jig Sawyers	M	
Screw Machine Oper. (Hand)	M	W
Screw Machine Oper. (Automatic)	M	
Shears Operators	M	
Scribing (cutting with sharp hard tool)		W
Grinder Hands	M	
Shaper Hands	M	
Set up Hands	M	
Tube Shop		
Bench Filing	M	W
Dip Brazing	M	
Drill Press Oper.		W
Lay out men	M	
Hand Screw Machine Oper.		W
Acetylene Welding	M	W
Bench Machinists	M	
Tube Bending	M	
Tool Makers	M	
Blacksmiths	M	
Sheet Metal		
Bench Filing 1st class	M	
Bench Filing	M	W
Machine Filing		W
Bench Forming	M	
Dip Brazing	M	
Spot Welding	M	

Bench Assembling	M	
Drill Press Oper.	M	
Bench Machinists	M	
Lay out men	M	
Heavy Bending	M	
Acetylene Soldering	M	
Acetylene Welding and Brazing	M	W
Roustabout (mechanics)	H	
Tin Shop		
Bench Forming	M	W
Riveting	M	W
Soldering	M	W
Shearing Machine Operators	M	
Punch Press Operators	M	
Drill Press Operators	M	W
Hand Cutting	M	W
Scribing	M	W
Trip Hammer Operators	M	
Heat Treat		
Furnace Operators	M	
Central Station Operators	M	
Carbonizing Packer	M	
Cyaniders and Tool Hardeners	M	
Sand Blast.		
Hose Room Operators	M	
Hand Cabinet Operators	M	
Tumbler Operators	M	
Laborers	M	
Polishing		
Grinding	M	
Polishing	M	
Plating		
Plating	M	
Helpers	M	

Washers	M	
Tumbler Operators	M	
Stringing		W
Enameling		
Spraying	M	
Stringing		W
Dipping and lacquering	M	
General Utility	M	
Wire		
Splicing		W
Wrapping	M	
Cutting	M	
Soldering	M	
Tinning	M	
Lay off men	M	
Dipping (lacquerers)		W
Straightening	M	
Tagging		W
Rough Mill		
Lumber Handlers	M	
Auto Planers	M	
Band Sawyers	M	
Swing Sawyers	M	
Rip Sawyers	M	
<u>WOOD.</u>		
Beam Mill		
Boring Machine Operators	M	W
Routing	M	
Band Sawyers	M	
Rip Sawyers	M	
Finishing Sawyers	M	W
Auto Sticker Oper.	M	W
Auto Shaper	M	W
Hand Shaper	M	
Team Box Hands	M	

Temponing Machine Operator	M	
Cut off Sawyers	M	W
Markers and Nailers		
Bench Workers	M	W
Drilling	M	
Nailing Machine Operator		W
Glueing	M	W
Helpers (misc)	M	W

Miscellaneous Wood Mill.

Planer Operator	M	
Drill Press Operator	M	
Band Sawyer	M	
Rip Sawyer	M	
Swing Sawyer	M	
Finishing Sawyer	M	
Auto Sanding Machine Operator	M	
Auto Sticker	M	
Hand Shapers	M	
Stampers		W
Helpers	M	
Cut off Sawyers	M	

Propeller.

Hand Forming and Balancing	M	
Copper Tipping	M	W
Glue Room Hands	M	
Band Saw helpers	M	
Lay out men	M	
Copying Lathe operators	M	
Pattern Makers	M	
Auto Planers	M	
Hand Riveting		W
Band Sawyers	M	
Soldering and Scraping	M	
Fabric Tipping	M	W
Hubbing	M	
Copper Cutting		W
Assembling	M	
Dry Kiln Operator	M	
Finishers (Varnishers, rubbers, fillers, etc.)	M	

Strut

Assembling (Bench	M	W
Bench Work		W
Cabinet Making	M	
Coppering	M	
Finishing Sawyers	M	
Copying Lathe Operator	M	W
Turning Lathe Operator		W
Bent Sanders	M	W
Boring Machine Operators	M	W
Over Lathe Operators		W
Locket Fitters	M	W
Checkers	M	W

Paint.

