SECONDARY AERONAUTICAL EDUCATION

RUTH WOODWORTH

THE UNIVERSITY OF WICHITA

AERONAUTICAL EDUCATION AS RELATED TO SECONDARY EDUCATION WITH PARTICULAR REFERENCE TO MATHEMATICS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

IN CANDIDACY FOR THE DEGREE OF

MASTER OF ARTS

DEPARTMENT OF EDUCATION

BY

RUTH WOODWORTH

WICHITA, KANSAS

JULY, 1930

TABLE OF CONTENTS

CHAPTER I

THE PROBLEM

Vitalizing Mathematics

No doubt every teacher of mathematics, or for that matter a teacher of any subject, has at times felt his ability challenged to keep the interest of the subject at a high point. School subjects are abstract and life is concrete: boys and girls feel this, although their progress in thinking may not have reached the point where they can express the idea. The criticism is that mathematics courses have little contact with the life the boys and girls lead after they leave school.

Most thinking people will concede that the world of today is different in many respects from the world of five years ago: in fact different from the world of one year ago. In past years, it has been considered sufficient preparation if teachers of mathematics familiarized themselves with the applications of the mathematics, of physics, chemistry, biology and commerce. Recently some mention to the mathematics of the automobile and the radio is found. Today the students of the Wichita schools are asking for the mathematics of the airplane.

Hence: the purpose in writing this thesis is twofold: first, to suggest material which may be used in the classroom; second, to justify the studying of certain fundamental principles in mathematics by a citation of their uses in the

study of aviation.

Local Situation

Wichita's aviation history began aeons ago when prehistoric seas subsided leaving a vast mid-continental plain that was destined to become the largest natural airport in America. Blessed with a climate permitting year 'round flying with no fogs, it was only natural that Wichita should assume a leadership in aviation as it developed. The central location of Wichita geographically, within a day's flight from any point in the nation, has made Wichita the "crossroads of the air" and given it exceptional advantages as a distribution point.[1]

The foregoing quotation is characteristic of the sentiment of the people of Wichita. It is not the purpose of this report to enumerate the factories, aeronautical accessories and supplies companies, air transportation companies, airplane and motor service companies, or even the aeronautical instruction institutions of Wichita. All such enterprises are listed in the city directory, and are thriving institutions in which the city takes great pride. Wichita is very fortunate in having many acres of land in and around the city devoted to flying fields. Walter Hinton, in the following quotation, gives an insight into the opportunity that the airports afford the young people of today.

Airplanes are kept in the air, in flying service, only because of efficient ground organizations. No flying, either commercial or military can be done unless there is a field from which airplanes can take off and on which they can land. Opportunities for men and women are great in the airports. Any man, therefore, who is willing to fortify

---

[1]A Directory of the Industries that have made Wichita the first city in American in Commercial Aviation. Published by the Aeronautical Division Chamber of Commerce, Wichita, Kansas. July, 1929.

his ambition with training or education along aeronautical lines, can win rapid advancement and rich rewards in one of many ground jobs in aviation.[2]

The most authentic and up-to-date description of the present situation in the aviation industry in Wichita, was found in a letter written June 21, 1930, by Mr. Arch N. Booth, secretary of the aviation department of the Chamber of Commerce, to Prof. Frank J. Coffey of the research department of Woodbury College, Los Angeles.

With Mr. Booth's permission extracts from the letter follow:

It is a source of much satisfaction to everyone concerned that Wichita's leadership in the air industry is not based on any one phase of air activity, but rather on a complete development of all lines, factories, flying schools, number of airports, favorable flying conditions, supply of skilled labor, men with sales and manufacturing ability, all supported by the most air minded and air going community in the United States.....

It is significant that located in this city was the pioneer factory for the building of commercial aircraft. In 1919 the first commercial airplane in America was built in Wichita by the Swallow Aircraft Company, which is still one of the best known factories in the country. From this one factory planes and men were developed to become famous in the aviation world.

Some of the direct outgrowth of this factory are the Travel Air, Cessna, Waco, Lincoln-Paige, Butler, Park Cardinal, Cavalier and Laird plants. When considering commercial aviation in its present state it is well to remember it originated in Wichita.

One of the outstanding reasons for Wichita's leadership in the air industry is that there are ten airplane factories in the city, five of which have received approved type cer-

---

[2]Walter Hinton, Opportunities In Aviation, p. 92, New York: W. W. Norton & Co., 1929.

tificates from the Department of Commerce. These five are Swallow, Travel Air, Stearman, Cessna and Watkins companies.

The output of the airplane factories always has been greater than the output of factories in any other one city. In 1925 these factories produced 150 planes; in 1927 approximately 300; in 1928, 927; in 1929 between 800 and 900 planes. The leadership of the Wichita factories is shown by the fact that during these years their production represented approximately 25 per cent of the total production of the United States.

In addition to the five factories producing approved type planes, five other are producing experimental planes, three companies are building gliders, two motor companies have made considerable progress on experimental engines, there are three flying schools, a full course in aeronautical engineering at the University of Wichita and numerous welding schools.

The municipal airport is one of the best in the entire country, covers 640 acres, situated on a well drained and gentle rolling stretch of Kansas prairie that never has been touched by a plow and is well set in native sod. The port is being developed to meet the requirements of the Department of Commerce for A1A rating. There are seven other fine airports in the city.

It is equipped with every possible lighting device, has telephone, telegraph, teletype and radio communication, a complete weather bureau and aerological station maintained by the government and a government report broadcasting station is maintained one mile north of the airport. Most of the runways are 4,800 feet long and none less than 3,600. The municipal hangar is 102 by 272 feet and work is starting on a $150,000 administration building.

Wichita is located in almost the geographical center of the United States and is a strategic station on some of the most important air lines in the country, including Western Air Express, Transcontinental Air Transport, United States Airways, Inc., Browers Air Service and National Air Transport.[3]

---

[3]Arch N. Booth, Letter to Prof. Frank J. Coffey of the Research Department, Woodbury College, Los Angeles, June 21, 1930, Wichita, Kansas.

The Wichita Public Schools have not attempted any definite course in aeronautical education. During the school year of 1929 and 1930 a glider club was organized in High School East. About twenty boys became members, and the construction of a glider was started under the direction of Mr. J. E. Moore, a member of the vocational training faculty.

That there is some investigation into the subject of aeronautical education for the Wichita schools is indicated by the following report from the sub-committee on aviation instruction in the public schools, of which Mr. Frank D. Hall is the chairman, which was submitted to Mr. Marcellus Murdock, chairman of the aeronautical Committee of the Wichita Chamber of Commerce, May 12, 1930. This report is still in the hands of the committee.

Report of the Sub-Committee of the Aviation Committee of Commerce on the Matter of Aeronautical Instruction In the Public Schools.

Mr. Marcellus Murdock, Chairman,
Aviation Committee,
Wichita Chamber of Commerce.

Your sub-committee appointed to determine the advisability of recommending some course of study in the Public Schools on the subject of aviation beg to report as follows.

The committee finds there is some sentiment in Wichita for a course of study in the senior high schools on the subject of aviation. Two definite lines have been suggested:

first, a vocational training along the line worked out by the Department of Commerce through the Division of Aeronautics; second, a course less elaborate and informative only.

The Division of Aeronautics of the Department of Commerce has developed a definite plan and program for the promotion of the work in the public schools and some cities have adopted that program. It is vocational in its nature, attempting to afford some training in airplane mechanics and aircraft engine mechanics.

By the Act of Congress May 26, 1928 the Secretary of War was authorized to transfer or loan certain aeronautic equipment to accredited schools for exhibitional and instructional purposes and there is still available a limited amount of equipment such as engines, wing assembly, propellers, etc. The course as outlined, however, by the Division of Aeronautics would require considerable additional equipment which would have to be purchased. It would require also instructors of qualifications that would meet the approval of the Federal Board of Vocational Education.

The second plan or program is that followed by the State of California where the work has been outlined through the University of Southern California. This provides a course of study with a text book, informative only and in no respect vocational training. A copy of the text used in California published in February 1929, has been read with

interest by some of the members of our committee and an outline of the course has been furnished to us by Prof. Yingling, Supervisor of Industrial Education for Wichita Schools which is hereto attached.

While a text on the subject of aviation is out of date soon after its publication, your committee is of the opinion:

First: That some course of study should be introduced into our senior high schools to answer the aroused interest in aviation in Wichita.

Second: We do not recommend for the school year 1930 and 1931 any attempt at vocational training as outlined above.

Third: We do recommend the introduction in our senior high schools of some course of study informative only in its nature. While not definitely committed to the text employed in California, we would favor the same if our local school authorities are not able to recommend a better course of study.

Respectfully submitted,

Frank D. Hall, Chairman.
F. D. Quinlisk
W. M. P. Sullivan
F. M. Eisenhour
Vernon H. Branch
S. Ray Miller
E. A. Watkins

Demands The Aviation Industry Is Asking Of Education

Those who have watched the rapid growth of aviation the past two years realize that the future of the industry is so great that it challenges the imagination. No one dares to say to what size the airplane will grow; to what uses it will be put, and over what distances it will operate.

The development of aviation will bring about a variety of situations demanding social readjustments and a change in the mode of living of each of us. The men and women of the rising generation will take easily and naturally to the air, and put the airplane to unthought of uses in business, and derive from it a vast amount of pleasures.

It is important that the educator anticipate as many of these situations as possible and adjust the educational content of the course of study accordingly. The success of any community, it seems, will depend in a large measure upon the familiarity with which the young people of the community can deal with aeronautics.

Man power is the greatest problem which confronts aviation today: its greatest need is a sufficient body of intelligent and skillful men and women to carry on the innumerable and complex divisions of the industry, the creation of the brilliant and enthusiastic personnel.[4]

---

[4]Walter Hinton, Op. Cit. p. viii.

Colonel Charles A. Lindbergh in addressing the National Education Association in Boston, 1929, gave a picture of what may be expected in the future with respect to the influence of aviation on education.

Said he:

Aviation will affect practically all the subjects now taught in our schools. It will affect language, inasmuch as it will bring all countries more closely together. It will affect science through the new countries encountered and the mediums through which people will travel and through the new instruments brought into use. For instance, our weather forecasting will undoubtedly be improved through the coming of aviation. It will be necessary to forecast more accurately for aeronautics than it is today for agriculture. It will be necessary for the man who flies, and most of us will fly in the future, to know more of the atmospheric condition than it is now necessary to know.....

Rapid as the development has been in the last decade, we expect that there should be still more rapid development in the years to come. Consequently I believe that it is essential to incorporate in our school system elementary aeronautics. It is not necessary to teach aeronautics in detail. But everyone even today, should have a general idea of the subject in order to understand the newspapers. And tomorrow there will be great deal more concerning this new means of travel than has been in the past.[5]

In a report published by The Curtis Publishing Company[6] a statistical graph is printed which gives the following educational statistic concerning the previous education of the students of the aviation schools.

---

[5]Col. Charles A. Lindbergh, Address before National Education Association, Department of Superintendents, Boston, 1928.

[6]The Aviation Industry, A Study of Underlying Trends. Division of Commercial Research. The Curtis Publishing Co. Philadelphia, 1930. P. 173.

College Men	40.5%
High School graduates	35.8%
Now attending High School	2.4%
Did not graduate from High School	21.3%

This shows that a greater per cent of the students are high school graduates. Hence, might lead one to believe that the secondary schools may soon be asked to furnish material which would be required as an entrance prerequisite for aviation schools.

The Aeronautical Chamber of Commerce furnishes the following data concerning the number of aviation schools in the United States for the given dates.

December 31, 1926, Number of schools	175
December 31, 1927, Number of schools	375
December 31, 1928, Number of schools	475
December 31, 1929, Number of schools	419

Twenty-six of the 419 in 1929 are schools reported as having approved certificates. There were no approved schools before 1929.

Mr. Arch Booth of the Wichita Chamber of Commerce suggested that there is a rumor in the aviation industry that aviation schools are decreasing in number. The above report from the Aeronautical Chamber of Commerce report shows a falling off in schools in 1929. This data covers such a short duration of time that such a conclusion is not justifiable. However, if it proves true that aviation schools are decreasing in number, might that be another argument for more attention to be given to aeronautical education in the secondary schools.

CHAPTER II

PROCEDURES AND LIMITATIONS

Procedures

The method of procedure in this report has been almost entirely the interview technique. This has been carried on through personal interviews and through personal letters.

The Chairman of the Aeronautical Division of the Wichita Chamber of Commerce; the Secretary of the Aviation Department of the Chamber of Commerce and the Director of the Municipal Airport were very courteous in granting personal interviews. The managers of the various factories generously gave information and suggestions for the report.

Personal letters were written to the members of the class conducted at the New York University in 1928 under the auspices of the Daniel Guggenheim Fund Committee on Elementary and Secondary Aeronautical Education.

The historical facts presented were collected through library reading. These facts are facts which might be found in any library and in general reading. This chapter was placed in this report through the recommendation of Mr. Mac Short of the Stearman Aircraft Company. Mr. Short suggested that many young people interested in aviation were not familiar with the history of aviation and that a brief mention here might inspire readers of this report to bring more history before the students.

Sources of Data

Some of the most helpful and interesting material used in this report was secured from the Daniel Guggenheim Fund Committee. An explanation of this committee is found in the following quotation.

