The training programs used by the aircraft industry for training new workers and old employees offer a fruitful field for investigation of new methods of instruction which could be fitted into a high school program.

Apprenticeship training, which had its origin back in the fifteenth century, has been industry's principal method of training skilled workers to meet its normal needs. Unprecedented demands for skilled workers have forced industry to adopt other methods than apprenticeship training to train unskilled help.

Location of the Study

The study was made in Burbank, California, where the Lockheed Aircraft Corporation has developed a very diversified program which provides for the training of engineers, technicians, apprentices, skilled craftsmen, semi-skilled craftsmen, and unskilled workers.

Method of the Study

The writer made personal visits to directors of the trade training classes and to many of the classes held in various buildings in Burbank.

Questionnaires were used during the interviews with these men. The purpose of the questionnaires was to limit the interviews to the items listed for discussion.

The information obtained through these interviews, from personal observation, and from articles taken from trade and professional magazines has been used in writing this study.
These articles, in many cases, have been written for publication by the office personnel from the Lockheed Aircraft Corporation.

Findings

The Lockheed program is effective in:

1. Retraining newly employed engineers and technical men for aircraft work.
2. Training skilled craftsmen by the apprenticeship and upgrading systems.
3. Training semi-skilled men by an upgrading system.
4. Preparing unskilled workers for aircraft work in pre-employment trade classes.

The company uses batteries of pre-employment and post-employment tests. These tests serve as a basis for:

1. Acceptance for employment.
2. Adjustment of employees to jobs.
3. Grouping workers with similar characteristics.

Supplementary subject material is taught for direct application to job uses and not for mental training alone.

All employees receive training in trade ethics which might be summed up as:

1. Developing pride in good workmanship.
2. Doing a day's work for a day's pay.
3. Avoiding cut-throat competition.
4. Avoiding unfavorable criticism of a competitor.
5. Emphasizing safe operative procedures.
6. Keeping up with the latest improvements in materials and production methods.

They also receive instruction in certain aspects of human relations which deal with:

1. Ways of developing cooperative habits among workers.
2. Methods of developing adaptability to work situations and fellow workers.
3. Methods of giving instructions and orders to fellow workers which will meet with willing response.
4. Methods of earning the good will of fellow workers.
A STUDY OF THE TRAINING METHODS
USED BY A MAJOR AIRCRAFT INDUSTRY
IN WAR TIME

by

JOSEPH VERNE MILLER

A THESIS
submitted to the
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A STUDY OF THE TRAINING METHODS USED BY A MAJOR AIRCRAFT INDUSTRY IN WAR TIME

CHAPTER I
INTRODUCTION AND CONSIDERATIONS

Statement of the Values of and the Results Expected From This Study

Job training and the fitting of men to the job have become vital factors in the task of making our nation the arsenal of democracy. At the present time, every industry is making use of some kind of job training program. The aircraft industry especially has adopted a variety of types of training. These range from long-term apprenticeship courses to short-term intensive instruction for single machine tasks, such as drill press operating and riveting. These training programs offer a fruitful field for investigation of new methods of instruction which could be fitted into our high school program.

Training a large number of men to fill the needs of a rapidly expanding production program is a complex and difficult problem to solve. It is further complicated by the induction of large numbers of men already trained into the military organizations of our nation.

It is estimated that a production goal of 50,000 planes per year by the nation's aircraft industry alone will require the selection and training of a skilled and
semi-skilled army of 680,000 workers (28:34). These will be apportioned as follows: 41 per cent skilled craftsmen, 47 per cent semi-skilled craftsmen, and 12 per cent office helpers and administrators.

After World War I, many firms tried using the Army Intelligence tests for appraising applicants and employees. They discovered that such tests did not solve their selection problems. Some firms experimented with aptitude and dexterity tests with beneficial results. At the present time, there is a wide-spread use of multiple testing for intelligence, aptitude, dexterity, and attitude.

Job analysis has been expanded from a mere breakdown of machine operations and manual movements to the place where elements of skill, effort, intelligence, and work conditions are all considered.

The Need for Such Training

The present emergency has arisen after one of the longest and most serious depressions in our economic history. During that period many of the skilled craftsmen drifted into other fields of work. Others lost their skill because of many years of idleness at a time when there were many changes in production methods, with which they could not become familiar by reason of their unemployment.
New workers were no longer seeking training in the skilled crafts because there was no assurance of getting work when the training was finished. Many crafts and unions restricted the number of boys who could take apprenticeship training, because their members considered these boys as probable competitors for their jobs in the near future. Thus, our economic shortsightedness produced the greatest obstacle in our all-out-for-war production schedule.

Blitzkrieg war requires mass production of many kinds of war machines. Airplanes and tanks, which were used only incidentally (26:60) in World War I, have become the principal implements in World War II. Large numbers of ships are needed to carry supplies and troops to battle areas and to replace the many ships being sunk by submarines, mines, and airplanes.

Such an expanding program of production requires the rapid training of greater numbers of skilled and semi-skilled workers than this nation has ever had to train before. The public and private school systems can assist to a large extent; but, because of lack of the necessary machines in the school shops, much of the final training of workers must be done in the production shop.
Methods Used in This Study

The information used in this thesis is taken from material accumulated by personal interviews with directors and instructors of training classes and by a survey of a great many available articles pertinent to the study and published in trade and professional magazines. When personal interviews were held, a questionnaire was used at the time of the interview for the purpose of holding the discussion to the topics outlined.

The questionnaire used when interviewing the directors of training covered the following items:

1. Types of tests used in selecting employees
2. Types of tests used for job placement
3. Kind of instruction offered employees
4. Type of instruction given in human relations
5. Methods used for upgrading workers
6. Method of supplying the class instructors

The questionnaire used when interviewing class instructors covered the following items:

1. The aim of the course
2. The content of the course
3. The order of presentation of content
4. The time allotment for job training
5. Time allotment for supplemental instruction
Location of the Study

There are many aircraft industries in southern California. All of them sponsor job training schools in their plants or in nearby public and private educational plants. One of the first of the airplane industries to institute a planned program of job training was the Lockheed Aircraft Corporation of Burbank, California. Its present training program is as diversified as that of any industry, and for this reason it was selected for this study. The course of training was developed through the cooperative efforts of the company, the Burbank Public School Board, and the State Department of Vocational Education.

