

Iowa State College  
Ames, Iowa

# WAR TRAINING PROGRAMS - WORLD WAR II

CURTISS-WRIGHT ENGINEERING CADETTE TRAINING PROGRAM

VOLUME A I



LD2532  
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I08w

April 1, 1945

Iowa State College  
Ames, Iowa

# WAR TRAINING PROGRAMS - WORLD WAR II

CURTISS-WRIGHT ENGINEERING CADETTE TRAINING PROGRAM

VOLUME A I



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IOWA STATE COLLEGE  
AMES, IOWA

Faculty Committee on Naval  
Training Schools

April 14, 1945

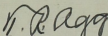
President Charles E. Friley  
Beardshear Hall

Dear President Friley:

I am transmitting herewith Volume AI of a report on the War Training Programs -- World War II, conducted at the Iowa State College. The volume covers the Curtiss-Wright Engineering Cadette Training Program conducted by the college under the auspices of the Curtiss-Wright Corporation.

The report was prepared by Professor Wilbur C. Nelson, Head of the Department of Aeronautical Engineering, and was arranged and bound under the supervision of Assistant Professor Arthur M. Gowan, Assistant to the Dean of Engineering.

Respectfully submitted,

  
T. R. Agg  
Chairman

TRA/1  
Encl.

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### HISTORY

On October 10, 1942, the Curtiss-Wright Corporation, through the Society for the Promotion of Engineering Education, consulted over one-hundred engineering colleges and universities concerning a plan for the emergency war training of college women to function as assistants in the Curtiss-Wright engineering departments. Iowa State College expressed itself as interested and willing to cooperate in such a program and on December 9, 1942, a contractual agreement was received.

Preliminary conferences were held in New York on December 12, 1942, and in St. Louis on December 31, 1942, in order to set up the curriculum and reach an agreement on the many related details. A total of seven institutions were to train 750 women for the various engineering departments of the Curtiss-Wright Corporation. Iowa State College had an initial quota of 100 students to train for the St. Louis Plant - Airplane Division. Other participating institutions and quotas were as follows:

<u>School</u>	<u>Quota</u>	<u>Plant</u>	<u>Division</u>
Cornell University	125	Buffalo, N. Y.	Airplane
Pennsylvania State College	125	Buffalo, N. Y.	Airplane
Purdue University	( 65	Columbus, Ohio	Airplane
	( 35	Louisville, Ky.	Airplane
University of Minnesota	100	Columbus, Ohio	Airplane
University of Texas	100	St. Louis, Mo.	Airplane
Rensselaer Polytechnic Institute	100	Caldwell, N. J.	Propeller

The students were to be known as "Engineering Cadettes." They were selected by interview from 44 states on the basis of academic ability, attitude and interest. They were required to have completed two years of college, including one year of college mathematics or its equivalent. They must have been at least eighteen years of age and have been better than average in their previous college work. The "average cadette" was 19.6 years of age, had 2.5 years of college with one year and three months of mathematics.

Actual course work on the campus started on February 15, 1943. The cadettes were housed and fed at the Memorial Union and attended class on the campus. Due to the nature of their courses, they were completely segregated in special classes.<sup>1</sup> Courses were arranged in two semesters of approximately five months each so that the complete curriculum was covered in a ten-month period (February 15 to December 15, 1943). The caliber of the course work was such that college credit was granted for all course work completed.<sup>2</sup>

<sup>1</sup>See p. 37 for their curriculum and schedule of classes.

<sup>2</sup>See p. 57 for a list of course credits and content.

A resident Curtiss-Wright personnel supervisor maintained an office on the campus and was available at all times to counsel the trainees on their many difficulties. Pay checks were issued weekly and were used by the student to purchase books, drafting equipment, and other miscellaneous expenses.<sup>1</sup>

Dormitory problems were handled by the Director of Residence and the Memorial Union management. Academic problems were handled through the Dean of Engineering with the Department of Aeronautical Engineering in direct charge of the program details.

A program of this type demanded a special study and adjustment by the teaching staff as well as the student.<sup>2</sup> All of the Iowa State College instructional staff directly concerned made a visit to the St. Louis plant to become acquainted with the plant set-up and to better understand course objectives. On the campus, counselling hours were arranged between the staff and the students to assist the student in her most difficult courses. Monthly grades were sent to the plant and the girls were counselled by the resident campus personnel supervisor in accordance with these reports. The intensity of the program was such that several short "vacation" periods were interjected in addition to the interval between semesters in July.

The most difficult courses proved to be those in analytical mechanics involving concepts of force, acceleration, velocity, vectors, etc. A large amount of time was spent on drafting work due to the high probability of that work being required at the plant. Related work in mathematics, theory of flight, and materials processing occupied the balance of their time.

A general review of the entire program has been made by C. W. Cole in a paper entitled "Training of Women in Engineering" which reviews the need for the training, type of trainee involved, and basic concepts behind the curriculum.<sup>3</sup>

A program of this type must be evaluated over a period of time. From 101 course enrollees, Iowa State College graduated 90. Of this number, 6 withdrew after graduation and before entering the plants. Of the 84 entering plant duties 32 had left by September 1944 for various reasons. A detailed study of the plant record at the year of this report will show a good correlation between school grades and plant ratings. It will also show that the great majority of the cadettes are performing their assignments satisfactorily. An analysis by Warren Bruner entitled "A Report on Engineering Cadette Training" one year after graduation, reveals that the plants had many problems adjusting the girls to plant work and at times serious grievances arose. In any event, the complete program placed 591 trainees into the plants with special skills at a time when these skills were greatly needed. It should be remembered that practically all of the cadettes were not looking upon aeronautical engineering as a life career but as ~~an immediate aid in the war effort~~ and at every step they had to feel their relation to this immediate need.

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<sup>1</sup>Room, board, tuition and railroad fare were furnished by the Curtiss-Wright Corporation in addition to the ten dollar weekly pay check.

<sup>2</sup>See p. 4 for a list of all staff members on this program.

<sup>3</sup>See p. 62 for a complete copy of this paper.

The Iowa State College budget is appended as an integral part of the contract at the rear. The final statement<sup>1</sup> shows that Curtiss-Wright paid Iowa State College \$111,139.32 for costs incurred on this program. This represents a cost of approximately \$1122 per course graduate.

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<sup>1</sup>See p. 59.

CURTISS-WRIGHT ENGINEERING CADETTE STAFF

General Supervision - Dean T. R. Agg  
 Director of Residence - M. McGlade  
 Memorial Union - J. C. Schilleter, Manager  
 Women's Physical Education - G. Guiot

EDUCATIONAL STAFF

Course Director - W. C. Nelson

Engineering Mathematics (A-1, B-1)  
 L. R. Hillyard, in charge  
 H. Birkness

Job Terminology, Theory of Flight (A-2, B-2)  
 W. C. Nelson, in charge  
 L. G. Kelso

Aircraft Drafting (A-3, B-3)  
 A. S. Gaskell, in charge  
 D. H. Scott  
 G. F. Gardner

Engineering Mechanics, Aircraft Stress Analysis (A-4, B-4)  
 Glenn Murphy, in charge  
 J. M. Coan  
 E. W. Ohlsen  
 H. O. Ustrud  
 A. M. Johnson  
 C. W. Peterson

Properties and Processing of Materials, Aircraft Assemblies (A-5, B-5)  
 R. W. Breckenridge, in charge  
 L. L. Carver  
 J. K. Walkup

Society for the Promotion of  
ENGINEERING EDUCATION

Office of the Secretary  
Pittsburgh, Pa.

October 10, 1942

Dear Sir:

The information contained in this letter is for exploratory purposes. Please do not release it to the press or give it any general publicity.

The Society for the Promotion of Engineering Education has been asked by the Curtiss-Wright Corporation to consult the engineering colleges as to the possibility of carrying on a special training program for the preparation of college women for responsibilities in engineering. In view of the decreasing supply of professional graduate engineers, Curtiss-Wright feels that, in order to "continue in business" from an engineering development standpoint, the Corporation must be able to utilize its present engineering staff in responsible development and design assignments within a short time. To do that it must have nearly a thousand college women with sufficient training to back up this advanced group. This supporting group of a thousand will fill the same range of jobs as are now performed by its recent graduate engineers.

As a possible solution to this problem, Curtiss-Wright is proposing a plan which will involve the training of such women in a number of accredited engineering college on a contractual basis with the Corporation for the duration of the war. The Corporation, under this plan, will pay directly to the institutions the full tuition, plus cost of room and board, for each student enrolled. It is estimated that the cost to be paid by the Corporation for fifty weeks' training, at forty hours a week, will be approximately \$500 to \$700 for tuition, plus \$10 to \$12 a week for room and board.

The existing faculty of the colleges will be utilized to teach the required courses. The curriculum will be prescribed for the Corporation with the assistance of a committee representing all selected schools.

The students will be recruited from girls now enrolled in colleges and universities, under a plan to be developed with the assistance of the American Council on Education. The minimum requirements for acceptance will be one and one-half years of college work, including elementary mathematics. In addition, applicants will be required to pass some type of screening test. They will be hired by Curtiss-Wright and placed on its payrolls. They will then be assigned to colleges in groups of 50 to 100 for specified training and receive a nominal salary while at school.

The Corporation will assign an operating supervisor to each cooperating school. Her duties will be (a) to act as a liaison officer between school and Curtiss-Wright; (b) to supervise the students from the

Corporation point of view, as the students would actually have the status of employees; (c) to keep personnel records and to advise in placement selection. (It is quite possible that a certain percentage of the students will not be able to complete the entire curriculum; however, there are sufficient jobs available with the Corporation to place satisfactorily anyone coming out of the school at any level.) (d) to assist development of social activities and company interest and knowledge. It will be necessary that the selected colleges make provision to house the students in a group.

This training will be designed to fill the needs in the engineering departments of all divisions of Curtiss-Wright, which includes the Curtiss Airplane Division, Curtiss Propellor Division, and Engine Division (Wright Aeronautical Corporation). The jobs toward which this training will be directed are listed below under respective division headings:

#### A. Airplane Division

1. Drafting. First assignment will be as a detailer. Later an employee will be expected to develop into advanced design work (mechanical, electrical, etc.)
2. Stress Analysis. First assignment will be in computation and graph making; later on into structural design and stress determination.
3. Materials Laboratory. This will comprise physical testing of materials (X-ray, etc.)
4. Aerodynamics. Here a woman so trained would be employed in text book research and mathematical computation.
5. Production Liaison. First assignment would be in the design change group and later on in liaison between engineering and production.

#### B. Engine Division

1. Experimental Test. First assignment will be in the test program which includes operation of dynamometer test stands, calibrating performance results and attending lecture courses as a basis for further advancement. Later, an employee will advance into test engineering which will comprise the writing of test specifications, supervising actual testing, analyzing results, and writing reports.
2. Stress, vibration, and other speciality analysis. This would be similar to that described under airplane stress.
3. Materials Laboratory. This is also very similar to that described under airplane materials laboratory.

### C. Propellor Division

Jobs will be fairly similar to those described under both airplane and engine divisions, and would be classified under the following:

1. Drafting
2. Vibration Analysis
3. Test
4. Materials Laboratory.

It is not necessary that all institutions selected for this program supply training for all of the above jobs.

It might be possible to divide the full curriculum into halves. The first half would comprise elementary courses and be the same at all schools. The second half would comprise specialized and applied courses with each school teaching only one speciality. This, of course, would require transfers of students.

Below is a brief outline of the courses which might be included. It is expected that students will spend forty hours a week in class and supervised study. The course instruction will comprise approximately thirty hours a week; the additional ten hours will be spent in supervised study. The Corporation supervisor could be used to assist in this supervised study. It is tentatively scheduled to have actual classes begin on February 1, 1943, or thereabouts.

#### A. Mathematics

1. Algebra and trigonometry (for those not meeting our maximum prerequisites)
2. Analytical geometry, calculus, and practical differential Equations (this course will only be given to those qualified and interested).

#### B. Sciences

1. Elementary engineering physics (with laboratory)
2. Elementary engineering chemistry (with laboratory)
3. Mechanics and strength of materials (with laboratory)
4. Mechanics or structures.

#### C. Drawing and Design

1. Engineering drawing
2. Descriptive geometry
3. Machine design or electrical design

- 4 -

## D. Special Courses

1. Aerodynamics (theory of flight)
2. Thermodynamics (theory of internal combustion engines)
3. Electrical currents (with laboratory)
4. Engine laboratory

## E. Applied Courses

1. Slide rule
2. Company
3. Manufacturing procedures and production engineering
4. Machine tools and shop practices (with laboratory)
5. Lofting

The undersigned officers of the Society feel that this proposal represents a very significant development in war training, and merits your cooperation. We are, therefore, bringing this to your attention to determine whether or not you would be interested in being considered as a participating college.

Mr. C. W. Cole, Engineering Personnel Bureau, Curtiss-Wright Corporation, Passaic, New Jersey, must present this plan to his management for final approval at an early date and, therefore, must receive the reaction of the colleges as soon as possible. Will you, therefore, fill out the attached questionnaire and mail it to him no later than October 20, 1942. Mr. Cole will advise you of the details of the plan when approved.

Very truly yours

(signed) H. I. Heald  
President

(signed) F. L. Bishop  
Secretary

SOCIETY FOR THE PROMOTION OF  
ENGINEERING EDUCATION

October 15, 1942

Mr. H. T. Heald  
Mr. F. L. Bishop  
Society for the Promotion of  
Engineering Education

Gentlemen:

I have your confidential letter relative to the possibility of carrying on a special training program for the preparation of college women for certain engineering activities. The proposal has been given careful consideration in conference with the executives of our Division of Engineering, particularly those in the departments of Mechanical Engineering, Theoretical and Applied Mechanics and Aeronautical Engineering.