Of conspicuous service in the development of aeronautics in the United States has been the work undertaken by the Daniel Guggenheim Fund for the Promotion of Aeronautics. Formed in January 1926, with deeds of gift from Mr. Daniel Guggenheim totalling $2,500,000, of which both interest and principal may be expended. The purpose of the Fund as set forth in its first report covering the years 1926 and 1927, "is to promote aeronautical education throughout the country: to assist in the extension of aeronautical science: and to further the development of commercial aircraft, particularly in its use as a regular means of transportation of both goods and people."

Among the more important contributions of the Fund in its two years of activity are: offering of a first prize of $100,000 and of five other prizes of $10,000 each in a "Safe Aircraft Competition" open to all aircraft manufacturers and designers throughout the world: grants to educational institutions as follows, California Institute of Technology--$230,000; Leland Stanford University--$195,000; University of Michigan $78,000 (previously to establishment of the Fund, Mr. Daniel Guggenheim had created a school of Aeronautics at New York University); financial assistance to societies interested in aeronautical research both in this country and abroad; created a committee on Elementary and Secondary Aeronautical Education to disseminate accurate information through the public schools; establishment

of a Committee on Aeronautical Meteorology and sponsorship of the Byrd and Lindbergh tours of the United States.[1]

The Daniel Guggenheim Fund for the Promotion of Aeronautics ended its official existence on December 31, 1929, but an additional gift of $500,000 was received from Mr. Daniel Guggenheim for the complete realization of its objectives. The outstanding grants from this sum are of interest here. A grant of $25,000 was given to the Committee on Elementary and Secondary Aeronautical Education for its work conducted in the public schools so that that committee will be able to continue for another year. This includes the preparation of textbooks, the conducting of courses on the teaching of aeronautics, and the assistance of introducing aeronautics in the school curriculum.

A second grant of $140,000 was allotted for a Chair at the Library of Congress for the purpose of composing a complete aeronautical library in Washington, D. C.

During the summer of 1928, the New York University offered a course entitled, "Problems of Aeronautics in the Schools". This course was given under the auspices of the Daniel Guggenheim Fund Committee on Elementary and Secondary Education. A complete report of the course was prepared by Mr. Roland H. Spaulding, instructor in charge. The report

---

[1]James G. Wooley and Earl W. Hill, Airplane Transportation, pp. 52-4. Hollywood, California, Hartwell Publishing Co.: 1929.

contains a list of the special speakers who appeared before the class with a full review of the lectures given except in cases where slides, motion pictures, charts or blackboard diagrams were used. The report also contains a roster of the class, a tentative program of the activities of the Daniel Guggenheim Fund Committee on Elementary and Secondary Education for the year 1929, together with a list of the members of the executive committee.

The Committee on Elementary and Secondary Education was a sub-committee of the Daniel Guggenheim Fund for the Promotion of Aeronautics. This committee organized late in 1927 under the chairmanship of Dr. John Withers, Dean of the School of Education, New York University, is national in its scope.

On Wednesday, February 26, 1930, at the Ambassador Hotel, New York City, a meeting was held under the auspices of the Daniel Guggenheim Fund Committee on Elementary and Secondary Education coincident with the Annual Meeting of the Department of Superintendence of the National Education Association. A complete program of this meeting follows:

Atlantic City

AERONAUTICAL EDUCATION
A Meeting Under the Auspices of
THE DANIEL GUGGENHEIM FUND COMMITTEE
on
ELEMENTARY AND SECONDARY AERONAUTICAL EDUCATION
coincident with
The Annual Meeting of the Department of Superintendence of the National Education Association.

WEDNESDAY, FEBRUARY 26, 1930
2:15 P.M. AT THE AMBASSADOR HOTEL

PROGRAM
Short Addresses

Progress in Aeronautical Education in the Public Schools During 1929
Dr. John W. Withers
Chairman of the Daniel Guggenheim Fund Committee on Elementary and Secondary Aeronautical Education

Method of Procedure in Securing a Teaching Staff and Equipment, and in Building a Curriculum for Aeronautical Instruction in the Public Schools
Mr. Roland H. Spaulding
Specialist in Aeronautical Education For the Daniel Guggenheim Fund Committee on Elementary and Secondary Aeronautical Education

School Girls and Their Relationship to Aeronautical Education
Miss Amelia Earhart
Assistant to General Traffic Manager Of the Transcontinental Air Transport, Inc.; Aviation Editor Cosmopolitan Magazine

Public-School Aeronautical Education From the Standpoint of the Aviation Industry
Mr. William P. MacCracken, Jr.
Chairman of the Board of Directors for the New York-Rio-Buenos Aires Line, Inc.; Former Assistant Secretary of Commerce for Aeronautics Branch

A General Discussion from the Floor

******

The Aeronautical Chamber of Commerce of America, 10 East 40th St., New York, was another valuable source of information. Mr. Roland H. Spaulding is Chairman of the Educational Committee.

On February 17, 18, 19, 1930, at St. Louis, the National Conference on Aeronautical Education under the auspices of the Aeronautical Chamber of Commerce of America, Inc., with

the co-operation of the Daniel Guggenheim Fund Committee on Aeronautical Education in the Public Schools was under the chairmanship of B. G. Schackelford, Assistant Superintendent of Schools, St. Louis, Missouri. A complete program of this meeting follows:

PROGRAM

NATIONAL CONFERENCE ON AERONAUTICAL EDUCATION
under auspices of
AERONAUTICAL CHAMBER OF COMMERCE OF AMERICA, INC.
with the co-operation of
DANIEL GUGGENHEIM FUND COMMITTEE OF ELEMENTARY AND SECONDARY AERONAUTICAL EDUCATION

February 17-18-19, 1930

HOTEL STATLER ST. LOUIS, MO.

Monday Morning February 17

10 A.M. Registration
12 M. Luncheon
Address of Welcome: Dr. George R. Throop, Chancellor, Washington University, St. Louis.

Response: Roland H. Spaulding, Chairman, Educational Committee, Aeronautical Chamber of Commerce; Specialist in Aeronautical Education, Daniel Guggenheim Fund Committee on Elementary and Secondary Aeronautical Education.

Monday Afternoon February 17

2 P.M. General Session
Address: "Aeronautical Education in the Public Schools of the United States." Dr. John W. Withers, Chairman, Daniel Guggenheim Fund Committee on Elementary and Secondary Aeronautical Education. Dean, School of Education, New York University.

Address: "Aeronautical Education in Colleges and Universities." Professor Earl W. Hill, University of Southern California, Chairman,

California State Advisory Committee on Aeronautical Education. Educational Director, Western Air Express.

Address: "Aviation Ground School Education." Mr. Andrew D. Althouse, Head of Automotive and Aero Departments, Cass Technical School, Detroit, Mich.

Address: "Aeronautical Education from the Standpoint of the United States Department of Commerce." Mr. J. S. Marriott, Chief Inspection Service, U.S.Department of Commerce.

Announcement of Committees.

Monday Evening February 17

9 P.M. Inspection of Exhibits at International Aircraft Exposition, St. Louis Arena.

Tuesday Morning February 18

10 A.M. Meetings of Sub-Committees:

Committee on Aeronautical Education in the Public Schools.

Chairman--B.G.Shackelford, Asst. Supt. of Schools, St. Louis.

Address: Mr. Charles S. ("Casey") Jones, President of Curtiss-Wright Flying Service.

Committee on College and University Aeronautical Education.

Chairman--Bradley Jones, Head of Department of Aeronautics at University of Cincinnati.

Address: Mr. Edward P. Warner, Former Professor of Aeronautics at Massachusetts Institute of Technology. Former Assistant Secretary of Navy for Aviation. Editor of "Aviation".

Committee on Aviation Ground School Education.

Chairman--W. Harold Taylor, Head of Ground School at University of Buffalo.

Address: Mr. Willis B. Haviland, Director of Schools, Universal Aviation Corporation.

Address: Mr. H. F. Lusk, Dean, Boeing School of Aeronautics.

Tuesday Afternoon February 18

2 P.M. Meetings of Sub-Committees Continued.

Wednesday Morning February 19

10 A.M. Meetings of Sub-Committees Continued.

Wednesday Afternoon February 19

2 P.M. General Meeting - Roland H. Spaulding, Chairman

The report and recommendations of each of the Sub-Committees will be presented for the consideration and action of the conference.

Wednesday Evening February 19

6 P.M. Joint Banquet Society of Automotive Engineers and Aeronautical Chamber of Commerce.

****

On February 28, and March 1, 1930, the New York University, dedicated a new building for the School of Education. Listed as one of the activities housed in this building is the "Division of Aeronautical Education". In the future this department will be a valuable source of information. A complete program of the dedication of the School of Education of the New York University follows:

DEDICATION
of the
NEW BUILDING OF THE SCHOOL OF
EDUCATION AND FORMAL OPENING
OF THE CENTERS

Ten forty-five A. M.
FRIDAY, FEBRUARY 28, 1930

IX
DIVISION OF AERONAUTICAL
EDUCATION
First Floor, South Building

11:26 A.M.
Transfer of the Division of Aeronautical Education from New York University to the School of Education
Chancellor Brown
Dean Withers

11:31 A.M.
Formal Opening of the Division of Aeronautical Education And Address Aeronautical Education from the Standpoint Of the Aviation Industry
Mr. Luther K. Bell
Secretary, Aeronautical Chamber of Commerce

AERONAUTICAL EDUCATION DISCUSSION CONFERENCE
First Floor, South Building
Saturday, March 1, 1930, 10:00 A.M.-12:00 M.

Sound Principles Underlying Aviation Ground-School Education
Mr. Roland H. Spaulding
Specialist in Aeronautical Education
New York University

Aviation Education from the Standpoint of the United States Government
Mr. G. E. Gardner
United States Department of Commerce

Discussion from the Floor

Mr. Erwin M. Peake	Curtiss-Wright Flying Service
Mr. John D. Peace, Jr.	Pioneer Instrument Company
Mr. Hugh Copeland	Roosevelt Aviation College
Mr. Robert L. Copsey	Newark Air Service

The following list of aviation schools having approved school certificates and their ratings and dates approved certificate issued, was obtained from the Department of Commerce, Aeronautical Branch, Washington, D. C.

DEPARTMENT OF COMMERCE
Aeronautics Branch
WASHINGTON

SCHOOLS HAVING APPROVED SCHOOL CERTIFICATES

	Ratings for which Approved	Approved Certificate Issued

Airtech Training School Airtech Field San Diego, California	Ground and Flying	(Transport (Lim. Commercial (Private	7-15-29
Standard Flying School 9401 S.Western Avenue Los Angeles, California	Ground and Flying	(Transport (Lim. Commercial (Private	10-26-29 7-15-29
Embry-Riddle Flying School Lunken Airport Cincinnati, Ohio	Ground and Flying	(Transport (Lim. Commercial (Private	7-15-29
Parks Air College, Inc. Parks Airport E. St. Louis, Illinois	Ground and Flying	(Transport (Lim. Commercial (Private	7-15-29
D. W. Flying Service, Inc. Le Roy Airport Le Roy, New York	Ground and Flying	(Lim. Commercial ((Private	7-15-29
T. C. Ryan Flying Service Ryan Airport 3300 Barnet Avenue San Diego, California In combination with Pacific Technical Univ. 2119 Kettner Boulevard San Diego, California	Ground and Flying	(Transport (Lim. Commercial (Private	7-19-29
Universal Flying School Wold-Chamberlain Field Minneapolis, Minnesota	Ground and Flying	(Transport (Lim. Commercial (Private	8- 9-29
Curtiss Flying Service Valley Stream Airport Valley Stream, L.I.,N.Y. In combination with New York University New York, N. Y.	Ground and Flying	(Transport (Lim. Commercial (Private	2- 6-30 8-14-29
Universal Flying School Lambert Field St. Louis, Missouri	Ground and Flying	(Transport (Lim. Commercial (Private	8-19-29
Curtiss Flying Service Grosse Ile Airport Grosse Ile, Michigan	Ground and Flying	(Transport (Lim. Commercial (Private	10- 9-29 8-20-29

Calif. Aerial Transport Flying School Municipal Airport Los Angeles, California In combination with Western College of Aero. Municipal Airport Los Angeles, California	Ground and	(Transport (Lim.Commercial	8-29-29
Curtiss Flying Service of the Middle West Fairfax Airport Kansas City, Kansas	Ground and Flying	(Transport (Lim.Commercial (Private	9-24-29
Universal Flying School Fairfax Airport Kansas City, Kansas	Ground and Flying	(Transport (Lim.Commercial (Private	10-3-29
Von Hoffman Aircraft School Lambert Field Anglum, Missouri	Ground and Flying	(Transport (Lim.Commercial (Private	10-3-29
Curtiss-Wright Flying Service 1258 Russ Building San Francisco, Calif.(Ground) Oakland Airport Oakland, Calif. (Flying)	Ground and Flying	(Transport (Lim.Commercial (Private	10-4-29
Curtiss-Wright Flying Service 1338 S. Michigan Avenue Chicago, Ill. (Ground) Curtiss-Reynolds Airport Glenview, Ill. (Flying)	Ground and Flying	(Transport (Lim.Commercial (Private	10-9-29
Boeing School of Aeronautics Oakland Municipal Airport Oakland, California	Ground and Flying	(Transport (Lim.Commercial (Private	10-17-29
Spartan School of Aeronautics Apache Blvd. & Chamberlain Dr. Tulsa, Oklahoma	Ground and Flying	(Transport (Lim.Commercial (Private	10-18-29
Curtiss Flying Service Los Angeles Municipal Airport Inglewood, California	Ground and Flying	(Transport (Lim.Commercial (Private	10-21-29
Roosevelt Aviation School, Inc. 119 West 57th St. (Ground) Roosevelt Field #1 Mineola, L.I.,N.Y.(Flying)	Ground and Flying	(Transport (Lim.Commercial (Private	10-25-29

