DOCUMENT RESUME

ED 360 170 SE 053 549

AUTHOR	Poff, Norman O., Ed.
TITLE	Of Wings & Things. Aeronautics Information Stuff & Things for Students & Teachers.
INSTITUTION	Oklahoma State Univ., Stillwater. Aerospace Education Services Project.
SPONS AGENCY	National Aeronautics and Space Administration, Washington, D.C.
PUB DATE	90
NOTE	91p.
AVAILABLE FROM	Aerospace Education Services Project, 300 N. Cordell, Oklahoma State University, Stillwater, OK 74078-0422.
PUB TYPE	Guides - Classroom Use - Instructional Materials (For Learner) (051) -- Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	*Aerospace Education; Aircraft Pilots; Elementary School Science; Elementary Secondary Education; Mathematics Education; Models; Physical Sciences; *Science Activities; *Science Education; *Science Instruction; Scientific Concepts; Scientific Literacy; Secondary School Science
IDENTIFIERS	*Aeronautics; Aircraft Design; Airplane Flights; *Paper Airplanes (Toys)

ABSTRACT

This book presents information, activities, and paper models related to aviation. Most of the models and activities included use a one page, single concept format. All models and activities are designed to reinforce, clarify, or expand on a concept, easily and quickly. A list of National Aeronautics and Space Administration (NASA) Center education programs officers, a list of NASA teacher resource centers and 18 sources of additional information are provided. (PR)

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OF WINGS & THINGS

AERONAUTICS INFORMATION STUFF & THINGS FOR STUDENTS & TEACHERS

1990 EDITION

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NASA AEROSPACE EDUCATION SERVICES PROGRAM - OSU CONTRACTOR

OF WINGS & THINGS

NORMAN O. POFF
editor

Of Wings & Things is published by NASA Aerospace Education Services Project, Oklahoma State University, for use by the educational community of the USA, and the price is right.

Aviation is a most interesting field of real-time true life adventures, where problems are solved using multidisciplinary tasks. In real life, one must integrate knowledge and skills from many disciplines to survive and prosper. Aviation involves many science disciplines including life, physical, earth, computer science, and psychology. All areas of mathematics are involved in aviation. English is the international language of civil aviation, and communications is now the name of the game. Aviation encompasses the social sciences like geography and history. In fact all educational disciplines that I can think of are, in some way, tied to aviation.

We often hear that learning is good if it is fun. I contend that learning is often work, but work can be, and is fun if it is interesting. Almost everyone has a natural interest and curiosity about aviation and space. Interest and curiosity equate to motivation. What all this means is a student does not need to be motivated to learn something about aviation, so a teacher can use this inherent interest, on which to hang learning. Aviation interest, as an educational tool, is much more than a "grabber," it is a "hanger." There are studies that show that by using aviation educational goals are enhanced. Whatever, we think learning goals can be facilitated using aviation. Try it you may be pleasantly surprised.

The following protocol was used in putting together *Of Wings & Things*:

01. For borrowed material, the author is credited if known. Please do the same if you copy.
02. Most models and activities use a one page. one concept format.
03. Most models are quickly and easily built. Most do not require glue, so there is no wait-time.
04. All models and activities are designed to reinforce, clarify, or expand on a concept, easily and quickly.
05. Student success is important, all models fly, but.
06. Quality control is demonstrated. The better any model is constructed, the better it flies.
07. Creativity and problem solving are emphasized in that only the most necessary directions and instructions are given. The student is forced to think, and.
08. The instructor can tailor the concepts and instructions to fit the instructional level of the student, so.
09. Material is presented in an easy to read, easy to use, uncluttered format, and.
10. As many goodies as possible are included. Everything you ever wanted to know about aeronautics is included.

IF YOU WANT MORE INFORMATION.
IF YOU NEED HELP UNDERSTANDING WHAT THIS IS ALL ABOUT.
REACH OUT AND TOUCH SOMEONE

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National Aeronautics and Space Administration Educational Services

NASA Education Services Division

Dr. Robert Brown, Director
Mr. Frank Owens, Deputy Director
Elementary & Secondary Programs Branch
Dr. Eddie Anderson, Chief
Mr. Larry Bilbrough

The National Aeronautics and Space Administration offers educators a wide range of educational services including speakers, publications, audiovisual materials, software, advanced educational technology, curriculum assistance, electronic communications, in school satellite programs, student programs, and training opportunities. Additional information and contract addresses follow.

Aerospace Education Services Program

The AESP provides qualified Aerospace Education Specialists for student and teacher programs. These specialists are available for teacher workshops, conferences, curriculum development, interactive laser-disc demonstrations, assembly programs, classroom presentations, civic and professional group programs, and radio and television appearances.

Oklahoma State University is the contractor for AESP, Dr. Kenneth Wiggins is the program director, and Dr. Nelson Ehrlich is the associate director.

Services of specialists in aeronautics and space, curriculum, and minority colleges and universities can be requested by contacting your local center education programs officer or:

Aerospace Education Services Program
CODE XEO, NASA Headquarters
Washington, DC 20546
202-453-2992

Teacher Resource Centers

NASA maintains collections of audiovisual and printed materials for use by educators. These collections located in NASA Teacher Resource Centers in each of the NASA Educations Service Regions are available for examination by educators. Each center features duplicating equipment for copying video tapes, 35 mm slides, and lesson plans. In addition, NASA educational publications and curriculum guides are available. Contact the Teacher Resource Center serving your area for assistance. A listing of TRCs is in this publication.

Spacelink

Space link is an electronic bulletin board to be operated by the Marshall Space Flight Center. It provides NASA news and educational Resources including software that can be accessed by use of a computer and modem. Spacelink can be accessed at 205-895-0028. The data format is 8 - NONE - 1. BAUD rates of 300, 1200, and 2400 can be used. Interested educators should contact:

NASA Marshall Space Flight Center, CA-20
Huntsville, AL 34812
205-544-6527

NASA Educator Mailing List

To receive the NASA Report to Educators and other NASA publications contact your NASA center education programs office for a mailing list card.

Satellite Videoconferences

A series of educational programs is delivered to teachers by satellite each year. The interactive broadcasts cover various aerospace topics of interest to educators. For information on scheduling and topics contact:

Videoconference Coordinator
NASA/ AESP
300 N. Cordell, OSU
Stillwater, OK 74078 405-744-7015

NEWMAST & NEWEST

NASA in association with the National Council of Teachers of Mathematics sponsors annual NASA Educational Workshops for Math and Science Teachers (NEWMAST) for secondary teachers, and NEWEST for elementary teachers at several regional NASA centers. Teachers accepted for these two week workshops receive educational materials, observe current scientific research and development activities, are briefed on aeronautical and space sciences, and interact with scientists and engineers in their research laboratories.

Nominations for teachers to attend NEWMAST or NEWEST must be received early each year. Be sure to send in your nomination as early as possible. Request nominations packets from:

NEWMAST or NEWEST
National Science Teachers Association
Space, Science, and Technology Programs
5110 Roanoke Place Suite 101
College Park, MD 20740

Teacher Workshops

Each summer, several thousand teachers attend aerospace workshops at NASA regional centers or at colleges and universities. AESP specialists and NASA scientists often play a major role in workshop sessions. These workshops provide aeronautical and space science information supplemented with hands on-activities and curriculum resources. College credit is often provided by the sponsoring institution or Oklahoma State University.

Information concerning NASA supported aerospace workshops can be obtained by contacting your NASA regional center educational office.

Space Science Student Involvement Program (SSIP)

The SSIP is an annual competition in two categories for students in grades 6 - 8 and 9 -12 sponsored by the National Science Teachers Association and NASA. The competition fosters student creativity in the following categories: space station, micro-gravity research, wind tunnel research, school newspaper, and a national juried art competition on a Mars settlement concept illustration. Student winners receive various prizes.

Additional information about SSIP is available from:

National Science Teachers Association
1742 Connecticut Ave. NW
Washington, DC 20009
202-328-5800

MATHCOUNTS

MATHCOUNTS is an annual competition for grades 7 and 8 to reward excellence in mathematics. It is a cooperative project of the National Society of Professional Engineers, CNA Insurance Companies, National Council of Teachers of Mathematics, NASA, and the Department of Education.

For additional information on MATHCOUNTS contact:

National Society of Professional Engineers
1420 King Street
Alexandria, VA 22314
703-684-2810

Urban Community Enrichment Program (UCEP)

UCEP is an opportunity for urban school districts to participate in aerospace education activities. NASA aerospace education specialists visit urban district schools for an intensive three day a period to promote awareness of aerospace careers, motivate students, and provide supplemental material and technical assistance for teachers.