Dippers - Rubbers, Fillers, Varnishers	M	W
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ASSEMBLY

Dope

Doping (Star transferring, etc.)	M	W
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Cover

Linen Cutting	M	
Hand Sewing		W
Machine Sewing		W
Upholstering	M	
Stretching and Tacking	M	
Tape Fraying		W

Panel

Wire Assembling	M	
Assembling (Panel, Aileron, Rudder, Stabilizer, tail unit	M	W
Bent Edge Assembling	M	
Coppering	M	
Repairing	M	
Tape Wrapping, veneering, web and cap assembling	Boys	W
Wireless installation		W

Final Wing

Floor Assembling	M	
Bench Assembling	M	W
Lining up (roustabouts)	M	
Coppering	M	W
Painting	M	W

Small Parts.

Bench Assembling	M	W
Painting	M	
Coppering and soldering	M	
Stream lining		W

Fuselage Assembly

Jack assembling	M	
Parts assembling	M	W
Assembling helpers	M	
Trueing	M	
Floor assembling	M	W
Wire Assembling		W

Final Assembly.

Installing motors	M	
Installing cintrolls	M	
Installing gas and oil lines	M	
Installing instruments and appurtenances	M	
Cowling	M	
Veneering and miscellaneous floor assembling	M	W

Testing

Testing, adjusting, etc.	M	
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Shipping

Nailing, sewing, greasing,	M	W
Miscel. work	M	
Mechanics	M	

BOAT.

Boat Hull

Woodworking (machine)	M	
Boat Building	M	
Coppersmiths	M	
Wing float makers	M	W
Canvassing	M	
Painting	M	
Sub - Assembly (Miscel.)	M	W

Final Boat Assembleys

Motor installation	M	
Tanks installation	M	
Engine Section Panel Assembly	M	W
Engine Bed Assembly	M	
Instrument and Appurtenances assembly and installation	M	
Tail unit erection	M	
Engine Section erection	M	
Stays installation	M	
Installation (Pipe-manufolds, bomb dropper, venturi meter, fan pump, controlls, floor, hatch covers, gun mounts)	M	
Ignition Wiring	M	
Testing	M	
Clean up and miscel.	M	W

In the Churchill plant the women were employed in the following departments in May:

TABLE II SHOWING OCCUPATIONS IN WHICH WOMEN WERE EMPLOYED IN THE CHURCHILL PLANT IN MAY 1918.

<u>Department.</u>	<u>Number women employed.</u>
Inspection	29
Small parts	54
Drills	10
Copper	18
Wire	38
Stores	12
Panels	3
Webs	19
Cover	23
Final Wing Assembly	7
School	<u>31</u>
Total	224

30

Description of Principal Processes.

Inspection.

Inspection is one of the most responsible occupations in the making of the airplane, since the weakness of any part may mean the fall and collapse of the machine as well as the life of the pilot and the observer.

Initial Inspection. Every small metal part, screw, bolt, or turnbuckle which goes into the airplane is inspected by a force of girls who measure and test each part, with scale, micrometer or calipers to see if they conform to blue print specifications. Inspectors The/ sit on stools at tables, take the small metal parts from the boxes or cases, and measure them according to all the specifications of length, width, number and accuracy of threads, etc. So, too, the wooden parts, the webs of the wing, the fuselage struts, the panel struts, the parts of the wing floats or pontoons must be carefully tested according to definite specifications.

Inspection of each process. After each important stage of assembly, the airplane is also

Processes already described in Part I are not described again in Part II.

inspected. For instance, the cables, the splicing, soldering, and wrapping of the ends of the cables used both in the wings and fuselage must be carefully inspected. The exact number of threads in the wrapping are counted through the thin veneer of solder. A single cut or broken thread might mean the fall of the airplane under any special strain. The cables of the English model ^{S E 5} soon to be produced at this plant are spliced in a very scientific way so the loose end is woven into the wire rope as firmly as if it were an original part of the wire rope. In this case the wrapping and soldering are eliminated.

The joints and metal fittings of the fuselage or skeleton framework of the body of the airplane are inspected to see that they are perfect in form and shape; that the screws are all in, the metal clasps firm, and that the wooden beams ^{or struts} have not been cracked.

The panels, ailerons, elevators, tail piece, wing floats, and other parts are each inspected before they are assembled in the body of the plane.