Universal Aviation School 344 North Exchange Street St. Paul, Minnesota In combination with Universal Flying School Wold-Chamberlain Field Minneapolis, Minnesota	Ground and Flying	(Lim.Commercial ((Private	10-30-29
Curtiss Flying Service of Ind. Stout Field, Mars Hill Indianapolis, Indiana	Ground and Flying	(Lim.Commercial ((Private	11-7-29
Universal Aviation School Memphis Municipal Airport Memphis, Tennessee	Ground and Flying	(Transport (Lim.Commercial (Private	11-16-29
Curtiss Fly.Service of South Memphis Municipal Airport Memphis, Tennessee	Ground and Flying	(Lim.Commercial ((Private	11-16-29
Garland School of Aeronautics 51st & Sheridan Road Tulsa, Oklahoma	Ground and Flying	(Transport (Lim.Commercial (Private	11-27-29
Penn School of Aviation Pittsburgh-Butler Airport Butler, Pennsylvania	Ground and Flying	(Transport (Lim.Commercial (Private	12-12-29
Art Goebel Aviation Co.,Inc. 101 West 12th St. (Ground) Kansas City, Missouri Liberty Field (Flying) Liberty, Missouri	Ground and Flying	(Transport (Lim.Commercial (Private	12-27-29
Curtiss Flying Service of Ky. Bowman Field Louisville, Kentucky	Ground and Flying	(Lim.Commercial ((Private	12-27-29
Curtiss Flying Service 1013 Madison Avenue Toledo, Ohio Transcontinental Airport Walbridge, Ohio (Flying)	Ground and Flying	(Transport (Lim.Commercial (Private	5- 5-30 12-27-29
Mamer Air Transport School of Flying, 320 Paulsen Bldg. Spokane, Washington Felts Field Spokane, Washington	Ground and Flying	(Transport (Lim.Commercial (Private	12-27-29

Curtiss-Wright Flying Service 115 High Street (Ground) Portland, Maine Portland Airport (Flying) Scarboro, Maine	Ground and Flying	(Transport (Lim.Commercial (Private	1-21-30
Curtiss-Wright Flying Service Miami Municipal Airport Miami, Florida	Ground and Flying	(Transport (Lim.Commercial (Private	2-18-30
Universal Flying School Cleveland Airport Cleveland, Ohio	Ground and Flying	(Transport (Lim.Commercial (Private	2-25-30
Curtiss-Wright Flying Service 46th & Colorado Blvd. Denver, Colorado	Ground and Flying	(Lim.Commercial ((Private	3- 5-30
Curtiss-Wright Flying Service 1360 Main Street (Ground) Buffalo Municipal Airport Buffalo, New York (Flying)	Ground and Flying	(Transport (Lim.Commercial (Private	3-13-30
Curtiss-Wright Flying Service Port Columbus Columbus, Ohio	Ground and Flying	(Transport (Lim.Commercial (Private	3-13-30
Lincoln Airplane & Flying 2415 "O" Street School Lincoln, Nebraska (Ground) Municipal Airport Lincoln, Nebraska (Flying)	Ground and Flying	(Transport (Lim.Commercial (Private	3-31-30
Yellow Cab School of Aviation Municipal Airport Des Moines, Iowa	Ground and Flying	(Transport (Lim.Commercial (Private	4- 3-30
Altoona Aircraft Corp. Stultz Field Tyrone, Pennsylvania	Ground and Flying	(Lim.Commercial ((Private	4-22-30
Curtiss-Wright Fly.Service N.C.State College (Ground) Raleigh Airport Raleigh, N. Car. (Flying)	Ground and Flying	(Lim.Commercial ((Private	4-28-30
Hancock Found.College of Aero. Santa Maria Airport Santa Maria, California	Ground and Flying	(Transport ((Private	4-30-30

Curtiss-Wright Flying Service 1811 Main Street (Ground) Owens Field Columbia, S. Car. (Flying)	Ground and Flying	(Lim.Commercial ((Private	5- 5-30
Curtiss-Wright Flying Service Curtiss-Wright Airport Dalworth, Texas	Ground and Flying	(Lim.Commercial ((Private	5-16-30
Pitcairn Aviation of Pa.Inc. Pitcairn Field Willow Grove, Penna.	Ground and Flying	(Lim.Commercial ((Private	5-28-30
Curtiss-Wright Flying Service Curtiss-Wright Airport (Logan Field-Auxiliary) Baltimore, Maryland	Ground and Flying	(Transport (Lim.Commercial (Private	6- 9-30
Curtiss-Wright Flying Service 613 Grant Building Pittsburgh, Penna. (Ground) Curtiss Bettis Airport McKeesport, Penna. (Flying)	Ground and Flying	(Lim.Commercial ((Private	
Nepco Tri-City Flying Service, Nepco Tri-City Airport/Inc. Wisconsin Rapids, Wisconsin	Ground and Flying	(Transport (Lim.Commercial (Private	6-16-30

Limitations

The field in which this investigation has been made is so altogether new that this report might be classed as an attempt at exploration. The industry itself is so young that organization has been barely accomplished in the commercial field, and what has been done in the educational field is indeed pioneering. Therefore no apology need be made for the evident disorganized sources of material.

The inexperience of the investigator in this field, which however is not due to lack of interest but to lack of opportunity, is one of the chief reasons for the incomplete-

ness of the report.

The future possibilities for further research are many. As the industry grows, and more of the higher educational institutions open training courses for teachers of secondary education, a greater interest will be found in the secondary and elementary school staffs.

It is the earnest hope of the writer that from this attempt to present to educators the urgent need for some organized material in this field, more detailed and extensive reports may be the result.

CHAPTER III

AERONAUTICAL EDUCATION IN SECONDARY SCHOOLS OF THE UNITED STATES

Reports on the Schools Conducting Special Aeronautical Courses

There are two methods of presenting any educational feature to boys and girls; one is organized courses, with detailed course of study and a well equipped laboratory; the other is through some correlated form.

From reports which the writer has investigated the conclusion is reached that organized courses for aeronautical education are not considered practical outside of vocational schools. The following extract, a bulletin put out by the Federal Board for Vocational Education, Washington, D. C., explains some of the outstanding objections.

In view of the exceedingly rapid development of the aeronautical industry, with the accompanying changes in the design of the planes and engines, the requirements upon aircraft mechanics are in a continual state of flux. Any standards that may be set up at this time should be considered as tentative only.

Wherever it may be considered desirable to teach large groups of people in courses related to the aeronautical industry without regard to whether the persons receiving the instruction or training will make a practical use of it, the work should be considered as a phase of general education and not in any sense as vocational training.....

Aeronautical Education Requirements:

Instructors - Secured direct from the Industry.
Selected Groups - Men who expect to use it in their work.
Subject Matter - Must directly function in the work for which the pupil is being trained.
Building and Equipment - The best, no junk material.....

Dangers to be avoided:

1. Boys 14 and 15 who cannot legally be employed in the industry upon completion of one to two years training.
2. Offering a so-called general course, expecting the graduate to be able to fit anywhere.
3. Emphasis upon certain sub-engineering work.[1]

An article[2] which appeared in the Industrial Arts Magazine, by Ammon Swope, Associate Professor of Industrial Education, Purdue University, leads one to believe that most of the organized courses are carried on through the vocational departments. He has written letters to all the cities having a population of 100,000 or more to inquire what is being done. In many cases the work was reported as conducted in the night schools or in what is often termed the Opportunity School, indicating that many outside of the public school age were taking advantage of this opportunity to acquire knowledge concerning aeronautics.

Buffalo, New York, issues a bulletin which contains a complete outline of the aeronautical course presented by the Elm Vocational High School.[3]

---

[1]Vocational Training for Airplane Mechanics and Aircraft Engine Mechanics. Trade and Industrial Education Service, 46 pp. Washington, D. C. Federal Board for Vocational Education, January 1930.

[2]Ammon Swope, Teaching of Aeronautics in the Public Schools Of The United States, (Associate Professor of Industrial Education), Purdue University, Industrial Arts Magazine, p. 327. Sept. '29.

[3]Elm Vocational High School. Bulletin of Information Aeronautical Courses. Buffalo, New York. 1929.

The George Washington High School, Los Angeles, California, presents a two-year course. An outline of the course and a letter from Principal Thomas E. Hughes follows:

George Washington High School
108th St. & Denker Avenue
Los Angeles, Calif.

July 3, 1929.

Miss Ruth Woodworth,
234 North Hillside,
Wichita, Kansas

My dear Miss Woodworth:

Replying to your letter relative to our course in aviation at the George Washington High School, we are herewith enclosing an outline of the course of study and other documents which will give you a fairly good idea of what we are doing in this new subject in high school. We have a new shop building designed especially for courses in aviation which will accommodate three or four planes. We have also about twelve engines and fusilades, and considerable rigging. The Board of Education has furnished us tools to properly service any make of plane or engine. The equipment, engines, etc., have been loaned us by the Army and Navy Department.

We are limiting our courses to eleventh and twelfth year students. They must have at least eleventh year standing before being permitted to take this work. The course covers a period of 1600 hours, two years, 200 days per year, and four hours per day. We keep a close connection with the government demands and try as far as possible to fit our boys so that they will be able to accept positions anywhere, including the government.

If there is any further special data that we can furnish you, we will be glad to do so.

Very truly yours,
THOMAS E. HUGHES,
Principal

TEH:EA

LOS ANGELES CITY HIGH SCHOOL DISTRICT
DEPARTMENT OF VOCATIONAL EDUCATION
******

AVIATION (Ground Work)

Two Year Course - 1600 hours (4 Hours per day)

To be given at
George Washington High School
108th and Denker Streets

September, 1928

George Washington High School will offer a course in Aviation (Ground Work) in September. This is the first vocational course in aviation in the Los Angeles High Schools to be authorized by the Board of Education. The course was organized at this high school because the shop building there can accommodate these classes. This school is also located near several airports on Western Avenue. Although the school will not instruct in flying, it is desirable to have airports near for visitations.

EQUIPMENT FOR THE COURSE

The United States Naval Air Station at San Diego, Cal., through the Secretary of the Navy, has offered to give the following equipment to this school for the course:

2 VE (Vought) landplanes, complete (including Wright Hispano type engines and all instruments).

2 Liberty engines.

3 Wright whirlwind type, air-cooled engines

Miscellaneous instruments as available (airspeed meters, altimeters, tachometers, turn indicators, etc.)

ENTRANCE REQUIREMENTS

1. General requirements

A. Student must be at least 16 years of age when applying for admission.

B. Student must have completed the 9th and 10th years of high school work when first applying for admission to this course.

C. Student must average B grade to continue in this course.

D. Student must present the written consent of his parents.

2. Academic requirements
   A. Student must make a satisfactory grade in academic subjects.

   B. Student must take physics as one of his academic subjects.

3. Shop requirements
   A. Student must have had at least a one year's course in auto mechanics and a satisfactory grade.

   B. Student must have had at least a semester's work in general electricity and a satisfactory grade.

   C. Student must be willing to spend 4 hours per day for two years in actual shop work as required in this course.

4. Physical requirements
   A. Student must be physically fit.

STUDENTS MAY TRANSFER TO THIS COURSE

Any student in any high school in Los Angeles can transfer to this course provided he meets the entrance requirements. All applicants desiring to transfer should get in communication with the Department of Vocational Education, 520 Chamber of Commerce Building, immediately. Only one applicant from each high school will be accepted up to September 5, 1928. All applicants must bring verification that they have met the entrance requirements.

LESLIE G. STIER
Supervisor, Trades and Industries

Approved:
SUSAN M. DORSEY
Superintendent

LOS ANGELES CITY HIGH SCHOOL DISTRICT
DEPARTMENT OF VOCATIONAL EDUCATION

CONTENT OF TWO YEAR COURSE IN AVIATION (GROUND WORK)

AIRPLANE MOTORS

Practical Work	Theory
Firing order of motors	Types of construction Design of motors History of motors Theory of motors
Valve and valve timing	Composition of valves Discussion of valves
Lubrication	Effect of oil film Changing of oil Kinds of oil
Carburetion	Theory of carburetion
Ignition	Principles of ignition Theory of ignition
Trouble shooting	Discussion of systematic procedure

CONSTRUCTION

Practical Work	Theory
Strip plane. Begin with fuselage and completely overhaul and repair ready for flight	Fundamentals of rigging Care of wings Care of turnbuckles
	Properties of airplanes
Install instruments Repair wire and metal work Adjust propeller	Fuselage alignment and repair Diagnosis of
Emergency repair work	Rigging troubles
Sketch various types of construction	Cleaning
Sketch various designs	Principles of design
	Principles of construction
	Strength of materials

INSTRUMENTS

Practical Work	Theory
Install altimeter	Study of altimeter
Install radiator	Study of air speed indicator
Install thermometers	Study of operation and construction
	Pressure gauges Construction & Operation
	Fuel Gauges Principles of Operation
	Flight Indicators Principles of Operation

MAP READING AND SKETCHING

Practical Work	Theory
Scale maps	Types of maps used in aviation
Measure maps	Study of maps used in aviation
Find distance between two points on maps	Map projections
Read maps for elevation	Data on maps
Simple sketches	Knowledge of conventional signs used.