To request UCEP for your school district contact:

NASA UCEP Manager Code XEE Headquarters
Washington, DC 20546
202-453-8397

Summer High School Apprentice Research Program (SHARP)

SHARP is designated to attract under-represented minorities and women to aerospace careers. Selected high school students, living within commuting distances from participating NASA centers, become summer apprentices to scientists and engineers. SHARP students carry out assignments under the supervision of a mentor, prepare reports, and participate in a variety of enrichment activities.

To learn more about SHARP contact:

NASA Educational Affairs Division
CODE XEE
NASA Headquarters
Washington, DC 20546
202-453-8397

Lunar Sample Education Project

Representative samples of rock and soil from the moon are available for loan to teachers to use with their students. The samples are encased in a clear plastic disk for use with a stereo microscope. Printed and audiovisual materials accompany the samples to provide a complete package of classroom activities.

To qualify for a lunar sample loan educators must attend a certification workshop. Contact your regional NASA education office for information about future certification workshops.

Science an Engineering Fairs

NASA annually participates in the International Science and Engineering Fair (ISEF) and affiliated science fairs. Winning students and their teachers from the ISEF receive trips to NASA regional centers for tours and enrichment activities. NASA also provides Certificates of Achievement for affiliated science fairs.

For more information about NAS participation in science fairs contact:

NASA Educational Affairs Division
CODE XEE
NASA Headquarters
Washington, DC 20546
202-453-2992

Central Operation of Resources for Educators (CORE)

Core is a centralized mail-order audiovisual library for Educators; no printed materials are available. Submit a written request on your school letterhead for a catalog and order forms. Orders are processed for a fee that includes the cost of the media.

NASA CORE
Lorain County Joint Vocational School
15181 Route 58 South
Oberlin, OH 44074
216-774-1051 ext. 293 or 294

Cooperative Education Program

The Cooperative Education Program gives high school, college, and graduate students an opportunity to work at a NASA field center while completing their education. Each field center negotiates its own cooperative agreements in its geographical area. Contact the Center Personnel Officer , or contact:

Personnel Policy and Work Force Effectiveness Division
Code NPM, NASA Headquarters
Washington, DC 20546
202-453-2603

NASA Graduate Student Researchers Program

This program awards fellowships to graduate students whose research interests are compatible with NASA programs. Approximately 120 new awardees are selected each year based on a competitive evaluation of academic qualifications, the proposed research plan or plan of study, and where appropriate, the planned utilization of NASA Research facilities. For further information contact:

University Programs Branch
Educational Affairs Division
Code XEU
NASA Headquarters
Washington, DC 20546

NASA Space Grant College and Fellowship Program

As the result of a congressional mandate in 1987, NASA has named schools or consortia as Designated Space Grant Colleges/Consortia. These colleges/consortia receive grants and fellowships based on their existing aerospace activities and the quality of their plans to strengthen the national educational base for science, mathematics, and technology.

The National Space Grant College and Fellowship program comprises three elements: (1) designation of Space Grant Colleges/Consortia that provide a national network of universities and colleges; (2) awards to support space grant programs at other institutions that have not been extensively involved in aeronautics and space research education; and (3) space grant fellowships made available to students selected in the first two elements.

A list of Space Grant Colleges and Consortia can be obtained from the University Programs Branch, NASA Headquarters.

NASA University Affairs Officer (UAO)

Each NASA field center employs a University Affairs Officer (UAO) who conducts a variety of programs for university students and faculty. The UAO serves as a focal point for information to the university community about research, grant and fellowship opportunities, and other university related activity at the center. For further information contact the UAO at your area center.

NASA Education Technology Office

NASA's Educational Technology Branch produces four nationally televised interactive video-conferences each year fro the campus at Oklahoma State University using the WESTAR IV satellite. The Educational Technology Branch also publishes *Software for Aerospace Education*, a bibliography of software available to teachers. For more information contact:

Mr. William D. Nixon, Head
Education Technology Office
Code XET
NASA Headquarters
Washington, DC 20546

NASA CENTER EDUCATION PROGRAMS OFFICERS

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Kennedy Space Center, FL 32899
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601-688-1957

Mr. Phillipp Neuhauser, Manager
Public Education Services
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91103
818-354-8592

NASA TEACHER RESOURCE CENTERS

If you live in	Contact	
AK, AZ CA, HI ID, MT NV, OR UT, WA WY	NASA Ames Research Center Attn: Teacher Resource Center Mail Stop: 204-7 Moffett Field, CA 94035 415-694-6077	
FL GA PR VI	NASA Kennedy Space Center Attn: Educators Resource Library Mail Stop: ERL Kennedy Space Center, FL 32899 407-867-4090	
KY NC SC VA WV	NASA Langley Research Center Attn: Teacher Resource Center Mail Stop 146 Hampton, VA 23665-5225 804-864-3293	University of North Carolina at Charlotte Attn: NASA Teacher Resource Center J. Murrary Atkins Library Charlotte, NC 28223 704-547-2559
	Murray State University Attn: NASA Teacher Resource Center Waterfield Library Murray, KY 42071 502-762-4420	
AL AR IA LA MO TN	Alabama Space and Rocket Center Attn: NASA Teacher Resource Room Huntsville, AL 35807 205-544-5812	Bossier Parish Community College Attn: NASA Teacher Resource Room 2719 Airline Drive Bossier City, LA 71111 318-746-7754
MS	NASA Stennis Space Center Attn: Teacher Resource Center Building 1200 Stennis Space Center, MS 39529 601-688-3338	
CO KS NE, OK NM, SD ND, TX	NASA Johnson Space Center Attn: Teacher Resource Room Mail Stop: AP-4 Houston, TX 77058 713-483-8696	U.S. Space Foundation Attn: NASA Teacher Resource Center 1525 Vapor Trail Colorado Springs, CO 80916 303-550-1000
	Oklahoma State University Attn: NASA Teacher Resource Ctr. 300 North Cordell Stillwater, OK 74078-0422 405-744-7015	Kansas Cosmosphere & Space Center Attn: NASA Teacher Resource Center 1100 North Plum Hutchinson, KS 67501 316-662-2305
	Education Service Center Attn: NASA Teacher Resource Center, Region XVI 1601 South Cleveland St. Amarillo, TX 79102 806-376-5521	

CT
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PA
RI
VT

NASA Goddard Space Flight Center
Attn: Teacher Resource Laboratory
Mail Stop: 130-3
Greenbelt, MD 20771
303-286-8570

NASA Industrial Applications Center
Attn: Christa McAuliffe Teacher Res. Inst.
23 William Pitt Union
University of Pittsburg
Pittsburg, PA 15260
412-648-7008

The City College
Attn: NASA Teacher Resource Center
NAC Bldg. Room 5/224
New York, NY 10031
202-690-6693

Champlain College
Attn: NASA Teacher Resource Center
174 S. Willard Street
P. O. Box 670
Burlington, VT 05402-0670
802-658-0800 ext. 433

IL
IN
MI
MN
OH
WI

NASA Lewis research Center
Attn: Teacher Resource Center
Mail Stop: 8-1
Cleveland, OH 44135
216-433-2016 or 2017

Oakland University
Attn: NASA Teacher Resource Center
O 'Dowd Hall, Room 216
Rochester, MI 48309-4401
313-370-2485

Museum of Science & Industry
Attn: NASA Teacher Resource Center
57th Street and Lakeshore Drive
Chicago, IL 60637-2093
312-684-1414 ext 429

Mankato State University
Attn: NASA Teacher Resource Center
Dept. of Curriculum and Instruction
MSU Box 52/P. O. Box 8400
Mankato, MN 56002-8400
507-389-5710 or 1516

University of Evansville
Attn: NASA Teacher Resource Center
School of Education
1800 Lincoln Avenue
Evansville, IN 47714
812-479-2393

Center for Information Media
Attn: NASA Teacher Resource Center
St. Cloud State University
St. Cloud , MN 56301
612-255-2062

Northern Michigan University
Attn: NASA Teacher Resource Center
Olson Library Media Center
Marquette, MI 49855
906-227-2270

Discovery World Museum
Attn: NASA Teacher Resource Center
818 West Wisconsin Avenue
Milwaukee, WI 53233
414-765-9966

The Children's Museum
Attn: NASA Teacher Resource Center
P. O. Box 3000
Indianpolis, IN 46206
317-921-4001

University of Wisconsin at LaCrosse
Attn: NASA Teacher Resource Center
Morris Hall, Room 200
LaCrosse, WI 54601
608-785-8148

Central Michigan University
Attn: NASA Teacher Resource Center
Ronan Hall, Room 101
Mount Pleasant, WI 48859
517-774-4387

Parks College of St. Louis University
Attn: NASA Teacher Resource Center
Rt. 157 and Falling Springs Road
Cahokia, IL 62206
618-337-7500

Jet Propulsion Laboratory
Attn: Teacher Resource Center
JPL Educational Outreach
Mail Stop CS-530
Pasadena, CA 91109
818-354-6916

Office of Education, ERC
National Air and Space Museum
Room P-700
Washington, DC 20560

What's New in NASA Aeronautics

NEW CONCEPTS

NASA has a proud heritage of achieving significant advances in aeronautics research and technology. In a continuing pursuit of excellence, NASA's current aeronautics research covers all of the major aeronautics disciplines and vehicle classes:

- Aerodynamics
- Propulsion
- Human Factors
- Materials and Structures
- Controls and Guidance
- Flight Systems
- Transports
- Rotorcraft
- Hypersonic
- General Aviation
- Supersonic
- High-Performance Military Aircraft

Accomplishments from these efforts result in major improvements in flight safety and efficiency that can be seen in new vehicle concepts and new research and design tools.