Limitations of the Study

When this study was started, our nation was not at war. Since December 7, 1941, airplane plants have been closed to outsiders; and practically all plant classes have been moved to buildings outside the plant. However, many articles have appeared in recent magazines, written by directors of job training and by personnel managers. These articles deal with the problems of job and trade training and thus furnished much useful information for this study.
Terminology

The aircraft industry, like all fast-developing industries, has borrowed or introduced terms which have meanings specifically associated with the industry. Then there are agencies which are usually referred to by an alphabetical group of letters rather than by name. These are listed and defined below:

Apprentice......... An employee whose principal occupation is learning a trade
Anodizing.......... The process of producing a protective oxidized coating on aluminum alloys by chemical treatment
C. A. A. .......... Civil Aeronautics Authority
C. C. C. .......... Civilian Conservation Corps
Dope............... A liquid material applied to cloth surfaces for protection against the elements, for shrinkage, and to reduce surface drag.
Dural............... A shortened term for duraluminum, an alloy of aluminum
Fuselage.......... The airplane structure to which the wing assembly, tail assembly, and landing gear parts are fastened
Hand Bumping...... A process of hand shaping or working sheet metals with composition-type hand hammers
Jig............... A locating device for guiding machine tools or for locating parts during the assembly of plane parts
Layout............. The flat pattern or layout of a part
Lofting............. The process of laying out curves or shapes of the parts of an airplane to full scale

N. Y. A. ............ National Youth Administration

S. A. E. ............. Society of Automotive Engineers

Skin fitting........ The process of applying metal surface covering to a plane

Squeezer riveting.. The process of setting rivets by compression rather than by hammer blows

Up-grading........ The method of promotion from job to job within a department
CHAPTER II
HISTORICAL BACKGROUND OF WORKER TRAINING

A Brief History of Job Training

Ever since the dawn of civilization, men have made the training of their children a definite task of their everyday lives. Training was more or less haphazard until the establishment of apprenticeship training during the fifteenth and sixteenth centuries (22). Ever since that time, apprenticeship training has been the principal source of our skilled craftsmen, its use being widespread during periods of prosperity and the practice falling into disuse during periods of economic depression.

Prior to World War I, apprenticeship training was carried on in manufacturing plants on a moderate scale only. Its principal function was to supply enough skilled craftsmen to meet the needs of each plant rather than to produce a source of supply for national emergencies.

The youths selected were the sons or relatives of workers in the plant. The usual range of acceptable age for apprenticeship was 14 to 16 years.

For instance, an apprenticed machinist advanced through a schedule of training in approximately the following way. During the first six months of training, he swept floors, cleaned benches, oiled machines, and
ran errands. At the same time, he picked up some of the simpler skills through observation, experimentation, and the helpful advice of the shop craftsmen. He also became familiar with the names and the uses of the various machines in the shop. Then he learned the manipulative controls of the simpler machines. The first tasks given to him were jobs on the drill press. Later, as he acquired more ability and experience, he progressed to jobs on other machines in about the following order: the lathe, the milling machine, the shaper, the grinder; and finally to such specialty machines as the turret lathe, the broaching machine, the screw machine, and others.

The economic depression which followed the 1929 stock exchange crash saw the apprenticeship system of training almost disappear from industrial shops. The paralyzing effect of this economic catastrophe threw millions of workers out of jobs.

Since youth saw no chance of skilled craftsmen getting employment, they felt no desire to become indentured for three or four years of training. Moreover, many skilled craftsmen felt that competition was plentiful for the few jobs which were available and had little enthusiasm to take part in, or to give support to a craft training program.

It was not until 1934 that public interest was again aroused in trade training. Several things were responsible
for this new interest in worker training. They were:

1. Increased school attendance because of the lack of employment opportunities. Many of these students were not adapted to academic courses and thus were assigned to shop courses.

2. Rapid increase of Public Works projects, which brought demands for more mechanics than were available.

3. Increasing use of aircraft and expansion of the aircraft industries.

Since there were too few men with aircraft experience available, some of the aircraft companies had begun to give specialized training in their assembly departments.

**Examples of Training in Industry**

**The Douglas Aircraft Company**

The Douglas Aircraft Company, Inc., Santa Monica, California, has for years been gradually adding to its staff men with vocational training. These men were employed as beginners in their trades and acquired their aircraft experience on the job. As the plant expended very slowly, this method of supplying plant needs for mechanics proved to be satisfactory. When aircraft manufacturing methods were stabilized, plant expansion became more rapid; and the demand for experienced workers increased rapidly. Private schools, established near these
plants, were able to provide an adequate supply of men with sufficient training to be employed as beginners. They were not skilled mechanics, but had learned enough of the fundamentals of aircraft construction to qualify for employment. Public demand for this kind of training caused the high schools in the nearby cities to provide vocational courses for pre-employment training.

All of these educational provisions solved the problem of pre-employment preparation; but they did not provide training for upgrading of employees, nor for retraining experienced men to keep up with changes in practice and procedure.

Mechanical experience alone is not a satisfactory basis for upgrading workers, since it involves the trial and error method.

Mr. P. A. Neal (14:11), personnel director of Douglas Aircraft Corporation, Inc., writes:

The problem of upgrading present employees so that they may fulfill duties of responsibility and complexity to form a nucleus or "cadre" of experience to maintain and integrate the activities of rapid expansion is, if anything, more serious than that of pre-employment training. In the aircraft industry, as elsewhere, nothing can adequately take the place of experience, and whereas a job-trained man with proper supervision may take his place in the production line on a detail operation after a very short training period, the foreman and workman who must provide the supervision can do so only if equipped with the knowledge and experience of the work which makes their judgment valid in any situation which may arise.
To provide a solid basis for upgrading, this company has developed a program of in-service training which ranges from apprenticeship courses through specialist programs and company-sponsored classes in high schools and colleges. These latter are offered to eligible employees who are interested in increasing their knowledge and skill.

This company has furnished about 200 employees as teachers in the public schools of Los Angeles county under the National Defense Program. Day workers teach night classes and night workers teach day classes.

The E. I. du Pont de Nemours & Company

The E. I. du Pont de Nemours & Company dye works, at Deepwater Point, New Jersey, first organized an apprenticeship training program in 1921. There were two objectives for the institution of this training: namely, to develop leadership and responsibility and to provide engineering trade training for the sons of older employees. Two boys indentured to learn the machinist trade made up the first class. Their training was given in machine shop practice, foundry work, welding, electrical shop work, millwright practice, and pump maintenance instruction.

The results achieved in this training experiment
were entirely satisfactory to all who participated in the program.

According to the present plan, 20 to 25 young men start training each year. Applicants are accepted semi-annually. There are 61 boys in training now, distributed among 11 trades.

Since 1936, the management has added a study program to the work program. A small classroom, located in the center of the plant, is used for carrying on the study program. Each apprentice spends two periods of 2½ hours each, or 5 hours each week, in classroom work. The youths pay for their books and instruction material. All studying in the classroom is done on company time.