It is our belief that the Iowa State College has adequate staff, equipment and facilities to handle such a program as is indicated in the outline, and we shall be glad to participate in the event such a program is set up.

Sincerely yours,

Charles E. Friley  
President

CEN:rw

cc - Dean T. R. Agg

December 9, 1942

Mr. Charles Friley, President  
Iowa State College  
Ames, Iowa

Dear Mr. Friley:

This is to confirm our wire of December 9th. It is our pleasure to enter into a formal agreement with you as previously discussed with our Mr. C. W. Cole whereby Iowa State College will contract to train approximately one hundred college women for the St. Louis Plant of the Curtiss-Wright Airplane Division. These women are to be selected by our representatives and are to be trained for a continuous period of ten months. It is understood that the course to be taught will be designed for this particular group through a conference with representatives from the other selected schools and representatives from our company. Classes will begin Monday, February 1, 1943.

Curtiss-Wright Corporation, Airplane Division, St. Louis Plant will pay Iowa State College on a monthly basis (upon receipt of invoice from you) tuition and room and board per student on a pro-rated basis. A budget outline will be sent to you shortly. When filled out, this budget will be used as a basis for payments to you. It is our understanding, however, that the total cost per student will not be in excess of \$1220.

A formal contract will be prepared in the near future by our local department and will be submitted to you for your acceptance. This letter, therefore, is not to be construed as a formal contract but merely as a written agreement that we proceed forthwith to put into operation plans previously formulated with you.

Further details and administration of this program will be handled between yourself and our Mr. C. W. Cole. This will include actual selection of students, preparation of curriculum, and supervision of the students selected as employees of the Curtiss-Wright Corporation.

Kindly accept my appreciation and thanks on behalf of the Curtiss-Wright Corporation for your cooperation in the development of this program and may I assure you of my anticipation of our continued friendly relationship.

Very truly yours,  
CURTISS-WRIGHT CORPORATION  
Airplane Division, St. Louis Plant

G. A. Page  
Chief Engineer

cc: Dean T. R. Agg  
C. W. Cole

CURTISS-WRIGHT CORPORATION  
Airplane Division, St. Louis Plant  
Lambert Field, St. Louis, Missouri

January 30, 1943

Mr. Charles Friley, President,  
Iowa State College,  
Ames, Iowa.

Dear Mr. Friley:

I am enclosing contract in triplicate covering the Engineering Cadette Training to be given at Iowa State College.

This contract has been properly executed by Curtiss-Wright Corporation. If conditions of the contract meet with your approval, please execute and return two copies for our file. Copies of the budget, which has been made a part of the contract, must also be signed by the person who executes the contract on your behalf. We did not change any figures shown in your budget, however, a slight change was made in the wording, which we trust will meet with your approval.

Upon receipt of the executed contracts, our Priorities Coordinator will be in a position to assist you on preference ratings.

Very truly yours,

CURTISS-WRIGHT CORPORATION  
Airplane Division, St. Louis Plant

H. A. Steel  
Engineering Office Manager

HAS:LO

cc: G. A. Page  
H. E. McDonald  
W. L. Wells  
E.F.J. Meyer  
C. W. Cole  
W. C. Nelson (Iowa State College)

AGREEMENT made the 30th day of January 1943 by and between CURTISS-WRIGHT CORPORATION, a Delaware corporation, acting through its Airplane Division - St. Louis, Missouri, Plant, (hereinafter referred to as "Curtiss") and Iowa State College of Agriculture and Mechanic Art, an Iowa educational corporation, (hereinafter referred to as "Iowa").

1. Iowa shall within the term specified in paragraph 11 hereof provided adequate and competent instructor personnel for the purpose of teaching, and shall (subject to the provision of paragraph 12a) teach not less than ninety (90) or more than one hundred and ten (110) women employees of Curtiss (hereinafter referred to as "Curtiss students"), to be selected and designated by the latter, in the following subjects: Engineering Mathematics, Job Terminology and Specifications, Elements of Aircraft Drawing, Standards, and Design, Engineering Mechanics, Properties and Processing of Aircraft Materials, Materials Testing. A copy of the syllabus of said courses is annexed hereto, as a part of this Contract and marked Exhibit A. Iowa shall assign a sufficient number of instructors to teach the above courses, so as to make it possible to teach the Curtiss students in reasonably small groups.

Each Curtiss student shall receive forty (40) hours of instruction per week, which may be distributed over six (6) days; provided, however, that night instruction shall not be given more than twice a week and that no instruction shall be given on Sundays or after two o'clock P. M. on Saturdays.

2. Iowa shall provide all materials, equipment and supplies necessary in connection with a course of instruction referred to in paragraph 1 above, except textbooks, drawing instruments and slide rules.

3. Iowa shall provide adequate buildings and facilities for the instruction of Curtiss students as provided in paragraph 1 above and shall make available to Curtiss students satisfactory living quarters, accommodations and prepared meals, all of which shall be at least equivalent to those supplied to the other regular women students in attendance at Iowa

4. Iowa shall provide facilities for the conducting of seminars and other group meetings of Curtiss students by the Curtiss supervisor referred to in paragraph 10 below, which seminars and meetings shall not be a part of the course of instruction outlined in paragraph 1 above.

5. Iowa shall provide for and extend to all Curtiss students precautions and privileges at least equivalent to those supplied to other regular students now in attendance at Iowa, including but not limited to the following:

- (a) First Aid and medical care
- (b) Customary or lawfully prescribed safety devices and appliances.
- (c) Instruction in, and required compliance with, customary safety precautions.
- (d) Supervision of proper discipline and conduct during instruction periods and other wise.
- (e) Matriculation, recreational facilities, athletic activities, clubs, social events, etc.

6. Curtiss shall select the students to be instructed hereunder. After selection and matriculation, however, each student shall, except as herein otherwise specifically provided, be considered a student of Iowa in the same manner as any other regular student attending Iowa, and Curtiss shall not be liable to Iowa for any act or damage caused by any such student. All Curtiss students shall be subject to the disciplinary rules of Iowa in force with respect to the student body generally. If any Curtiss student should violate such rules or otherwise conduct herself in such a manner as to cause or justify her expulsion or the imposition of other discipline if she were a regular student attending Iowa, then Iowa shall notify in writing the Curtiss representative referred to in paragraph 9 below and shall thereupon discipline the student accordingly; and any student expelled by Iowa hereunder shall be withdrawn from the scope of this agreement. It is understood, however,

that Iowa shall not discipline or expel any Curtiss student on the ground that her scholastic standing is unsatisfactory; and Curtiss shall have the sole right to decide whether or not a Curtiss student shall be dismissed for scholastic deficiencies. Curtiss reserves the right to withdraw from the course any student who in the opinion of the Curtiss representative does not fulfill the requirements of Curtiss or is incapable of satisfactorily completing the course. Curtiss may also withdraw from the course any student who in the opinion of the Curtiss representative has received sufficient instruction to qualify such student for work in a Curtiss plant.

7. Iowa shall keep reasonably complete records of the scholastic standing and progress of each student. Reasonably frequent marking periods shall be established for the grading of each student in each course. All said records and markings shall be at all times available and open to the inspection of the Curtiss representative and the Curtiss supervisor, who may make transcripts thereof.

8. Curtiss may at any time request in writing that Iowa make reasonable changes or additions to existing courses or add new courses to or omit courses from the curriculum specified in paragraph 1 and Iowa shall thereupon put such changes, additions, or omissions into effect; provided, however, that if any such changes or additions shall cause a material increase or decrease in the amount or character of the materials, equipment or services to be furnished by Iowa hereunder or in the time required for its performance, the consideration to be paid herunder by Curtiss shall be subject to an equitable adjustment, and this agreement shall be modified accordingly. If the parties shall fail to agree on the amount if the adjustment to be made the dispute shall be determined as provided in paragraph 15 hereof; but nothing herein contained shall excuse Iowa from proceeding with its performance hereunder pending such determination.

9. Curtiss may by notice in writing to Iowa designate from time to time a representative (hereinbefore and hereinafter referred to as the "Curtiss representative"), who shall be generally in charge of administering and supervising the performance of this contract. The subject matter and contents of each course to be taught by Iowa hereunder and any changes to be made in such courses shall be subject to his approval. He shall select

the Curtiss students to be instructed hereunder and shall decide on behalf p. 15 of Curtiss whether and when a student is to be withdrawn in accordance with paragraph 6 above. He shall be advised in writing of any disciplinary action which Iowa may wish to take with respect to any Curtiss student.

10. Curtiss shall assign an employee (hereinbefore and hereinafter referred to as the "Curtiss supervisor") to act as supervisor of the Curtiss students. Iowa shall provide for the Curtiss supervisor office facilities, equipment and supplies and the full time services of one clerical assistant for the administrative duties of the Curtiss supervisor.

The Curtiss supervisor shall also be advised of all disciplinary action which Iowa may wish to take with respect to any Curtiss student and shall generally be consulted by Iowa with respect to administrative problems. The Dean of Women or other equivalent officer of Iowa and the director of the course provided for herein shall cooperate with the Curtiss supervisor. The supervisor shall act as personnel counselor to the Curtiss students and shall be in charge of administering the seminars and other discussion groups referred to in paragraph 4 above.

11. The course of instruction provided for herein shall begin on February 15, 1943 and shall continue for a period of approximately forty-three (43) weeks to December 15, 1943. If Curtiss has failed to assign one hundred and ten (110) students to Iowa by February 15, 1943, it may assign additional students up to a total of one hundred and ten (110) on or before February 22, 1943.

12. Based upon a certain budget analysis heretofore supplied Curtiss by Iowa annexed hereto as a part of this contract, and marked Exhibit B, and in reliance upon the information set forth therein, Curtiss hereby agrees to pay to Iowa in consideration of the services, materials and supplies, to be furnished pursuant to this agreement and in full payment of all obligations of Curtiss under this agreement or in connection with the training course herein provided for:

(a) For a minimum number of ninety (90) students the sum of ten thousand, seven hundred and ninety-six dollars, and four cents (\$10,796.04) per month for a period of ten (10) months. If by February 22, 1943 less than ninety (90) students have been assigned by Curtiss under this agreement the parties shall nevertheless perform the terms of this agreement, and Curtiss shall nevertheless pay to Iowa the above-mentioned sum; provided, however, that if on or before said date Curtiss shall have been unable to assign more than seventy-five (75) students to Iowa, then Curtiss may on or before March 1, 1943 terminate this contract by ten (10) days' notice in writing, and in such event this agreement shall so terminate and Curtiss shall be liable to Iowa only for such out-of-pocket expenditures as Iowa may have made on account of this agreement up to the date of termination and for any other unavoidable monetary loss which Iowa may have incurred by reason of such termination.

(b) For each Curtiss student in excess of ninety (90) in attendance at Iowa and receiving instruction and maintenance hereunder, at the rate of one hundred nineteen dollars, and ninety six cents (\$119.96) per month; fractions of a month shall be computed on the basis of the nearest full day and payment for a full day shall not exceed one-thirtieth (1/30th) of the above monthly rate. Curtiss shall be under no obligation to make any payments under this paragraph (b) for any students in excess of ninety (90) who may be withdrawn from the scope of this agreement for any reason whatsoever.

(c) Curtiss shall pay Iowa all sums due hereunder monthly upon receipt from Iowa of invoices for the last preceding monthly period.

13. The parties recognize that this agreement is made necessary by the needs of the National War Effort. In the event of the cessation of hostilities, whether by armistice or otherwise, Curtiss may terminate this

agreement by written notice to Iowa effective immediately or at such other P. 17 date as shall be stated in said notice; provided that said termination shall in no event be effective before July 15, 1943. In the event of such termination Curtiss shall only be liable to Iowa for the payment of the monthly installment and other payments due to it under paragraph 12 for the monthly period during which the termination occurs and, as and for liquidated damages an additional sum of ten thousand, seven hundred and ninety six dollars and four cents (\$10,796.04) (one monthly payment under paragraph 12a hereof), and all further obligation of Curtiss hereunder shall thereupon cease and terminate.

14. Iowa agrees to be responsible in matters within its control for the safeguarding of all secret, confidential, or restricted matter that may be disclosed or that may be developed in connection with the performance of this agreement and to require a similar agreement of all subcontractors and agents of Iowa to whom any part of the performance of or duty relating to this agreement may be allotted. Neither this agreement or any interest therein may be assigned, and neither the whole nor any part of the work under this agreement may be subcontracted without the written consent of Curtiss.

15. Any dispute, claim, grievance or difference arising out of or relating to this agreement shall be submitted to arbitration, upon notice of either party to the other party under the Industrial Arbitration Rules, then obtaining, of the American Arbitration Association, and the parties agree to abide by the award, the cost of such arbitration to be borne equally by both parties.

The parties further agree that there shall be no suspension of the performance of this agreement when such dispute arises or while it is in the process of arbitration, except in the case of termination of this agreement pursuant to paragraph 12a and paragraph 13.

16. This agreement supersedes all agreements, whether oral or in writing, heretofore made between the parties hereto, all of which shall be deemed merged into this agreement.

IN WITNESS WHEREOF, the parties have executed this agreement as of the date first above written.