The success of NASA's aeronautics program is exemplified by the Collier Trophy, which was awarded to a NASA/Industry Team in recognition of the Advanced Turboprop Program. The Award cited the conception, development, and flight verification of high-speed turboprop propulsion technology applicable to several new fuel-efficient aircraft propulsion system concepts.

The NASA aeronautics program is conducted at the three NASA Research Centers-Ames, Moffett Field, CA; Langley, Hampton, VA; and Lewis, Cleveland, OH-and supported by the Ames/Dryden Flight Research Facility, other NASA installations, universities, industry, and other Government agencies, nationwide.

FLIGHT EFFICIENCY

Aerodynamics. NASA is continuing to develop the technology to increase the lift and reduce drag in wings, shaping them to meet the needs of new generations of aircraft.

Four concepts are significant:

- Natural laminar flow--where the shape is designed to maintain a laminar boundary layer for subsonic general aviation and transport aircraft.
- Laminar flow control--where suction through tiny slots or perforations in the wing surface maintains low-drag laminar boundary layer flow over larger wings, especially those of transports.
- Hybrid laminar flow control--combining active and passive laminar boundary layer control techniques.
- Advanced design concepts for induced drag reduction and turbulent drag reduction--where laminar flow control is not effective.

Materials and Structures. NASA is developing composite materials that can reduce the structural weight of a conventional wing or fuselage by 30 percent. New aircraft will have optimized structures with high strength, fiber-reinforced composites, advanced aluminum alloys, titanium, and superalloys. Advanced materials and structures also apply to selected engine parts for cost and/or weight reduction.

In response to concerns about the aging commercial transports, NASA is focusing research on non-destructive inspection and evaluation methods, fatigue and fracture analysis, and structural integrity prediction methods. NASA has already gained experience in these areas as part of a program on inspection of bondliness in solid rocket boosters for the Space Shuttle and fatigue cracks in metal structures. The goal of the NASA research is to support the FAA in developing, demonstrating, and

transferring to industry new methods for determining required inspection intervals. increasing reliability, and enhancing safety or aging aircraft.

Propulsion. Turbine engine research over the past 20 years has cut fuel consumption in half while increasing performance. Advances turboprop research has resulted in a 30 percent fuel savings while maintaining the performance and cabin environment of modern turbofan aircraft. Turboprop propulsion system technology is being conducted in a NASA/industry/university program covering the necessary aerodynamic, structural, mechanical, and acoustics technologies. The potential performance improvements of the advanced systems are being verified in extensive wind tunnel and flight test investigations.

Research in internal fluid mechanics is providing the analytical tools to describe the complex flows within engine components such as compressors, combustors and turbines. In parallel experimental efforts, NASA has completed the fabrication of a large, low speed centrifugal compressor facility. This facility is being used to develop a fundamental understanding of the complex fields of centrifugal turbomachinery.

Flight Systems. Increased passenger traffic and congestions are growing concerns.

Flight management and human factors research is exploiting advances in electronic and automation technology to develop improved concepts for cockpit systems that will provide safer and more efficient operations within the evolving National Airspace System. Advanced concepts applied to airborne flight management, controls, displays, and crew stations interfaces will provide aircraft system designs able to achieve time and fuel savings by following planned flight paths more accurately and improving interactions with the FAA air traffic control system. Human factors research directed toward developing optimum human-centered interfaces and displays will provide increased margins of safety while capitalizing on the potential value of computer-based and automated system technology.

FLIGHT SAFETY

Improving flight safety is a continuing program emphasis. These efforts are aimed at improving the safety of flight in severe weather and congested traffic areas, and eliminating accidents due to human error or equipment failures. Severe weather research includes rain effects, icing, lightning, and wind shear.

Low altitude wind shear has proven to be a great hazard to all aircraft during take-off and landing. NASA research has provided methods for identifying wind shear conditions and characterizing its potential, and through flight simulation, demonstrating improved pilot techniques for recovering from actual wind shear encounters.

NASA research on rain is determining the effects of heavy rain on airfoil drag and lift. To help establish accurate large-scale data for transport category aircraft, NASA has built a rain simulation system to accommodate a 13-foot span by 10-foot chord wind section. Rain rates up to 40-in./hr can be achieved as the wind section travels through the simulated rain at speeds of about 170 kts. Results of this research will further improve piloting recovery techniques during wind shear encounters in the presence of heavy rain.

NASA icing research in aimed at understanding the process of ice formation, its effect on aircraft, ways to prevent its forming and better ways to de-ice the aircraft when required. Evaluation of advanced ice protection concepts continues with the investigation of the electro-expulsive deicer system. Electric pulses are transmitted through wires parting mechanical motion to the surface and ejecting ice build up.

Forward Swept Wing. The DARPA/NASA X-29A research plane has successfully demonstrated an integrated set of advanced technologies. Its unusual shape is made possible, in part, by use of improved materials and computerized digital flight control systems. By validating these and other high-risk technologies in flight testing at Ames-Dryden, the X-29A has provided a technology base for

the design of future generations of high-performance aircraft with increased performance, longer range, and improved maneuverability.

Tiltrotor. At takeoff and landing the tiltrotor is like a helicopter with the rotors tilted up for vertical lift. At cruise the rotors are tilted forward enabling the tiltrotor to fly like a conventional aircraft at nearly twice the speed of a helicopter. The technology for a viable tiltrotor, such as the Navy's new V-22 Osprey, is based on over 20 years of NASA and Army research on the tiltrotor concept for high-speed flight. This research included proof-of-concept flight testing with the XV-15 Tiltrotor Research Aircraft. The opportunity for large-scale inter-city and inter-regional transportation using civil tiltrotor transports has led to a cooperative agreement between NASA, FAA, and DoD to study and quantify the civil technology benefits that can be derived from the V-22 tiltrotor program.

STOVL. NASA continues to conduct research on advanced Short Takeoff and Vertical Landing (STOVL) aircraft. One concept, an E-7 transonic aircraft, utilizes an ejector thrust augmentation system for low speed STOVL operations.

NEW TOOLS

Experimental. One element of NASA's high-performance aircraft research program is utilizing a modified F-18 aircraft to investigate the capability to achieve stable and controllable flight at angles-of attack approaching 90 degrees. This operation of high performance aircraft at extreme angles to the oncoming airflow is referred to a "high-alpha" flight.

The F-18 High-Alpha Research Vehicle, or HARV, is extensively instrumented to obtain research data in support of coordinated analytical, wind tunnel, simulator, and flight research investigations.

A unique flow visualization system for the F-18 HARV has been developed to allow direct observation of the complex aerodynamic flow environment throughout a wide rnage of flight conditions. This system includes a specially developed smoke generator, oil flow techniques, and onboard photographic and video system.

Through the use of smoke and oil flow techniques, the vortices generated on the forebody of the F-18 at high angles-of attack were documented in flight. This data is being used to correlate with previously obtained wind tunnel results and to validate advanced analytical prediction methods.

Theoretical. The Numerical Aerodynamic Simulation (NAS) program at Ames Research Center provides the most powerful computational system in the world for aeronautical research and development. The NASA facility currently houses a Cray Y-MP supercomputer and a Cray-2 supercomputer which are operating in the pathfinder and production modes, respectively. The Cray Y-MP supercomputer has eight processors, 32 million words of main memory, 256 million words of secondary memory and a sustained operating speed in excess of 1 billion floating point operations per second. The NAS system features high-speed processing networks with mass storage systems, support processors, work stations, graphics capabilities, and long range satellite and landline communication links between research centers, universities, and industry. The NAS processing system is supporting pioneering calculations in aerodynamics, structures, chemistry, and controls. Examples include hypersonics, aerodynamics and propulsion simulations for the National Aerospace Plane and the space shuttle, as well as calculations probing into the fundamental physics of flow transition and turbulence.