Occupations in the Metal Working Shops.

Machine Processes.

One large machine shop room in the Elmwood plant is filled with machines of all kinds most of which are operated by women. The machines are set close together in rows or aisles with adequate space in the Elmwood plant but crowded in the smaller work rooms of the Churchill plant. The women sit on high stools with low backs before most of the machines.

These women machine operators are making the many small metal parts and fittings which join the parts of the airplane. They are operating punch presses, drill presses, single and double spindles, power milling machines, hand milling machines, filing machines, lathes and ^{hand} screw machines,

Experience on operating the lathes, milling and screw machines provides the woman with a valuable mechanical equipment which can

be used in almost any machine shop, if she learns to set up her machine for different purposes, acquires a knowledge of the requisite mathematics, and learns how to read the mathematical tables which the skilled machinist used in setting up the machine.

At present, the women who operate these machines are not taught these fundamental principles. They simply follow instructions for making a particular metal part or fitting. When a new part is required, the foreman must help them set up their machine and give new instructions which the workers follow.

Hand Processes.

Bench work and hand processes on metal

work also occupy a large number of girls. Light bench work such as ^{bench} filing, riveting, fitting, assembling, and soldering metal parts; bench forming, riveting and soldering the lids of the gasoline tank; scribing or cutting with hand tools ^{the} copper tips for the propellers; cable splicing; wrapping and soldering; bracing and acetylene welding, are all new processes on which women have been introduced within the last year.

Filing. →

A certain amount of hand-filing is always necessary to smooth the edges of small metal parts, metal fittings for the fuselage, bolts and screws, when they come from the tool cutting machines. The piece of steel is clamped in a vise. The worker takes hold of each end of the long file and files the metal piece until the edge seems smooth. It is then rubbed on a piece of steel covered with color. If certain spots show the color the

edge is not yet even. When the whole edge shows an even color the edge is straight. This can be done sitting on a high stool before the bench or table but is often done standing and involves a good deal of muscular exertion.

Copper forming, riveting and soldering.

Girls shape, rivet and solder the lid of the gasoline tank, which is about two feet in diameter with cross bars which must be riveted and soldered; and attach such other small metal parts as are required. The girls sit before tables on high stools, put in the rivets with the usual small hand riveter, and solder the edges of the cross bars to the top of the lid. Men make the gasoline tank which is about three feet high and two feet in diameter on which the lid fits.

Scribing or Cutting Copper Tips and tin plates.

Large copper plates or tips are fitted over the ends of the propeller of the flying boat. These are cut out with a pattern by sharp hand tools and as they are being continually

changed in size and shape. Tin plates or supports are cut in much the same way.

† Cable splicing, wrapping and soldering. The ends of the wire cables or ropes which are stretched diagonally back and forth from beam to beam in the wing and the fuselage of the plane are looped over and fastened down by wrapping and soldering in the Bristol fighting plane and by splicing the threads of the wire rope in the British S E 5. An expert can splice five loops in an hour. For a beginner it requires about 30 minutes to splice one loop. The latter method was just being introduced at the time of the last visit in August. The British experts say women do this splicing much better and more rapidly than men though the sharp pointed wires prick their hands viciously at first until they have become hardened.

Brazing and oxy-acetylene welding which are comparatively new processes in industry are decidedly new openings for women workers in America. The process is fairly familiar to all interested in industrial work. The girl sits in this factory before a small table on which is placed the metal parts to be welded. She holds in one hand a small blow pipe which leads from an acetylene tank. The hot flame formed by the

combustion of acetylene and oxygen which issues from the pipe is turned on the brass, steel or soft metal wire which she holds near the junction of the two metal parts or edges. The wire melts and forms a soft liquid metal which joins or welds the two edges together.

In welding, the two pieces or edges of metal are joined together by heating them to an intense degree of heat and adding steel wire which melts and welds the parts together. In brazing the two metals are brought to a "cherry red" glow and joined by the melting of brass wire.

These girls wear khaki uniforms or overalls, caps, gloves and a special kind of dark goggles which protect the eyes from the glare of light and from the sparks which fly in all directions. The girls are instructed while in the training school to keep their hair tucked tightly under their caps, which some do not do after they get out in the work-rooms. There is a continual shower of sparks though they are said to be harmless and not inflammable.