CURTISS-WRIGHT CORPORATION  
Airplane Division-St. Louis Plant

Attest: L. M. Kincaid (Asst. Sec'y) (s)

By G. W. France Vice-Pres.(s)

IOWA STATE COLLEGE OF AGRICULTURE  
AND MECHANIC ART

Attest: \_\_\_\_\_

By \_\_\_\_\_

CURRICULUM FOR CURTISS-WRIGHT ENGINEERING CADETTE PROGRAM

ALPINE DIVISION SECTION

To be given at: Cornell University  
 Iowa State College  
 Pennsylvania State College  
 University of Minnesota  
 Purdue University  
 University of Texas

Entire course of 44 weeks to be given from February 1, 1943 to December 1, 1943. Division made into two sections (A and B) of 22 weeks each.

Hours	A - 22 weeks	Hours	B - 22 weeks
6	(1) ENGINEERING MATHEMATICS	6	(1) ENGINEERING MATHEMATICS
3	(2) JOB TERMINOLOGY & SPECIFICATIONS	3	(2) THEORY OF FLIGHT
9	(3) ELEMENTS OF AIRCRAFT DRAWING AND STANDARDS	9	(3) AIRCRAFT DRAWING AND DESIGN
6	(4) ELEMENTARY ENGINEERING MECHANICS	6	(4) MATERIALS STRENGTH OR AIRCRAFT STRUCTURAL ANALYSIS 11 weeks
6	(5) PROPERTIES AND PROCESSING OF AIRCRAFT MATERIALS	6	(5) AIRCRAFT MATERIALS AND TESTING 11 weeks
10	(6) SUPERVISED STUDY	10	(6) SUPERVISED STUDY
TOTAL	40	TOTAL	40

Course (1) - 198 hours  
 " (2) - 132 "  
 " (3) - 462 "

Course (4) - 264 hours  
 " (5) - 262 "  
 " (6) - 440 "

Total Hours - 1760

Engineering Mathematics -- 6 hours per week for 22 weeks1. Logarithms - 12 hours

Definition of logarithms; Common logarithms for multiplication, division, powers, and roots. Natural logarithms and conversions.

2. Slide Rule - 12 hours

Addition and subtraction with simple scales; relationship to logarithms; multiplication, division, powers, and roots by slide rule; rules for decimal points.

3. Trigonometry - 60 hours

- (a) 42 hours - Definitions, functions, solution of right triangles.
- (b) 18 hours - Solution of general triangles, and problems. Functions of double angles.

4. Areas and Volumes - 18 hours

(Coordinate with manual and handbook)

Areas of plane figures; volumes and areas of surfaces of prisms, cones, pyramids, frustums; volumes of revolution (include Simpson's rule and Pappus's rule). Centroids of simple areas and volumes. Use of planimeter.

5. Review of Algebra - 30 hours

Through quadratic equations.

## B - I

3 hours per week for 22 weeks1. Analytical Geometry -- 33 hours

Rectangular coordinate systems; properties of conic sections; brief treatment of polar coordinates.

2. Aircraft Problems (Construction of Graphs and Charts -- 33 hours

Graph paper, rectangular and polar coordinates; logarithmic papers; construction of charts; graphic solution of equations; and curve plotting.

Plotting of normals and tangents to irregular curves.

Construction of graphs as computing aid.

Job Terminology and Specifications - 6 hours per week for 22 weeks

1. The Airplane - 9 weeks (27 hours)  
Brief outline of the airplane --
  - a. The ABC of flight - suggested use of film.
  - b. Types of military and commercial aircraft.
  - c. Airplane components and their functions.
    1. Airplane
    2. Propeller
    3. Engine
    4. Accessories

Suggested Books  
 CAA Bulletin - The Airplane and Its Parts (Pre-Flight) and Lockheed's Aircraft Design Sketchbook  
 Otis & Page - Pre-Flight Aeronautics (prepared by Bureau of Education, published by MacMillan for highschool use.)  
 Shield's Theory of Flight and the Aircraft Engine

2. Aeronautical Industrial Organization - 2 weeks
3. Function and Operation of Curtiss-Wright's Engineering Department - 11 weeks

This course should be developed to show the application of material given under the other four. It should be a drill class of questions and answers using as a reference the Engineering Manual and Procedure. In addition, the material given in the Engineering Manual should be developed from a processing and usage point of view. (It is recommended that the instructor giving this course visit the Curtiss-Wright plant.)

## B - II

Aerodynamics and Theory of Flight - 3 hours per week for 22 weeks

1. Fundamental Aerodynamics of the Airplane
  - a. Standard air
  - b. Elementary formulas and equations
  - c. Parasite resistance
  - d. Interference resistance
2. Air Foils
  - a. Lift and drag characteristics
  - b. Characteristic curves
  - c. Pressure distribution and center of pressure
  - d. Criteria for the selection of airfoils
  - e. Tapering wings
  - f. Aspect ratio and its effect
  - g. Reynolds number
  - h. Compressibility effects
3. Maneuvers
  - a. Rectilinear flight
    1. Climb
    2. Glide
    3. Dive

- b. Curvilinear flight
  - 1. Banking
  - 2. Turning
  - 3. Stalling
  - 4. Spinning
  - 5. Special maneuvers

4. Elements of Stability and Control

- a. Static stability
- b. Dynamic stability
- c. Longitudinal stability
- d. Lateral Stability
- e. Directional stability and control

5. Design Consideration

Performance, specification, and charts

6. Load Factors

Development and use (2 weeks minimum)

## A-III

Elements of Aircraft Drawing and Standards - 9 hours per week for 22 weeks

Based on Curtiss-Wright drafting manual and standards book, elements of drawing to include use of instruments; upper case lettering throughout the course (slant and vertical); line essentials; sketching; orthographic projections; tracing; auxiliary views and sections; dimensioning, limits and tolerances; fits; developments, intersections and projections; isometric drawings.

Drawing problems to be based on typical blue prints and parts furnished by Curtiss-Wright with work done chiefly on vellum, tracing paper and some cloth (furnished by Curtiss-Wright). Periodical blue print checks are to be made. All drawings should be dimensioned on the decimal system even though the samples furnished will probably all be dimensioned on the fraction system.

## B-III

Aircraft Drawing and Design - 12 hours per week for 22 weeks

1. Detailed drawings of actual airplane parts.
  - a. Detailing of wood parts
  - b. Detailing of sheet metal parts
  - c. Detailing of machined parts and forgings
  - d. Detailing of welded parts
  - e. Detailing of castings
2. Assembly drawings
3. Layout and Development

Drawing problems to be based on typical blue prints and parts furnished by Curtiss-Wright with work done chiefly on vellum, tracing paper and some cloth (furnished by Curtiss-Wright). Periodical blue print checks are to be made. All drawings should be dimensioned on the decimal system even though the samples furnished will probably all be dimensioned on the fraction system.

Elementary Engineering Mechanics - 6 hours per week for 22 weeks1. Introduction - 10 weeks

Fundamental concepts dealing qualitatively with the following:

Force; weight; mass; density; specific gravity; lever; pulley; gears; screws; hydraulic and pneumatic pressure systems; tension; compression; flexure; functions of columns; beams, tension members; brittleness; ductility; hardness; friction; viscosity.

2. Statics and Dynamics - 12 weeks

The following items should be covered on the basis of qualitative determinations and that liberal use be made of problems based on aircraft design:

a. Statics - 7 weeks

Force, vectorial representation, couples, combination and resolution of forces, concurrent and non-concurrent force systems, reactions space systems, truss analysis, buoyancy, metacentric height.

b. Dynamics - 5 weeks

Laws of motion, linear and angular velocities, acceleration, energy, work, inertia, momentum, impact, motion on inclined plane, friction.

## B- IV

1. Strength of Materials - 6 hours per week for 11 weeks

- a. Stress, strain, elasticity, proportional limit and yield point, tension, compression, shear.
- b. Joints - riveted and welded under direct and eccentric loads. Simple pressure vessels.
- c. Beams - load diagrams, reactions, moment and shear diagrams, moment of inertia, stress and tension, compression, shear (longitudinal and transverse), deflection using handbook methods, fixed and continuous beams.

## B- IV (cont'd)

2. Aircraft Structural Analysis - 6 hours per week for 11 weeksa. Columns

1. Euler's column formula
2. End restraint
3. Other column formulas

b. Stressed skin analysis

1. Strength of thin webs in tension, compression, and shear.
2. Stiffened compression panels

c. Torsion

1. Solid sections
2. Hollow sections using membrand analogy
3. Torsion of single cell sheet metal structures.

d. Fittings

1. Transmitting concentrated loads to thin webs.

Properties and Processing of Aircraft Materials  
6 hours per week for 22 weeks

1. Shop - 4 hours per week for 22 weeks  
(To be given simultaneously with lecture (a) and (b))

AIM: TO FAMILIARIZE THE STUDENT WITH SHOP PROCEDURES AND SHOP TOOLS AND THEIR OPERATIONS AS USED IN AIRCRAFT ENGINEERING

- a. Bench work  
Use of hammer on sheet metal aluminum alloy, file, layout, and drilling of aluminum alloy, use of hand taps and dies, sheet metal layout on aluminum alloy, cutting and forming of aluminum alloy, riveting (flush, blind, and machine).
- b. Lathe work  
Straight turning, screw thread cutting, chuck work, boring, internal threading.
- c. Milling machine work  
Plane milling, index milling, production milling.
- d. Shaper and planer  
Surfacing and squaring
- e. Routing machine
- f. Turret lathes and screw machines  
Set-up and operation; production.
- g. Press operations on aluminum alloys  
Mechanical and hydraulic; use of punches and dies; kirkslet dies, rubber dies, temporary dies and wood dies.
- h. Demonstration of miscellaneous machines  
Boring mills, grinders, hobbing machines, do-all machines.
- i. Precision measurements  
Use of instruments; use of gauges, indicators, and gauge plots.

2. Lecture - 1 hour per week for 22 weeks  
(a) (To be given simultaneously with shop and with lecture (b))

- a. Manufacture of aluminum and aluminum alloys
- b. Rolling, forming, and shaping of aluminum alloys (rolling, forging and extruding)
- c. Aluminum alloys  
Physical properties and specifications; demonstration of materials testing in the testing laboratory.
- d. Heat treating of aluminum alloys  
Annealing, hardening, anodizing. In this connection, there will be demonstrations of heat treating, heat treating equipment, and hardness testing machines.

- e. Aluminum castings  
Physical properties and specifications
  - f. Manufacture of iron and steel  
Physical properties and specifications
  - g. Tool steels and other cutting material  
Physical properties and specifications; carbon steel,  
hi-speed steel, stellite and cemented carbides.
  - h. Welding of aircraft materials  
Techniques and equipment; demonstration of both in the  
laboratory.
  - i. Plastics  
Physical properties and specifications. (Stress appli-  
cation of plastics -- not chemical makeup.)
  - j. Die casting  
Production methods, physical properties and specifications;  
zinc base, aluminum base, and magnesium base metals.
  - k. Magnesium alloys  
Physical properties and specifications
3. Lecture - 1 hour per week for 22 weeks  
(b) (To be given simultaneously with shop and with lecture (a))
- a. Shop terminology and machine operations
  - b. Bench and hand work  
Lectures dealing with specific machine tools beyond that  
type of work that can be accomplished in the shop, in-  
cluding filing, layout, and riveting of aluminum.  
(Emphasizing the use of aircraft materials.)
  - c. Lathe, turret lathe, and screw machines
  - d. Milling machine
  - e. Drilling machine
  - f. Grinding machine
  - g. Broaching
  - h. Surface finishing  
Honing, lapping, buffing, and polishing
  - i. Press working of metals  
(With particular reference to aircraft machines.)
  - j. Measurement and measuring devices

Aircraft Materials and Testing - 6 hours per week for 22 weeks

1. Materials Testing - 48 hours
  - a. Tension testing
  - b. Compression testing
  - c. Shear testing
  - d. Bending
  - e. Buckling
  - f. Torsion
  - g. Buckling of columns
  - h. Thin web beams
  
2. Airplane Parts and Assemblies - 48 hours
  - a. Spars
  - b. Control surfaces and mechanisms
  - c. Loading and vibration
  - d. Torsion
  
3. Wind Tunnel - 18 hours
  - a. Demonstration
  
4. Production Engineering in Aircraft Industry - 18 hours
  - a. Production methods, equipment, and operations
  - b. Production planning
  - c. Routing procedure
  - d. Shop liaison

IOWA STATE COLLEGE BUDGET  
for  
Curtiss-Wright Engineering Training Program

This budget reflects charge for 100 students for a period of ten months (February 15, 1943 to December 15, 1943).

1. Personal Services

(a) Administration \$3500.00  
(b) Faculty

Full time

1 (No.) at 400 per month \$4000.00  
1 250 2500.00  
1 215 2150.00  
1 150 1500.00

Part time

2 (No.) at 400 per month (pro-rated) 1156.00  
1 320 800.00  
1 360 3060.00  
1 300 1700.00  
1 280 700.00  
1 260 1300.00  
2 240 3600.00  
6 225 6755.00  
2 260 800.00  
Student assistants as problems checkers 1200.00

(c) Clerical Assistance

(At least one stenographer will be required for Curtiss-Wright Supervisor)

2 (No.) at 120 per month 2880.00

Registrar and student record reports 500.00

Total

\$38,101.00

2. Supplies and Expenses

Traveling expenses	\$2400.00
Postage	100.00
Telephone and telegraph	300.00
Educational supplies	2150.00
Educational equipment	3725.00
Use of an office for Curtiss-Wright Supervisor	No charge
Office supplies for Curtiss-Wright Supervisor	<u>180.00</u>

\$8855.00

Total3. Student Fees

This is to cover privileges granted to regular students such as medical care, recreation facilities, athletic activities, clubs, social events, matriculation, etc.