Computational fluid dynamics is emerging as a powerful tool for improved understanding of flow physics. It simulates conditions and flow phenomena that are difficult to measure physically. The NAS can be used to calculate real flow over complete aircraft as well as through complex internal passages of turbine engines. An example is shown below of the launch configuration of the Space Shuttle. It illustrates the flow over the orbiter, solid rocket boosters, and external tank. The modeling of the shuttle ascent configuration includes the simulation of the exhaust plume and the relative motion of the orbiter when the external tank is released.

AERONAUTICS GOALS

The Aeronautics Policy Review Committee of the White House Office of Science and Technology Policy (OSTP), in their reports "National Aeronautic R & D Goals" and "Agenda for Achievement," set national priorities and a course a maintain US preeminence in aeronautics. The following goals hold many technological challenges in the hypersonic, supersonic cruise and subsonic speed regimes.

1. **Subsonics Goal:** To build "trans-century" renewal--by advancing the technology for an entirely new generation of fuel-efficient U.S. aircraft operating in a modernized National Airspace System;

2. **Supersonic Goal:** To attain long distance efficiency--and enable the development of civil and military aircraft featuring sustained supersonic cruise capabilities; and

3. **Hypersonic/Transatmospherics Goal:** To secure future options--and exploit the convergence of aeronautics and space technology in developing the capability to routinely cruise and maneuver into and out of the atmosphere, with take-ff and landing from conventional runways.

NASA's Aeronautics Research and Technology Program has been carefully planned to respond effectively to these challenges within the context of the OSTP goals and agenda.

NASA Memorabilia

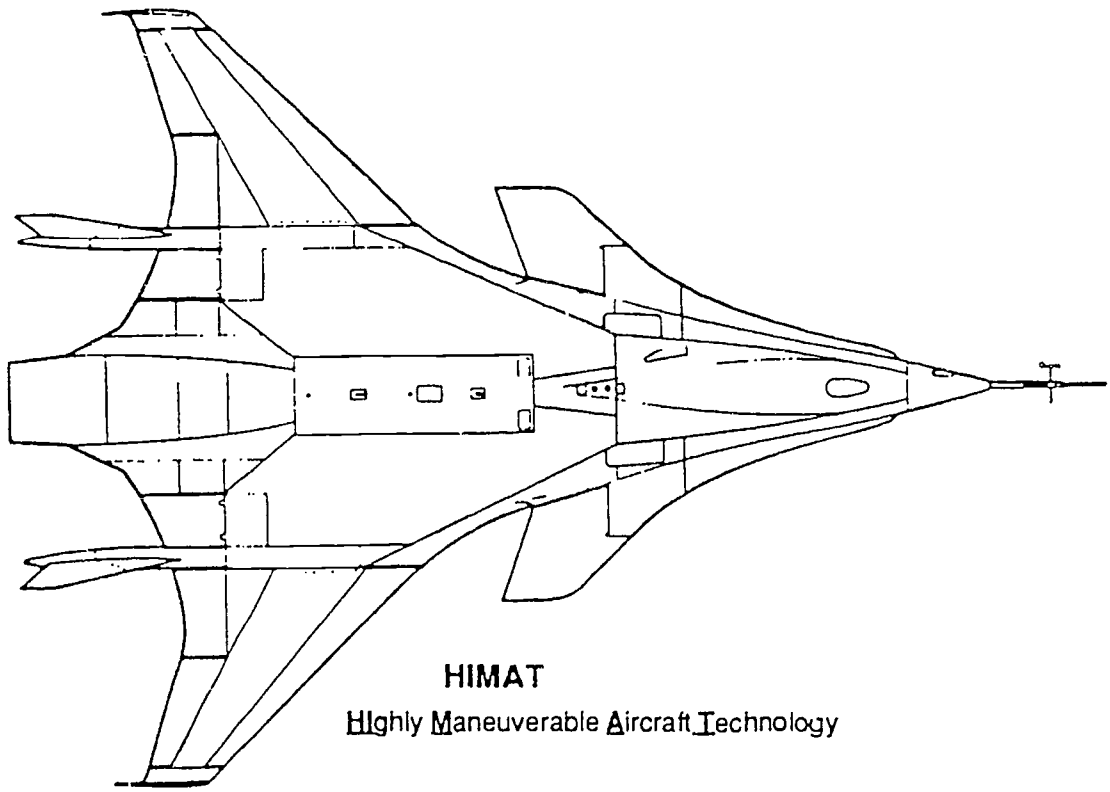
Often people ask where they can get NASA "stuff" and there is one supplier that has many products at reasonable prices. I suggest you call or write for a catalog.

NASA - Ames Dryden
Exchange Council Gift Shop
Bldg. 4825
P. O. Box 86
Edwards, CA 93523-0086
805-258-5360

They have:

- Models/Toys
- Tie Tacs/Lapel Pins
- Miscellaneous/Decals/Cachets
- Charms/Necklaces/Bracelets
- Commemorative/Sugar/Pewter/Spoons
- Mugs
- T-Shirts/Sweat Shirts/Hats
- Patches
- NASA Logo Office Supplies
- Photographs/Posters
- Books
- Belt Buckles

The Gift Shop is open from 8:45-3:45 Pacific Monday thru Friday.



HIMAT

Highly Maneuverable Aircraft Technology

33 Greatest Lies in Aviation

Source unknown
(often seen on T-shirts and posters)

Me? I've never busted minimums.
We will be on time, maybe even early.
Pardon me ma'am, I seem to have lost my jet keys.
I have no interest in flying for the airlines.
I fixed it right the first time, it must have failed for other reasons.
All that turbulence spoiled my landing.
I'm a member of the mile high club.
I only need glasses for reading.
I broke out right at minimums.
The weather is gonna be all right, it's clearing to VFR.
Don't worry about the weight and balance--it'll fly.
If we get a little lower I think we'll see the lights.
I'm 22, got 6000 hours, 3000 in Lears, and a 4 year degree.
We shipped the part yesterday.
I'd love to have a woman co-pilot.
All you have to do is follow the book.
This plane out-performs the book by 20%.
We in aviation are overpaid, underworked, and well respected.
Oh sure, no problem, I've got over 2000 hours in that aircraft.
I have 5000 hours total time, 3200 are actual instrument.
No need to look that up, I've got it all memorized.
Sure I can fly it--it has wings, doesn't it?
We'll be home by lunchtime.
Your plan will be ready by 2 o'clock.
We fly every day--we don't need recurrent training.
It just came out of annual--how could anything be wrong?
I though YOU took care of that.
I've got the field in sight.
I've got the traffic in sight.
Of course I know where we are.
I KNOW the gear was down.
I'm from the FAA and I'm here to help you.
I'm always glad to see the FAA.

CAREERS IN AEROSPACE TECHNOLOGY

Has it happened to you? Have you started thinking about the year 2000? If you are a student now, you will be spending most of your life in the 21st century, and the future may offer many unpredictable opportunities.

It will be a time of space stations, robotic probes, moon outposts, and manned missions to the surface of Mars. All this, and more scientific accomplishments that have not even been dreamed of, will happen because Americans want to live and work in space.

Where Will You Be In 10 Years?

To be ready for the 21st century, the world will need aerospace scientists, engineers, technologists, and technicians.

What Could An Aerospace Technology Career Mean for You?

Aerospace workers are professionals who work independently or as part of a team. They conduct research, and design and develop vehicles and systems for atmospheric and space environments. Individuals who are successful in aerospace careers have the proper education background, possess good communication skills, and are committed to being part of a team.

A wide variety of aerospace career fields offers opportunities for high job satisfaction and excellent compensation. Starting salaries for technicians currently exceed $18,000. Depending upon education and experience, starting salaries for aerospace scientists and engineers range from $24,000 to $34,000. (Salary estimates are based on 1987 statistics.)

What Education Will You Need Beyond High School?

A career in aerospace as a scientist or engineer requires four to seven years of college study following high school. A bachelor's degree requiring four years of study is the minimum necessary to enter this field. Colleges and universities also offer graduate programs where students can obtain master's and doctoral degrees. The master's program usually takes two years. An additional two to four years is needed to earn a doctorate.