The factors which are considered for eligibility for apprenticeship training are:

1. Satisfactory completion of a high school course
2. Age range between 18 and 21 years
3. Economic conditions of the boy's family
4. Industrial experience in vacation time
5. Physique and health
6. Personality and aptitude

The periods of time spent in each shop are as follows:

1. Machine shop.......................... 37 months
2. Foundry.................................... 2 months
3. Electric shop............................ 1 month
4. Plate shop.............................. 1 month
5. Welding shop............................ 1 month
6. Millwright craft........................... 6 months
7. Pump shop............................... 6 months

Total........... 4½ years

Since the students are older than typical high school youths, many of the subjects taught are more advanced and involved than those taught in the average high school. The following list shows the range of classroom subjects: (9:16)

1. Shop economics
2. Mechanics and machine elements
3. Geometry and trigonometry
4. Electricity and magnetism
5. Theory and construction of motors and generators
6. Electrical measuring instruments
7. Geometrical drawing
8. Machine drawing
9. Machine sketching
10. Materials of construction
11. Physics
12. Gear calculations
13. Hardening and tempering
14. Power and rotary pumps
15. Reciprocating pumps
16. Metallography
17. Metallurgy
18. Mechanical principles
19. Strength of materials

The apprenticeship training program has resulted in encouraging outstanding and far-sighted youths to continue their technical education beyond the limits of the apprenticeship program. It has encouraged workers outside the plant to register for extra educational work. It has offered the goal of a better position in the plant for those who will develop personality and leadership ability.

The Manufacturing Association of York, Pennsylvania

The Manufacturing Association of York, Pennsylvania, as a result of its determination to participate in the manufacture of goods for national defense, has developed an interesting job training program. This company made a very complete survey of the tools, the equipment, the skilled and unskilled manpower, and the training facilities available in York City and York County. This information was carefully analyzed, filed for ready reference, and used for bidding on government contracts.

All-day trade classes were organized in the high schools, and in-service training programs were started
in many of the manufacturers' shops. Refresher courses were instituted for those men who had drifted from the shops to other kinds of work. Night school classes were organized covering such subjects (21:3) as:

1. Tool design
2. Time study
3. Production control
4. Drafting
5. Test calculations
6. Foremanship

This training program has supplied the labor needs of the manufacturers of York to the extent that they have completed 130 million dollars worth of defense contracts.

The Ford Trade School

The Ford Trade School, located at Dearborn, Michigan, was started in 1916 as a one-teacher school. At the present time, it has a faculty numbering 349 teachers. It provides courses ranging from a three-week pre-employment training program to a three-year apprenticeship training program. The school also retrain old employees to fit them for new type jobs. There are facilities for training 12,000 men in the present school.

Among the more advanced subjects (6:41) taught are:

1. Tool and die work
2. Radio
3. Electricity
4. Metallurgy
5. Heat treating
6. Chemistry
7. Instrument testing

Examples of Industrial Training in the Public Schools

The Smith-Hughes and George-Deen Aided Schools

The Smith-Hughes Act of 1917 and the George-Deen Act of 1936 appropriated funds for the promotion of trade and industrial education below college level. The two acts required that any state which received allotments under this act must match the amount received dollar for dollar. The purpose of these acts was to encourage vocational training for gainful employment.

There have been various types of school organizations instituted under these acts. They range from all-day trade schools for those persons who wish to take a complete trade training course to schools which provide specialized intensive training courses for specific jobs.

The Central Trade School. The Central Trade School in Oakland, California, is a typical example of the all-day trade school. This school offers courses (25) in:
1. Body and fender work 11. Soda fountain dispensing
3. Mill cabinet work 13. Pattern making
5. Radio service 15. Millinery
7. Radio telegraphy 17. Dress making
8. Printing 18. Welding
10. Shoe repairing 20. Upholstering

The John Burroughs Evening School, at Burbank, California, illustrates a Smith-Hughes aided specific job training program. It offers classes in:

1. Sheet metal riveting
2. Cable splicing
3. Aircraft blueprint reading
4. Spot welding
5. Detail design and drafting

The National Defense Training Program

The National Defense Training Program was started when Congress, at the urgent request of the United States Office of Education, appropriated $15,000,000 to provide specific training for unemployed workers. This training was to be in occupations essential to the national defense.
This law did not require the state to provide any of the funds as a prerequisite for their expenditure for this defense training. The funds were to be used for classes in all available vocational schools and facilities. Any unemployed person between the ages of 18 to 60 years was eligible for training in:

1. Machine shop occupations
2. Aviation services
3. Manufacturing
4. Automobile service and repair
5. Welding
6. Electrical work
7. Sheet metal drafting
8. Foundry
9. Radio service and repair
10. Forge work
11. Ship and boat building

The N. Y. A., O. S. Y., and C. C. C. were brought within the National Defense Training Program when Congress made an additional appropriation of $26,500,000 for the fiscal year of 1941. Of this amount, $7,500,000 was set aside for training N. Y. A. project employees; $10,000,000 was to be used for training the O. S. Y. enrollees of the C. C. C.; and $9,000,000 was assigned to the United States Office of Education to pay the cost of
short-term engineering courses of college grade in specialized fields essential to the national defense.

The Training Within Industry Division of the War Production Board was organized late in 1941 to assist industries concerned with the national war production effort to meet manpower needs by training men on the job. This program was instituted to train the experienced plant employee in the most effective methods to use for imparting his knowledge to the new worker. The training is free, and there is no cost to the company. The classes are organized by a representative of the local school authorities, with the probable assistance of a representative from the War Production Board.

Group sessions are held within the plant wherever it can be arranged and are held during or outside of working hours. The sessions are accommodated to plant conditions as to time and convenience. They are of equal value for training new workers or present employees to become eligible for upgrading to new skills. About 90 per cent of the training consists of actual practice under close supervision and coaching by institute men. The men certified as trainers in this program are practical men with a background of industrial training experience. They have been specially instructed and prepared for this work by the men who organized this training institute.
All these examples of training, both in industry and under public school supervision, represent a belated effort on the part of the people to correct their national shortsightedness in not providing a training program which would safeguard the nation in an emergency.
CHAPTER III
THE STUDY

The Source of Labor Supply

The demands for labor which followed the conversion of industry to an all-out-for-war program absorbed practically all of the skilled and semi-skilled workers available. Those who were left were unskilled men and women. This critical situation has been instrumental in forcing a rapid expansion of industrial training. One of the first companies to institute a well-rounded program of industrial training was the Lockheed Aircraft Corporation. It has sponsored, developed, and expanded its training program to include all types of job training necessary to meet the needs of aircraft manufacturing. Consequently, this training program offers a fertile field for investigating the factors and methods involved in successful job training.

At the time of this study, the Lockheed Aircraft Corporation employed about 40,000 workers. Approximately 70 per cent (7:103) of the labor power is assigned to production jobs; and 30 per cent to such factory work as clerical, stenographic, accounting, engineering, administrative, and executive jobs.
Men and women secure employment with the company by application to the company offices or by application to the United States Employment Service offices. To qualify for acceptance for possible employment, they are given an intelligence and an aptitude test (20:3) at the places of application. All who are accepted for employment report to the company's employment offices, where they are given other tests, such as physical, psychological, trade aptitude, and physical capacity tests. They are then assigned to the departments for which they are best fitted to begin work.