Total charged at \$150.00 per student for 10 months \$ 15000.00

4. Overhead and Maintenance

5200.00

5. Room and Board

This includes --

(a) Student housing in the Memorial Union

(b) 3 (No.) per room (average)

(c) Laundry of bed linens

(d) Three meals per day in acceptable commissary arrangement

(e) Resident chaperone and house mother

Total charged at \$12.00 per student per week

\$52,800.00GRAND TOTAL

\$119,956.00

Charge per student

1,199.56

The above is to the best of my knowledge a true statement of the approximate costs of performing the program as required by Curtiss-Wright Corporation.

Submitted by \_\_\_\_\_  
(President)

Iowa State College

December 24, 1942.

February 6, 1943

President Charles E. Friley  
Iowa State College  
Ames, Iowa

Dear President Friley:

This is to introduce Mrs. Jean O'Leary who has been appointed as Personnel Supervisor for the Curtiss-Wright Engineering Cadette Program, stationed at Iowa State College.

Mrs. O'Leary has up until this time been acting as an interviewer recruiting Cadettes and therefore is familiar with the type of people we have been hiring, the problems which have come to our attention, and understands, I believe, the philosophy of our program very well. Before coming with us, Mrs. O'Leary has been in the educational field in the capacity of counselor to women students, and I am sure that this will be a great asset to her.

Mrs. O'Leary will report directly to me in pursuit of her duties on your campus, but she fully understands that she is to work very closely with Professor Nelson and anyone else whom you indicate as having administrative authority in connection with the Cadette program.

I assume that you have made arrangements for an office for Mrs. O'Leary's use. However, I would like to suggest that her office be located somewhere in the General or Engineering Administration Building. On the question of clerical help for Mrs. O'Leary, Professor Nelson has already written us to that effect, and I am sure that adequate arrangements will have been made. It might be necessary, however, to supplement these arrangements with some temporary help for Mrs. O'Leary over next weekend, as there is a great deal of detail that she must clear in order that the Cadettes be placed on the Plant's payroll in due course.

I am planning to arrive in Ames on Friday morning, the twelfth, and to leave Saturday evening, the thirteenth, in order to discuss the problem in detail with you and to be of some assistance to Mrs. O'Leary. Here's hoping for a grand start for the Cadette program.

Yours sincerely,

CURTISS-WRIGHT CORPORATION

C. Wilson Cole, Supervisor

CWC/ek

cc: Prof. W. G. Nelson

CURTISS-WRIGHT CORPORATION  
Lambert Field  
St. Louis, Mo.

February 6, 1943.

Iowa State College  
Ames, Iowa

Attention: President Charles E. Friley

Gentlemen:

Referring to Article 9, page 5, of the Curtiss-Iowa Training Contract it is stated as follows:

"Curtiss may by notice in writing to Iowa State College designate from time to time a representative (hereinbefore and hereinafter referred to as the 'Curtiss Representative') who shall be generally in charge of administering and supervising the performance of this contract."

We are hereby assigning Mr. H. A. Steel, Engineering Manager of the St. Louis Plant, as "Curtiss Representative" as defined above. Our Mr. C. W. Cole will continue to act in the capacity of Coordinator between your school and our Plant in order to continue maintenance of standards relative to Curriculum, activity of students, etc. We therefore, request that you continue the policy of addressing to Mr. Cole copies of all correspondence direct to our Plant and that you likewise address to Mr. H. A. Steel copies of all correspondence directed to Mr. Cole.

Referring to Article 10, page 5, of the Curtiss-Iowa Training Contract it is stated as follows:

"Curtiss shall assign an employee (hereinbefore and hereinafter referred to as the 'Curtiss Supervisor') to act as Supervisor of the Curtiss Students."

We are hereby assigning Mrs. Jean O'Leary as Curtiss Supervisor as defined above. Mrs. O'Leary will report to your school during the week of February 8. At the present date and until such time as the program is more fully developed she will report to Mr. Cole in discharging her function. Thereafter she will report to the "Curtiss Representative" as indicated in the above paragraph.

We wish to take this opportunity to express our appreciation for your cooperation in this endeavor. We feel sure that the program will result in a substantial contribution to the War effort.

Very truly yours,

CURTISS-WRIGHT CORPORATION  
Airplane Division, St. Louis Plant

C. W. France  
Vice President & General Manager

May 15, 1943.

Mr. Charles E. Friley, President  
Iowa State College  
Ames, Iowa

Dear Mr. Friley:

As you probably have been informed by now, Mrs. Jean O'Leary is leaving her position as personnel supervisor of the Curtiss-Wright Cadette Program at Iowa State College. This move has been necessary in view of some personal complications, and we have therefore given Mrs. O'Leary a leave of absence during which time she will be able to take care of these matters. As soon as her leave of absence has terminated, she will then be transferred to some other position within the Curtiss-Wright organization.

We in the corporation are extremely sorry to lose Mrs. O'Leary even for a short period and are extremely disappointed that she will not complete her term of office in connection with the present group of Cadettes at your school. Plans have been made for Mrs. O'Leary to leave Ames on Saturday or Sunday, May 22 or 23.

We are assigning Miss Elizabeth Robertson as personnel supervisor for the Iowa Cadette unit in Mrs. O'Leary's place. She will arrive at Ames on Thursday, May 20, and will officially take up her duties the following Monday. I am taking the liberty of sending Miss Ruth Cleverly, my assistant, along with Miss Robertson in order that Miss Robertson may have valuable assistance during her first few weeks. Miss Cleverly will be responsible to assist member of your staff in effecting the transition between Mrs. O'Leary and Miss Robertson.

May I take this opportunity to thank you and the members of your staff for the excellent cooperation given to Mrs. O'Leary to date. May I also express my sincere hope that you will find in Miss Robertson a person with whom mutual cooperation can be obtained.

Yours very truly,

CURTISS-WRIGHT CORPORATION

C Wilson Cole, Supervisor  
Engineering Personnel Bureau

CWC/ek

cc: Professor W. C. Nelson  
Dean T. R. Agg  
Mrs. M. McGlade  
Mr. J. K. Walsh  
Mrs. Jean O'Leary  
Miss Ruth Cleverly  
Miss Elizabeth Robertson

CURTISS-WRIGHT CORPORATION  
Airplane Division, St. Louis Plant  
Lambert Field, St. Louis, Missouri

p. 34

May 18, 1943

Iowa State College  
Ames, Iowa

Attention: President Charles E. Friley

Gentlemen:

Referring to Article 9, Page 4, of the Curtiss-Iowa Training Contract it is stated as follows:

"Curtiss may by notice in writing to Iowa State College designate from time to time a representative (herinbefore and hereinafter referred to as the "Curtiss Representative") who shall be generally in charge of administering and supervising the performance of this contract."

My letter of February 6, 1943 assigned Mr. H. A. Steel, Engineering Manager of the St. Louis Plant as the "Curtiss Representative". Mr. J. K. Walsh, Supervisor of Training at the St. Louis Plant is hereby appointed the "Curtiss Representative" relieving Mr. Steel of this responsibility, effective today.

Mr. G. W. Cole will continue to act in the capacity of Coordinator between your school and our Plant, therefore request that you forward to Mr. Cole copies of all correspondence addressed to Mr. Walsh. There should be few instances that will require you to address correspondence directly to Mr. Cole, however, should the necessity arise, please forward copies of this correspondence to Mr. Walsh.

I trust the above change will not cause you any inconvenience, and wish to take this opportunity to thank you and your faculty for past cooperation in the operation of the entire Cadette Training Program.

Very truly yours,

CURTISS-WRIGHT CORPORATION  
Airplane Division, St. Louis Plant

C. W. France  
Vice-President & General Manager

HAS:LO:4315

cc: G. A. Page  
H. E. McDonald (B)  
C. W. Cole  
H. A. Steel  
O. L. Allman  
E.F.J. Meyer  
W. L. Wells

Dean T. R. Agg  
Prof. W. C. Nelson  
L. L. Holmes (B)  
J. O'Leary (Curtiss Supervisor)  
J. K. Walsh

CURTISS-WRIGHT CORPORATION  
Airplane Division - St. Louis Plant

Lambert Field  
St. Louis, Missouri

July 9, 1943

Professor W. C. Nelson  
Iowa State College,  
Ames, Iowa.

Dear Professor Nelson:

Only a few short months ago, Iowa State College and Curtiss-Wright together were busy making final arrangements for our Engineering Cadette program. Since that time weeks and months have slipped by rapidly, and we are suddenly aware of the fact that the Cadette program has nearly reached the half-way mark.

Looking back over these first few months we can hardly help being aware of the splendid work done and the fine cooperation given by the University of Iowa toward the successful accomplishment of the program. We have many times felt your keen interest in the success of this project, and your results to date certainly have justified our belief that much can be gained through close cooperation between Education and Industry, such as that which now exists between Iowa State College and Curtiss-Wright.

As this type of training program was as much of an experiment from your standpoint as it was from ours, occasional problems were bound to arise for which there were no precedents. You and your staff have accepted this as a challenge, and each and every faculty member deserves our heartfelt recognition for the spirit with which they have risen to meet it. In behalf of the St. Louis Plant of the Curtiss-Wright Corporation, may I take this opportunity to express our sincere appreciation for the efforts you and your staff have so generously extended. Our contacts with you and Iowa State College during these five months have been most enjoyable, and it is with great pleasure that we anticipate the continuance of our association during the coming months.

Very truly yours,

CURTISS-WRIGHT CORPORATION  
Airplane Division, St. Louis Plant

H. A. Steel  
Engineering Manager

HAS:LO

cc: Pres. Chas. E. Friley  
Dean T. R. Agg  
J. K. Walsh

## EVALUATION OF FIRST CURTISS-WRIGHT ENGINEERING CADETTE PROGRAM

DECISIONS MADE IN CINCINNATI JUNE 24, 1944 AT A MEETING OF:

Mr. R. L. Auten, Curtiss-Wright Engineering Personnel Bureau  
 Professor M. V. Barton, University of Texas  
 Professor C. W. Beese, Purdue University  
 Professor Bollinger, Pennsylvania State College  
 Professor E. F. Bruhn, Purdue University  
 Mr. Warren Bruner, Curtiss-Wright Cadette Training Dept.  
 Professor S. C. Hollister, Cornell University  
 Professor W. C. Nelson, Iowa State College  
 Professor G. L. Von Eschen, University of Minnesota  
 Professor M. J. Thompson, University of Texas

1. It will not be necessary to interview the girls or the supervisors.
2. Ratings on questionnaires by individual supervisors and Cadettes of the subjects taught the girls would be of doubtful value. They will not be requested to make any.
3. What is wanted is information as to:
  - a. What each girl is doing in the plant.
  - b. How well she is doing it.
4. This can be obtained from the merit ratings which are made periodically for each girl.
5. Plants will be requested to furnish the Cadette Training Department copies of the merit ratings already made, and those to be made during the next year.
6. In about six or eight months Mr. Bruner will call another meeting at which the accumulated merit ratings will be compared with school grades.

Recorded by:

(signed)  
 Warren Bruner  
 June 24, 1944

cc: Messrs.	J. E. Akerman	L. L. Holmes
	W. R. Boocock	J. W. Long
	H. S. Butler	H. E. McDonald
	H. P. Hammond	V. Norris
	E. S. Harrar	J. M. Rice
	P. E. Hemke	H. A. Steel

CURTISS-WRIGHT CORPORATION  
Airplane Division - St. Louis Plant  
Lambert Field - St. Louis, Missouri

June 10, 1943

Iowa State College  
Ames, Iowa

Attention: President Charles E. Friley

Gentlemen:

Please substitute the attached revised curriculum in place of the curriculum known as Exhibit "A" in the original Iowa-Curtiss Contract.

By way of explanation it may be stated that the attached curriculum was revised to conform with the changes recommended at the Chicago Curriculum Meeting, May 10 to 12, with, of course, the knowledge and approval of Professor W. C. Nelson, of your institution. This new revised curriculum supersedes the old one.

Please acknowledge receipt of this curriculum and your acceptance of this substitution for Exhibit "A" in our contract.

Very truly yours,

CURTISS-WRIGHT CORPORATION  
Airplane Division, St. Louis Plant

C. W. France  
Vice President & General Manager

JKW-b-4398

Att.

cc: Messrs. G. A. Page  
H. H. McDonald (B)  
C. W. Cole  
H. A. Steel  
E. F. J. Meyer  
W. L. Wells

Dean T. R. Age  
Prof. W. C. Nelson  
L. L. Holmes (B)  
E. Robertson (Curtiss Supervisor)  
J. K. Walsh



A-1

Engineering Mathematics -- 6 hours per week for 22 weeks1. Logarithms - 12 hours

Definition of logarithms; Common logarithms for multiplication, division, powers, and roots. Natural logarithms and conversions.

2. Slide Rule - 12 hours

Addition and subtraction with simple scales; relationship to logarithms; multiplication, division, powers, and roots to slide rule; rules for decimal points.

3. Trigonometry - 60 hours

(a) 42 hours - Definitions, functions, solution of right triangles

(b) 18 hours - Solution of general triangles, and problems. Functions of double angles.

4. Areas and Volumes

(Coordinate with manual and handbook)

Areas of plane figures; volumes and areas of surfaces of prisms, cones, pyramids, frustums; columns of revolution (include Simpson's rule and Pappus' rule). Centroids of simple area and volume. Use of planimeter.

5. Review of Algebra - 30 hours

Through quadratic equations.

B-1

3 hours per week for 22 weeks1. Analytical Geometry - 33 hours (To be taken by all sections)

Rectangular coordinate systems; properties of conic sections; brief treatment of polar coordinates.