A starting position as an engineer, mathematician, physical scientists or life scientist requires a bachelor's degree. (A master's and/or doctoral degree is highly desirable in life sciences.) Some examples of engineering degrees required for aerospace technology are: electrical/electronics, aerospace, and mechanical. Other types of bachelor's degrees that may lead to aerospace careers are: physics, chemistry, geology, meteorology, mathematics, experimental psychology and biology.

Engineering technicians typically earn a two-year Associate of Science degree. Some may continue for two additional years and obtain a bachelor's degree in engineering technology. Others may earn a bachelor's degree in engineering or one of the physical sciences. A few complete a five-year apprenticeship program offered at some NASA field centers.

How Do You Know If You Want An Aerospace Career?

If you think you would be interested in a career in aerospace technology, check your potential for success by answering these questions:

- Do you enjoy math and science?
- Are you interested in knowing what makes things work?
- Do you enjoy learning?
- Do you like to build things?
- Do you achieve good grades?
- Do you have an inquisitive and searching mind?
- Do you like to solve problems and puzzles?
- Do you like to create things?
- Do you enjoy working with computers?
- Are you prepared to study hard and do homework ?

If you answered yes to most of the questions, you may want to consider an aerospace career.

What Should You Do To Prepare For An Aerospace Career Now?
Education is a critical requirement. What are your favorite subjects? Mathematics and science are the basis for an aerospace technology career. Decisions you make in school can affect your career possibilities. Some of the recommended high school courses are listed below:

- Algebra
- Trigonometry
- Calculus
- Biology
- Physics
- Word processing
- Geometry
- Math Analysis
- Computer Mathematics
- Chemistry
- English
- Speech

How Can You Find Out More About Aerospace Jobs?
Contact people working in the aerospace field such as scientists, engineers, and technicians. Your teacher or guidance counselor should be able to arrange this for you or your class. Visit your school and public libraries to get names of professional organizations you can contact for more information. Contact the NASA personnel office closet to you if you would like additional information.

Some Kinds of Aerospace Careers

Pilots or Crewmembers of a spacecraft
- Pilot Astronaut
- Mission Specialist
- Payload Specialist

Physical Scientists
- Astronomer
- Chemist
- Geologist
- Meteorologist
- Physicist
- Oceanographer

Life Scientists
- Biologist
- Medical Doctor
- Physiologist
- Nutritionist

Social Scientists
- Economist
- Sociologist

Technicians
- Electrical/Electronics
- Engineering
- Aerospace Modeler
- Aircraft
- Avionics
- Fabrication
- Materials
- Pattern Maker and Molder

Other Fields
- Quality Control Inspector
- Ground Radio Operator
- Teletypist

Mathematicians
- Computer Scientist
- Mathematician
- Systems Analyst
- Statistician

Engineers
- Aerospace/Astronautics
- Chemical
- Civil
- Biomedical
- Computer
- Electrical
- Industrial
- Environmental
- Materials
- Mechanical
- Nuclear
- Petroleum
- Plastics
- Safety
- Systems

Engineering Designers
- Architectural
- Electrical
- Mechanical

Technical Communicators
- Writer
- Artist
- Editor
- Education Specialist
- Public Relations
- Audiovisual Specialist
- Photographer

What Are Engineers?
Engineers are people who make things work. The work and ideas of engineers make achievements possible. They put power and materials to work. Engineers have moved America into skyscrapers, high speed cars, jets, and space vehicles. They make life interesting, comfortable, and fun. Computers, television, and satellites--products of the communication industry--depend on engineers. Engineers will design safe and comfortable space stations for the 21st century.

What Are Technicians?
Technicians are an important part of the aerospace team. They work closely with scientist and engineers in support of their research. Their skills are used to operate wind tunnels, work in laboratories, construct test equipment, build models and support many types of research.

What Are Scientists?
Scientists are knowledge seekers, always searching out why things happen. They are inquisitive. This means they are always questioning. They possess a sense of wonder. Nature, Earth, and all the universe are what fascinate the scientist. The scientist questions, seeks answers, and expands knowledge.

NASA CAREER INFORMATION

Astronaut jobs are very scarce, but other equally important and rewarding positions are available in NASA's aeronautics and space research programs--and they all call for good education or strong experience, or both. Individuals considering a career with NASA , should ascertain what level of education is required for their chosen career and attain that education.

Many jobs in the aerospace industry are common to those in other businesses--personnel specialists, accountants, labor relations specialists, secretaries, and the like--while others are unique. NASA refers to its jobs in the engineering and scientific fields as "aerospace technology" positions.

Aerospace technology positions cross traditional academic disciplines because NASA work is not channeled in the usual manner. The job may require a combination of talents--mechanical and electronic engineering, for example. Because of the uniqueness of the work being done, new occupations and related terminology have been created. A majority of the occupations are in the engineering field.

Some major types of engineering positions are in the areas of applied Physics and Chemistry, Fluid and Flight Mechanics, Materials and Structures, Propulsion Systems, Flight Systems, Measurement and Instrumentation Systems, Data Systems, and Experimental Facilities and Equipment. A lesser number of positions include Space and Earth Sciences, (including such specializations as aerodynamics, structures, metalurgy, meteorology, ionospherics, lunar and planetary studies, radiation fields and particles, and meteoroid studies); and Life Sciences and Systems, the study of living processes, i.e., psychological and physiological studies, microbiology, hematology, neurobiology, botany, exobiology, biochemistry, radiobiology, and interactions between man and machine systems.

All of the engineering and scientific positions under the broad term "aerospace technology" require certain educational achievements. That is, in order to qualify, one should hold a bachelor's degree for disciplines of engineering, mathematics, and the physical and biological sciences. In the Life Sciences, a master's degree and/or doctorate degree is highly desirable. Administrative positions in areas such as personnel, financial and budget management, public information, procurement and contracts are often filled through the Professional Administrative Career Examination (PACE).

Most schools have a career guidance counseling program designed to help the student select a career and formulate the educational schedule needed to reach the goal. Students are also encouraged to contact their choice af accredited universities to determine if they offer instruction in the Aerospace field.

Jobs with NASA are covered under the rules of the Office of Personnel Management. Information on Civil Service jobs, including how to apply, is available at most post offices and at Federal Job Information Center offices in most major cities.

I WANT TO BE A PILOT !!

The following is from the newsletter
formerly published by the
Virginia Aeronautics Commission

A FIFTH GRADE STUDENT FROM WILLIAMSBURG, VIRGINIA CONCLUDED:

When I grow up I want to be a pilot because it is a fun job and easy to do. That's why there are so many pilots flying around.

Pilots don't need much school. They just have to be able to read numbers so they can read their instruments. I guess they should be able to read road maps too so they can find their way if they get lost.

Pilots should be brave so they won't get scared if it's foggy and they can't see or if a wing falls off. They should always stay calm so they will know what to do.

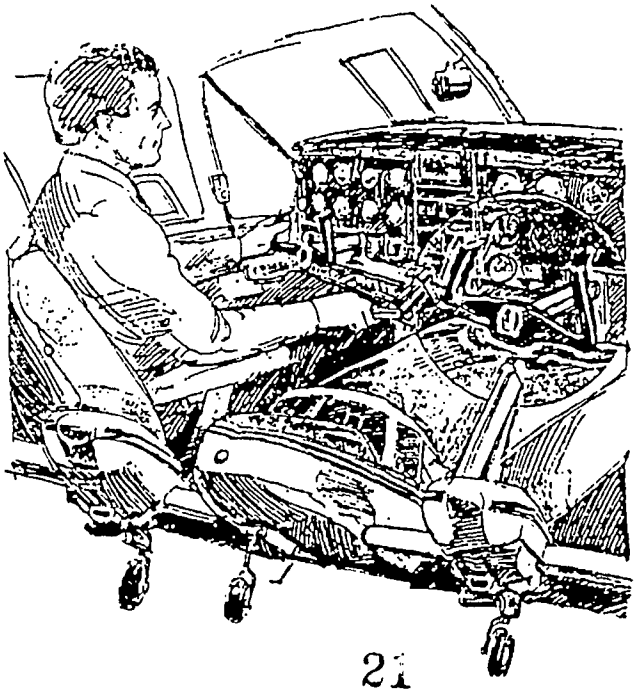
Pilots have to have good eyes to see through the clouds and they can't be afraid of thunder and lightning because they are so much closed to them than we are.

The salary pilots make is another thing I like. They make more money than they know what to do with. this is because most people think plane flying is dangerous, except pilots don't because they know how easy it is.

Hope I don't get airsick because I get car sick and if I get air sick I couldn't be a pilot and then I would have to go to work.