**Description of the Training Program**

At the present time (November, 1941), Lockheed Aircraft Corporation is sponsoring a very diversified training program, varying from a four-year apprenticeship course to the single-skill type of job, such as riveting, which requires ten or more weeks of six to eight hours per day for completion.

There are sixty four-year indentured apprentices in four different trades, all under the direction of a supervisor of apprentice training. These four trades are:
1. Aircraft machinist
2. Aircraft tool, die, and jig builder
3. Aircraft wood pattern and wood jig builder
4. Aircraft sheet-metal mechanic

Plans have been made to develop courses for apprentice training in three other trades:
1. Aircraft electricians
2. Aircraft painters and processors
3. Upholsterers and trimmers

New engineers and technicians are subjected to an induction training program before they are assigned to the departments where they will work.

New professional engineering graduates from selected schools are put through a year's internship (7:103), with varied practical shop experiences throughout the plant. They are then placed in those departments which can make the best use of their services.

The company collaborates with engineering colleges participating in engineering defense training. It helps them to map out the courses and the curricula for those expecting to major in aerodynamics and aeronautical engineering.

Technical employees who can benefit from the training are directed into such classes as will suit their needs.
Qualifications for apprentice training are:

1. Proof of United States citizenship
2. An age-limit range, 18 to 23 years
3. Graduation from high school
4. Good health and high moral character
5. Evidence of successful work in the trade

The apprenticeship program exemplified a carefully thought out plan of training procedure. In Table I is shown the training program for an apprentice aircraft sheet metal mechanic. It is a representative program of aircraft apprentice training.

The company's plants look to the apprenticeship program as a source of supply of such key men as all-around machinists, tool makers, pattern makers, and supervisors. The minimum starting wage is 30 per cent of the senior mechanic's pay rate. Pay is increased at least six cents per hour every six months. The training consists of thirty-six hours of work experience in the plant and four hours of classroom instruction each week. For those who have had previous experience and training, the apprenticeship training time is reduced proportionately.

At any time during the first 520 hours (17:10) of the training program, the company may shift the apprentice; or the apprentice himself may ask to be shifted from one
line of training to another, if the personal capacity and fitness of the learner are found more suited to such other trade. During the training period, the apprentice is given opportunities to develop supervising ability and to assume responsibility. At the end of this "earn-as-you-learn" period of training, the apprentice is qualified to do the work of a master craftsman.

In addition to the apprenticeship system, the goal of master workman can be attained in another way. It is accomplished through the company's upgrading system. This system permits the workman to progress from job to job within a department and thereby to gain his work experiences. He gets his initial training in the operation of machines such as are used in aircraft production in the National Defense Training classes. These are located near the Lockheed plant and offer many machine shop courses in day and night schools. Training on machines that are too large or too expensive to be found in public or private school shops is given in machine shop classes held within the company's plant. The workman gets his technical instruction through extension courses, through correspondence school courses, or in public school day and night classes.

For example, a worker in the sheet-metal department is ambitious to become a sheet-metal mechanic. He would
### TABLE I

**Training Program for an Aircraft Sheet-Metal Apprentice**

<table>
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<th>Kind of Work</th>
<th>Training Hours</th>
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<tr>
<td><strong>Detail Assembling</strong></td>
<td></td>
</tr>
<tr>
<td>Hand riveting, squeezer riveting,</td>
<td>3,500</td>
</tr>
<tr>
<td>wing assembly, fuselage assembly</td>
<td></td>
</tr>
<tr>
<td>Hand forming, metal fitting,</td>
<td>1,000</td>
</tr>
<tr>
<td>control surface assembly</td>
<td></td>
</tr>
<tr>
<td>Layout work</td>
<td>500</td>
</tr>
<tr>
<td>Sheet metal pattern drafting</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>Power Forming and Rolling</strong></td>
<td></td>
</tr>
<tr>
<td>Shear, brake, roll, punch press,</td>
<td>1,000</td>
</tr>
<tr>
<td>drop hammer, router, inspection</td>
<td></td>
</tr>
<tr>
<td><strong>Hand Operated Machines</strong></td>
<td></td>
</tr>
<tr>
<td>Shear, brake, roll, kick press,</td>
<td>1,000</td>
</tr>
<tr>
<td>inspection</td>
<td></td>
</tr>
<tr>
<td><strong>Special Work</strong></td>
<td></td>
</tr>
<tr>
<td>Production office work, tabulating,</td>
<td>320</td>
</tr>
<tr>
<td>operation sheets, office system work</td>
<td></td>
</tr>
<tr>
<td>in the department</td>
<td></td>
</tr>
<tr>
<td><strong>Total number of training hours for</strong></td>
<td>8,320</td>
</tr>
<tr>
<td>four-year course</td>
<td></td>
</tr>
</tbody>
</table>
start in the sheet-metal department as a burrer or cleaner and then progress through the various stages of work experiences in about the following order (5):

1. Driller and reamer
2. Driller and router loader
3. Router operator
4. Shaper operator
5. Detail assembler
6. Drill press operator
7. Turret lathe operator
8. Hand milling machine operator
9. Radial drill press operator
10. Bench machinist
11. Milling machine operator
12. Tool grinder
13. Engine lathe operator
14. Horizontal boring mill operator

A workman may aspire to work up to a skilled job, such as experimental assembling. He proceeds along the stages of training and education through the following jobs:

1. Riveter and bucker
2. Integral tank tester and riveter
3. Structural assembler and riveter
4. Center section tank riveter and bucker
5. Experimental assembler

A worker may only want to work up to a semi-skilled job, such as shaper operating. His rise would be through the following stages of upgrading:

1. Burrer and cleaner
2. Driller and reamer
3. Drill and router loader
4. Router operator
5. Shaper operator

**Classification of Aircraft Jobs**

Workers in aircraft production are classified into three major groups: skilled, semi-skilled, and unskilled.

The skilled workman is able to do any and all types of work belonging to his field. The following is a list of types of skilled craftsmen with the kinds of work they can do.

The machinist is able to do such jobs as:

1. Drill press work
2. Radial drill press work
3. Engine lathe work
4. Metal bench work
5. Nibbling machine work
6. Boring mill work
7. Grinder work
8. Shaper work
9. Planer work
10. Steel heat treating

The painter and finisher is able to do such jobs as:
1. Dope fabric
2. Use paint spraying equipment
3. Sign painting
4. Touch-up painting

The tool and jig builder is able to do such jobs as:
1. Die casting
2. Die finishing
3. Drill press work
4. Radial drill press work
5. Engine lathe work
6. Turret lathe work
7. Hand milling machine work
8. Molding for making castings
9. Punch press work
10. Steel heat treating
11. Nibbling machine work
12. Tool making
13. Tool grinding
14. Wood working
15. Bench work

The wood and plaster pattern maker and wood jig builder is able to do such work as:
1. Millwright work
2. Model building
3. Metal pattern making
4. Plaster pattern making
5. Wood pattern making
6. Wood working
7. Wood jig building
8. Cabinet making

The sheet metal worker is able to do such jobs as:
1. Hand and power brake work
2. Hand and power roll work
3. Hand and power shear work
4. Hand bumping
5. Power hammer work
6. Router work
7. Riveting and rivet bucking
8. Layout work
9. Shaper work
10. Drill press work
11. Sub-assembly work
12. Sheet metal bench work
13. Skin fitting

The plater and processor must have ability to do such work as:

1. Metal anodizing
2. Cadmium plating
3. Dural heat treating
5. Processing skins, bulkheads, brackets, supports, and castings by various methods of solution, baths, silica sand, and heat treatment.