2. Applied Differential and Integral Calculus

(This course is to be covered only by those advanced sections capable of doing so). Emphasis should be made on application of aircraft problems.

3. Aircraft Problems - 33 hours (To be taken by all sections simultaneously)  
(Construction of graphs and charts)

Graph paper, rectangular and polar coordinates; logarithmic papers; construction of charts; graphic solution of equations; and curve plotting.

Plotting of normals and tangents to irregular curves.

Construction of graphs as computing aid.

This subject will be treated substantially as outlined. The outline below is not intended to be a hard and fast requirement. It is merely intended as a suggested development of this topic.

Kinds of Graph Paper

Rectangular coordinates  
Graphs of Simple Functions

Non-linear Functions  
Graphs of Functions

Logarithmic Paper  
Graphs of Logarithmic Equations

Semi-Logarithmic Paper  
Graphs of Logarithmic Equations

Construction of Charts  
Factors Governing the Selection of Charts

Ratio Charts  
Graphic Comparisons  
Cumulative Charts

Graphical Solution of Equations

Curve Plotting, Empirical Equations

Curve Plotting, Straight Line Law, Method of Averages

Curve Plotting  
Method of Least Squared

Curve Plotting  
Fitting a Curve of the Power Series  
A Curve of the Second Degree

Use of Logarithms in Curve Plotting

Other Curve Types  
Exponential Curves  
Hyberbolic Curves

Special Parabolic Law  
Method of Averages Applied to General Parabolic Law

Plotting of Normals and Tangents to Irregular Curves

## A-II

Job Terminology and Specifications - 3 hours per week for 22 weeks1. The Airplane - 9 weeks (27 hours)

Brief outline of the airplane--

- a. The ABC of flight- suggested use of film.
- b. Types of military and commercial aircraft.
- c. Airplane components and their functions.
  1. Airplane
  2. Propeller
  3. Engine
  4. Accessories

Suggested Books  
 GAA Bulletin - The Airplane and its Parts (Pre-Flight)  
 Lockheed's Aircraft Design Sketchbook  
 Otis & Page- Pre-Flight Aeronautics (prepared by Bureau of Education, published by MacMillan for high-school use.)  
 Shield's Theory of Flight and the Aircraft Engine.

2. Aeronautical Industrial Organization - 2 weeks3. Function and Operation of Curtiss-Wright's Engineering Department - 11 weeks

This course should be developed to show the application of material given under the other four. It should be a drill class of questions and answers using as a reference the Engineering Manual and Procedure. In addition, the material given in the Engineering Manual should be developed from a processing and usage point of view. (It is recommended that the instructor giving this course visit the Curtiss-Wright plant.)

## B-II

Aerodynamics and Theory of Flight - 3 hours per week for 22 weeks1. Fundamental Aerodynamics of the Airplane

- a. Standard air
- b. Elementary formulas and equations
- c. Parasite resistance
- d. Interference resistance

2. Air Foils

- a. Lift and drag characteristics
- b. Characteristic curves
- c. Pressure distribution and center of pressure
- d. Criteria for the selection of airfoils
- e. Tapering wings
- f. Aspect ratio and its effect
- g. Reynold's number
- h. Compressibility effects

3. Maneuvers

- a. Rectilinear flight
  1. Climb
  2. Glide
  3. Dive

- b. Curvilinear flight
  1. Banking
  2. Turning
  3. Stalling
  4. Spinning
  5. Special maneuvers

4. Elements of Stability and Control

- a. Static stability
- b. Dynamic stability
- c. Longitudinal stability
- d. Lateral stability
- e. Directional stability and control

5. Design Consideration

Performance, specification, and charts.

6. Load Factors

Development and use (2 weeks minimum)

7. Wind Tunnel

- A. Demonstration

A-III

Elements of Aircraft Drawing and Standards - 9 hours per week for 22 weeks

Based on Curtiss-Wright drafting manual and standards book, elements of drawing to include use of instruments; upper case lettering throughout the course (slant and vertical); line essentials, sketching; orthographic projections; tracing; auxiliary views and sections; dimensioning, limits and tolerances; fits; developments, intersections and projections; isometric drawings.

Drawing problems to be based on typical blue prints and parts furnished by Curtiss-Wright with work done chiefly on vellum, tracing paper and some cloth (furnished by Curtiss-Wright). Periodical blue print checks are to be made. All drawings should be dimensioned on the decimal system even though the samples furnished will probably all be dimensioned on the fraction system.

B-III

Aircraft Drawing and Design - 12 hours per week for 22 weeks

1. Detailed drawings of actual airplane parts
  - a. Detailing of wood parts (Purdue University only)
  - b. Detailing of sheet metal parts
  - c. Detailing of machined parts and forgings
  - d. Detailing of welded parts
  - e. Detailing of castings
2. Assembly drawings
3. Layout and Development

Drawing problems to be based on typical blue prints and parts furnished by Curtiss-Wright with work done chiefly on vellum, tracing paper and some cloth (furnished by Curtiss-Wright) Periodical blue print checks are to be made. All drawings should be dimensioned on the decimal system even though the samples furnished will probably all be dimensioned on the fraction system.

Note: A total of forty to fifty class hours should be spent on intersections and projections as applied to aircraft layout problems. This can be included either in the second eleven weeks of A-III or in the first eleven weeks of B-III.

A-IV

Elementary Engineering Mechanics - 6 hours per week for 22 weeks

1. Introduction - 10 weeks

Fundamental concepts dealing qualitatively with the following:

Force; weight; mass; density; specific gravity; lever; pulley; gears; screw; hydraulic and pneumatic pressure systems; tension; compression; flexure; functions of columns; beams, tension members; brittleness; ductility; hardness; friction; viscosity.

2. Statics and Dynamics - 12 weeks

The following items should be covered on the basis of qualitative determinations and that liberal use be made of problems based on aircraft design:

a. Statics - 7 weeks

Force, vectorial representation, couples, combination and resolution of forces, concurrent and non-concurrent force systems, reactions, space systems, truss analysis, buoyancy, metacentric height.

b. Dynamics - 5 weeks

Laws of motion. linear and angular velocities, acceleration, energy, work, inertia, momentum, impact, motion on inclined plane, friction.

B-IV

1. Strength of Materials - 6 hours per week for 11 weeks

- a. Stress, strain, elasticity, proportional limit and yield point, tension, compression, shear.
- b. Joints- riveted and welded under direct and eccentric loads. Simple pressure vessels.
- c. Beams - loads diagrams, reactions, moment and shear diagrams, moment of inertia, stress and tension, compression, shear (longitudinal and transverse), deflection using handbook methods, fixed and continuous beams.

- d. Beam Deflection- fixed and continuous beams. (This topic to be taken up only if sufficient time can be found to approach the subject from the standpoint of fundamental concept)
- e. Aircraft Loads- 3 to 4 periods  
(As specified in government publications on airworthiness)

2. Aircraft Structural Analysis - 6 hours per week for 11 weeks

The following topics should be covered in the eleven weeks devoted to aircraft structural analysis.

a. Columns:

- 1. Euler column formula
- 2. End restraint
- 3. Other column formulae
- 4. Design of tubes in compression

b. Torsions:

- 1. Solid sections
- 2. Thin circular sections
- 3. Membrane analogy
- 4. Allowable stresses for thin tubes
- 5. Design of round tubing
- 6. Torsion of non-circular thin cylinders
- 7. Torsion of open sections
- 8. Comparison of open and closed sections in torsion

c. Combined Stress at a Point

- 1. Biaxial stress
- 2. Shear and normal stress

d. Buckling of Sheet:

- 1. Single panels in compression
- 2. Single panels in shear

e. General Design Consideration

- 1. Stress concentration
- 2. Fatigue
- 3. Weight reduction
- 4. Use of standard parts

3. Materials Testing- 3 hours per week for 22 weeks

A suggested breakdown of this course, based on the original outline, is as follows:

- 7 -

- |                        |  |
|------------------------|--|
| a. Tension testing     | f. Torsion of test specimens                 |
| b. Compression testing | g. Buckling of columns                       |
| c. Shear testing       | h. Thin web beams                            |
| d. Bending             | i. Loading and vibration of major assemblies |
|                        | j. Torsion of major assemblies               |

It is recommended that this outline should be covered completely insofar as Items a. through f. are concerned. If facilities are not available for handling the remaining items, it is suggested that this time be devoted to additional work in the wind tunnel laboratory, or to the preparation of technical reports.

A-V

Properties and Processing of Aircraft Materials- 6 hours per week for 22 weeks

1. Shop - 4 hours per week for 22 weeks  
(To be given simultaneously with lecture (a) and (b))

AIM: TO FAMILIARIZE THE STUDENT WITH SHOP PROCEDURES AND SHOP TOOLS AND THEIR OPERATIONS AS USED IN AIRCRAFT ENGINEERING.

- a. Bench work

Use of hammer on sheet metal aluminum alloy, file, layout, and drilling of aluminum alloy, use of hand taps and dies, sheet metal layout on aluminum alloy, cutting and forming of aluminum alloy, riveting (flush, blind, and machine)

- b. Lathe work

Straight turning, screw thread cutting, chuck work, boring, internal threading.

- c. Milling machine work

Plane milling, index milling, production milling.

- d. Shaper and planer

Surfacing and squaring

- e. Routing machine

- f. Turret lathes and screw machines

Set-up and operation; production

- g. Press operations on aluminum alloys

Mechanical and hydraulic; use of punches and dies; kirksite dies, rubber dies, temporary dies and wood dies.

- h. Demonstration of miscellaneous machines

Boring mills, grinders, hobbing machines, do-all machines.

- i. Precision measurements

Use of instruments; use of gauges; indicators, and gauge plots.

2. Lecture - 1 hour per week for 22 weeks

(a) To be given simultaneously with shop and with lecture (b)

- a. Manufacture of aluminum and aluminum alloys
- b. Rolling, forming, and shaping of aluminum alloys  
(rolling, forging, and extruding)
- c. Aluminum alloys  
Physical properties and specifications; demonstration of materials testing and testing laboratory.
- d. Heat treating of aluminum alloys  
Annealing, hardening, anodizing. In this connection, there will be demonstrations of heat treating; heat treating equipment, and hardness testing machines.
- e. Aluminum castings  
Physical properties and specifications
- f. Manufacture of iron and steel  
Physical properties and specifications
- g. Tool steels and other cutting materials  
Physical properties and specifications; carbon steel, hi-speed steel, stellite and cemented carbides.
- h. Welding of aircraft materials  
Techniques and equipment; demonstration of both in the laboratory.
- i. Plastics  
Physical properties and specifications. (Stress application of plastics-not chemical makeup)
- j. Die casting  
Production methods, physical properties and specifications; zinc base, aluminum base, and magnesium base metals.
- k. Magnesium alloys  
Physical properties and specifications

3. Lecture - 1 hour per week for 22 weeks

(b) (To be given simultaneously with shop and with lecture (a))

- a. Shop terminology and machine operations
- b. Bench and hand work  
Lectures dealing with specific machine tools beyond that type of work that can be accomplished in the shop, including filing, layout, and riveting of aluminum. (Emphasizing the use of aircraft materials)
- c. Lathe, turret lathe, and screw machines
- d. Milling machine
- e. Drilling machine

- f. Grinding machine
- g. Broaching
- h. Surface finishing  
Honing, lapping, buffing, and polishing
- i. Press working of metals  
(With particular reference to aircraft machines)
- j. Measurement and measuring devices

## B-V Aircraft Production Methods and Operations.

### 1. Use of Mass Production Tools in Design Engineering

The following is an enumeration of some of the suggested topics that should be treated in this course with the emphasis on each to depend upon the past coverage of such items given in the shop course (A-5) of the first semester.

- a. Jigs
- b. Production Machines
- c. Fixtures
- d. Hand Processes
- e. Special Production Tools
- f. Routing Machines
- g. Cutting Machines
- h. Forming Machines- Use of Rubber
- i. Punching Machines

### 2. Airplane Parts and Assemblies

- a. Spars
- b. Control Surfaces and Mechanisms
- c. Loading and Vibration
- d. Torsion

### 3. Production Engineering in the Aircraft Industry

#### A. Production Methods, Equipment and Operation

- 1. Assembly Methods
  - a. Line Production
  - b. Sub-assemblies
  - c. Major assemblies
- 2. Assembly of Electrical Harnesses
- 3. Quality Control and Inspection
- 4. Tube Bending- Use of Mock-up
- 5. Production Welding
  - a. Acetylene and Electric Welding in Jigs and Fixtures
  - b. Spot Welding
- 6. Heat Treatment, Anodizing and Plating

- 10 -

7. Construction of Experimental Airplanes
  - a. Wooden Model
  - b. Mock-up
8. Die Casting of Metals and Plastics
9. Modification Center and its Functions

B. Production Planning

C. Routing Procedure

D. Shop Liaison

The Course should be closely correlated with Aircraft Detail Design so as to bring out the importance of a good working knowledge of production methods on the part of the designer, so ~~that he may~~ avoid laying out a part or assembly which cannot be built in the shop, or which may involve considerable difficulty in its fabrication.

A-VI and B-VI

SUPERVISED STUDY AND METHODS - 8 hours per week for 44 weeks

Instruction in study methods to be given by mathematics and mechanics instructors. Presentation of engineering problems, emphasizing method of approach used in the solution of each type of problem. Periods to be left open as to the subject matter to be covered, but work should be directed definitely toward analytical thinking. Students' efforts to be directed toward obtaining solutions to problems by themselves, not from instructors. Assistance should be given by instructors in visualizing problems.