NAVIGATION

Practical Work	Theory
Plot a course	Effect of magnetism
Check up on wind	Knowledge of workings of instruments
	Effect of forces
	How course is found
	How wind is found
	Procedure before flight
	Procedure during flight
	Methods of locating a position

METEOROLOGY

Practical Work	Theory
Check on weather maps	Study of atmosphere
	Study of temperature & heat
Read weather maps	Effect of moisture
	Study of clouds
	Study of fogs
	Study of winds

APPROVED:

W. S. Kienholz, Director

A. Gould, Asst. Superintendent

Study of weather maps
Study of thunder storms
Study of upper air data
Atmospheric conditions affecting airplane's flight
Principles of forecasting weather

The following extract from an article by Andrew D. Althouse, Department Head of the Cass Technical High School, Detroit, Michigan, describes the work of the school of Detroit.

The aeronautical courses were first introduced in Cass Tech in the evening school in the spring of 1925 in response to more than one hundred requests for aeronautical instruction. The early courses were more or less general and were patterned after courses at the University of Michigan, and M.I.T. aeronautical engineering colleges. The demand for such courses in the day school was soon felt, and in 1926 a joint conference of educational authorities and leaders in the aeronautical industry was called. At that conference plans for a complete four-year course in aeronautics for the high school were discussed. The industry co-operated to the fullest extent. The course which was laid out follows the automotive course. The aero subjects replace the automotive subjects. In a large measure the tools and equipment are used for both courses so that the aero work was established at little expense. The United States Navy has since furnished much material from its store of obsolete equipment.[4]

An outline of the four-year aero course given by Cass Technical High school is now made up as follows:

9b grade	Aero	I	Machine Fitting (use of hand tools)
9a grade	Aero	II	Elementary Aerodynamics and Engines
10b grade	Aero	III	Elementary Electricity
10a grade	Aero	IV	Advanced Electricity, Meteorology, and Navigation
11b grade	Aero	V	Acetylene and Aec Welding and Heat Treatment
11a grade	Aero	VI	Advanced Machine Shop (all machine tools)

[4]Report - Problems of Aeronautics in the Schools. Prepared by Roland H. Spaulding. Published by the Daniel Guggenheim Fund Committee for the Promotion of Aeronautics, Inc., New York, 1929. P 47.

12b grade Aero VII Advanced Aerodynamics and Airplane Construction
12a grade Aero VIII Engine Testing, Fuels, and Carburetors.

In addition to these specialized aeronautical courses the boys take the following subjects:

7 courses in English
7 courses in Mathematics
6 or 7 courses in Mechanical Drawing
4 courses in Social Science
2 courses in Chemistry
2 courses in Physics
2 courses in Physical Education
1 course in Metallurgy (special)

Upon graduation the boys receive a diploma which will admit them to any of the state colleges or universities. The graduates this last June (1928) were all offered jobs in aircraft industries before the final day of school.[5]

A Junior College in connection with the Public Schools affords an opportunity for a more extended course in aeronautical education. The Public Schools of Hibbing, Minnesota, furnish an example of this situation. The outline is headed, "Information Regarding Aviation Instruction in the Hibbing Public Schools and Junior College, Industrial Arts Department, Jay F. Knowlton-Supervisor, and R.F.Davis-Instructor".

The outline follows:

I. Objectives.

1. To acquaint the students with the general field of aviation, that they may read and converse intelligently on the subject.

2. To give information that the student may use, in his choice of a vocation.

---

[5] Ibid., p.48.

3. To give such information as is possible, in a correct way, that the student may know the problems involved.
4. To create a public interest in aviation.
5. To satisfy the boys' desire to know something about a vocation so romantic as aviation.

II. Phases of Aviation in which instruction is given.

1. History of Aviation.
   (a) Early history
   (b) Development of engines
   (c) Important flights
   (d) Commercial development
2. Flight principles and nomenclature.
3. Nomenclature.
   (a) Names of plane parts
   (b) Names of motor parts
   (c) Flying terms
4. Definitions of ship types.
   (a) Air ships
   (b) Balloon
   (c) Airplane
   (d) Helicopter
   (e) Ornithopter
5. Airplane Rigging.
6. Airplane Construction.
   (a) Material
   (b) Construction
7. Instruments.
   (a) Aircraft instruments
      (1) Altimeter
      (2) Turn and bank instrument
      (3) Mag. Compass
      (4) Earth induction compass
      (5) Aircraft engine instruments
8. Airplane engines.
   (a) Principles
   (b) Types of motors
   (c) Special motors
9. Ignition
10. Carburetion
11. Meteorology and Aerology
    (a) Cloud formations
    (b) Winds
    (c) Weather maps
    (d) Weather forecasting

Second Year Course

1. Theory of flight.
   (a) Effect of controls
   (b) Combinations of controls
   (c) Skidding
   (d) Path of flight
   (e) Turning
   (f) Stalled flight
   (g) Power off
   (h) Taxying
   (i) Warming up motor
   (j) Taking off
   (k) Landing
   (l) Cross country flying

2. Airports.

3. Navigation.
   (a) Theory
   (b) Instruments
   (c) Problems

4. Airways and aids to navigation.

5. Air commerce regulations.

6. Straight flying.
   (a) Keeping nose on horizon
   (b) Banking
   (c) Climbing
   (d) Gliding

7. Taking off.
8. Landing.
9. Vertical banks.
10. Tail Spins.

Shop Practice Given.

1. Airplane construction and repair.
   (a) Use of tools.
   (b) Motors.
      (1) Valve grinding.
      (2) Timing.
      (3) General assembly.
   (c) Fuselage
      (1) Welding.
   (d) Wings.
      (1) Aligning.
      (2) Covering and doping.
   (e) Airplane rigging.

III. Length of Course and School Year.

High School

Grade - 11th grade boys in high school.
Time - 50 minutes each day for 19 weeks.
Prerequisites - Automotive Course No. I.

Junior College

Year - Freshman.
Time - 200 minutes a week for 13 weeks.
Prerequisites - None.

Night School for Adults

Open to all; no prerequisites and no charge.

IV. Instruction in airplane motors.

We give some practical shop work on airplane motors and theory of flying, but no actual training, in flying. Each student has a chance to sit in a dead plane and work the controlls. The plane is a complete one, moved into the shop for a short time, so that students may have such experience.

Different small models are made, complete to scale, with all controlls.

The students are given a close contact with the practical work when a complete over-haul job is done on one plane, each year, in the shop. While this is not student work, yet by so viewing these repairs, a valuable fund of knowledge is acquired.

The outline of other instructional material is given in the preceding outline.

V. Equipment.

(1) 1 Hispano engine (
(2) 1 Liberty Motor (Given by the United States Government
(3) Varied plane parts and sections
(4) Defective parts of different motors to show construction.
(5) Models to scale built by the students.

VI. Correlation.

This work is correlated very closely with our two years of Automotive work. Students must have had at least one year's work in Automotives before they can enroll in the Aviation work. This we do not consider necessary, but it gives a back ground on which the aviation instruction can be more quickly built. This

regulation also controls the number of students who may enroll, hence keeps our classes open to those having real interest in the subject.

An interesting booklet from Miss Mason's School at Tarrytown-on-Hudson, New York, is entitled, "The Aviation Course of Mason Junior College". The three courses, which are according to the requirements of the Department of Commerce, are as follows:

I. Ground Aviation.

II. Preparation for Private Pilot's License.

III. Preparation for Commercial Pilot's License.

Reports on Schools Conducting Correlated Courses in Aeronautics

The correlation of aeronautics with other subjects in school and as an extra curricular activity has many possibilities.

The state of California has organized what is known as the State Advisory Committee on Aeronautical Education. This Committee, which is under the leadership of Professor Earl W. Hill of the University of Southern California, is charged with the responsibility of recommending what should be undertaken in the various high schools and junior colleges in the way of uniform courses in aeronautical education. An outline has been adopted by the state to be given in the high schools under the social science group, The text book adopted is AIRPLANE TRANSPORTATION, by J. G. Wooley and Earl W. Hill, Hartwell Publishing Corp., 1622 N. Highland

Ave., Hollywood, California, 1929.

Ralph E. Pickett, Professor of Education, New York University, cites the following list of activities by means of which schools are giving aeronautical information. The grade level in which they were to be found to be most satisfactorily presented is also given.

A. Industrial Arts Shop Activities.

1.	Toy Parachutes	Grades 4 - 7
2.	Non-flying models	4 - 8
3.	Carrier Balloons	6 - 9
4.	Flying models	6 -12
5.	Paper Weights	6 - 9
6.	Kiddy cars	6 - 9
7.	Glider Construction	6 -12
8.	Operation and repair of airplane models and parts	7 -12

B. Vocational Activities.

1. 4-year and 2-year high-school courses, junior-college courses, and evening-school courses for training ground-service men, pilots, and mechanics.
2. College courses, graduate and undergraduate, for training aeronautical engineers are beyond the scope of this class except as to preparation required for admission.

C. Avocational Pursuits and Activities

1. Parachutes, carrier balloons, paper weights, kiddy cars, non-flying models, flying models.
2. Contests
3. Scrapbooks
4. Club activities

D. Classroom Activities

1.	Commercial geography maps	Grades 4- 9
2.	Study of government air-route maps	
3.	Picture collections	3- 6
4.	Scrapbooks	3-12
5.	Cut-out Collections	3- 5
6.	Cut-out Assemblies	4- 6
7.	Lectures to class	7-12

8. Student-class programs Grades 4 - 9
9. Assembly programs by students 7 - 9
10. Commencement programs by students and outsiders 7 - 9
11. The writing of imaginative stories and poems 4 -12

E. Out-of-Class Activities
1. Club activities
   a. Contests
   b. Lectures by prominent men or club members
   c. Assembly or commencement programs
   d. Visits to airports and factories
   e. Flights in commercially operated planes
   f. The acquisition, care, and flying of a club-owned plane (Grades 9-12, Buffalo, N. Y.)
   g. Glider construction 9 -12
   h. Model plane construction as an individual or club activity
   i. Taking movies and giving projections
   j. Reading of government air-route maps
2. Contests -- Grades 6 - 12
   a. Flying models of various natures
   b. Construction of various types of models
   c. Map reading and construction
   d. Cut-out assembling
   e. Model airport construction
   f. Scrapbook construction
   g. The making of ingenious and artistic shop projects centering around aviation activities.
   h. The construction of directional signs for air-mail and commercial aviators
   i. Man carrying gliding contests[6]

Mr. Herbert L. Gregory, Supervisor of the Inudstrial Arts Department, Great Neck, New York, High School, reports that aeronautical education in the Great Neck High School is carried on through extra-currular activity. The following excerpt from his letter:

We visit flying fields and factories, hold a model flying contest, and have reports presented by the members at our weekly meetings concerning topics of interest. We

---

[6]Report-Problems of Aeronautics in the Schools. Prepared by Roland H. Spaulding. Published by the Daniel Guggenheim Fund for the Promotion of Aeronautics, Inc., New York, 1929.

have a small library available for use of club members, and the list published by the Guggenheim Fund includes practically all of them.

Miss Eleanor Bloomfield, a teacher in the public schools of Newark, New Jersey, recommended a list of books which used in connection with an aviation club organized to promote aeronautical education. This list will be found in the fourth chapter of this report.

Mr. Kenneth H. Campbell, at one time an instructor in the High School of Patchogue, New York, described an aviation club which he organized in his school. Quoting from his letter:

> The boys held meetings weekly and held field meets two or three times a year, exhibiting and flying their various models for prizes offered by the Local Chamber of Commerce. Inter-school meets were also held. An interesting development that came out of this Club was an organization of an Adult Flying Club, which eventually purchased a plane and at the present time (April 4, 1930) fifty or a hundred people in Patchogue can fly.....
>
> The only attempt I made to correlate with other courses was my own subject, which happened to be history. The Lindbergh fever was still very strong in the country and most of the boys were air-minded and we did work out several projects along aeronautical lines in planning the future history of the United States, as seen from the air.

Arthur L. Jordan, of the Polytechnic High School, of San Francisco, is the author of ELEMENTARY LABORATORY AERODYNAMICS,[7] published by the Roland Press, New York.

---

[7]Arthur L. Jordan, Elementary Laboratory Aerodynamics. New York: The Roland Press Company. 1929.

This Manual gives directions for laboratory experiments suitable for students of the ordinary high school, and assumes a knowledge of elementary algebra and geometry only. This course could be correlated with any physics course, with the addition of a few carpenter and mechanical tools.

In a recent publication from the Daniel Guggenheim Fund Committee, prepared by Roland H. Spaulding, the following list of school systems reported giving some aeronautical instruction in one form or another.

Aberdeen, S. D.
Alameda, Calif.
Alexandria, Minn.
Amesbury, Mass.
Ann Arbor, Mich.
Appleton, Wis.
Ardmore, Okla.
Athens, Pa.
Batavia, Ill.
Boston, Mass.
Beaver Dam, Wis.
Bellefontaine, Ohio
Bellingham, Wash.
Bloomington, Ind.
Boone, Iowa
Boulden, Colo.
Brawley, Calif.
Bridgeport, Conn.
Brooklyn, N. Y.
Buffalo, N. Y.
Burlington, N. J.
Campbell, Ohio
Canandaigua, N. Y.
Canastota, N.Y.
Cape Girardeau, Mo.
Central Village, Conn.
Charlotte, N. C.
Cherryvale, Kan.
Chicago, Ill.
Claremont, N. H.
Cleveland, Okla.
Cleveland Heights, Ohio.
Cleveland, Ohio
Coalinga, Calif.
Coldwater, Mich.
Columbus, Ga.
Corona, Calif.
Coshocton, Ohio
Cowallis, Oregon
Crown Point, Indiana
Crystal Falls, Mich.
Dansville, N.Y.
Danville, Va.
Darby, Pa.
Darien, Conn.
Delavan, Wis.
Detroit, Mich.
Dover, Del.
Duncan, Okla.
East Chicago, Ind.
East Newark, N. J.
East Orange, N.J.
Elizabeth, N.J.
Elwood, Ind.
Erie, Pa.
Escanaba, Mich.
Evanston, Ill.
Eveleth, Minn.
Flint, Mich.
Flushing, N.Y.
Fort Dodge, Iowa
Galt, Calif.
Georgetown, Ky.
Glendale, Calif.
Glendive, Mont.
Glen Ridge, N.J.