(The same or a very similar rendition of the above has been seen posted to bulletin boards at FBOs* in South Carolina and Kentucky. A fifth grade student had the wisdom to come up with this??? No way.)

FBO - Fixed Base Operation. This is a term from the barnstorming era of the1920s. When the barnstorming pilots became tired of traveling and settled at one spot, it was called a fixed base. The term continues today. So where you learn to fly, or get fuel, or maybe have your aircraft repaired at an airport is a FBO.



Learn to Fly

from the General Aviation Manufacturers Association
brochure of the same name

What Learning to Fly Can Do for Me

Learning to fly a general aviation airplane opens the door to a wide variety of career opportunities. Most obvious is becoming a professional pilot for one of the many commercial flying services - major airline, regional airline, air charter, corporate, overnight mail, small package, and cargo. Pilots are needed for the many special missions of general aviation - emergency medical evacuation, agricultural work, law enforcement, news gathering, aerial surveying, photography, and a multitude of industrial purposes. Flying may also compliment your career path in business or sales or a profession that you haven't even chosen yet.

There are many careers in the aviation industry in which the skill and knowledge you gain as a pilot are a special asset, even though daily flying is not a part of your job. These careers include air traffic control, computer science, electronics, and aviation safety; air carrier, airport, and general aviation operations management; flight navigation, communications, and maintenance; and engineering, law, medicine, finance, and insurance. The possibilities are as limitless as your imagination because general aviation touches many facets of our lives. As a pilot, you speak the language of aviation.

General aviation is a unique industry, combining the romance and enthusiasm of our heritage with the high-tech equipment and modern proficiency skills of today. It is a superb tool of business and a personal time machine. It is a partner in our nation's productivity. Learning to fly can lead to your discovery of rewarding career opportunities.

FLYING IS FUN!

When a plane passes over, do you wish you could be flying high above the ground, soaring like a bird? You can be. You can know the freedom that pilots experience as they travel the limitless sky, near the stars, clouds, and winds that encircle the earth.

If you think that piloting a plane is only for those who joined the military or became commercial airline pilots, think again. You can be a part of general aviation.

The term general aviation refers to all aviation activity that is not military or commercial. Each year more than 100,000 people in the united States take flying lessons to learn to fly general aviation aircraft. When asked why they want to learn to fly, most say, "because flying is fun."

Some of the people who learn to fly are salespeople who want to expand their business territories or doctors who need to reach patients in remote areas. Others fly for recreation, like going on vacation. Some people who learn to fly are teenagers getting a head start on a piloting career.

And not only is flying fun, but it's also efficient. Many trips that normally take a whole day by car can be made in half the time, or less, in an airplane.

Piloting your own plane also increases the number of destinations you can reach directly by air. In the United Stated, about 800 airports serve commercial airlines, but more than 5,300 airports are open to general aviation pilots.

If you think you'd enjoy flying and wonder if it's more than an impossible dream, then read on. This "Learn to Fly" brochure will tell you all the general aviation flying basics. It answers the questions most frequently asked of flight school instructors the world over. You'll learn about the physical and written examination requirements, the training costs, and the time it takes for flying lessons.

QUESTIONS AND ANSWERS ABOUT FLYING

Q. *How do I know that I can learn to fly?*

A. Somewhere there is someone just like you who recently became a pilot. Although the average student pilot is 32 years old, anyone 16 years old or older can learn to fly an airplane (14 if you fly gliders). People from every occupation and every geographic location in the nation are pilots.

Q. *What are the requirements?*

A. There are three basic requirements for learning to fly powered airplanes in the United States. First, you have to be at least 16 years old. Second, you have to be in good health. And third, you have to be able to read, speak, and understand English.

You can apply for a student pilot certificate if you are at least 16 years old. When you're 17, you can apply for a private pilot certificate. There is no maximum age limit because it's health and not age that determines a person's ability to fly well.

The Federal Aviation Administration (FAA) requires everyone who wants to become a pilot or continue to be a pilot to pass a routine medical exam every two years. This requirement ensures that pilots do not have medical problems that could interfere with their ability to fly safely. Allowances are made for many physical limitations. For example, glasses and contact lenses are perfectly acceptable. The physical exam can be obtained anytime from one of many FAA-designated physicians. If you're planning to learn to fly, it's advisable to complete the physical exam early in your flight training to assure that you qualify.

Q. *How difficult is it?*

A. As with any other skill you master, flying is learned step by step by step. It's a fascinating experience. But it's not particularly difficult. It can be learned by practically anyone who is willing to invest some time and effort.

Pilot training has two aspects: ground training and flight training. Ground training takes place on the ground. It covers flight rules and regulations, flight planning, navigation, radio procedures, and weather. In the next phase, flight training, you learn to fly to actually controlling the airplane yourself. Under the supervision of a certificated flight instructor, you learn how to take off, land, and fly cross-country (from you home airport to another airport and then back again).

Millions of people have learned to fly. By the time you're ready for your private pilot certificate, you'll be secure in the knowledge that you're a safe and competent pilot.

Q. *Do I need special skills to fly?*

A. No. Perhaps the most important element in successfully learning to fly is desire. Once you're ready to invest your time and effort in learning to fly, then it's time to take the first steps.

Q. *Where is the best place to learn to fly?*

A. There are several types of flight-training schools across the country. Choosing the right one for your depends on your specific needs and reasons for learning to fly. Most flight training programs use a mixture of audiovisual, textbooks, and workbooks designed for ground training. You may receive your ground training instruction from your certificated flight instructor (CFI) individually or as part of a ground training class. Certificated flight instructors have been specially trained and examined by the federal government to ensure that all of your training is the safest and most effective possible.

The flight training itself is conducted with your personal certificated flight instructor. You'll probably learn to fly in an airplane that was developed for student pilots. Such planes are designed to provide the best possible flight training environment.

Many people learn to fly through a local Fixed-Base Operator (FBO) or through a local flying club that offers flight training. FBOs are general aviation air terminals--they work like gas stations for small aircraft. A flying club is a group of individuals who own aircraft and rent them to members. They usually offer flight instruction and other flying-related activities to their members. FBOs and flying clubs offering flight training are listed in the yellow pages of the telephone directory under aircraft schools.

Each year more vocational and technical schools, colleges, and universities are offering aviation programs that include flight training. If you're seeking a career in aviation, you may want to consider learning to fly at one of these schools.

Q. *What is the first step?*

A. Deciding to learn to fly is obviously the first step and often the most difficult one. Before you make the big decision to take flying lessons, you may want to experience flying in a small plane. Once you've viewed your community from the perspective of a general aviation aircraft and felt the sensation of flight, you'll know whether piloting is for you.

To arrange for a flight in a small plane, contact the FBO at your local airport. FBOs service local and transient aircraft. They often provide flight training, sell and rent aircraft, and provide charter services and aircraft maintenance. Many of them offer introductory flights or sight-seeing flights at reasonable rates.

Q. *How long will it take?*

A. Most people receive their private pilot certificate after about 55 hours of flight time, including time spent with an instructor about (dual time) and time spent flying alone (solo time). Training will include some night flying, some instrument flying (flying solely by reference to the airplane's instruments), and some cross-country flying. The minimum time required by federal regulations is 35 to 40 hours of flight time, depending on the type of school you attend.

You can fly in the early morning, during the day, or on weekends. Scheduling your flying is up to you and your instructor.

How long it takes to accumulate flight time is largely up to you and your instructor. Usually two to three hours flying time per week is a good learning rate, with more hours during weeks when cross-country flights are made. Statistics indicate that the average student pilot completes the requirements for a private pilot certificate in four to six months. Depending on the schedule and number of hours spent flying, some people will complete it sooner and other will take longer.

Q. *What will my first flight be like?*

A. Your instructor will introduce you to the general aviation airplane you'll learn to fly. You'll be briefed on the instruments, controls, and equipment in the plane and on what to watch for when your flying.

After this preflight briefing, the two of you will take off. When aloft, and under close supervision of your instructor, you'll take control of the airplane. It will be unlike anything you've experienced before. Soon you'll feel the exhilaration--impatient for the next flight.

Q. *What kind of tests will I take?*

A. No test is required for a student pilot certificate. But before a private license is issued, you must pass two tests. One is a written FAA examination--largely a practical exam on flying rules and

regulations. You'll also have to work out the details of a hypothetical flight for this exam. But don't worry; you'll have done it all before in planning the cross-country flights you made as part of your training program.

Following this exam is a practical examination of your flying ability. Here you take a designated FAA examiner for a checkride to demonstrate your ability to maneuver the airplane safely and confidently. You'll have practiced the maneuvers many times before, and your flight instructor will have prepared you thoroughly.