Additional course material should not be given in the supervised study and methods. Advanced students should not be used as tutors.

A-VII and B-III

PHYSICAL EDUCATION - 2 hours per week for 44 weeks

The committee recommends that the work in Physical Education should be given primarily from the standpoint of relaxation and recreation. Some corrective calisthenics might be included with benefit, but this should not be compulsory, nor should it take up a great deal of time. A correlation of physical training with health service activities and dormitory supervision might well be included with regard to such topics as adequate sleep, dietary advice, and general health.



TIME SCHEDULE

SECTION A

TERM SECOND

(July 15-Dec. 15, 1973)

HOUR	DAY	MON.	TUES.	WED.	THUR.	FRI.	SAT.
7-8 AM		DPR- FST	"	"	"	"	"
8-9 AM		MEM. UNION	"	"	"	"	"
9-10 AM		210 Eng. Hall	B-5----- 312 MECH. ENGR. LAB.	B-4----- 210 ENG. HALL	B-4----- 304 LAB. OF MECH.	B-7----- 210 ENG. HALL	B-6----- 306 Eng. Hall
10-11 AM		B-7----- 209 Eng. Hall	"	B-2	"	B-2	"
11-12 AM		210 Eng. Hall	"	B-1	"	B-1	"
12-1 PM		MEM. UNION	"	"	"	"	"
1-2 PM		B-1	"	"	"	"	"
2-3 PM		Lunch	"	"	"	"	"
3-4 PM		MEM. UNION	"	"	"	"	"
4-5 PM		LANDSCAPE ARCH.	B-6----- 210 ENGR. HALL	B-3----- LANDSCAPE ARCH.	B-6----- 210 ENGR. HALL	B-3----- LANDSCAPE ARCH.	"
5-6 PM		"	"	"	"	"	"
6-7 PM		DINNER	"	"	"	"	"
7-8 PM		MEM. UNION	"	"	"	"	"
8-9 PM		"	"	"	"	"	"
9-10 PM		"	"	"	"	"	"

# Graduation Exercises

## Curtiss-Wright Engineering Cadettes

THE IOWA STATE COLLEGE  
AMES, IOWA



In South Ball Room, Memorial Union  
Tuesday Evening, December Fourteenth, at Seven o'Clock  
Nineteen Hundred and Forty-Three

THE IOWA STATE COLLEGE  
OF AGRICULTURE AND MECHANIC ARTS  
AMES, IOWA

This Certifies that  
*Exhibitor's Marie Joku*

has completed the

**Curiss-Wright Engineering Cadette Training Course**

conducted by The Iowa State College in cooperation with the  
Curiss-Wright Corporation from  
February 15, 1943 to December 14, 1943.

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DEAN, DIVISION OF ENGINEERING

---

COURSE DIRECTOR

---

PRESIDENT OF COLLEGE

CURTISS-WRIGHT CADETTESCOURSE GRADE LIST

<u>Name</u>	<u>A-1</u>	<u>A-2</u>	<u>A-3</u>	<u>A-4</u>	<u>A-5</u>	<u>B-1</u>	<u>B-2</u>	<u>B-3</u>	<u>B-4</u>	<u>B-5</u>	<u>Plant Rating</u>	<u>Remarks</u>
Acton, Geneva M.	F	C	D	F	C	D	C	C	D	C	Poor	
Acuff, Annice V.	C	B	C	B	C	A	A	C	A	C	Good	
Adams, Harriet Dolores	A	B	B	B	A	A	B	B	B	A	Good	
Allen, Marjorie Nell	B	B	D	C	C	B	A	D	C	B	Good	
Anderson, Mary Alice	A	C	B	C	C	C	B	B	C	C	Good	Dropped 6/3/44
Bagley, Marion Eleanor	C	C	C	D	C	C	D	C	D	D	Good	
Ball, Ruth Emilie	C	B	C	D	C	B	B	D	C	A	Good	
Baumgartner, Annette M.	C	C	C	D	C	C	C	C	F	C	Fair	Dropped 5/3/44
Beck, Betty Jo												Dropped 4/12/43
Berry, Norma Dean	C	B	B	D	B	C	D	C	C	B	Excellent	
Blacet, Mary Jane	A	B	C	D	C	B	C	C	C	C	Fair	
Black, Emily Carnall	C	C	C	C	C	C	B	C	C	C	Good	
Boniface, Jane Lee	B	C	C	C	C	B	B	C	F	C	Good	Dropped 9/6/44
Cambier, Joyce Esther	C	B	C	D	C	B	C	C	C	C	Excellent	Dropped 5/30/44
Carlson, Joan Barbara	B	C	D	C	C	B	A	C	B	C	Good	
Claybourn, Betty	B	B	C	C	C	B	C	C	D	C		Dropped 12/15/43
Clevenger, Mary Carol	B	A	B	B	A	B	B	C	A	A	Excellent	
Converse, Mary Louise	C	C	C	C	C	B	B	C	D	B	Fair	
Cook, Mary Louise												Dropped 5/16/43
Cooney, Kathryn Mercedes	B	C	D	D	C	A	C	D	F	C	Excellent	
Crawford, Norma Austin	C	C	C	C	C	C	B	B	C	C		Dropped 12/15/43
Crawford, Harriet												Dropped 5/18/43
Curtis, Maxine Doris	A	B	C	B	C	C	A	B	B	B	Good	
Douglas, Alice Jo	C	C	C	B	C	B	C	C	B	C	Good	Dropped 8/31/44
Engle, Eloise	A	A	B	A	A	A	A	C	B	B	Excellent	
Floyd-Jones, Jane												Dropped 2/18/43

<u>Name</u>	<u>A-1</u>	<u>A-2</u>	<u>A-3</u>	<u>A-4</u>	<u>A-5</u>	<u>B-1</u>	<u>B-2</u>	<u>B-3</u>	<u>B-4</u>	<u>B-5</u>	<u>Plant Rating</u>	<u>Remarks</u>
Frymire, Gussie Adelle	C	C	C	D	C	B	C	C	D	C	Good	
Gardner, Betty Isabel	B	C	B	B	B	B	A	C	B	C	Good	
Gauge, Nema Lue												Dropped 5/8/43
Gilbert, Patricia May	B	A	A	A	A	A	A	A	A	A	Excellent	
Glanville, Betty Jo	C	C	C	D	B	C	A	C	C	B	Excellent	
Goodwin, Wanda	C	A	C	C	A	A	A	B	B	A	Good	
Graddy, Sarah Kathleen	C	C	C	D	C	B	B	C	D	C	Good	
Grant, June Elizabeth	C	C	B	D	C	C	C	B	D	B	Good	
Greenstone, Helen												Dropped 3/25/43
Grosso, Eda												Dropped 5/17/43
Grundon, Helen Marjorie	A	C	B	C	C	A	B	A	C	C	Good	
Hake, Murray	B	C	C	C	C	D	C	C	F	C	Fair	
Harlow, Leah Jean	B	C	D	F	C	C	D	D	D	C	Fair	
Harris, Anna Lee	B	C	C	B	C	B	A	B	B	C	Fair	Dropped 8/29/44
Hartshorn, Lucy Lair	A	A	A	A	A	A	A	A	A	A		Dropped 3/11/44
Heckman, Elizabeth Ann	A	B	B	C	C	B	B	C	B	B	Fair	
Henderson, Lillian Fern	A	A	A	A	A	B	B	A	A	A	Excellent	
Hendrickson, Ethelyne E.	B	B	B	A	A	A	B	B	B	A	Excellent	
Hettmannsperger, Dorain	C	C	B	C	C	C	C	C	C	C	Good	Dropped 5/17/44
Hillen, Rose Loraine	A	A	A	A	B	B	B	A	A	A		Dropped 12/15/43
Holladay, Marjorie												Dropped 3/15/43
Hultmark, Searle Lee	C	C	D	F	D	B	D	C	F	C	Good	
Johnson, Mary Elizabeth	A	B	B	C	C	A	B	A	B	B		Dropped 12/15/43
Johnson, Mary Josephine	C	A	B	B	A	B	A	C	A	A	Good	Dropped 5/25/44
Johnson, Mildred Marie	B	B	A	C	C	C	B	B	C	A	Good	
Johnson, Sarah Vivian	A	B	B	B	A	A	B	C	B	A	Excellent	Dropped 6/20/44



- 4 -

Name	A-1	A-2	A-3	A-4	A-5	B-1	B-2	B-3	B-4	B-5	Plant Rating	Remarks
Palmer, Eleanor Ann	C	C	C	D	C	C	C	C	D	C	Good	Dropped 8/15/44
Patterson, Loyce E.	C	B	B	D	C	B	B	A	D	B	Good	Dropped 7/8/44
Pirkey, Marion	B	D	B	D	C	B	D	C	F	C		Dropped 2/4/44
Folk, Dolores N.	C	C	C	D	C	D	B	C	D	C		Dropped 6/30/44
Fressly, Geraldine M.	A	B	C	B	C	A	A	C	C	D	Fair	Dropped 7/12/44
Ragland, Mary Margaret	B	A	A	B	B	B	B	B	A	B	Fair	Dropped 4/28/44
Ragsdale, Jane Alys	C	C	C	F	C	C	D	C	F	C	Fair	
Rill, Anne	B	C	B	C	C	A	C	B	D	C	Fair	
Ritter, Jean Louise	B	B	C	B	B	C	C	B	B	B	Excellent	
Schleuter, Gloria Mildred	B	B	A	B	A	C	B	A	B	C	Excellent	
Scribner, Florence Evelyn	C	C	B	C	C	C	B	C	C	B	Good	
Scrogam, Elizabeth Ruth	B	B	B	A	B	B	B	B	B	B	Good	Dropped 4/28/44
Short, Golden Juanita	B	C	C	C	C	C	C	C	D	C		Dropped 12/15/43
Sollitt, Nancy Blanche	B	C	D	D	C	B	B	C	D	C	Fair	Dropped since 9/1/44
Stevens, Marie Louise	C	C	C	C	C	B	C	C	C	B	Good	
Story, Jewell Elizabeth	C	C	B	C	B	B	B	D	C	C	Fair	Dropped 4/21/44
Surwillo, Phyllis Ludwika	A	A	A	A	A	A	A	A	A	A	Good	
Suydam, Edna Reid	C	B	C	B	C	C	A	C	B	B	Good	
Swarts, Marjorie Leah	B	A	A	B	B	B	C	A	A	A		Dropped 4/8/44
Sweeney, Anne Marie	C	D	C	D	C	C	C	C	D	C		Dropped 12/15/43
Todd, Doreen Gaston	C	C	B	F	C	C	D	B	F	D	Good	Dropped 8/12/44
Trembley, Dorothy F.	C	C	B	F	C	C	C	D	F	C	Good	
Wight, Jane Anita	C	B	C	C	C	C	A	C	C	B	Good	Dropped 7/28/44

## CURTISS-WRIGHT ENGINEERING PROGRAM

Courses conducted from Feb. 15, 1943 to Dec. 15, 1943

Detailed information to accompany student transcripts.

## DESCRIPTION OF COURSES

## First 5-month period

- CW. A-1. Engineering Problems \*(0-6-0) 5 quarter credits  
Prerequisite: College mathematics through algebra. Theory and use of slide rule; logarithms; trigonometry; areas, volumes, and weight; use of planimeter; Simpson's Rule; Centroids, moment of inertia, radius of gyration, Pappus rule; review algebra through quadratic equations.
- CW. A-2. Airplane Design & Construction. (3-0-0) 2 quarter credits  
Prerequisite: College mathematics through algebra. History of flight; types of airplane; airfoil characteristics; forced in flight; control and stability; wing construction; fuselage construction; powerplant and propeller operation. Organization of typical aircraft company and detailed organization of the engineering department. Detailed study of Curtiss-Wright Engineering manual; dimensioning; screw threads; AN standards; stock sizes; tolerances and fits; forgings and extrusions; engineering change orders; design and layout practices.
- CW. A-3. Aircraft Drafting. (3-0-6) 7 quarter credits  
This included the work usually completed in the freshman year in Engineering Drawing with the exception of ink tracing. Use of Instruments, lettering, geometric curves, pencil tracing, orthographic and isometric projection, descriptive geometric theory of projection and applications, technical sketching, dimensioning, standard conventions, detail and assembly drawings of machines and structures. Use of CW standard books, Army-Navy Standards, specification and use of standard parts, aircraft nomenclature.
- CW. A-4. Elementary Engineering Mechanics (6-0-0) 5 quarter credits  
Prerequisite: College mathematics through algebra and classification in CW A-1. Definitions and properties of materials. Use of the stress-strain diagram. Composition and resolution of forces, triangle and Parellelogram laws, moment of a force, couples. Resultants of force systems. Free-body diagrams and equations of equilibrium. Graphic statics. Friction. Buoyant forces and stability of floating bodies. Rectilinear and curvilinear velocity and acceleration. Newton's laws of motion. Equations of motion for translation, rotation and plane motion. Work and energy, impulse and momentum. Direct central impact.
- CW. A-5. Properties and Processing of Aircraft Materials. (2-0-4) 2 quarter crs.  
Prerequisite: College mathematics through algebra. A series of lectures dealing with aluminum and its alloys, magnesium and its alloys, steels used for both aircraft construction and for tools, die casting materials, plastics, plywood and fabrics. A second series of lectures dealing with measurements, metal casting, machine shop tools and operations, power press work, welding, finishing of aircraft parts and testing and inspection methods. Laboratory

\*The first number in parenthesis indicates the number of lectures a week, the second, the number of recitations, the third the number of hours of laboratory a week.

work consisting of sheet metal lay-out, cutting, forming and riveting sheet metal, welding, soldering, brazing, torch cutting, casting, power press forming and blanking, machine shop operations of lathe, grinders, milling machine, drill press, and power hack saw, use of rubber dies for cutting and forming, "nail and glue" type of wood construction, and use of measuring instruments.