Stringing and Dipping. One of the least skilled processes is stringing small metal parts which are to be dipped into lacquer on long wires preparatory to dipping which is done by men.

Occupations in the Woodworking Departments.

Women are employed on a great variety of woodworking processes, requiring varying degrees of skill, some of which have been more fully described in Bulletin 4, Women Workers in the Philadelphia Naval Aircraft Factory.

The Millroom.- Women are running a few woodworking machines which smooth and finish the struts, bore the stringer hole in the center web, and nail the wooden supports on the webs, but here the Philadelphia factory, women's work in as in the mill room is largely hand finishing.

They are sandpapering and smoothing by hand the webs, stringers, struts and propellers which have many rough edges when they come from the woodworking machines. They are riveting the copper tips on the leading edges of the flying boat propeller, and covering some of the airplane propellers with fabric strips. They also rivet the metal strips or bands on the struts, wrap the ends with adhesive tape and varnish the whole with a brush.

These wooden parts of the airplane have been fully described in Bulletin No. 4, and need only brief mention here.

The webs constitute the ribs of the wings. They are made of three open-work strips of thin spruce

wood, a nose web, a center web, and a tail web. These webs are strengthened by small wooden slabs glued and nailed by girls between the openings and held together by upper and lower cap strips extending the length of the three webs. These cap strips are also glued and screwed on the webs by women workers. The web is set in a frame or jig. under a nailing machine, the cap strip is fitted to the edge of the web, and the nailing machine nails or screws the cap strip to the web.

The stringer is a long wooden rod which extends the length of the wing or panel through a hole bored in the upper and lower edge of each center web by girl workers who operate the "boring machine."

The struts are strong wooden supports inserted at intervals between the beams of the wings, or between the upper and lower wings or in the fuselage to give additional strength.

The propeller of the airplane is made of finest mahogany wood by a most complicated process. About a dozen boards are glued together, allowed to stand in a certain temperature a definite length of time, then put into a woodworking machine which shapes out the two blades according to specifications. These blades are about five feet long and are placed on tables

before which girls stand and smooth off the surface with scraping tools and sandpaper. When smooth, the propellers are given an oil finish, varnished and hung up on hooks for days to test for balance and accuracy.

The Propeller Room.

The propeller of the flying boat is usually tipped with copper plates on the leading edge to give additional strength and prevent cracking or breaking if the propeller should strike the water. The propellers of some airplanes are wrapped with fabric and varnished, but some are neither tipped nor wrapped, according to the use for which they are designed.

Copper tipping- The copper plates are riveted by girls on the leading edge and end of the propeller. Men turn over the outside edge and smooth it down. Girls then solder over the rivet holes and scrape the surface smooth. They stand at their work side by side with the men who are also working on the propeller.

Fabric wrapping. The propellers which are tipped with fabric are wrapped with strips of linen or cloth by girls and varnished or painted for additional security.

Panel Assembly.

~~Panel Assembly~~ - Women do not occupy as large a place in assembling the panels or wings in the Curtiss plant as in the Philadelphia Naval Aircraft Factory. However, the women work beside the men in assembling the wing panels, the ailerons, (or stationery wings next to the body), the rudder, the stabilizers and the tail unit. All these are made of the lightest wooden webs, slats, or beams which are set in place, glued and screwed down. This woodwork constitutes the skeleton of the several parts of the plane.

The assembly of the wing panel has been described in detail in Bulletin No. 4. A brief summary only is given here.

Placement of the two beams or back bones of the panel on a long table.

Fitting the webs at proper intervals.

Glueing and nailing the webs to the beams.

Fitting the stringers through the center webs.

Squaring up the panel with trammel.

Fitting the leading edge of the panel.

Fitting in intermediate webs.

Putting on the veneer over the leading edge.

Fitting the trailing edge.

Putting in struts, plates, wires, supports,
wireless and electric light installation.

Wing Float Assembly.