Gloucester, Mass.
Goshen, Ind.
Grand Rapids, Mich.
Great Neck, N. Y.
Greenfield, Ohio.
Greenville, Mich.
Grinnell, Iowa
Hammond, Ind.
Hampton, Va.
Hamtramck, Mich.
Harland, Iowa
Hartford, Vt.
Hasbrouck Hts., N.J.
Hasting, Mich.
Hendersonville, N.C.
Hiawatha, Kan.
Highland Park, Mich.
Indiana, Pa.
Jackson Heights, L.I.
Jacksonville, Texas
Jermyn, Pa.
Jersey City, N. J.
Jewett City, Conn.
Johnson City, N.Y.
Jonesboro, Ark.
Kingston, Mass.
Kokomo, Ind.
Lake Geneva, Wis.
Leavenworth, Kan.
Lebanon, Mo.
Lindsay, Calif.
Long Branch, N. J.
Los Angles, Calif.
Loveland, Colo.
Ludlow, Mass.
Marion, Ind.
Mayfield, Ky.
Medina, Ohio
Miami, Fla.
Milton, Pa.
Milwaukee, Wis.
Mission, Texas.
Missoula, Mont.
Modesto, Calif.
Mohawk, N.Y.
Monett, Mo.
Monrovia, Calif.
Moultrie, Ga.
Monaca, Pa.
Morgantown, W. Va.
Mt. Vernon, Wash.
Mt. Vernon, N.Y.
Muscatine, Iowa
Napa, Calif.
Nashville, Tenn.
Newark, N.J.
Newberg, Ore.
New Haven, Conn.
Newport, Ky.
New Rochelle, N.Y.
Newton, Iowa
Newtonville, Mass.
New York, N. Y.
Northampton, Pa.
North Providence, R.I.
Oakland, Calif.
Oakmont, Pa.
Ogden, Utah
Oklahoma City, Okla.
Olympia, Wash.
Oneida, N.Y.
Oregon City, Ore.
Orlando, Fla.
Osceola, Iowa
Palisades Park, N.J.
Palmertown, Pa.
Paragould, Ark.
Pasadena, Calif.
Patchogue, N.Y.
Paterson, N.J.
Peoria, Ill.
Peterboro, N.H.
Piedmont, Calif.
Pinckneyville, Ill.
Pleasantville, N.J.
Pleasantville, N.Y.
Portage, Pa.
Port Jervis, N.Y.
Port Washington, Wis.
Princeton, Ind.
Pueblo, Colo.
Rahway, N.J.
Reading, Pa.
Redlands, Calif.
Richmond, Va.
Rushville, Ind.
Rye, N.Y.
St. Anthony, Idaho
St. Cloud, Minn.
St. Louis, Mo.
St. Paul, Minn.
San Antonio, Texas
San Bernardino, Calif.
San Francisco, Calif.

San Luis Obispo, Calif.
Santa Ana, Calif.
Santa Barbara, Calif.
Schuylkill Haven, Pa.
Shawano, Wis.
Sioux City, Iowa
Comerville, Mass.
Stillwater, Okla.
Stillwater, Minn.
Stoneham, Mass.
Streator, Ill.
Summitt, N.J.
Toppenish, Wash.
Tucumcari, N.M.
Tulare, Calif.
Tuscola, Ill.
Tyrone, Pa.
Union City, N.J.
Uniontown, Pa.
Vandergrift, Pa.
Visalia, Calif.
Waltham, Mass.
Washburn, Wis.
Webster Groves, Mo.
Wellesley Hills, Mass.
West Allis, Wis.
West Bend, Wis.
W. Bridgewater, Mass.
Westfield, N.Y.
Westfield, N.J.
Weston, W. Va.
West New York, N.J.
Westport, Conn.
Whitman, Mass.
Wilmington, Mass.
Wilmington, Del.
Winston Salem, N.C.
Winthrop, Mass.
Winthrop, Me.
Woonsocket, R.I.
Wyandotte, Mich.
Ypsilanti, Mich.

CHAPTER IV

SUGGESTED SOURCES OF MATERIAL IN THE FIELD OF SECONDARY AERONAUTICAL EDUCATION

From the Guggenheim Fund Committee was secured a very valuable annotated bibliography of the books which are appropriate for school use in courses in which aeronautical education is conducted.

From the ninety-six listed in the booklet[1] put out by the Committee, the following twenty-five have been selected as outstanding, and ones which might be selected for an aeronautical shelf in a library.

1. Amundsen, Roald. MY LIFE AS AN EXPLORER. Doubleday, Doran and Company, 1927.
   An autobiography by one of the outstanding explorers. This work tells something of his early life, his conquest of the northwest passage, the dash to the South Pole, his association with Lincoln Ellsworth, and the transpolar flight in the Norge.

2. Armstrong, Fred O. HOW TO MAKE AND FLY A MODEL AEROPLANE. Practical Arts Publishing Company, 44 Vista Ave., Elizabeth, New Jersey.
   This is a small pamphlet written by a junior high-school teacher at Orange, New Jersey. Full instructions for the development of a model aeroplane is given. Industrial Arts teachers will find this a fine project outline.

3. Arnold, Henry H. AIRMEN AND AIRCRAFT; AN INTRODUCTION TO AERONAUTICS. The Roland Press Company, New York, 1926. The main purpose of this book is described as an effort to set forth in simple terms certain aspects of aeronautics which are thought to be of particular interest to those not initiated in the mysteries of flying.

---

[1]Roland H. Spaulding, Books on Aeronautics, A Bibliography of Books. Likely to be used in Elementary and Secondary Schools. Published by Daniel Guggenheim Fund For The Promotion of Aeronautics, Inc. New York, 1928.

4. Barber, Horatio. THE AEROPLANE SPEAKS. Robert M. McBride and Company, 1928.
The author endeavors to explain elementary principles of flight through personification of each, and then allows each to explain its work as through all were in a play on a stage.

5. Bellah, James Warner. GODS OF YESTERDAY. D. Appleton & Co.
One of the best books of air fiction by a man who first of all is a writer. The seven stories of the collection are clean cut and the characters appear human in limitation and accomplishments.

6. Benson, Charles Beverly. MAP READING FOR AVIATORS. D. Appleton & Co., 1918.
Drawing and mathematics teachers will find this book of value in preparing work for their more alert students.

7. Boy Scouts of America. AVIATION. Merit Badge Series, Boy Scouts of America, 2 Park Avenue, New York.
This pamphlet is intended to suggest the scope of the subject and to serve as a guide to the boy in his quest for sufficient information to enable him to gain his Merit Badge for Aviation.

8. Brockett, Paul. BIBLIOGRAPHY OF AERONAUTICS. Smithsonian Institution, 1910.
This will be found useful for advanced students in search of historical or debate material.

9. Brown, C.L.M. THE CONQUEST OF THE AIR; A HISTORICAL SURVEY. Oxford University Press, 1927.
This is an interesting book, and certainly the best short history of aeronautical development from the teacher's standpoint that has appeared to date.

10. Byrd, Commander Richard E. (U.S.N. Retired) SKYWARD. G. P. Putman's Sons, 1928.
This is a book that young children will enjoy hearing read aloud, while those of junior and senior high-school grade will devour it.

11. Clark, Virginius Evans. ELEMENTS OF AVIATION - AN EXPLANATION OF FLIGHT PRINCIPLES. The Roland Press Company, 1928.
This book represents an effort to acquaint the general public with the principles of flight and elementary design considerations in a simple manner without resorting to complex mathematics. High schools planning courses in aviation will wish to consider this as a text.

12. Clevenger, Floyd P. MODERN FLIGHT; A MANUAL OF PRACTICAL FLYING. Alexander Aircraft Company, Denver.
Probably the most practical book on the subject for the high school student who plans to fly.

13. Collins, Francis Arnold. THE BOYS' BOOK OF MODEL AEROPLANES. The Century Company. Revised edition, 1928.
This book has been the standby of many model builders for years.

14. Duke, Donald G. AIRPORTS AND AIRWAYS. The Roland Press Company, 1927.
It will be found worth while in the school library of any city that already has an airport, or is planning a campaign to obtain one.

15. Edwards, Ivo A. E. and Tymns, F. COMMERCIAL AIR TRANSPORT. Isaac Pitman and Sons, 1926.
The teacher of elementary economics of business training classes will find this book of value.

16. Ferris, Richard. HOW IT FLIES. Thomas Nelson Sons, 1910.
Though somewhat old the work will appeal to the boy interested in the history of aeronautics.

17. Hart, Ivor Blashka and Laidler, W. ELEMENTARY AERONAUTICAL SCIENCE. Oxford University Press, New York, 1923.
A work on aeronautics designed for the student who desires to make an elementary scientific survey of the subject without involving himself in anything more intricate than elementary algebra and trigonometry.

18. Jacobs, A.M. KNIGHTS OF THE WING. The Century Co., 1928.
A delightful book of aeronautical literature. It will appeal alike to the boys and girls of the elementary, as well as to those of the junior and senior high schools.

19. Klemin, Alexander. IF YOU WANT TO FLY. Coward, McCann Company, New York, 1928.
An inviting narrative concerning Peter and his uncle.

20. LePage, W. Laurence. A.B.C. OF FLIGHT. John Wiley and Sons, New York, 1928.
A book for the layman which requires no more knowledge of physics than arises out of everyday observation.

21. Niles, Alfred S. AEROPLANE DESIGN. Government Printing Office, Washington.
An authoritative work on aeroplane design which is elementary enough for use by high-school students. In fact, it is now used as a text at Cass Technical High School, Detroit, Michigan.

22. Page, Victor W. MODERN AIRCRAFT. Norman Henley Publishing Company, New York, 1928.
This work is a veritable gold mine of information encyclopedic in scope. It is used as a reference book in several of the western high schools giving courses in aeronautics.

23. Spaight, J. M. AIRCRAFT IN PEACE AND THE LAW. The Mac Millan Company, 1919.
This is one of the few works dealing with the legal problems raised by the development of aviation. To the boy who is dreaming of the law as a profession this will prove a thought-provoking book.

24. Yancy, L. A. AERIAL NAVIGATION AND METEOROLOGY. Published by the author, 425 West End Avenue, New York.
The mathematically inclined boy will find enjoyment in some of the questions and answers which the book contains.

25. Zollman, Carl. THE LAW OF THE AIR. Bruce Publishing Company, Milwaukee, 1927.
Of interest to the legally inclined boy in the senior high school.

The following list of books was suggested by Miss Eleanor Bloomfield, an elementary grade teacher in Bloomfield, New Jersey. Quoting from Miss Bloomfield's letter,

We had a small but good aviation library, and the children seemed vitally interested in the books provided. I will enclose a list of some of the books which were in great demand.

1. A.B.C. OF FLIGHT, W. Laurence LePage, John Wiley & Sons, New York.
2. EVERYBODY'S AVIATION GUIDE - Victor Page, The Norman W. Henley Publishing Company, New York.
3. KNIGHTS OF THE WING, A.N.Jacobs, The Century Company.
4. THE THREE MUSKETEERS OF THE AIR - Koehl, Fitzmaurice, Von Huenefeld. G.P.Putnams, New York.
5. FLYING THE ARCTIC, Geo. H. Wilkins. G.P.Putnams,N.Y.
6. DICK BYRD - Fitzhugh Green
7. THE LONE SCOUT OF THE SKY - James E. West, Boy Scouts of America, 2 Park Avenue, New York.
8. MODERN FLIGHT - Floyd C. Clevenger, Alexander Aircraft Company, Denver.
9. SKYWARD - Richard E. Byrd, G.P.Putnam's Sons, N.Y.

The foregoing list of books may be a guide for schools, either elementary or secondary, which may be interested in organizing a club and desirous of placing a shelf of books of aeronautics in their library.

Miss Ruth Hammond, Librarian of the Wichita Public Library very graciously furnished a list of all books in the Wichita Public Library for this report. The list up-to-date is given here.