Q. *How much does it cost?*

A. Flight training costs vary. Fuel prices, maintenance, and insurance costs are but a few of the variables. You can expect to pay between $2,500 and $4,000 for a good private-pilot flight-training program. Many schools offer finance packages that allow low monthly payments spread over several years.

Compared to the costs of training in other business skills, becoming a licensed private pilot is a good value. Prorated over a lifetime, it's probably one of the best bargains you'll ever find. The cost of becoming a pilot is a solid investment in your future.

Q. *Is flying safe?*

A. General aviation airplanes are built to rigid federal specifications, and they are constantly checked and rechecked to make sure they are mechanically and structurally safe. People who fly are safety conscious. As the pilot-in-command of an airplane, you're also in command of most variables that affect flying safety. Safety is the most important word in the general aviation vocabulary.

Your flight instructor will emphasize training you to operate the airplane safely. Flying as pilot-in-command of the airplane puts you in charge. A well-build and will-maintained airplane in the hands of a competent, prudent, and well-trained pilot makes flying safer than many other forms of transportation.

Q. *What happens if the engine quits?*

A. An aircraft engine is a piece of finely built machinery that is designed to keep running. If the improbable should happen, however, you won't fall out of the sky. Your airplane descends slowly in a glide. You'll simply do what your instructor will have had you practice during your lessons: select the nearest safe landing site and land there without power.

Q. *What about insurance?*

A. Life Insurance--The insurance companies have come to learn how extremely safe flying really is. Most new policies don't even mention general aviation flying. If you have an older policy, restrictive clauses for private flying can often be removed at little or no cost.

Liability Insurance--Some flight training schools include this insurance in your rental fee. If not, many people purchase special low-cost pilot insurance that covers private flying. At any rate, you should check with your own insurance agent to find out where you stand and whether there are any additional requirements.

Q. *Do I have to own an airplane?*

A. Not at all! Of course, owning your own general aviation airplane will give you complete freedom to set your own schedule. You'll have a pride of ownership like nothing you've known before. But many pilots don't own their own planes. Often pilots belong to flying clubs--groups who pool their money to buy and share a plane.

Other pilots rent airplanes. Rental fees are normally based on an hourly rate for actual flying time.

Q. *What happens after I get my pilot's license?*

A. You'll never be quite the same person you were before. You'll have access to a whole new world of personal freedom. You'll think of travel in terms of hours, not miles. You'll know what it means to make your own schedules, go your own way...far above the crowds, the congestion, the hassle, and the annoyances of ordinary transportation.

You'll find a new sense of personal fulfillment in your ever growing flying skills. You'll push the old growing flying skills. You'll push the old boundaries of your life forward and you'll have the opportunity to plan, seek, and find new experiences that will enrich your life in countless ways. You'll gain greater self-reliance and confidence.

Through your own initiative and effort, you'll be a master of our 20th century's most distinctive and rewarding art–flying.

FAA FLYING REGULATIONS

As a pilot, you'll be governed by the regulations set by the FAA. The more responsibility you take on as a pilot, the more stringent the FAA requirements become. For instance, pilots who want to fly as commercial pilots for hire must pass stricter requirements than pilots who fly only for personal pleasure or business. Some of the basic FAA regulations for the different levels of piloting are shown below.

Student pilot regulations. You must be 16 years old and pass Class III medical exam given by an FAA-designated physician to obtain a student pilot certificate. The medical certificate doubles as a student pilot' certificate. You may fly only with an instructor or, with your instructor's written approval sole (by yourself).

Private pilot regulations. To obtain a private pilot certificate, you must be 17 years old and have a minimum of 35 or 40 flight hours, depending on the type of school you attend. You must also pass the FAA private pilot's written examination (a 60-question, multiple-choice test) and a checkride with an FAA examiner. As a private, pilot, you can fly solo or with passengers. Special weather requirements pertaining to visibility and cloud conditions must be met, and you must continue to pass your Class III medical exam every two years. You may not be paid for your services as a pilot.

Instrument rating regulations. An instrument rating allows you to fly when visibility is poor and clouds are low in the sky. To obtain this rating, you must have a total of 125 hours of pilots experience and 40 hours of instrument instruction. Then you must pass a written examination and an FAA checkride.

Certificated flight instructor regulations. To become a certificated flight instructor, you must be 18 years old and hold a commercial or airline transport certificate with an instrument rating. Then you must pass a written examination and a FAA checkride. As a certificated flight instructor, you may instruct private or commercial students. You may also obtain additional instructor ratings to teach instrument instructor or multi-engine instructor.

Airline transport pilot certificate regulations. You must have a commercial certificate, have passed a Class I medical exam within the last six months, have 1,500 flight hours, and pass a FAA written examination and checkride. This certificate allows you to perform pilot-in-command duties for commercial airlines and other transport operations.

Commercial pilot regulations. Commercial pilots can "fly for hire." To exercise the full rights of a commercial pilot, you must have an instrument rating, be at least 18 years old, hold a Class II medical certificate, and have a minimum of 250 hours of flying time. You must also pass a 60-question written FAA examination and a FAA checkride.

Multi-engine rating regulations. To earn a multi-engine rating, you must take instructions from an appropriately certificated instructor. There is no hourly requirement or a written examination, but there is an FAA checkride, after which you'll be licensed to fly airplanes with two or more engines. You may hold either a private or commercial certificate.

THE GOOD OLD DAYS

Or were they?

Instructions issued with the 1911 Glen Curtiss 'Pusher'

1. The aeronaut should seat himself in the apparatus, and secure himself firmly to the chair by means of the strap provided. On the attendant crying "Contact" the aeronaut should close the switch which supplies electrical current to the motor, thus enabling the attendant to set the same in motion.

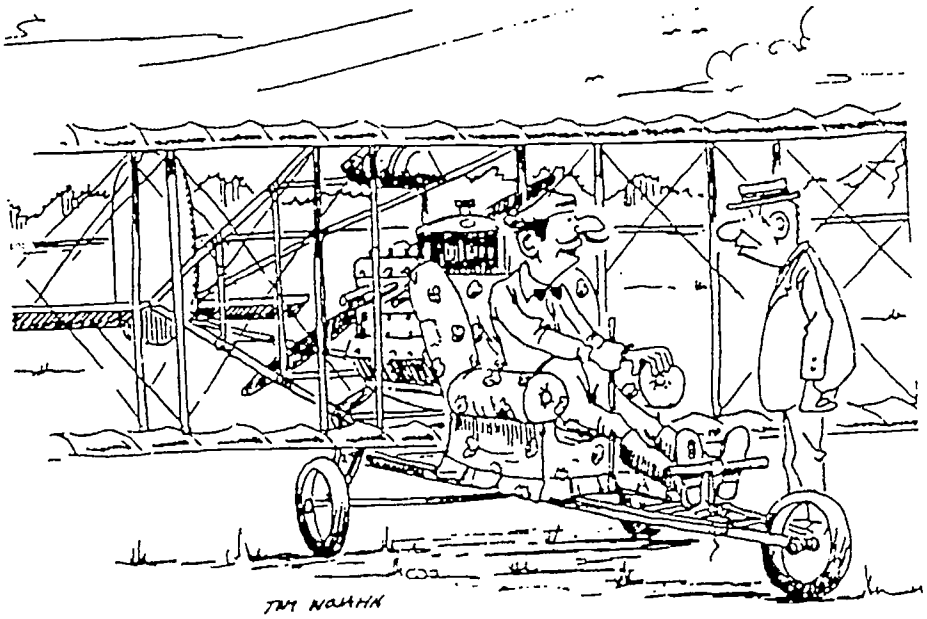
2. Opening the control valve of the motor, the aeronaut should at the same time firmly grasp the vertical stick or control pole which is to be found directly before the chair. The power from the motor will cause the device to roll gently forward, and the aeronaut should govern its direction of motion by use of the rudder bars.

3. When the mechanism is facing into the wind, the aeronaut should open the control valve of the motor to its fullest extent, at the same time pulling the control pole gently toward his (the aeronaut's) middle anatomy.

4. When sufficient speed has been attained, the device will leave the ground and assume the position of aeronautical ascent.

5. Should the aeronaut decide to return to terra firma, he should close the control valve of the motor. This will cause the apparatus to assume what is known as the "gliding position", except in the case of those flying machines which are inherently unstable. These latter will assume the position known as "involuntary spin" and will return to earth without further action on the part of the aeronaut.