Wing Float Assembly. Wing floats or pontoons which are attached to the under side of the wings of the flying boat are made entirely by women. At full capacity 100 girls were employed on this process alone. These are boat shaped, water tight boxes of the lightest wood with flat upper and lower surface. They are about three feet long, one and one-half feet wide at the broadest, tapering to a point at each end and about one foot in height. The processes are as follows:

Making the keel- Fastening three light bow-shaped strips about six inches apart into the two wooden ends of the wing float.

Laying the keel-on a wooden frame shaped to fit the side of the float, which is built on its side.

Clamping in the center wooden supports which are thin open-work wooden plates resembling the web of a panel in construction and which are screwed to the keel strips.

Attaching the wooden bow-shaped strips which

constitute the skeleton for the upper side to the ends and center supports.

Putting in the nail holes on the edges of the wooden side wall which is a single piece of thin wood, about three feet long and one foot wide curved to fit the side of the float.

Fastening with screws the wooden walls on the upper and lower sides.

Cementing, stripping with linen, and cementing again the edges to make the float waterproof.

Putting the nail holes in the edges of the top and bottom wooden slabs.

Fastening on the top and bottom slabs which are also one thin piece of wood shaped like an ellipse but pointed at each end.

Cleaning the edges with a brush dipped in gasoline.

Bending the copper binding strips in the middle at right angles by inserting them half way in a jig and bending over with a wooden hammer.

Marking the nail holes on the edges.

Fitting the copper strips over the edges of the float.

Riveting down the strips.

Smoothing and soldering the edges.

Attaching small metal parts such as
water outlet etc.

Fuselage Assembly. Assembly.

The assembly of the fuselage or skeleton of the airplane body is light work but absolute accuracy is so important that women have only recently been put on this work even in England. Four long curving beams, two upper and two lower, coming almost together at the tail end, constitute the four edges of the airplane fuselage. It is built on wooden frames or supports, the two lower strips serving as a keel. Light wooden struts, or supports, join the upper to the lower beams, and also connect the two upper and the two lower beams over which is laid a light wooden veneer.

The small wooden struts are placed by women in wooden jigs or patterns where they are fastened together with metal fittings, so they will be joined at exactly the right angle. Men build up the fuselage from these parts. Women also lay the flooring in the fuselage and put in the electric light and wireless installation.

The boat-like body of the flying-boat is much heavier and clumsier than that of the airplane since it is made to float on the water, and women do not work on the flying-boat's body in the Curtiss plant.

V. Varnishing and Finishing the Wooden Parts.

All the wooden parts which go into the airplane are first given an oil finish. In large scale production a brush is not used at all. Over a great trough, filled with oil finish, projects a large wooden drying wheel which looks like a mill wheel, the slats of which are covered with hooks. Women dip the light wooden parts, webs, fuselage, struts, etc., into the varnish with bare arms and hands and hang them on the drying wheel. The wheel moves slowly around with the weight of the new pieces. In the Churchill plant, only one woman dipped the wooden pieces into a small trough of varnish or oil finish after which she hung them on the wall just above the trough.

Wing Covering.

Stitching the linen coverings.

The linen cover of the wing is so large that several strips of linen must be stitched together. The covering is shaped according to the panel it is to fit. The panel is set up on a low wooden frame, and the cover stretched tightly over it, and the edges tacked down with small tacks.

Sewing up the end.

Women sit in specially constructed low wooden chairs with tack and nail pans in the side of the seat, and with upholstered backs, and sew up the loose ends of the panel covering with large curved darning needles threaded with heavy linen thread. Many of the women on this work were gray-haired women and most of them had been seamstresses.

Mid-rib sewing.

After the cover has been put on, the panel is set up vertically with the long edge on the floor. A girl stands on each side and sticks a long three-inch darning needle back and forth, through the wing, fastening the covering to the

ribs by long stitches to make the cover firm in the center of the wing and prevent flapping of the two sides in the air.

Tape Fraying and Cementing.

Strips of linen tape with frayed edges are cemented across the wings over the mid-rib sewing for additional strength. Small patches of linen are also frayed and cemented on the wing where metal attachments are to be put on to give additional strength. The frayed edge is said to hold the tape more firmly and the edges are less likely to come loose.

Doping and Painting.