Second 5-month period.

- CW. B-1. Aircraft Problems. (0-3-0) 3 quarter credits  
Prerequisite: College mathematics through algebra and CW. A-1.  
Analytical geometry, 11 weeks; Rectangular, polar and logarithmic graph papers; construction of charts; ratio charts; graphical solution of equations; empirical equations; straight line law, method of averages and method of least squares for curve plotting; curve fitting; plotting of normals and tangents to irregular curves.
- CW. B-2. Theory of Flight. (0-3-0) 3 quarter credits  
Prerequisites: College mathematics through algebra CW. A-2. Properties of air; lift and drag equations; parasite drag; airplane engine; propeller action; power required and available; performance analysis of climb, cruising, glide, dive; turns; landing; spins; stability and control; gust and maneuvering loads; load factors; applied load distribution. Wind tunnel testing of airfoil and airplane.
- CW. B-2. Aircraft Drafting and Design. (3-0-9) 9 quarter credits  
Prerequisite: College mathematics through algebra and CW. A-3.  
Detailing of wood joints and general wood construction; detail of welded parts and welded assemblies; major assemblies and installation drawings; Curtiss-Wright Engineering change-orders, title blocks and bill of materials, layout and design, and the use of the various standard books and reference material. Advanced details and assembly drawings, and some original design work.
- CW. B-4. Strength of Materials Structural Analysis. (6-0-3) 7 quarter credits  
Prerequisite: College mathematics through algebra and CW. A-4  
Stress determinations in axially loaded tension and compression members, riveted and welded joints, shafts, and beams. Shear and moment diagrams. Columns and column formulas. Torsion of hollow and non-circular sections, the membrane analogy. Combined stresses. Buckling of thin sheets. General design considerations.
- CW. B-5. Aircraft materials and assembly. (0-0-3) 2 quarter credits  
Prerequisite: College mathematics through algebra and CW. A-5.  
Laboratory in the use of such inserted fasteners as rivets, screws, bolts, pins, keys, and special vibration-proof fasteners. Laboratory in the use of jigs and fixtures. Laboratory work on a fabric-covered wing panel. Laboratory study of friction fits. Observation of maintenance work at the airport. Projected pictures of aluminum manufacturing, welding and riveting procedures, plastics, use of power machinery in cutting metals, use of measuring instruments, and the die casting of metals. Series of lectures on production engineering during latter part of course.

WAR DEPARTMENT  
HEADQUARTERS ARMY AIR FORCES  
Budget and Fiscal Office, Midcentral Audit District  
39 S. LaSalle St.  
Chicago 3, Illinois

22 February 1944

Subject: Cost of Subcontract for College Training  
Curtiss-Wright Corp., St. Louis, Mo. (Contractor)

To: Iowa State College  
Ames, Iowa

1. This office has received a memorandum from our Midwestern Audit District requesting that we obtain from you a statement of actual costs incurred under the above subcontract.

2. On 24 December 1942 your college submitted a budget in the amount of \$119,956.00, and it is requested that the statement of costs which you submit at this time be prepared in equal detail in order that the actual cost may be compared item for item with the estimate dated 24 December 1942.

3. It is requested that you advise this office as to how soon we may expect the statement of costs.

EARL H. CHUMNEY  
Major, Air Corps  
District Auditor

Comparison of the Preliminary Budget and the Costs Incurred for the  
Curtiss-Wright Cadette Training Program Conducted  
February 15, 1943 to December 15, 1943

		<u>Preliminary</u>	<u>Budget</u>
1. Personal Services			
a. Administration of teaching program		3,945.80	3,500.00
T. R. Agg	\$1,000.00		
Prof. J. K. Walkup	500.00		
Prof. H. J. Gilkey	500.00		
Prof. D. L. Arm	500.00		
Prof. O. A. Olson	500.00		
Loraine Henry--Business Secretary	708.30		
Frances Kurtzweil--Clerk	237.50		
	<u>\$3,945.80</u>		
		28,923.80	31,221.00
b. Faculty			
J. K. Walkup <sup>1</sup>	600.00		
W. C. Nelson	1,958.39		
Glenn Murphy	4,000.00		
L. R. Hillyard	2,911.10		
Harold Birkness	1,715.29		
R. W. Breckenridge	2,600.00		
Dale H. Scott	2,322.23		
Alfred Gaskell	2,322.23		
Lester G. Kelso	900.00		
H. O. Ustrud	2,210.00		
E. H. Ohlsen	2,620.00		
Lowell L. Carver	1,473.50		
John M. Coan	720.00		
Guy F. Gardner	1,361.06		
Don L. Sorenson	135.00		
Carlyle Peterson	675.00		
A. Morgan Johnson	400.00		
	<u>\$28,923.80</u>		
c. Clerical Assistance		3,166.71	2,880.00
Irma Benson	1,200.00		
Myra Thompson	687.10		
Louise Haug	509.03		
Students paid by the hour	770.58		
	<u>\$ 3,166.71</u>		
Registrar and Student Record Reports		500.00	500.00
2. Supplies and Expenses		5,000.87	8,855.00
Travel	939.74		
Postage	63.31		
Telephone and Telegraph	195.38		
Educational Supplies	2,486.09		
Educational Equipment	304.71		
Office supplies, equipment and Maintenance of equipment (938.96 + 72.68)	<u>1,011.64</u>		
	5,000.87		

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3. Student Fees		\$ 13,965.50	\$ 15,000.00
To cover medical care, recreation facilities, athletic activities, clubs, social events, matriculation, etc.			
4. Overhead and Maintenance		6,338.55	5,200.00
Janitor, utilities, maintenance of buildings, etc.		\$2,079.90	
Use of facilities at 4% of value		1,080.00	
General Administration at 3% of expenditure less depreciation		<u>3,178.65</u>	
		\$6,338.55	
5. Room and Board		<del>48,258.31</del>	<del>52,800.00</del>
Total		110,099.54	\$119,956.00
Unallocated		<u>1,039.78</u>	
Received from Curtiss-Wright		\$111,139.32	

<sup>1</sup>In addition to supervising the teaching of applied mathematics this professor also taught one course.

## TRAINING OF WOMEN IN ENGINEERING \*\*

by C. Wilson Cole

Head of Training Division, Wright Aeronautical Corporation  
 Supervisor of Engineering Personnel Bureau, Curtiss-Wright Corporation

Seldom in the history of either education or of industry has a more unique problem in the training of personnel been faced than the present one of introducing large numbers of women into the engineering profession.

National statistics indicate that during the last decade less than twenty-five women throughout the United States received engineering degrees each year. Though it is true that many outstanding engineering institutions finally removed long-standing entrance barriers to women, few have actually encouraged them to enter a profession generally looked upon as being "reserved for men only."

Drastic efforts currently being put forth by many companies to persuade women en masse to become "engineers" appear paradoxical compared to the many years of rebuff in the past. This change of attitude, however, has been a process of evolution even though it has taken place in less than two years.

In order to meet the industrial expansion resulting from demands for increased war production, large and small concerns alike were forced to turn to a labor supply other than male graduate engineers. It is pertinent to note that during the college year of 1941-42 there were approximately 6,342 engineers who entered the employment of private industry. During the current year of 1942-43 it is estimated that less than 4,000 will have the opportunity of accepting a position in private industry, and many of these may later find it necessary to enter military service.

One of the first major attempts to develop a substitute supply of personnel to fill engineering needs was the Engineering, Science, and Management Defense Training, now known as Engineering, Science, and Management War Training. During its three and one half years of existence, this branch of the U. S. Office of Education has trained over one million people. During the first year or two most of the training given by the ESMWT was of a pre-employment nature, but current training is almost exclusively given

\* \* \* \* \*

\*Note: The following table shows the yearly enrollment of ESMWT.

<u>Year</u>	<u>Number of Persons Enrolled</u>	<u>Women Enrolled Percent of Total</u>
1940-1941	120,000	less than 1%
1941-1942	440,000	9%
1942-1943	600,000	25%

\*\* To be presented at the 51st Annual Meeting, S.P.E.E., Chicago, Illinois, June 18-20, 1943.

to persons now employed in industry. Excellent results have been obtained by this latter method, but unfortunately it has not adequately assisted in training unskilled persons for positions of a high level. The reason for this is that the short-term nature of the courses given seriously limits the amount of material that can be given both in scope and penetration.

Consequently, with all due respect for the excellent intentions of the Office of Education and the results they have obtained through the ESMWT, industry has been forced to take supplementary steps of its own to develop new sources of supply and more comprehensive methods of training.

Some companies made a concerted effort to hire older men -- men who either lacked an engineering background altogether or whose engineering backgrounds were obtained many years ago without subsequent experience. These men were brought directly into the organization and trained on the job. One company, however, actually sent them to an engineering school for a short time prior to their placement within the organization.

All these efforts were only partially successful and were eventually curtailed because of the two following main factors:

1. It soon became obvious that older men were not sufficiently flexible in their thinking to absorb present day concepts and applications of engineering, particularly as it is practiced in the aeronautical industry.
2. It is impractical to employ older men for jobs that are on a beginner's level, particularly when the majority of such men have been accustomed to fairly important jobs at proportionately large salaries.

Simultaneously with the above efforts, a great many companies turned their attention to the utilization of woman power. One of the first attempts in this direction was the employment of graduate college women who had majored in mathematics and/or physics, in the hope that such women could be successfully trained directly on the job.\* It was soon realized, however, that it would be difficult to teach many of these women to apply their academic mathematics and physics to practical engineering problems.

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\*Note: Last year Wright Aeronautical Corporation (the engine division of Curtiss-Wright) employed 25 such women and have attempted since that time to train them for experimental test engineering duties. Their training to date has consisted mainly of guided working experience in several departments closely allied to the Test Engineering section where they will be placed at the completion of their training a few months hence. This experience has been supplemented by a certain amount of classroom work.

This experiment has been promising at least in part. There have been several notable examples within the aeronautical industry of women who have been promoted to responsible positions in structural and stress analysis during the past year or two.

Industry again failed, however, to find a solution to its overall problem. This was true for the following main reasons:

1. As with all of the other approaches mentioned above, the supply of qualified people was nowhere near adequate to meet the total need. From figures obtained through questionnaires sent to a high percentage of colleges throughout the United States, it was estimated that there were less than 600 women, majoring in mathematics and/or physics, being graduated from colleges in this country each year.
2. That women in general have had little exposure to mechanical things, and the mere fact that some women have taken mathematics or physics is not necessarily any indication that they are endowed with "mechanical horse-sense", or that they can do work of a highly technical nature.

During September last year it was realized that in spite of the efforts made up to that time industry was still faced with a serious shortage of engineering manpower which promised to become far more acute by January, 1944.

Searching for an entirely different approach to the problem, Curtiss-Wright devised a plan which has been named the Engineering Cadette Program. Under this plan young women with at least two years of college education were to be employed as Engineering Cadettes and assigned to an engineering university for their training. This reduction in the educational requirement immediately enlarged the available source of woman power, but at the same time it increased the complexity of our training program.

After making a preliminary study, the following basic decisions were reached:

1. That of the three divisions of Curtiss-Wright (namely, airframe, propeller, and engine) the Cadette program would be used by the airframe and propeller divisions only. This decision was founded on the belief that many engineering universities are admirably staffed and equipped to train personnel for aircraft and propeller work, but that few universities, if any, have the experience or the laboratory facilities to teach experimental engineering of aircraft engines.\*

With valuable assistance from the Promotion of Engineering Education, every engineering institution in

\*Note: Plans are being formulated to inaugurate a program whereby college girls of the type referred to above will be employed directly by the engine division. They will be trained in the company's experimental engine test laboratories supplemented by classroom lectures and demonstration.

2. That in order to recruit sizeable numbers of Cadettes, minimum requirements for employment and enrollment in the program should be established realistically. As a result, four essentials were agreed upon:
  - a) Education - At least two years of college including at least one year of college mathematics or its equivalent.
  - b) Age - At least eighteen years.
  - c) Previous scholastic record - Upper third of class in related subjects and better than average in non-related subjects.
  - d) An awareness of the engineering profession - (In most cases among the present Engineering Cadette group this was obtained through personal acquaintance with an engineer.)
3. That the curriculum to be taught by the universities should be custom-built, deleting any subjects which could be considered non-essential. However, it was agreed that sufficient fundamental should be included in order that the Cadettes would be at least potentially qualified for subsequent up-grading.
4. That the program should be of ten months duration, commencing February 15, 1943, and terminating on December 15, 1943.
5. That the company should contract with the participating schools for the cost of tuition and room and board. In addition, the Cadettes should be paid \$10 per week, which would establish them as employees and distinguish them from students endowed with industrial scholarships.

From this preliminary stage the plan was developed in four phases:

1. Selection of the universities in which to conduct the program.
2. Recruitment of applicants.
3. Preparation of a curriculum.
4. Development of an administrative organization.

#### I. Selection of Universities

With valuable assistance from the Society for the Promotion of Engineering Education, every accredited engineering institution in the country was queried in respect to our proposed plan. Subsequently, seven schools were offered the program and contractual negotiations were instigated. These schools were: Cornell University, Iowa State

College, University of Minnesota, Pennsylvania State College, Purdue University, Rensselaer Polytechnic Institute, and University of Texas.

It is apropos to mention here that not only did each of the above seven schools accept our offer, but did so recognizing the fact that from an educational point of view this program offered a definite pioneering challenge.