The gas and electric welder must be capable of performing such jobs as:

1. Acetylene spot and continuous welding
2. Electric welding
3. Metal fitting and cutting
4. Torch tacking and operating
5. Aluminum welding
6. Stainless steel welding
7. Brazing and soldering

The template maker must be capable of doing such jobs as:

1. Interpret blueprints
2. Make extremely accurate layouts on sheet metal, wood and other materials
3. Cut templates with great exactness
4. Draft outlines on materials used for templates

The aircraft assembler must be capable of doing such jobs as:

1. Conduit installing
2. Final assembly
3. Frame building and covering
4. Precision assembling
5. Riveting
6. Spar building
7. Plumbing
8. Rigging
9. Engine installing

The electrician, radio, and instrument man must have the ability to do work involving such jobs as:

1. Wiring
2. Installing instruments and radio equipment
3. Radio building, testing, and trouble shooting

The aircraft trimmer and upholsterer must have the ability to do such jobs as:

1. Developing, fabricating, and applying trim to interior fittings such as seats, pockets, arm rests, cushions, and windows
2. Upholstering and trimming

Qualifications for Skilled Aircraft Workers

An all-around machinist must have ability to understand and to plan a course of action; individual initia-
tive and judgment; patience with and interest in detail and precision work; ability to do calculations involved in the "setting up" of his work; an understanding of materials and equipment; and some knowledge of heat treatment of materials. Preparatory courses which furnish a background for the machinist's trade are algebra; plane and solid geometry; trigonometry; mechanical drawing; machine shop; general science; and physics. Advancement to the goal of master workman requires training in: blueprint reading; trade drafting; freehand shop sketching; trade mathematics; metallurgy; S. A. E. standards; safety precautions; cutting lubricants; trade ethics; human relations.

An aircraft painter and finisher must have ability to do spray painting; brush painting; sign painting; fabric doping; the adjusting, cleaning, and handling of spray guns and equipment; the painting of prepared parts and surfaces such as fuselage, skins, bulkheads, small parts, and assemblies. He must be able to follow instructions and to withstand continuous physical exertion in arm-extended, bending, standing, and stooping positions. Preparatory courses for this job are chemistry and commercial art. Advancement to the goal of master workman in this trade requires: training in blueprint reading; shop sketching; freehand drawing; trade mathematics;
paint chemistry; material specifications; color matching; safety regulations; trade ethics; and human relations.

A skilled tool and jig builder must have a high degree of ingenuity and judgment; good physical development; and ability to work to very close dimensions. Preparatory courses which furnish a background for the trade are geometry; trigonometry; blueprint reading; algebra; mechanical drawing; machine shop; general science; and physics. Advancement to the goal of master workman in this craft requires training in blueprint reading; machine and tool drafting; theory of simple tool design; freehand shop sketching; trade mathematics; metallurgy; material standards; safety precautions; trade ethics; and human relations.

The wood and plaster pattern maker and wood jig builder must have physical ability to withstand continuous physical exertion; ability to work accurately with hand tools; and creative ability to design; all of which require a steady hand. Preparatory courses which furnish a background for this trade are geometry; trigonometry; blueprint reading; wood shop; and general science. Advancement to the goal of master workman in this trade requires training in blueprint reading; shop drafting; trade mathematics; foundry practice; template development; lofting; theory of jig design; theory and operation
of woodworking machinery; safety precautions; chemistry of glues and gluing; knowledge of lumber characteristics; trade ethics; and human relations.

The sheet metal worker must have ability to do precision work; to understand and to plan a sequence of operations; and to cooperate with the engineering department. Preparatory courses which furnish a background for this trade require training in blueprint reading; shop trigonometry; sheet metal drafting; general science; refrigerants; and lubricants. Advancement to the goal of master workman in this trade requires training in blueprint reading; shop drafting; descriptive geometry; trade mathematics; metallurgy; template development; lofting; material standards; material processing; Army-Navy standards; operation study; production and tooling problems; safety precautions; trade ethics; and human relations.

A skilled plater and processor must have better than average judgment and superior physical endurance. Preparatory courses which furnish a background for this trade are algebra, chemistry, and physics. Advancement to the goal of master workman in this trade requires training in blueprint reading; trade mathematics; materials and processing; electro-chemistry; trade ethics; and human relations.
A skilled gas and electric welder must have good eyes; an Army-Navy rating as a welder; ability to interpret simple drawings; ability to sit still for a long period of time; and ability to work with intense concentration under conditions of high temperature. Preparatory courses for this job are blueprint reading; decimals and fractions; and chemistry and physics. Advancement to the goal of master workman in the welding trade requires training in blueprint reading; shop drafting; trade mathematics; metallurgy; template layout; Army-Navy standards; inspection; chemistry of gases; safety precautions; elementary electrical theory; trade ethics; and human relations.

A skilled template maker must have ability to exercise sound judgment; to do a certain amount of independent thinking; to be exact, precise, and patient with detail work. Preparatory courses which furnish a background for this trade are algebra; plane and solid geometry; trigonometry; drafting; physics; and wood and sheet metal shop. Advancement to the goal of master workman in this trade requires training in blueprint reading; shop drafting; applied mathematics; template layout; rigging problems; inspection; trade ethics; and human relations.
A skilled aircraft assembler must have ability to understand and to plan a sequence of operations and to work in cramped positions. Preparatory courses for this job are blueprint reading; geometry; general science; physics; and shop courses. Advancement to the goal of master workman in this trade requires training in blueprint reading; shop drafting; trade mathematics; metallurgy; template layout; material processing; Army-Navy standards; S. A. E. standards; Civil Aeronautics Authority regulations; theory of flight; rigging problems; inspection; trade ethics; and human relations.