The wings are still doped with a brush although there is talk of spraying the dope as the paint is sprayed on automobile bodies, gas mask canisters, etc. The chief obstacle is the high cost of the dope and the waste of dope in spraying. The wings are spread on low wooden frame supports. With a tall tin pitcher or dope can in one hand and a large brush in the other, the worker stands over the linen covered wing and varnishes it with many layers of dope. Most of the doping and painting is done by men but several women and girls were doping and painting the narrow stabilizing wings.

Several women were painting the large doped wings with paint which necessitated a very long reach of the arm.

The wings and body of the airplanes for the Army are painted a khaki color, and the wings and body of the flying boats are painted a blue gray color.

Women also transfer the insignia of three concentric rings of red, white and blue from transfer paper to the lower side of the wings.

Light Final Assembly.

When the wing is dry small metal fittings are put on it to which are attached the cables, steel rods, and other devices for fastening the wings to the body and to each other. The fittings are screwed on through the wooden beam.

After the airplane has been finally set up by the men who put in the motors, the propeller, the wings and tail pieces, the cables, the pilot's seat, the steering wheel, etc., every metal part must be wrapped for shipping.

Wrapping.

Women smear the cables, steering gear, and all metal parts with vaseline or petroleum, then wrap them with many layers of tissue paper. Girls climb

up into the body of the machine to wrap the inside metal parts. Nothing that will rust is left exposed to the salt air.

The women do this after the plane has been set on the bottom of the box casing in which it is to be shipped, and while the sides of the box are being built around it. When completed the lid is nailed on, and it is lifted by a huge derrick on the freight car which has been switched into the packing room.

IX Electric Truck Driving.

Women are now driving most of the small electric trucks which run all over the plant, carry boxes of supplies and parts of the airplanes from one part of the factory to the other.

CHAPTER IV.

THE TRAINING SCHOOL.

Training for Industrial Processes.

The training school in the Curtiss Factory was organized in April 1918. The school is in charge of an advisory educational director, a superintendent of the Training Department, a floor matron, and several teachers, mostly women, on special processes.

In the Elmwood Plant. ~~Elmwood Plant.~~

In the Elmwood plant, the school first occupied a long balcony about 50' x 600' in the center of the factory but the space has been increased since then. The school has a capacity for about 200 new women workers who spend a week or a few days according to the degree of skill required learning to run a machine or do a particular process. Part of the balcony is also used as a training school for sailors in the mechanics and repair of flying boats.

In the Churchill Plant.

~~The School.~~
The training school of the Churchill plant is much smaller. It also occupies a part of a balcony and about 30 new workers a week were trained here in May.

The School.

The school gives in miniature and in one place, some conception of the various processes on which women are employed throughout the factory. For here is a machine of each type in which women work, benches, or tables at which the various bench-work processes are being taught; a panel is being set up and another covered with a linen covering made by the machine stitchers. Most of the processes requiring preliminary training or explanation are found here.

The new women workers come from the employment department into the charge of the school matron who has general charge and supervision over them while they are in the school receiving training on some processes.

Training on Production Basis.

The training is done on a production basis and must pass the same inspection as the work done on the production floor.

The product consists of machine parts on order from the machine shop in the plant; wire cables, with ends looped, wrapped, spliced, and soldered; metal parts welded together; lids of gasoline tanks; wings, ailerons, elevators, stabilizers which are made of wood and covered with linen.

Occupations.

Four main occupations were taught in May; metal working occupations both hand and machine woodworking occupations, cloth working occupations, both hand and machine, and doping and painting.

Three materials, - metal, wood and cloth are used in the school.

Processes.

Twenty-four industrial processes were taught in May and the capacity of the school for training workers on each process is shown in the following table:

TABLE III SHOWING PROCESSES TAUGHT AND CAPACITY OF THE TRAINING
SCHOOL OF THE ELMWOOD PLANT, in MAY, 1918.

Processes	Capacity Number Operatives.
Metal-work - Hand processes	72
Brazing and welding	8
Cable Splicing	6
Wrapping	8
Soldering	6
Copper Riveting	8
Soldering	4
Propeller-tip	8
Filing	24
Metal-Work-Machine Processes	12
Drill Press	2
Single Spindle	1
Double Spindle	1
Milling Machine	1
Hand Milling	1
Punch Press	1
Screw Machine	1
Lathe	1
Shaper	1
Power Filing	2
Wood-Work - Hand Processes	74
Panel	56
Strut	12
Fuselage	6
Cloth	20
Power Machine Sewing	8
Panel Covering- Handwork	12
Doping	12
Total	190

Metal Work.