Abbot, W. J. Aircraft and Submarines
Aircraft power plants
Aircraft yearbook, 1920-1929
American Aircraft Directory
Amundsen, R.E.G. First Crossing of the Polar Sea
Amendsen, R.E.G. Our Polar Flight
Angle, G.D. Airplane Engine Encyclopedia
Arnold, H.H. Airmen And Aircraft
Barber, Horatio. Aerobatics
Barber, Horatio. The Aeroplane Speaks
Barnwell, F.S. Aeroplane Design
Bedell, Frederick. The Airplane
Berry, W.H. Aircraft In War And Commerce
Black, Archibald. Transport Aviation
Blakmore, T.L. Pressure Airships
Briggs, L.J. Aerodynamic Characteristics Of Twenty-five Airfoils At High Speed
*Britton, T.S. Aero Dopes And Varnishes
Brown, A.W. Flying The Atlantic In Sixteen Hours
Brown, C.L.M. The Conquest Of The Air
Bryan, L.A. Aerial Transportation
Burgess, C.P. Airship Design
Byrd, R.E. Skyward
*Camm, F.J. Building A Full-size Glider
Chatley, H. Force of the Wind
Chatley, H. Problem Of Flight
Clark, V.E. Elements Of Aviation
Collins, F.A. Air Man
Collins, F.A. How To Fly
*Colvin, F.H. Aircraft Handbook
*Crowley, J.W. Characteristics Of Five Propellers In Flight
Crump, Irving. The Boys' Book Of Airmen
Davis, E.J. Aircraft
Davis, E.J. The World's Wings

Day, O.H. Miniature Aircraft: How to Make and How to Fly Them
Diehl, W.S. Engineering Aerodynamics
*Diehl, W.S. Two Practical Methods for the Calculation Of the Horizontal Tail Area Necessary for A Statically Stable Airplane
Dille, H.C. Practical Aviation & Flight Instruction
Duke, D.G. Airports And Airways
*Dumanois, P. Aviation Fuels
Duncan, Richard. Simplified Aviation
Dyke, A.L. Aircraft Engine Instructor
Eaton, H.N. Aircraft Instruments
Edwards, I.A.E. Commercial Air Transport
Fales, E.N. Learning To Fly In The U.S. Army
Faunce, C.Q. The Airliner And Its Inventor
Fraser, C.C. Heroes Of The Air
Fraser, E.S. Motor Vehicles And Their Engines
French-English-German. Dictionary of Aeronautical Terms in Abridged Form, German-English-French
Glazebrook, Sir R.T. A Dictionary of Applied Physics
Goodyear Tire Company. The Story of the Airship (pamp)
Gould, Bruce. Sky Larking
*Gove, W.D. Variation in Engine Power
Gregg, W.R. Aeronautical Meteorology
Grosvenor, Edw. International Aircraft Markings
Hamburg, Merrill. Beginning To Fly
Hart, I.B. Elementary Aeronautical Science
Higgins, N.J. The Prediction Of Airfoil Characteristics
Hinton, Walter. Opportunities In Aviation
*Hicks, C.W. The measurement of the maximum cylinder pressures.
Hodgens, Eric. Sky High; The Story of Aviation
Holland, R.S. Historic Airships
Jacobs, E.N. Investigation of Air Flow in Open Throat Wind Tunnels
Joachim, W.F. Fuel Vapor Pressures
Johnson, J.B. Airplane Welding
Jordan, A.L. Elementary Laboratory Aerodynamics
Judge, A.W. Automobile And Aircraft Engines
Judge, A.W. Design of Aeroplanes
Judge, A.W. Handbook of Modern Aeronautics
Kaempffert, Waldemar. The New Art of Flying (pamp)
Aircraft Board, Aircraft Law of Kansas
Kennedy, T.H. An Introduction To The Economics Of Air Transportation.
Kenlegan, G.H. Investigation of damping liquids for aircraft instruments (pamp)
Keyhoe, D.E. Flying With Lindbergh
Klemin, Alexander. Aeronautical Engineering And Airplane Design
*Knight, Montgomery. Pressure Distribution Over A Rectangular Monoplane Wing Model

Kohl, Hermann. Three Musketeers Of The Air
Laufer, Barthold. The Prehistory of Aviation (pamp)
LaPage, W.L. A B C Of Flight
Lindbergh, C.A. "We"
Luchiesh, Matthew. Book Of The Sky
Maitland, L.J. Knights Of The Air
Manly, G.B. Aviation From The Ground Up
Middleton, E.C. Glorious Exploits Of The Air
*Miller, T.G. A Load Factor Formula
Mitchell, William. Winged Defense
*Muller, Waldemar. Parachutes For Aircraft
Munday, A.H. Eyes of the Army and Navy
*National Advisory Committee for Aeronautics. Aerodynamic Characteristics of Airfoils
*National Advisory Committee for Aeronautics. Bibliography Of Aeronautics
*National Advisory Committee for Aeronautics. Aircraft Accidents
*National Geographic Magazine. From London To Australia
*National Geographic Magazine. The Non-Stop Flight Across America
Neon. The Great Delusion
Page. A B C Of Aviation
Page, V.W. Everybody's Aviation Guide
Page, V.W. Glossary of Aviation Terms
Page, V.W. Modern Aircraft
Pannell, J.R. Measurement Of Fluid Velocity And Pressure
Pennsylvania Bureau Of Aeronautics. Aeronautics Laws Of The Commonwealth Of Pennsylvania
Pomillio, Ottorino. Airplane Design and Construction
Pritchard, J.L. The Book of the Aeroplane
Ramsey, L.C. Navigation Of Aircraft
Rathbun, J.B. Aeroplane Construction And Operation
Rathbun, J.B. Aeroplane Engines in Theory and Practice
*Rechtlich, A. Tensile strength of Welded Steel Tubes
*Rechtlich, A. Welding In Airplane Construction
*Reid, E.G. A warning concerning the take-off with heavy load
*Rhode, R.V. Pressure Distribution on Wing Ribs of the VE-7 and TS airplanes in Flight
Rotch, A.L. Charts of the Atmosphere for Aeronauts and Aviators
Rotch, A.L. New Conquest of the Air
Salverda, J.G.W.F. Van. Aerial Navigation
Santos-Dumont, Alberto. My Air-ships
*Schrenk, Martin. Calculation of Airplane Performances Without the Aid of Polar Diagrams
*Schrenk, Martin. A Few More Mechanical-flight Formulas Without the Aid of Polar Diagrams
Schweter, J.P. Manual On Gliders & Soarers
Smith, L.G. Romance of Aircraft
Smith, R.H. Aerodynamic Theory & Test of Strut Forms

*Sparrow, S.W. Friction of Aviation Engines
Stewart, Oliver. Aeolus: or the Future of the Flying Machine
Studley, Barrett. Practical Flight Training
Studley, Barrett. How To Fly
Sweetser, Arthur. Opportunities InAviation
Swoffer, F.A. Learning To Fly
Thomas, L.F. First World Flight
Thompson, F.L. Water Pressure Distribution on a Seaplane Boat
Thomson, C.B.T. Air Facts And Problems
Thomson, J.E. Aviation Stories.
Tichenor, F.A. Aviation
Travel Air Mfg. Co. "Travel Air" commercial airplane - Type 5000
Travelers Insurance Co. Airplanes And Safety
Aeronautics Branch of the Dept. of Commerce:
Air Commerce Regulations (pamphlet)
Airport RatingRegulations "
Construction of Airports "
U.S.War Dept. Air Service Medical Manual
Van Every, Dale. Chas. Lindbergh, His Life
Vincent, Terence. Miniature Aircraft Fliers
*Ware, Marsden. Comparative Performance of Roots Type Aircraft Engine Superchargers
Warner, E.P. Airplane Design
*Weick, F.E. A Comparison of Propeller and Centrifugal Fans for circulating the air in wind Tunnels
*Weick, F.E. Drag and cooling with Various Forms of Cooling for a "Whirlwind" Radial Air-Cooled Engine
*Weick, F.E. Full Scale Tests of Wood Propellers on a VE-7 Airplane in the Propeller Research Tunnel
*Weick, F.E. Full Scale Tests on a Thin Metal Propeller At Various Tip Speeds
*Weick, F.E. Full Scale Wind Tunnel Tests of a Series of Metal Propellers on a VE-7 Airplane
*Weick, F.E. Propeller Design
*Weick, F.E. Twenty-foot Propeller Research Tunnel
Weems, P.V.H. Line of Position Book; a Short Accurate Method Using Ogura's Altitude Tables and Rust's Modified Azimuth Diagram
Weems, P.V.H. Star-Altitude Curves
Wells, Linton. Around The World In 28 Days
Westervelt, G.C. The Triumph of the N.C's.
White, Claude Grahame-. Our First Airways, Their Organization, Equipment, and Finance
Widner, E.J. Military Observation Balloons
Wheat, G.S. Municipal Landing Fields And Airports
Wilkins, G.H. Flying the Arctic.

Williams, Archibald. Conquering The Air
Williams, K.P. Dynamics of the Airplane
*Wilson, E.E. Aircraft Engine Design
Wilson, E.B. Aeronautics, A Class Text
Wise, John. Through The Air
*Wolff, E.B. Mechanical properties of some materials used in airplane construction
Woodhouse, Henry. Textbook of Naval Aeronautics
Yancey, L.A. Aerial Navigation and Meteorology
*Zahm, A.F. An Automatic Speed Control for Wind Tunnels
*Zahm, A.F. Drag of C-class Airship Hulls
*Zahm, A.F. Forces on elliptic cylinders in uniform air stream
*Zahm, A.F. Theories of Flow Similitude
*Zahm, A.F. A Study of Wing Flutter

Civil aviation by the Joint committee on civil aviation
Textbook of military aeronautics, by Henry Woodhouse
Balloon and airship gases, by C.F.Chandler
Aircraft, by T.W.Corbin

Flying Simplified; a Manual of Theory and Practical Flying

*Titles starred are publications of National Advisory Committee for Aeronautics.

From the Department of Commerce, Aeronautics Branch, Washington, D.C., Aeronautics Bulletin No.6[2] was obtained. It is headed, "Aeronautical Publications", and the introductory paragraph describes the contents.

The department is constantly in receipt of requests for references on aeronautical subjects. The following list of books and other publications has been compiled to answer these inquiries. It is not to be considered as complete on account of the rapidly increasing number of publications on aeronautics. The department will be glad to receive suggestions and recommendations in regard to additions to this list.

---

[2]Aeronautics Bulletin No. 6 (Formerly Information Bulletin No. 6) Washington, January 1, 1929. Department Of Commerce, Aeronautics Branch. United States Government Printing Office

There is a complete bibliography which is classified under the following headings; Adventure and War, Aerodynamics, Astronomy and Navigation, Balloons and Airships, Bibliographies, Design of Airplanes, Elementary Aeronautics (General), Engines, Flying, Gliders, Handbooks, Historical, Instruments, Landing Fields and Airways, Legal Aspect of Aeronautics, Materials, Medical Aspect of Aeronautics, Meteorology, Model Airplanes, Performance Calculations, Periodicals, Photography, Propellers, Transports, Yearbooks, Miscellaneous and Miscellaneous Government Publications.

The list of periodicals includes those of both the United States and foreign countries.

The Aeronautical Chamber of Commerce of America maintains an office at 10 East 40th Street, New York. The Educational Committee is under the direction of Roland H. Spaulding.

Mr. Clyde V. Cessna of the Cessna Aircraft Company is one of the National Officers and very kindly furnished the following information for this report.

The Chamber of Commerce was organized directly after the World War. The object of the organization is to further development in the industry and to aid in all its branches where possible, such as National and local shows.

There is a branch for every department of the industry. The Chamber has done a vast amount of work in the way

of educating the public by a carefully systematized program where the public may see the latest in aircraft and meet with various Departments of the Chamber and discuss the subjects of transportation, engineering, performance standardization and other phases of aviation.

CHAPTER V

BRIEF HISTORY OF AVIATION

From the view point of achievement, aeronautics is a very young science; however, the philosophers dream of flying is as old as time.

Dreamers of air conquest pass before us throughout the panorama of the early history of civilization. We see them in the winged statuary of the Egyptians and we read of them in the stories of the ancient Greek mythology. Ever since man has learnt to think the challenge of the air has tantalized him. He has ever regarded it as an anomaly and an incongruity that the ability to fly should be granted to birds and yet denied to man. And so we read of such legendary figures as Icarus and Pereus and Hermes, and of such entertaining but improbable stories as of Simon Magus who, with the aid of some demon colleagues, essayed a short-lived flight and finished with a broken neck; of Abaris (as related by Diodorus of Sicily) and his flight round the world on a golden arrow (somewhat reminiscent of old Mother Shipton and of the nursery pictures of the cow jumping over the moon).[1]

The first historical record of mechanical flight is bogus, but at least it began, as it quite properly should have, with experiments on a model. In the fourth century before Christ lived Archytas, a learned man of Taranto. He was a scholar of geometry, a student of Pythagoras. He constructed a wooden pigeon, or dove, which is reputed to have flown by means of mechanical power plus "hidden and enclosed air" - a mysterious substance also described as an "aura of spirit". In the various cryptic descriptions which still remain, the machinery is vaguely explained, but the forces that held it up and pushed it forward are attributed to occult powers - with no apparent protest from contemporaries. The pigeon, it seems, could fly, "but if it fell, it could not lift itself up any more."[2]

---

[1]Ivor B. Hart and W. Laidler. Elementary Aeronautical Science, pp. 1-2, Oxford England: The Clarendon Press, 1924.

[2]Eric Hodgins and F. Alexander Magoun. Sky High, pp. 3-4, Boston: Little, Brown & Co., 1929.

It is not surprising to read that even Roger Bacon had hopes that at some future time an instrument might be made that would fly.

Perhaps the first indication of a glider is a contrivance fashioned by Regiomontanus, of Johann Muller, a German mathematician of renown. He is credited with having built an artificial fly in his workshop at Nuremberg.

Leonardo da Vinci, ranked as one of the greatest painters, was also a sculptor, an architect, an engineer, and a scientist. He was born in 1452 and was the true pioneer of aviation. He maintained that the flight of a bird was along the line of mathematical law; hence it was the bird that must be studied and imitated. Da Vinci contended that with wings large enough and properly connected man could fly. From this the principle of the parachute was recognized. A close study of da Vinci's notes reveals that he was conscious of the 'center of gravity'; 'stream line'; 'center of pressure', and perhaps the relationship between wing surface and resistance. Later he seems to have forsaken the idea of wings and to have tried jointed oars. Some give him credit for having successfully designed a helicopter.