A skilled electrician, radio, and instrument man must have ability to understand and to plan a course of action requiring a high degree of individual ingenuity, initiative, and judgment. Preparatory courses which furnish a background for this job are blueprint reading; algebra; geometry; trigonometry; chemistry; physics; and electric shop. Advancement to the goal of master workman in this trade requires training in blueprint reading; shop drafting; freehand sketching; trade mathematics; theory of electricity; theory of radio; theory of instruments; testing; Army-Navy specifications; Civil Aeronautics Authority regulations; trade ethics; and human relations.
A skilled aircraft trimmer and upholsterer must have a high degree of ingenuity, initiative, and judgment. Preparatory courses for this job are a knowledge of fractions and decimals and interpretation of drawings. Advancement to the goal of master worker requires training in blueprint reading; shop drafting; flat pattern making; trade mathematics; material specifications; inspection; safety regulations; color harmony; interior decorating; trade ethics; and human relations.

Qualifications for Semi-skilled Aircraft Workers

Semi-skilled jobs are those requiring abilities to do types of work within a field much smaller than that covered by the work capacity of the skilled craftsman. Preparation for these jobs includes vocational school education and experiences on jobs within the field. It is possible to advance to a foreman's job or to the job of skilled craftsman through extension courses, correspondence school courses, or day or evening classes.

Leadsme (leaders of work groups) and some machine operators are classed as semi-skilled workers.

Qualifications of Unskilled Aircraft Workers

Unskilled jobs are those of a repetitive nature such as riveting and bucking rivets. They require little
skill or responsibility. An unskilled worker should have the same preparation and training as that required of semi-skilled workers.

Mechanics' helpers are classified as unskilled workers.

Advancement is usually made to more responsible and better paying jobs within the unskilled job group, and from there to jobs in the semi-skilled group.

Desirable Factors in the Training Program

The Lockheed Aircraft Corporation's training program fits the educational courses to the job needs of the worker and provides for promotion from time to time. There is also a part of the program suited to the needs of those who desire to take up pre-employment training. No part of this program is forced upon the employees or prospective employees. The workers are kept so well informed of the advantages to be gained by taking such training that most of them avail themselves of the opportunity for advancement.

More than 6,000 employees of Lockheed attend trade extension classes in the Burbank schools.

Some of the factors emphasized in courses in trade ethics bring home to the worker and learner the prime importance of:
1. Developing pride in good workmanship
2. Doing a day's work for a day's pay
3. Avoiding cut-throat competition
4. Avoiding unfavorable criticism of a competitor
5. Emphasizing safe operative procedures
6. Keeping up with the latest improvements in materials and in production methods

How to get along with people is the subject covered in the courses and conferences on human relations. There are many points of interest and value to all workers and learners, such as:

1. Ways of developing cooperative habits among workers
2. Methods of developing adaptability to work situations and fellow workers
3. Methods of giving instructions and orders to fellow workers which will meet with willing response
4. Methods of earning the goodwill of fellow workers by:
   a. Taking a friendly interest in their health, happiness, and outside interests and activities
   b. Praising good work and extra efforts
   c. Being fair in dealing with one another
   d. Giving constructive criticism only
   e. Being courteous and patient with one another
   f. Giving helpful advice when it is requested

Effectiveness of the Training Program

Lockheed's training program was started in 1935. The growth has been rapid, as can be seen from available
statistics shown below:

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Employees</th>
<th>Class Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1935</td>
<td>Not available</td>
<td>70</td>
</tr>
<tr>
<td>1937</td>
<td>Not available</td>
<td>590</td>
</tr>
<tr>
<td>1938</td>
<td>2400</td>
<td>1550</td>
</tr>
<tr>
<td>1939</td>
<td>7000</td>
<td>2150</td>
</tr>
<tr>
<td>1941</td>
<td>40,000</td>
<td>6000</td>
</tr>
</tbody>
</table>

Not all of the new employees who have been hired during the rapid expansion of the plant have received their technical and machine training in the Lockheed-sponsored classes. A great number of them have been trained in private aircraft training schools. A still larger number have received their training in National Defense Training classes located in distant cities. Nevertheless, the fact that all training classes in nearby schools are well attended would prove that the training fits the needs of workers who wish to advance on the job.

Another feature of the Lockheed program which merits consideration is that the company had an organized, effective training program before the establishment of the National Defense Training program; and, as a result of this foresightedness, there was less confusion as to methods of expanding when the need arose.
Tables II and III, which follow, present in chart form a summary of the background or preparation needed by workers in the aircraft industry and the additional training required to advance to the status of master craftsmen in trade fields.
TABLE II
Chart Showing Preparatory Courses Needed for the Aircraft Trades

<table>
<thead>
<tr>
<th>Trades</th>
<th>Drawing</th>
<th>Mathematics</th>
<th>Science</th>
<th>Shop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Blueprint readings</td>
<td>Commercial art</td>
<td>Mechanical interpretation</td>
<td>Shop</td>
</tr>
<tr>
<td>Assembler</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrician, radio, and instrument man</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finisher and painter</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas and electric welder</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinist</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plater and processor</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheet metal worker</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Template maker</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tool and jig builder</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trimmer and upholsterer</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood or plaster pattern maker</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE III
Chart Showing Advanced Training Required to Reach the Status of a Master Aircraft Mechanic

<table>
<thead>
<tr>
<th>Trades</th>
<th>Chemistry</th>
<th>Theory and Practice of</th>
<th>Miscellaneous</th>
<th>Drawing</th>
<th>Shop Practice</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembler</td>
<td>x</td>
<td>x</td>
<td>x x x</td>
<td>x</td>
<td>x</td>
<td>x x x</td>
</tr>
<tr>
<td>Electrician, radio, and instrument man</td>
<td>x x x</td>
<td>x x x</td>
<td>x x</td>
<td>x</td>
<td>x</td>
<td>x x x</td>
</tr>
<tr>
<td>Finisher and painter</td>
<td>x</td>
<td>x x</td>
<td>x x x</td>
<td>x</td>
<td>x</td>
<td>x x x</td>
</tr>
<tr>
<td>Gas and electric welder</td>
<td>x x x</td>
<td>x x x</td>
<td>x x x</td>
<td>x x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Machinist</td>
<td>x</td>
<td>x x</td>
<td>x x x</td>
<td>x</td>
<td>x</td>
<td>x x x</td>
</tr>
<tr>
<td>Plater and processer</td>
<td>x</td>
<td>x x</td>
<td>x x</td>
<td>x</td>
<td>x</td>
<td>x x x</td>
</tr>
<tr>
<td>Sheet metal worker</td>
<td>x</td>
<td>x x</td>
<td>x x x</td>
<td>x</td>
<td>x</td>
<td>x x x</td>
</tr>
<tr>
<td>Template maker</td>
<td>x</td>
<td>x x</td>
<td>x x x</td>
<td>x</td>
<td>x</td>
<td>x x x</td>
</tr>
<tr>
<td>Tool and jig builder</td>
<td>x</td>
<td>x x</td>
<td>x x x</td>
<td>x</td>
<td>x</td>
<td>x x x</td>
</tr>
<tr>
<td>Trimmer and upholsterer</td>
<td>x x x</td>
<td>x x x</td>
<td>x x x</td>
<td>x x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Wood or plaster pattern maker</td>
<td>x x x x</td>
<td>x x x</td>
<td>x x x</td>
<td>x x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

**Process Specifications**

- S.A.E. standards
- S.E.E standards
- S.M. standards
- S.F.E standards
- S.C.A. standards
CHAPTER IV
SUMMARY AND CONCLUSIONS

Summary of Chapter I

The training program of the Lockheed Aircraft Corporation offers a fruitful field for investigation of new and effective teaching methods for adaptation to high school use.