Hand Processes.

Brazing and welding are skilled processes requiring preliminary training to make a perfect weld. About a dozen girls were doing this work in the factory at the time of the visit in May and five or six were being trained in the factory school. Two English women were teaching this process. One had been a silver-smith in England. They were in America when the war broke out, so offered their services and experience in this type of work.

Cable splicing, wrapping and soldering, are hand processes for which 22 girls can be trained in the school. A young English woman who had worked in the munitions factories of Canada teaches these processes. The girls are taught to loop the ends of the heavy wire cables with pincers and secure them firmly by separating and splicing the threads of the rope and wrapping it round and round with wire thread, after which it is soldered over lightly.

Working with metals either by hand or machine is all so new and strange to women, and the tools so

different from anything they have handled before, that an important part of their school experience is getting accustomed to strange tools; flaring blow-pipes, red hot soldering instruments. The next stage is learning to handle the instruments easily and deftly, and the third to recognize the requirements for a perfect product.

Copper riveting, soldering and propeller tipping involves much the same new experience for the girl. She learns to handle the hand rivet, how to rivet the strips on the gasoline tank lid or the copper strips on the propeller blade, how to solder over them and how to smooth off the surface with a sharp blade, until it is quite smooth.

Filing both by hand and by machine can be profitably taught in the school. The girl learns to handle the file, to recognize a smooth edge, and the importance of perfection in details.

Machine Processes.

The machine work is highly specialized, the girl being taught to operate only one machine, except in the case of transfers when the work on

the first machine proves too difficult. In that case, the girl is sent back from the production floor and taught to operate another machine.

Ten different types of machines are set up in the school, a drill press, a single and double spindle drilling machine, a power milling machine, a hand-milling machine, a punch press, a screw machine, a lathe, a shaper, and a power filing machine.

The girl is taught to operate the particular machine on which she is set to work, which may require from two days to a week and as soon as competent, sent out on the production floor.

She is not taught to read blue prints and specifications for setting up or adjusting the machine for a new type of product, but simply to run the machine according to instructions. The girl sits before the machine, puts the piece of metal under the drill. The exact place for the holes to be bored or the part to be milled or cut is usually marked. Setting up the machine is still done by men. The girl worker learns

principally where and how to place the part to be worked up and to turn on and off the power. The lathe is more complicated and involves more mechanical adjustments. These mechanical adjustments are learned and followed by memory.

Woodwork.

The panel department provides a clearing-house for woodworkers of all sorts.

Web-Assembling.

The entering workers are immediately put on the web processes assembling the panel. The first day they merely watch, and the second day begin trying to set in the webs of the wing. They are gradually sifted out. Those showing no special adaptation are sent to the strut, the beam, or the shipping rooms to perform processes requiring less deftness and dexterity.

Struts.

The training for the work on struts is done on the factory floor, one instructor having charge of six pupils. They are taught to sand-paper and smooth the strut, rivet on the copper strips, cover the ends with plaster tape, and varnish the strut with a brush.

Fuselage.

Training for putting together the parts of the airplanes fuselage or body is done on the factory floor, and has been previously described in the Chapter on Processes. The simplest process is putting two parts or joints together by laying them on a jig or pattern which holds them in exactly the right position, and fastening them together by means of screws driven through small metal clamps which hold the joints firm. Much skill is required in putting these combined parts together and putting up the light framework or skeleton of the airplane, which is also done by girls.

Cloth Processes.

Stitching together long strips of linen for the covering of the wings and the leather upholstery of the cushions for the seat requires the type of skill which women have long had, but a small number are especially trained for that process in the factory school.

Panel covering occupies an important place in the training school. A large number are taught to sew the ends of the cover together with a large curved needle. Men usually put on and stretch the cover for the women, holding it tight by means of tacks, but women sometimes do this

on the smaller parts of the wing.

Doping and Painting.

Training in doping and painting is acquired in the doping room, largely through doing it. Several young girls of about 20 were doping the smaller parts and two were painting one of the large wings.