Paolo Guidotti of Lucca in the latter half of the sixteenth century and Veranzio of Venice in the early seventeenth century, experimented on gliders and on parachutes, but nothing seems to have developed.

Borelli, who lived from 1608 to 1679, next became interested in imitating the birds in flight. His conclusion was that a heavier-than-air flight was impossible. However, Franesco Lana, a very poor but very brilliant priest, experimented with the lighter-than-air flight. His idea was to use thin copper globes. He had worked out their dimensions so that their weight would be less than their volume of air, hence would lift two men and the boat to which they were attached. His experiment never went beyond the calculations on paper. It was two hundred years later that flaws in his work were revealed: that is, he had not taken into consideration the density of copper.

Later in the seventeenth century, Robert Hooke designed a model that raised and sustained itself, but had little effect on the airplane development. About the same time Besinier constructed and flew a glider, but his work seems to lack the scientific influence; therefore it had little effect.

A hot-air balloon was produced in 1783 by the Montgolfier brothers. At about the same time Cavendish had discovered hydrogen. The first inventors seem to have made little use of this discovery, but Cavendish established a principle which is in use today.

Sir George Cayley known as "The Father of British Aeronautics" began his work about the beginning of the nineteenth century. He spent some time in trying to apply the steam en-

gine to the use of an airplane. It is said he was the first to realize the need of a cambered plane, the dihedral angle, the longitudinal control and stability, and lateral stability.

Following Cayley for a number of years all the experimentation sought to apply the use of the steam engine. Phillips, Henson and Stringfellow are mentioned in this connection.

In the year 1871, Lilienthal, a German, carried on a number of experiments. In 1889 he published the results of his experiments, and called it 'Bird Flight as the Basis of Aviation'. In this he explains the influence of wind-pressure on the wing surface, and demonstrated the necessity of camber. Pilcher, an English contemporary of Lilienthal, summarized the function of the glider. His idea was to have fixed wings, but to balance the machine by moving his own weight about. He felt that gliders were machines which might be used as practice work until engine driven machines would be made.

At the end of the nineteenth century, Chanute of America was experimenting with gliders. His plan was to have the driver seated and to be able to manipulate his machine through a shifting of the wings.

Another pioneer of Aviation in America was Professor John J. Montgomery, Santa Clara College, California. "Entirely unhonored, almost unknown, it was he who instituted gliding upon a really grand scale."[3]

---

[3] Ibid. P. 156.

He was killed while gliding in California in 1911. "For all boldness and success, the name of the first native American to build and operate successful gliders is almost wholly lost to fame."[4]

For many years the interest had been with gliding, experiments with engine driven machines had been neglected. Sir Hiram Maxin in England decided by building a very large plane he might be able to use the heavy engine of the day. Although he wrecked his plane, he proved that it was possible for such a heavy mass to be lifted by driving the plane against the air with sufficient velocity.

In 1886 a Frenchman, Clement Ader, built a machine driven by a steam engine of between twenty and thirty horse power. In 1887 he is reported to have flown 1000 feet.

Professor S. P. Langley, Secretary of the Smithsonian Institute of Washington, stands uppermost in the minds of the people with respect to aviation. He was a scientist and carried out a number of investigations before attempting the actual problem of flight.

May 6, 1896, one of his models flew over 3000 feet. In 1903 Langley built a machine which was driven by two propellers. Two tests were made but unfortunately both were unsuccessful. However, the same machine was successfully flown in 1914, after the death of Langley.

---

[4]Ibid. P. 157.

It is reported that the account of the tragic death of Lilienthal, whose experiments Wilbur and Orville Wright had followed so eagerly, turned the Wright brothers' attention seriously to the solution of flying. Their first flight under power was made December 17, 1903, on the windswept beach at Kitty Hawk, North Carolina.

Only five people were present beside the two brothers who were inaugurating a new era for the world. It is worth recording the names of those present on the historic occasion. John T. Daniels, A. D. Etheridge, W. S. Dough, W. C. Brinkly and John Ward, - seven people in all.[5]

Orville and Wilbur Wright won the right to be called the first airmen by a very narrow margin. In France, Captain Ferber made his first attempt on a power driven machine in 1905. His contemporaries were Henri and Maurice Farman, Santos Dumont, Hubert Latham, Bleriot and Voisin, all famous in the early days of aviation.

On September 21, 1908 Wilbur Wright remained in the air over an hour and flew over sixty miles. In 1909 the first British Aero Show was held at Olympia. In the same year Bleriot flew across the English Channel. The Rheims Aviation Week and the first meet for the Gordon-Bennett Aviation trophy were also held this same year.

---

[5]Capt. J. Laurence Pritchard. The Book Of The Aeroplane, p. 28, New York: Longmans, Green & Company, 1926.

Flying had ceased to be indulged in by a few rash experimenters, and was fast becoming one of the possibilities of transportation. Man had at last conquered the air.

CHAPTER VI

SUGGESTED TYPE EXERCISES FOR USE IN SECONDARY SCHOOL MATHEMATICS

The following exercises are suggested as supplementary work which may be presented to classes in secondary mathematics, in order that an interest in mathematics and its fundamental processes may be increased through this already interesting subject, aviation.

There has been an attempt to classify the exercises into the grade placement where they would be most suitable for the respective students of the grades of high school.

The glossary will be helpful to those who are not familiar with the nomenclature of aviation. All terms used in the exercises are defined in the glossary.

Glossary.

AERODYNAMICS.-Pertaining to the forces of air in motion relative to a rigid body or to another portion of air.

AERONAUTICS.-The science and art of self-sustaining flight in air.

AILERON.-A movable control surface on the main planes.

AIRFOIL.-Winglike structure, flat or curved, e.g., a fin, wing, aileron, rudder, etc.

AIR SPEED.-The speed of an aircraft through the air. It is independent of the motion of the air. Its symbol is V.

AIRPLANE.-A mechanically driven aircraft heavier than air, fitted with fixed wings, and supported by the dynamical action of the air.

ANGLE OF ATTACK.-The acute angle at which an airfoil strikes the air immediately in front of it.

ANGLE, DIHEDRAL.-The acute angle between the wing and the lateral axis of the airplane projected on a plane perpendicular to the longitudinal axis of the airplane.

ANGLE OF INCIDENCE.-The acute angle at which relative wind strikes an airfoil. It is equal to the angle of attack.

ASPECT RATIO.-The ratio of the span to the chord of an airfoil.

AVIATION.-The art of operating heavier-than-air craft.

AXES OF AN AIRCRAFT.-Three fixed lines of reference. The longitudinal axis in the plane of symmetry, usually parallel to the axis of the propeller, is called the longitudinal axis; the axis perpendicular to this in the plane of symmetry is called the normal axis; and the third axis perpendicular to the other two is called the lateral axis. In mathematical discussions the first of these axes, drawn from front to rear, is called the X axis; the second, drawn upward, the Z axis; and the third, running from right to left, the Y axis.

AXIS OF SYMMETRY.-A straight line about which the parts of a body or area are symmetrically arranged.

BIPLANE.-An airplane with two main supporting surfaces placed one above the other.

BURBLE.-When the air flow changes from a smooth and continuous flow into a state of violent turbulence, breaking away from the surface, and being forced to eddy, the air is said to burble. The angle of attack of an airfoil which gives the maximum lift, and beyond which the type of flow changes to one of violent turbulence with sudden loss of lift and increase of drag, is called the "burble-point".

CAMBER.-The rise in the curve of an airfoil section from its chord, usually expressed as the ratio of the departure of the curve from the chord to the length of the chord

CEILING.-The greatest height to which an airplane can fly.

CHORD LENGTH.-The length of the projection of the airfoil section on its chord. Its symbol is c.

DRAG.-The resistance of an airdraft along its flight, its head resistance. That part of the drag due to the wings is called "wing drag"; that due to the rest of the airplane is called "structural drag" or "parasitic resistance".

FUSELAGE.-The body of an airplane to which the wings and tail plane are attached, and in which the pilot and passengers sit or the load carried is placed.

GLIDER.-A form of aircraft similar to an airplane, but without a power plant.

GROUND SPEED.-The speed of the airplane over the ground. It varies with the velocity of the wind.

HANGAR.-An enclosed shelter for housing aircraft.

LIFT.-The force acting on aircraft perpendicular to the flight.

MONOPLANE.-An airplane which has but one main supporting surface, sometimes divided into two parts by the fuselage.

PARALLELOGRAM OF VELOCITIES. The method employed to calculate the effect of the wind on an airplane in flight.

PILOT.-An operator of aircraft. This term is applied regardless of the sex of the operator.

PROPELLER.-A type of screw with blades for rotating in the air and driving an airplane. A propeller is an airscrew working behind the main planes, and a tractor an airscrew working in front of the main planes. Commonly all airscrews are often spoken of as propellers.

SPAN.-The lateral dimension of an airfoil, i.e., its dimension perpendicular to its chord. Its symbol is b.

VELOCITY.-Rate of motion, direction as well as speed being considered. More commonly used in the sense of speed only, and measured by the distance traveled during a given period of time. Symbol: V.

WING.-A general term applied to a whole or a portion of the main supporting surface of an airplane, but in the latter case it is usually qualified as right wing, left wing, upper wing, lower wing, etc.

The following exercises and formula might be used in an algebra class:

I $\begin{cases} L = K_yAV^2 \\ D = K_xAV^2 \end{cases}$

Where L = lift in pounds
D = drag in pounds
A = area in square feet
V = velocity in miles per hour, m.p.h.
K_y = coefficient of lift for given angle.
K_x = cooefficient of drag for given angle.[1]

II (Resistance of a flat plate perpendicular to the wind.

$R = KAV^2$

Where K = .0032 (generally accepted)
A = square feet of area
V = velocity in m.p.h.[2]

III (Aspect ratio = l/c
(Where l = span or length of the wing area
c = chord or width of the wing area[3]

To maintain horizontal flight the lift on the wings of an airplane must equal the weight of the plane (W). The equation $L = K_yAV^2$ then becomes $W = K_yAV^2$. Rewrite this for K_y, A, and V.

When speed V is large what follows from the equation for K_y? From this equation would you conclude if a plane is to fly fast it must fly at a small angle?

When landing, the ship flies slowly, thus V is small. Hence, what is true for K_y?[4]

---

[1]Alexander Klemin, Simple Aerodynamics, p. 46. Popular Aviation.
[2]Ibid, p. 44.
[3]Laurence W. LePage, TheABC Of Flight, p. 47. New York: John Wiley & Sons, Inc., 1928.
[4]Alexander Klemin, op. cit., p. 67, February '29.

A monoplane with an area of 200 square feet flying at 90 miles an hour with an angle of attack of 6 degrees (K_y = .00215). What is the weight if $W = K_y AV^2$. Ans. 3483 pounds.

A wing of 200 square feet area is designed to land at 50 miles an hour, using K_y=.00318. Find the weight it can support. Ans. 1590 pounds.[5]

A rectangular wing with a span of 30 feet and a 5 foot chord with K_y = .0028 will have what lift force at 50 m.p.h. Ans. 1050 lbs. If K_x = .00034 find the drag force for the same plane at 50 m.p.h. Ans. 127.5 pounds.[6]

The pressure in pounds per square foot upon a flat plate may be obtained by squaring the velocity of the wind in miles per hour and multiplying this square by .004. Thus, if the velocity of the wind is 60 miles per hour, the pressure on the plate is,

.004 x 60 x 60 = 14.4 pounds per square foot.

This does not matter whether the plate is moving through the still air at the rate of 60 miles per hour or whether the plate is still and the wind blows against it with a velocity of 60 miles per hour. Also there would be the same pressure if the plate were moved 30 miles per hour with a wind blowing 30 miles per hour or moved 90 miles per hour with a wind blowing in the same direction at a rate of 30 miles per hour.

What is the pressure upon a plate 2 feet by 1-1/2 feet,

---

[5]Ibid, p. 90.
[6]Ibid, p. 46

at rest, when the wind is blowing squarely upon it at a speed of 40 miles per hour? Ans. 19.2 pounds.

Answer the above when the plate is moving against the wind at the rate of 60 miles per hour. Ans. 120 pounds.

For the wing of an air plane in general, the pressure in pounds is equal to a certain quantity called a constant multiplied by the area of the wing in square feet multiplied again by the square of the velocity in miles per hour.

If an airplane has a wing area of 200 square feet and a constant of .0025 for an angle of incidence of 6 degrees, what is its lift at this angle of incidence when the speed is 60 miles per hour? Ans. 1800 pounds.

As a very rough measure of the average parasitic drag, its amount in pounds may be given as .0002 times the wing area in square feet times the square of the velocity of the airplane relative to the air in miles per hour.

What is the parasitic drag if the area of the wings is 250 square feet and the velocity of the airplane relative to the air is 80 miles per hour? Ans. 320 pounds.

The above holds whether the speed of the airplane is 80 miles per hour in still air, 120 miles per hour with a wind of 40 miles per hour or 40 miles per hour against the same breeze.

A monoplane has a wing area of 294 square feet. What parasitic drag would you expect for the plane when making 40 miles per hour in still air? Ans. 94.08 pounds.

What parasitic drag would you expect for a plane with a wing area of 500 square feet making 80 miles per hour against a 30-mile breeze. Ans. 1210 pounds.

A monoplane has a wing area of 294 square feet and an aspect ratio of 6. What is the chord and the span?

Ans. span = 42 and chord = 7.

A biplane has a wing area of 500 square feet and an aspect ratio of 10. What is the chord and the span?

Ans. span = 50 and chord = 5.