II. Recruitment of Applicants

Because of the necessity of obtaining a large number of applicants, our recruiting program was set up on a nationwide basis. We contacted over 1,000 colleges with the cooperation of the American Council on Education to arrange for interviews to be conducted by female members of our Personnel Department. As a result of this procedure, nearly 4,000 girls were interviewed and 719 were finally accepted. ~~Those that were accepted~~ represented 44 states, 300 colleges, and entered our program with backgrounds varying widely as shown by the following table:

		<u>Age</u>		
<u>No. Students</u>	<u>Age</u>	<u>No. Students</u>	<u>Age</u>	
* 6	17 years	11	24 years	
116	18 "	12	25 "	
254	19 "	1	26 "	
189	20 "	1	27 "	
87	21 "	1	28 "	
24	22 "	1	29 "	
12	23 "	4	30 "	

Average - 19.6 years

<u>College</u>		<u>Mathematics</u>			
<u>No. Students</u>	<u>Yrs. Preparation</u>	<u>No. Students</u>	<u>Yrs. Prep.</u>	<u>No. Stud.</u>	<u>Yrs. Prep.</u>
** 54	under 1 year	220	less than 1 yr.	48	2½ years
163	1 - 1½ years	214	1 year	23	3 years
121	1½ - 2 years	110	1½ years	11	3½ years
217	2 - 3 years	71	2 years	22	4 years
108	3 - 4 years				
56	over 4 years				

Average - 1 year, 3 months

Average - 2.5 years (approx.)

\* These were accepted as they will be 18 years of age before Dec. 15, 1943.

\*\* These individuals were accepted with below stated minimum requirements because they had other qualifications which justified their employment.

This table indicates conclusively that the amount of training and the method of presenting such training would of necessity vary between the upper and lower strata of the ranges presented above.

### III. Preparation of Curriculum (see Appendix)

In designing the curriculum it was necessary to present essential fundamentals and their industrial applications. Consequently, effective collaboration between our company technicians and faculty members was obtained for the writing up of an outline of subject material. A copy of the resultant course of study is attached as an appendix to this paper. Some of its outstanding characteristics should be discussed at this point.

1. In order to obtain close direction and control over the method of teaching each and every course of the Cadette program, the schools were specifically requested by the corporation to designate a responsible official of the schools as Director of the Course. It was further requested that all faculty members teaching for Curtiss-Wright be made responsible to this Director of the Course. This type of faculty organization was in many schools a distinct innovation over previous departmental entities.
2. In order that the instructors would have some appreciation of the working methods used by Curtiss-Wright engineering departments, it was arranged for them to visit our plants and to consult with our technicians. Provisions were also made for Curtiss-Wright to send some of its personnel to the university to give special lectures, to conduct seminars, and to explain the applications of subjects being taught.
3. It was the general consensus that faculty members would be required to place more emphasis on individual accomplishments than would be normally true with privately enrolled students. The major difference in this case was that the Cadettes are employees and therefore should be trained for utilization in the plant in some capacity at least, even though the total number being trained will not in all cases absorb the same amount of subject material.
4. The curriculum incorporated subject material which would prepare the Cadettes to perform such duties as detail and minor layout drafting and design, computers in weight and balance determinations; liaison engineers for design change and shop contact work between engineering departments and fabrication and assembly departments.

It is a foregone conclusion that "on the job" training will be given to the Cadettes to supplement the preliminary material covered at the universities. Opportunity will therefore be open to each and every Cadette to be up-graded within the organization. This will be dependent solely on individual initiative and inherent ability.

The following is a brief description of each subject being taught:

### Mathematics

Acknowledging the diversification of mathematical background among the Cadettes, the mathematics course was so written as to give a review of elementary subjects, such as algebra and trigonometry. Slide rule and logarithms were inserted during the first few weeks. Subsequent to the above review, the following topics are covered in order: Areas and Volumes; Analytical Geometry; Applied Differential and Integral Calculus; and Aircraft Problems. Each school has divided its total group into three or four sections according to the individual abilities of the students as determined during the first month of the course. Each section will complete as much of the above material as possible. The slower sections will probably skip Applied Differential and Integral Calculus, and the advanced sections may, in addition to the above topics, devote some time to Differential Equations.

Every effort has been made to present the above subjects as tools to be used in solving current problems of design, structural analysis, Aerodynamics, etc. Calculus, for example, is definitely being taught as a tool to be used in mechanics. At the same time, this treatment makes it possible to cover each subject in considerably less time than has been usually possible when taught from a theoretical point of view.

From the experience we have had to date, several observations are possible:

1. Algebra and trigonometry, when presented in the applied manner as outlined, were different from anything the Cadettes had previously been taught in these subjects. They were so different that even those girls who had completed two to four years of mathematics elsewhere were able to make good use of the review.
2. One of the surprising discoveries made so far was that many of the Cadettes having a deficiency in mathematical preparation have grasped the above subjects as well as those who had a preponderance of mathematics prior to entrance in the Cadette program.
3. The schools have found it possible to rearrange the sequence of topics discussed in order to cover specific material before it is applied in mechanics or any other courses.

### Job Terminology and Specifications

Recognizing the fact that girls have little knowledge of aeronautical terminology or of the simple principles of airplane theory, we prepared a course to compensate for this deficiency. As the material being presented in this course is new to all students alike, we have not felt justified in dividing the group into fast and slow sections.

The entire course has been broken down under the following major headings:

1. The Airplane.

This is a brief outline of the airplane itself and its components, with special emphasis on terminology.

2. Aeronautical Industrial Organization.

3. Function and Operation of Curtiss-Wright Engineering Department.

4. Aerodynamics and Theory of Flight.

It has not been our intention to cover the subject of aerodynamics thoroughly. However, sufficient material will be given in order that the Cadettes will have a workable understanding of aerodynamics and its relationship to the design of an airplane.

From experience to date, several observations are possible:

1. That the subject material was foreign to the girls because of their lack of exposure to such things in the past. Consequently, additional measures were taken to teach them "the fundamental concepts"; for example, model building, plane spotting, and laboratory demonstrations were used.
2. This course was developed as the keystone of our whole program, as it has become the point of convergence where the real application of all other subjects becomes apparent. Several of the schools have indicated that serious thought will be given to post-war engineering curricula from the point of view of incorporating such a course as our Job Terminology in the Freshman year of engineering.
3. That visual guides and practical demonstrations have been much more successful in teaching the Cadettes than straight lecture work.

### Drawing

The Cadettes will be required to spend a considerable length of time on the drafting board after they are transferred to the plants. Consequently, every Cadette must be given a thorough ground-work in problems of drawing and design. The Curtiss-Wright Drafting Manual and Standards Book is being used throughout this course. This procedure makes it mandatory that the Cadettes prepare their drawings in accordance with company procedures and requirements, with particular emphasis on lettering, use of vellum, and use of the decimal system. Drawing problems are based on typical blue prints and parts furnished by the company, making it possible for the Cadettes to become familiar with the various parts of an airplane and to become cognizant of the relationship between manufacturing and design.

A minimum of forty to fifty hours is being devoted in all schools to the teaching of intersections and projections as applied to aircraft layout problems. This emphasis on applied descriptive geometry is, of course, particularly pertinent to aircraft design. From experience we have had to date, several observations are possible:

1. That in a manner similar to engineering students throughout the country our Cadettes became imbued with the idea that a drafting job would not measure up to their training and ability. The only way to counteract this obsession has been to continually emphasize designing rather than drafting and to repeatedly point out that top notch designers began their careers as draftsmen.
2. Many of the schools have rated the Cadettes as superior to freshman engineers in drafting, particularly in reference to neatness and accuracy. Many are having trouble, however, with three-dimensional problems and with projections. Here again is a place where visual aids and actual parts must be used to help the Cadettes to "see" what they are trying to do.
3. Previous efforts by industry to use women for drafting have indicated that although women might be good draftsmen, they would seldom be proficient in design. We have attempted through the Cadette program to give a sufficiently comprehensive training (which has been lacking before in other attempts) so that the Cadettes will eventually be qualified for such advancement. Our results in this attempt will not, of course, be determined for several years.

### Mechanics

The course in mechanics as written represents a combination of physics, strength of materials, engineering mechanics, and structural analysis. It is obvious that only a part of the material usually covered under the above subjects could be presented in ten months, yet the resultant course does cover, in both scope and penetration, sufficient subject material to qualify the better girls for work in structural analysis. At the same time it enhances the background of those going into other types of technical work.

To further insure that the subject material would be presented from an engineering point of view, we refrained from using academic terminology such as "physics" in any connection with this course and the schools agreed to use engineering instructors to teach the course. It is the opinion of several outstanding experts on structural engineering that the structural course being given in connection with the Cadette program is exceptionally outstanding and should prove equally effective if included in standard engineering curricula.

From experience we have had to date, several observations are possible:

1. As expected, wide diversity in ability is showing up among the Cadettes. Each school has, therefore, sectioned its unit, and each section will proceed to cover as much ground as possible.

It is a fallacy, however, to presuppose that proficiency in mathematics assures equal proficiency in mechanics or vice versa.

2. At the outset practically all the Cadettes had difficulty with mechanics. Their attempts to study mechanics in the same way as English or History proved a dismal failure. When the instructors realized this problem and made efforts to instruct the Cadettes accordingly, a high percentage of the Cadettes were able to take mechanics in their stride.
3. The presentation of mechanics proved perhaps more conclusively than the presentation of any other course that demonstration of visual aids are essential in teaching engineering to women.

### Properties and Processing of Aircraft Materials

This course was introduced into our program primarily for the following reasons:

1. Repeating a statement made several times heretofore, girls are confronted with a serious handicap when entering the engineering profession because as children they had never been exposed to everyday mechanical things. We recognize, therefore, that considerable time and effort must be spent in acquainting them with actual shop operations.
2. It was our opinion that the only way to give the Cadettes the opportunity of rising above the level of draftsmen would be to indoctrinate them with the problems of shop procedures, shop tools and their operations as used in aircraft engineering, the importance of understanding mass production tools and their relationship to correct design engineering, airplane parts and assemblies, and production engineering in the aircraft industry.

From experiences we have had to date, several observations are possible:

1. Although obviously clumsy at the outset, the Cadettes have mastered with a great deal of proficiency the handling of tools and the operation of machines.
2. As we expected, this course has greatly assisted the Cadettes in understanding the whys and wherefores of the subject material taught in other courses.

### Supervised Study and Methods

One of the greatest innovations in the entire Cadette program was the inclusion of the course called "Supervised Study." It was originally intended to be an organized class in analytical thinking. It has evolved, however, as a period of time set aside during which instructors are available for group or individual assistance. During this period Cadettes may prepare any outside assignments they desire. They are encouraged, however, to consult the instructor present for guidance in study methods and for assistance in clarifying fundamental

principles which might be hazy and confused. As pointed out previously, our goal in the Cadette program is to teach as much as possible to each individual and to the highest degree of which she is capable. Through the Supervised Study and Methods classes the instructors have this opportunity.

#### IV. Administrative Organization

Conducting a training program for 700 women in seven widely separated universities for subsequent placement in five plants of Curtiss-Wright presented a formidable problem of organization and administration. The following steps were taken:

1. The initial ground work was accomplished by a centralized bureau operating in behalf of the various plants of Curtiss-Wright. Each plant, however, contracted directly with one or two schools as the case might be, placed the Cadettes on its own payroll, and subsequently took over the direct administration of its own part of the program.

The centralized office will continue to act as a coordinating unit to insure maximum uniformity in all activities and procedures.

2. A female personnel supervisor was assigned to each one of the seven universities. It should be pointed out that although the Cadettes are regarded by the company as employees, they are isolated many miles from their plant and are intermingled with regular students. This means that our personnel supervisor must be the link between the school and the company, the resident "boss" and counselor of the Cadettes in their personal problems -- all these at the same time. There is no question that the efforts of these women supervisors have, to a large measure, been responsible for the success of the program to date and for the high level of morale maintained among the Cadettes. The spirit prevailing among all 700 girls of fervent enthusiasm and conscientiousness has no doubt been influenced considerably by the activities of the resident personnel supervisors.

#### The Cadette Engineering Society

Shortly after the Cadette program started, interest was developed among the Cadettes to organize an engineering society, through which it would be possible for the Cadettes to obtain pertinent information and data concerning the engineering profession as a whole and knowledge of Curtiss-Wright in particular. Consequently, a society now known as the Cadette Engineering Society was organized simultaneously at all units. This group is, of course, a temporary expediency and has been organized to meet current needs. Most of the Cadettes have subsequently become associated with student branches of various national engineering societies and these connections will probably be continued when they enter the plant.

CONCLUSION

I have dwelt considerably upon a discussion of the Curtiss-Wright Engineering program only because it represents a radical departure from previous training methods and because it embraces many fundamentals inherent to present and future educational problems.

Above all else this endeavor to accomplish closer collaboration between industry and education is a promising prognosis of post-war improvement of educational tie-up with their customers -- the industries.

Then again, the final results should fairly accurately predict the future place of women in the engineering profession.

Many other companies have already followed Curtiss-Wright in instigating or planning programs of a similar nature to the Cadette plan.

I am sure that I can speak in behalf of other companies as well as Curtiss-Wright in stating that regardless of all efforts being made to supply substitute engineers, industry will continue to have urgent need of four-year graduate engineers for the duration of the war. There is no substitute for the graduate engineer who has in addition to his degree at least some experience in industry and particularly in the company employing him. To preserve industry's ability to contribute to the war effort, provisions must be made to safeguard such valuable manpower.