Training for Non-industrial Processes.

Inspection.

A course in mechanical drawing is now given for inspectors, covering one-half day a week for three weeks. The man instructor has worked out a course in drawing, measurements, use of rule, micrometer, calipers, etc., and such mathematics, geometry and blue print reading as are essential to the inspector. The inspectors of wooden parts give half their time to the study of measurements of wood, kinds of wood, uses of the different types of wooden parts, and such facts as they should be familiar with.

Timekeepers.

A two months' course in mathematics is now being given the timekeepers- both men and women- in the factory to enable them to figure correctly the time, overtime, and wages to be paid.

CHAPTER V.SUMMARY.

The substitution of women for men has been found practicable in most of the occupations involved in making airplanes and flying boats. In the Curtiss plants, they have been tried in almost every department and found satisfactory. About seventeen hundred women were employed during the summer of 1918 in two Curtiss plants in Buffalo.

Occupations.

Nine principal occupation groups employed women workers - (1) inspection (2) metal work, (3) Woodwork, (4) varnishing and finishing the wooden parts, (5) wing covering, (6) doping and painting, (7) light final assembly, (8) shipping, and (9) electric truck driving.

Four materials, light weight metals, wood, linen, and varnish, dope, or paint, are used in these processes. Since the primary requisite for an airplane is light weight, most of the materials used are of a light weight. Most of these processes require some skill and experience, and a training school is maintained in both plants to prepare the new worker.

Training.

The training school in the Elmwood plant employing 1500 women had a capacity for 200 learners and the Churchill plant employing 225 women had a capacity for 30 new workers.

Training for industrial and non-industrial processes is given. For the industrial processes preliminary short/training ranging from a few days to a week is given for the hand and machine processes on metal work, wood work, and on the linen wing covers. For the non-industrial workers, longer part time courses of three weeks to two months are given the inspectors and timekeepers.

Conditions of Employment.

The airplane industry, on the whole, involves no special strain or hazards for the women workers. Most of the materials are light in weight and easily handled. The operation of the machines on which women work is comparatively simple and easily acquired.

The physical effects of doping the wings presents new problems with which we are less familiar. England after several years experience with the airplane industry has established specific regulations concerning women's work in the doping room, providing for (1) exclusion of other work from the doping room, (2) alternating employment,

(3) periodic medical examination of the dopers, and (4) requiring the workers to leave the doping room during lunch time.

All the conditions which England attempts to regulate exist in the airplane factories of this country. In the Churchill plant/^{of} the Curtiss factory the doping is done in the midst of the main workroom. Women work of the Elmwood plant nine hours a day in the doping room, and some even eat their lunch there.

Most of the industrial workers spend their half hour lunch period in the workroom. No lunch room is provided for them in either plant, though a good cafeteria lunch room in a separate building is patronized by the clerical and administrative force. Small lunch counters are scattered through the Elmwood plant, where the workers can buy such things to eat as they can carry away with them.

Personal cleanliness is also an important factor in maintaining good health. The girls who work on metal processes get very dirty and need plenty of hot water, soap and towels. In neither of the factories was there adequate dressing space, and washing facilities.

Transportation is a serious problem for the workers in most of the war industries. The workers in the Elmwood plant must depend on a single car line to get them to and from the factory on the outskirts of town. Other large factories in the same neighborhood add to the congestion.

The women workers were employed on a nine-hour day and 50 hour week at the time of both visits in May and in August. Under pressure, however, the factory has worked overtime.

The wage scale for women workers is low and not adjusted to the type of work done or to the degree of skill required. A uniform beginning rate of 25 cents an hour, an intermediate rate of $27\frac{1}{2}$ cents and a maximum rate of 30 cents an hour is established for women workers. This rate nets a weekly income ranging from \$13.00 to \$15.75 which is much lower than the wage scale for similar work prevailing in Government plants.

The airplane industry offers splendid new opportunities for women workers in many new lines. The handicaps described are local and to some extent the result of the mushroom-like growth of the industry which can be adjusted in time. Training, opportunity to acquire

the requisite experience, and time to make the requisite adjustments in these new lines of work are the fundamental problems confronting the women workers and their employers who are struggling under the pressure of changing war demands.