A rectangular wing has an area of 300 square feet and a span of 40 feet. Find the chord and the aspect ratio.

Ans. chord 7.5 feet; aspect ratio (5.3)[7]

Find the resistance of a square flat plate 16 square feet in area held perpendicular in a 60 mile wind?

Ans. 184.32 pounds.[8]

Find the resistance of a plate of 10 square feet held perpendicular in a wind of 100 m.p.h. Ans. 320 pounds.[9]

A square flat plate normal (K = .0032) to a wind of 120 miles has a resistance of 210 pounds. Find the area of the plate. Ans. 4.5.[10]

---

[7]Ibid, p. 97.

[8]Ibid., p. 44.

[9]Ibid., p. 97.

[10]Ibid., p. 97

The distance from East Boston to Old Colony is 15 miles. A plane flies between the two points in 10 minutes. Find the ground speed per hour? Ans. 90 M.P.H.[11]

The distance from Dixon Field to Hartford is 20 miles. Time from one point to the other is 12 minutes. Find the Ground Speed per hour. Ans. 100 M.P.H.[12]

The distance from New York to Albany is 140 miles. How long will it take to fly the two points at Ground Speed 80 M.P.H. Ans. 1 hr. 45 minutes.[13]

An aeroplane engine develops 365 b.h.p. (brake horse power). If the efficiency of the propeller by 81 per cent (.81), find the thrust of the propeller, if the speed of the machine by 100 M.P.H.

H = b.h.p. $T = \frac{3300Hn}{V}$
N = .81
V = 100 m.p.h. = 8,800 feet per minute.
Ans. 1108.7 pounds.[14]

An airplane weighs 1,000 pounds, and in turning is banking at an angle of 45 degrees. Find the load factor and the load on the main planes.

$L = \frac{W}{\text{Cos of angle}}$ Ans. L = 14200 pounds
N(load factor) = 1.42.[15]
$N = \frac{L}{W}$

---

[11]Captain Richard Duncan, Air Navigation & Meteorology, p. 77. Chicago: The Goodheart-Willcox Company, Inc., 1928.

[12]Ibid., p. 78.

[13]Ibid., p. 78

[14]Hart & Laidler, op.cit., p. 151.

[15]Ibid., p. 131.

An airplane weighing 1,500 pounds is banking at an angle of 60 degrees in a turn. Find the load imposed upon the main planes? Ans. L = 3,000 pounds.[16]

A machine which has a normal stalling speed of 75 m.p.h. (V), enters a turn. If its stalling speed during this turn be 90 m.p.h. (v'), calculate the maximum possible angle at which it may bank.

$$V' = \frac{V}{\sqrt{\cos \text{ of the angle}}}$$

Ans. Angle = 46 degrees. approx.[17]

The following exercises might be used in a geometry class. The ones related to trigonometric functions might be used either in geometry or a trigonometry class.

At what height must an observer in an airplane be in order to see over level country 50 miles in all directions?[18]

How high must an aviator rise to be able to see 40 miles in every direction over a smooth sea?[19]

Two boats are anchored 2500 feet apart. An airplane flies across the line joining them. Just as it does so its angle of elevation from one boat is 50 degrees and its angle of elevation from the other is 60°. Find the height at which it was flying. Ans. 1765 ft.

The angle of elevation of an airplane from a landing field is 22° . The plane glides straight toward the landing field and arrives 90 seconds after it is first sighted. If its average speed during that time is 40 miles per hour, how high was it when first sighted?

---

[16]Ibid., p. 132.
[17]Ibid., p. 133.

[18]Herbert E. Hawkes, William A. Luby, Frank C. Touton, New Plane Geometry, p. 413. New York: Ginn & Co., 1929.

[19]Ibid., p. 292.

An airplane is flying horizontally directly away from a station on the ground at the rate of 80 miles an hour. At a certain instant its angle of elevation from the station is 40°, and 30 seconds later its angle of elevation is 25°. Find the height at which it is flying.[20]

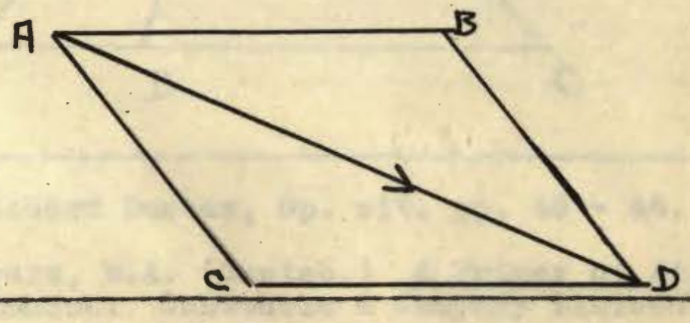
Parallelogram of Velocities is explained by Captain Richard Duncan, M.C., in the following paragraph.

The method employed to calculate the effect of the wind on an airplane in flight is governed by the theory of the parallelogram of velocities, by means of which the wind, the track and the course steered are represented graphically. The parallelogram of velocities depends on the following facts:

1. Any force can be represented in magnitude and direction by a straight line, and any force acting on a body to produce motion can be split up into two or more components.

2. Conversely, any two forces acting together on a body can be compounded into one resultant force.

From any point A, lay off AB, to represent any magnitude and direction the force B acting on the body A. From A, lay off AC, to represent the velocity produced by the force C. Complete the parallelogram ABCD. Then AD represents, in direction of magnitude, the resultant velocity of the two components AB, AC. Thus, if the force B produces a motion of 10 miles per hour in a direction AB, the body A would move 10 miles along AB in one hour, if acted upon by B alone: and similarly, if the force C produced a motion of 5 M.P.H. in the direction of AC, A would move 5 miles along AC in one hour. If, however, both forces are acting together, A cannot move in the direction AB or AC, but will take up the direction AD, with a velocity compounded from the other two.



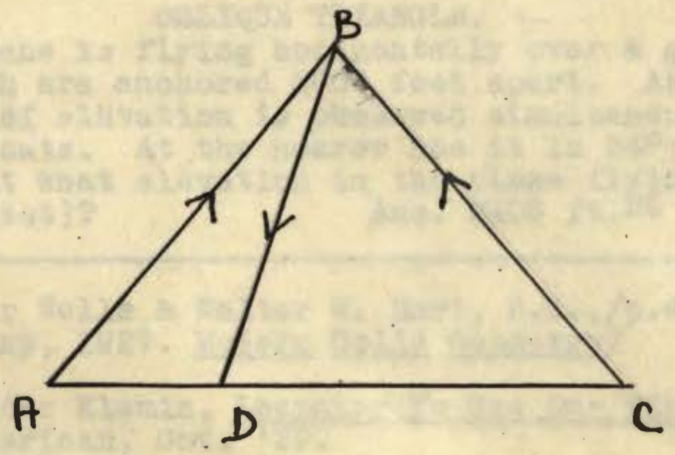
[20]Brink, Raymond W. Plane Trigonometry, p.35. New York: The Century Company. 1928.

Let 1/4" represent 1Mph, draw to scale the above problem.[21]

Wing bracings are good examples of parallelograms of forces.

In Air Navigation by H.E.Wimpers, under the heading "Allowance for wind", the following extract emphasizes some fundamental geometrical principles.

Note that on an "out and home" journey in the same wind and at the same air speed the drift angles out and home will be equal. Thus, to fly A to C, see (figure) Fig. 21, when the wind is equal to BD in velocity and direction means setting the head of the machine along AB on the outward flight and along CB on the home flight. Then as AB and BC are equal, the angles of drift (BAD and BCD) must also be equal. Why? Thus, if a navigator knows the right angle of drift to allow on his outward journey, he also knows it for his home journey if the same conditions as to wind and air speed remain.[22]



[21]Captain Richard Duncan, Op. cit. pp. 45 - 46.

[22]H. E. Wimpers, M.A. (Cantab.) A Primer of Air Navigation, p. 44. London: Constable & Company Limited., 1920.

These exercises might be supplemented in a solid geometry class.

The angle of elevation of an airplane at a certain point P is 58°30'. Point D, 1500 ft. distant is directly below the airplane. How high is the airplane?

An observer in an airplane, which is 2800 ft. high, finds that the angle of depression of a station on the ground is 35°18'. How far is it from his present position to a point directly over the station?[23]

The Great Circle Route. From New York to Cleveland. From Cleveland to Garden City, via Toledo, Chicago and Kansas City. From Garden City to Los Angeles. Flight is almost directly on the great circle.[24]

The following exercises might be used in a Trigonometry class.

RADIAN MEASURE.

An airplane propeller makes 1975 revolutions per minute, and is 7 feet 9 inches from tip to tip. What is the linear velocity of its tip? (Linear velocity is a moving object's rate of motion: it is equal to the distance passed over in a certain time divided by the time, or to the number of units of distance passed over in one unit of time.)[25]

OBLIQUE TRIANGLE.

An airplane is flying horizontally over a guiding line of boats which are anchored 2000 feet apart. As it approaches its angle of elevation is observed simultaneously at two neighboring boats. At the nearer one it is 24°; at the other it is 18°. At what elevation is the plane flying (to the nearest 100 feet)? Ans. 2400 ft.[26]

---

[23]Webster Wells & Walter W. Hart, D.C.,/p.49, New York: Heath & Company, 1927. Modern Solid Geometry/

[24]Alexander Klemin, Learning To Use Our Wings, p.336. Scientific American, Oct. '29.

[25]Raymond W. Brink, op.cit. p. 79.

[26]Ibid., p. 165

Two points, a and b, which are 3100 feet apart, are directly below the line of an airplane. At a certain instant when the plane is above the line AB its angle of elevation at A is 79° 20', and its angle of elevation at B is 18° 50'. Just 15 seconds later, while it is still above AB, its angle of elevation at A is 21° 10', and its angle of elevation at B is 49° 40'. What is its speed in miles per hr?[27]

An airplane is flying in a straight, horizontal line at the rate of 120 miles per hour. A person directly below the path of the plane observes it just after it has passed overhead. Its angle of elevation is 82° 30'. One minute later its angle of elevation is 20° 20'. At what height is it flying? Ans. 4114 ft.[28]

Work the above, using the two angles of elevation 74° 20' and 34° 15' and assuming that between the times of the two observations the plane passes directly over the observer.[29]

---

[27] Ibid., p. 166.

[28] Ibid., p. 169.

[29] Ibid., p. 169.

BIBLIOGRAPHY

Articles

Klemin, Alexander. "Learning to Use Our Wing", Scientific American, (October 1929), 336.

"Simple Aerodynamics", Popular Aviation, (Jan., Feb. '29).

Swope, Ammon. "Teaching of Aeronautics in the Public Schools of the United States". Industrial Arts Magazine, (September, 1929), 327.

Books

Brink, Raymond W. Plane Trigonometry. New York: The Century Company. 1928. pp. vii + 110

Duncan, M.C., Captain Richard. Air Navigation and Meteorology. Chicago: The Goodheart-Willcox Company. 1928. p. 233.

Hart, Ivor B. and Laider, W. Elementary Aeronautical Science Oxford, England: The Clarendon Press. 1924. vii + 280.

Hawkes, Herbert E., Luby, William A., Touton, Frank C. New Plane Geometry. New York: Ginn & Co. 1929. vii + 428.

Hinton, Walter. Opportunities in Aviation. New York: W. W. Norton and Company, Inc. 1929. xiv + 255.

Hodgins, Eric and Magoun, Alexander F. Sky High. Boston: Little, Brown & Co. 1929. xx + 337.

Jordon, Arthur L. Elementary Laboratory Aerodynamics, p. 67. New York: The Roland Press Company. 1929.

LePage, W. Laurence. The ABC of Flight. New York: John Wiley & Sons, Inc. 1928. ix + 141.

Pritchard, Capt. J. Laurence, Book of Aeroplane. New York: Longmans Green & Company, 1929. vi + 267.

Wells, Webster & Hart, Walter W. Modern Solid Geometry. New York: D.C.Heath & Company, 1927. vi + 509.

Wimpers, M.A. (Cantab.), H.E. A Primer of Navigation. London: Constable & Company, Ltd. 1920. xiv + 128.

Wooley, James G. and Hill, Earl W. Airplane Transportation. Hollywood, California: Hartwell Publishing Co. 1929. vii + 353.

Miscellaneous Material.

Aeronautics Bulletin No. 6. (Formerly Information Bulletin No. 6) Department of Commerce, Aeronautical Branch, Washington: January 1929. United States Government Printing Offices.

A Directory Of The Industries That Have Made Wichita The First City In America In Commercial Aviation. Wichita: Published by the Aeronautical Division of the Chamber of Commerce. July 1929.

Elm Vocational High School. Bulletin of Information Aeronautical Courses. Buffalo: 1929. Buffalo Public Schools.

Lindbergh, Col. Charles A. Address Before National Education Association, Department of Superintendents. Boston: 1928.

Vocational Training for Airplane Mechanics and Aircraft Engineers Mechanics. Washington: Trade and Industrial Education Service. Federal Board for Vocational Education. January 1930. 46.

Spaulding, Roland H. Books on Aeronautics. A Bibliography of Books Likely to be used in Elementary and Secondary Schools. New York: Published by the Daniel Guggenheim Fund For The Promotion of Aeronautical Education. 1928.

Spaulding, Roland H. and Others. Report, Problems of Aeronautics in the Schools. New York: Under the Auspices of the Daniel Guggenheim Fund Committee on Elementary and Secondary Aeronautical Education.

The Aviation Industry. A Study of Underlying Trends by Division of Commercial Research. The Advertising Department. The Curtis Publishing Co., Philadelphia, 1930.