Industry has had to create and to borrow training methods to meet its present requirements for large numbers of skilled and partly-skilled labor.

The material used in this study was obtained by personal visits to many classes devoted to job training, by interviews with directors and instructors of trade training classes, and from articles appearing in trade and professional magazines.

Special trade terms and certain alphabetical abbreviations used in the study are explained on the terminology sheet.

Summary of Chapter II

A review of the types of vocational training in use just before World War II was presented by:

1. A short history of vocational training
2. Examples of representative types of industrial training
3. Examples of Smith-Hughes aided types of vocational training

4. A resume of the types of training being given under the National Defense Training program

**Summary of Chapter III**

Lockheed Aircraft Corporation receives its labor supply from all parts of the nation. Persons seeking employment must pass qualifying tests at their local U. S. Employment Service office or at the company's offices at Burbank, California. After employment, they are given further tests for assignment to jobs and departments.

Lockheed's training program provides for:

1. Adapting newly employed engineers and technicians to aircraft work

2. Developing skilled craftsmen through apprenticeship courses and by job to job upgrading

3. Developing semi-skilled workers by job to job upgrading

4. Giving unskilled labor pre-employment training

5. Schooling in supplemental subjects pertinent to shop jobs

6. Schooling in trade ethics

7. Schooling in human relations which influence production schedules

The Lockheed program is not forced upon the employees but is publicized in such a way that it appeals strongly to them. The fact that there has been a rapid upgrading
of employees who have taken the training is proof that it is successful.

Conclusions

Industrial arts instruction is divided into manipulative and non-manipulative activities, the latter consisting of written and oral instruction. This information may be segregated into the following categories:

1. **Technical information** or that which is needed by a student for manipulative work

2. **Related information** or that which is interesting in a general way but is not essential for success in the manipulative work

3. **Occupational information** or that which the student may use in selecting his life's work

Aircraft manufacturing and maintenance offers a diversified field of employment. The information supplied in this study offers the industrial arts instructor who may also be the faculty guidance expert an overview of:

1. The basic training and schooling needed for each type job

2. The advanced training and schooling needed to progress to the terminal goals in the trades

The writer feels that from this study he will be better prepared to give more adequate counselling to high school youths for the selection of courses and future jobs; to plan more advantageous methods of teaching with
other faculty members; and to incorporate the new ideas concerning human relations in his shop courses.


28. Wright, T. P., 50,000 Planes a Year, Aviation, 39:-34-98, July 1940.
APPENDIX
Strathmore, California  
August 4, 1941

Mr. Svend Pedersen  
Director, Educational Division  
Lockheed Aircraft Corporation  
Burbank, California

Dear Mr. Pedersen:

Your program for training new workers for aircraft work is considered one of the most effective on the West Coast. Undoubtedly, it has many features which we high school shop teachers could use to advantage in our shop classes.

A personal conference with you, at your convenience, and visits to some of your training classes, would be of great value to me in my work.

These are the facts which I would be interested in discussing -- facts about which high school boys are continually inquiring:

1. Kinds of skilled training available in your shops
2. Kinds of semi-skilled training available
3. Amounts of schooling needed to be eligible for these training classes
4. Length of training periods
5. Kind of supplemental training available

I had expected to see you this summer during the Oregon State College Summer Conference, but was told by Dr. Chambers that other urgent duties made it impossible for you to be present.

If it would fit in with your schedules, I could make a trip to Burbank any time between August 6 and September 10.

Very truly yours,

/s/ Joseph V. Miller
August 22, 1941

Mr. Joseph V. Miller
Industrial Arts Instructor
Strathmore Union High School
Strathmore, California

Dear Mr. Miller:

Your letter of August 17 addressed to Mr. Pedersen was received on the day he left for the East Coast and the Gulf states on an extended trip. Upon reading your letter, however, he instructed me to acknowledge it and invite you to visit our department on September 3, 4, or 5, September 3 being preferable, contacting Dr. Albert T. Helbing, the Assistant Director of the department.

Mr. Pedersen sends his regrets for not being able to meet with you but is assured that Doctor Helbing will be able to give you the assistance desired.

Very truly yours,

/s/ Gilbert Weinberger
Secretary to Svend Pedersen
Director, Education Department
Industrial Relations Office
Questionnaire Submitted to Directors of Educational Training

POINTS OF INTEREST IN LOCKHEED'S TRAINING PROGRAM

1. What types of tests are used in selecting employees?
2. What types of tests are used in assigning employees to factory departments?
3. Where does the employee get his machine training, in the plant or in night school classes?
4. Does the worker have additional instruction when he is started on a production job?
5. Where does the employee get his training in trade ethics and human relations?
6. Is there a training program for supervisors and foremen in present-day methods of handling men?
7. Are any department conferences held for workers and supervisors where job difficulties can be discussed?
8. What methods are followed by supervisors and leadmen in getting acquainted with and winning the confidence of their men?
9. How does an employee advance to a more difficult job or to a different departmental job?
10. Does a foreman have to recommend a man for upgrading, or do the records in the office determine when he is eligible for advancement?
11. Are any of the instructors in the vocational classes outside the plant company employees?
12. Are there any special methods followed for censuring an employee?
13. If there any special effort made to gain the loyalty of the employees, so that they will want to stay rather than to drift to other jobs?
Questionnaire Submitted to Instructors of Defense Training Classes

POINTS OF INTEREST IN LOCKHEED'S SCHOOLING PROGRAM

1. Who tells these learners what classes to attend or what job to train for?

2. Will all these learners get jobs?

3. Does a learner have to qualify within a given time in order to be credited with having completed the course?

4. Does he get any help on the job during his first job assignment?

5. Suppose he doesn't like the job that is assigned to him and wants to take a course to qualify for a job he feels he could handle better; could he do this?

6. Who keeps in touch with his progress on the job and in the class-room?

7. Can a learner take classes which do not have any bearing on his job in the plant?

8. Can an outsider take shop work inside the plant if he does not work there?

9. Are you a faculty member of the regular high school staff, or are you an employee of Lockheed?

10. Does a student have to pay anything for the materials used in this course?
## A Brief Resume of the Kind of Work Performed by the Various Workers in the Aircraft Industry

<table>
<thead>
<tr>
<th>Job Name</th>
<th>Kind of Work Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle bender</td>
<td>Forms angles by hand manipulation. Forms extruded sections with the use of various rolling and forming machines.</td>
</tr>
<tr>
<td>Anodic loader</td>
<td>Loads anodic racks with parts and immerses them in separate anodizing tanks under the direction of the anodic operator.</td>
</tr>
<tr>
<td>Anodic operator</td>
<td>Supervises loading of anodizing racks. Regulates and controls time and manner of anodizing while material is in sodium solution, chromic acid solution, or clear water.</td>
</tr>
<tr>
<td>Assembler, final</td>
<td>Installs interior furnishings and equipment of the airplane, fuel lines, wings, ailerons, tail parts, and control systems.</td>
</tr>
<tr>
<td>Assembler, final</td>
<td>Uncrates, cleans, and installs motors in planes. Connects fuel lines, cowling, and propellor.</td>
</tr>
<tr>
<td>Assembler, final</td>
<td>Mounts all instruments in panel. Installs panel in ship. Connects instrument lines and electrical equipment. Installs radio and any other special equipment.</td>
</tr>
<tr>
<td>Assembler, fuselage</td>
<td>Assembles bulkhead parts. Assembles bulkheads, stringers, and other sub-assemblies into a complete fuselage.</td>
</tr>
<tr>
<td>Assembler, sub-</td>
<td>Makes minor assemblies which require complicated layouts and close hand and machine work such as bomb releasing mechanism, hydraulic equipment, etc.</td>
</tr>
<tr>
<td>Job Name</td>
<td>Kind of Work Performed</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Assembler, tank</td>
<td>Assembles oil and gas tanks from formed parts. Work involves filing, reaming, tapping,</td>
</tr>
<tr>
<td></td>
<td>and bushing.</td>
</tr>
<tr>
<td>Assembler, wing</td>
<td>Assembles ailerons, elevators, rudders, stabilizers, bulkheads, and spars.</td>
</tr>
<tr>
<td>Band saw operator</td>
<td>Cuts out flat-shaped parts from materials which have been previously scribed.</td>
</tr>
<tr>
<td>Brake operator</td>
<td>Forms various shapes and angle parts from sheet metal.</td>
</tr>
<tr>
<td>Carpenter</td>
<td>Builds wooden structures and crates parts of the airplane for shipment.</td>
</tr>
<tr>
<td>Die caster</td>
<td>Supervises heating and pouring of die metal.</td>
</tr>
<tr>
<td>Die finisher</td>
<td>Finishes the surfaces of dies by filing, scraping, and buffing.</td>
</tr>
<tr>
<td>Doper</td>
<td>Applies dope to fabric with hand brushes and spraying equipment.</td>
</tr>
<tr>
<td>Drill press operator</td>
<td>Lays out and drills airplane parts. Uses drills, jigs, and holding fixtures where</td>
</tr>
<tr>
<td></td>
<td>accuracy and interchangeability are required.</td>
</tr>
<tr>
<td>Electrician, aircraft</td>
<td>Installs wiring and electrical devices in planes.</td>
</tr>
<tr>
<td>Engine lathe</td>
<td>Lays out work according to blueprints. Sets up jobs in lathe and operates lathe.</td>
</tr>
<tr>
<td>operator</td>
<td></td>
</tr>
<tr>
<td>Foreman</td>
<td>Plans, distributes, and directs work in a department.</td>
</tr>
<tr>
<td>Foundryman</td>
<td>Supervises die casters in all their work.</td>
</tr>
<tr>
<td>Grinder operator</td>
<td>Sets up jobs in grinder and operates grinding machine.</td>
</tr>
<tr>
<td>Job Name</td>
<td>Kind of Work Performed</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hand bumper</td>
<td>Forms sheet metal by hand hammering over form blocks or through the use of sand bags and hand tools.</td>
</tr>
<tr>
<td>Heat treater, dural</td>
<td>Hardens duraluminum parts by heating in salt peter bath and then quenching in water or air cooling.</td>
</tr>
<tr>
<td>Heat treater, steel</td>
<td>Heat treats steel alloys to eliminate welding stresses and to change the physical properties of alloys.</td>
</tr>
<tr>
<td>Inspector</td>
<td>Inspects material purchased. Inspects completed parts after each operation for defective material or workmanship.</td>
</tr>
<tr>
<td>Leadman</td>
<td>Acts as a working forman with a group of workers.</td>
</tr>
<tr>
<td>Machinist, all-around</td>
<td>Sets up jobs of all kinds on all kinds of machines. Operates all kinds of machines.</td>
</tr>
<tr>
<td>Mechanic, semi-skilled</td>
<td>Can set up several types of jobs on one kind of machine and then completely machine these jobs.</td>
</tr>
<tr>
<td>Mechanic, un-skilled</td>
<td>Assists mechanics in the department to which he is assigned.</td>
</tr>
<tr>
<td>Metal bench hand</td>
<td>Makes metal fittings from cold rolled steel, stainless steel, and duraluminum.</td>
</tr>
<tr>
<td>Milling machine operator</td>
<td>Lays out jobs from blueprints. Sets up and machines parts in milling machine.</td>
</tr>
<tr>
<td>Molder</td>
<td>Produces molds for pouring castings.</td>
</tr>
<tr>
<td>Oiler</td>
<td>Oils machines and equipment. Helps with maintenance work.</td>
</tr>
<tr>
<td>Job Name</td>
<td>Kind of Work Performed</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pattern maker</td>
<td>Lays out and finishes metal forming blocks. Constructs plaster, or combination wood and plaster patterns for die casting. Lays out and finishes wood patterns for making foundry castings.</td>
</tr>
<tr>
<td>Punch press operator</td>
<td>Sets up dies for punching holes in sheet metal, for stamping small parts from sheet metal, and for forming small parts from sheet metal. Also operates punch presses.</td>
</tr>
<tr>
<td>Riveter</td>
<td>Uses hand operated and power operated riveting equipment. Alternates at work with rivet bucker.</td>
</tr>
<tr>
<td>Roller operator</td>
<td>Forms various shaped sheet metal parts by the use of a combination of various rolls on a metal rolling machine.</td>
</tr>
<tr>
<td>Router operator</td>
<td>Shapes metal parts on a router or profiling machine.</td>
</tr>
<tr>
<td>Shaper operator</td>
<td>Lays out work from blueprints. Sets up and machines jobs on the shaper.</td>
</tr>
<tr>
<td>Tool designer</td>
<td>Designs tools, jigs, and fixtures for machining, holding, and assembling airplane parts.</td>
</tr>
<tr>
<td>Turret lathe operator</td>
<td>Turns, bores, threads, drills, reams, faces, and taps parts on a turret lathe.</td>
</tr>
<tr>
<td>Upholsterer</td>
<td>Makes seats, cushions, zipper bags, motor covers, etc.</td>
</tr>
<tr>
<td>Welder</td>
<td>Joins parts by spot welding, brazing, and fusion welding with gas or electric welding equipment.</td>
</tr>
</tbody>
</table>