6. On approaching closely to the chosen field or terrain, the aeronaut should move the control pole gently toward himself, this causing the mechanism to alight more or less gently on terra firma



"A comfortable pilot is a good pilot."

Deluxe version of a Curtiss Pusher

Aeronautics Museums

Incomplete Listing, NOP 5/90

1. Air Force Museum, Wright-Patterson AFB, OH 45433
2. Champlin Fighter Museum, 4636 Falcon Drive Circle, Mesa, AZ 85205
3. Confederate Air Force Flying Museum, P.O. Box CAF, Harlingen, TX 78551
4. The Glenn H. Curtiss Museum of Local History, Corner of Lake and Main Street, Hammondsport, NY 14840
5. EAA Air Museum Foundation, Inc., Wittman Field, Oshkosh, Wi 54903
6. Kalamazoo Aviation History Museum, 2101 E. Milham Road, Kalamazoo, MI 49002
7. Mid-Atlantic Air Museum, Radar Avenue Harrisburg International Airport, Middletown, PA 17057
8. Musee del 'Air, 91 Boulevard Pereire, 75017 Paris, FRANCE
9. National Air and Space Museum, Smithsonian Institution, Room P-700,
10. National Soaring Museum, Route #3, Harris Hill, Elmira, NY 14903
11. Naval Aviation Museum, NAS, Pensacola, FL 32508
12. Oklahoma Air Space Museum, 2100 NE 52nd St., Oklahoma City, OK 73111
13. RAF Museum, Aerodrome Road, Hendron, London NW9 FLL, ENGLAND
14. San Diego Aero-Space Museum, 2001 Pan American Plaza, Balboa Park, San Diego, CA 92101
15. Southern Museum of Flight, 4343 73rd Street N, Birmingham, AL 35206
16. Spruce Goose, Pier J., P. O. Box 8, Long Beach, CA 90801
17. Strategic Air Command Museum, 2510 Clay Street, Bellevue, NE 68005
18. U.S. Army Aviation Museum, Ft. Rucker, AL 26262
19. University of Texas, Dallas Aviation Library, P. O. Box 643, Richardson, TX 75080
20. Wedell-Williams Memorial Aviation Museum of Louisiana, P. O. Box 655, Patterson, LA 70392
21. Yorktown (CV-10), Patriots Point Naval and Maritime Museum, Patriots Point, P. O. Box 986, Mt. Pleasant, SC 29464

Museums often have unique aircraft or hardware of which they are most proud. Usually they are happy to share information, pictures, history, and technical data with you and your students.

The museums listed above are just a sample. If you are really into museums get Michael Blaugher's book:

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Listing of Books on Aviation

Found Interesting by
Norman O. Poff NASA/AESP
Certificated Aviation Nut

Want to read a good book?Interested in flight and airplanes?Want to learn a bit about why airmen seem to be a little different from other mortals?Then why not read a good book about flight?

Suggestions, more or less in order of time period.

1. ***Glen Curtiss: Pioneer of Flight*** by C. R. Roseberry (1972) interesting as much for the Wright-Curtiss feud as the biography.
2. ***Falcons of France*** by Charles Nordhoff and James Norman Hall (1929) fictionalized story of their flying with the Lafayette Flying Corps in WWI. I seem to remember they wrote something else that was exciting. What was it ??
3. ***Night Flight*** by Antoine de Saint-Exuperly (1932) super exciting novel of early night airmail flight from Europe to Africa. Other exciting books by de Saint-Exupery: ***Wind, Sand, and Stars***, and ***Flight to Arras***. He also wrote ***The Little Prince.***
4. ***A Dream of Eagles*** by Ralph A. O'Neill, O'Neill build a 7,800 mile airline from New York to Buenos Aires in 1930 and lost it in a merger with the then smaller Pan AM and Juan Trippe.
5. ***North to the Orient*** by Ann Morrow Lindbergh the story of a flight across Canada and Alaska to Japan, interesting and often exciting.
6. ***Imperial 109*** by Richard Doyle (1977) excellent novel about the 30's glamorous flying boats, no one seems to have heard of this book.
7. ***The Sky Beyond*** by Sir Gordon Taylor (1963) the autobiography of transoceanic flying pioneer, often downright frightening.
8. ***West With the Night*** by Beryl Markham marvelous story of a woman who grew up in Africa a race horse trainer, then became the first person to fly solo from England to America.
9. ***Thirty Seconds Over Tokyo*** by Ted Lawson (1943) story of the Dolittle raid by one of the pilots in the raid, book exciting as was the movie.
10. ***Flights of Passage*** by Samuel Hynes (1988) a superb unembellished memoir of growing up and flying in WWII. Mr. Hynes approach to flying was 180° from that most famous spark plug salesman.
11. ***The High and the Mighty*** by Ernest K. Gann one of the most exciting flying books ever written, Gann's last the Aviator is one of the most boring, High and Mighty movie a classic.
12. ***No Highway*** by Neville Shute about a new jet transport with fatigue problems written just before the DH Comet had such problems, Shute was a master story teller who also wrote ***On the Beach*** the best anti-nuclear war book written, excellent movie with Jimmy Stewart.
13. ***The Bridges at Toko-ri*** by James A. Michener (1953) exciting fiction set in Korea, excellent movie.
14. ***The Right Stuff*** by Tom Wolfe (1979) about the first seven astronauts but glorifies Chuck Yeager, movie so so.
15. ***Chickenhawk*** by Robert Mason (1983) Helicopters in Vietnam, Mason was a real cowboy chopper pilot, interesting.
16. ***Illusions*** by Richard Bach (1977) although J.L. Seagull was close, reading this is a spiritual experience.
17. ***Test Pilots*** by Richard P. Hallion (1981) an illustrated history of the pilots with the right stuff, reads like a history with interesting facts and trivia.
18. ***Getting Off the Ground*** by George Vecsey and George C. Dade (1979), they let some of the old timers tell of the beginnings of aviation in their own words, an excellent idea done well.
19. ***Epic of Flight*** Time-Life Books, a whole bunch of books on flight from early times to jets, many pretty illustrations and pictures.
20. ***The Lore of Flight*** edited by John W. R. Taylor , a supurb book of flight divided into sections on history, structure, engines and equipment, and a section on flying not too dated for a 1970 book. Often used in basic aviation classes in college programs, 100s of drawings & cutaways.

Notice there are few recent interesting books on aviation. Is aviation no longer interesting and exciting??

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airline pilots union
Career information

American Institute of Aeronautics and Astronautics
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career information, technical publications

The Association for the Study of AfroAmerican Life and History
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Famous Black Americans in Aerospace

Mr. Frank G. Mitchell
Manager Marketing-Training
Beech Aircraft Corporation
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(see catalog listing)

CAP/CAED
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FAA educational publications and programs

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Frederick, MD 21701
info on General Aviation, AV stuff

Aviation Distributors and Manufacturers Association(ADMA)
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Philadelphia, PA 19103
teacher and student awards, info

National Agricultural Aviation Assoc.
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Washington, DC 20006
develop industry standards

Ninety-Nines, Inc.
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international organization of women pilots

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3410 Skyway Drive
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career & college aviation information

Soaring Society of America
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National Business Aircraft Association, Inc. (NBAA)
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Washington, DC 20036
info on corporate aviation

Air Traffic Control Association
2020 North 14th Street, Suite 410
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Professional organization

Instrument Flight is For the Birds
or
How to Duck the High Cost of Instruments

anonymous

Basic rules for the cat and duck method of flight under the hood are fairly well known and are, of course, extremely simple.

1. Place a live cat on the cockpit floor. Because a cat always remains upright, he or she can be used in lieu of a needle and ball. Merely watch to see which way the cat leans to determine if a wing is low, and if so, which one.

2. The duck is used for the instrument approach and landing. Because of the fact that any sensible duck will refuse to fly under instrument conditions, it is only necessary to hurl your duck out of the plane and follow her to the ground.

There are some limitations to the cat and duck method, but by rigidly adhering to the following checklist, a degree of success will be achieved which will surely startle you, your passengers, and maybe even an itinerant tower operator.

Checklist for cat and duck method

1. Get a wide awake cat. Most cats do not want to stand up at all any time. It may be necessary to get a large fierce dog to carry in the cockpit to keep the cat at attention.

2. Make sure your cat is clean. Dirty cats will spend all their time washing. Trying to follow a washing cat usually results in a tight snap roll followed by an inverted spin (flat). You can see this is very unsanitary.

3. Old cats are best. Young cats have nine lives, but an old used up cat with only one left has just as much to lose as you do, and will be more dependable.

4. Avoid stray cats. Try to get one with a good pedigree. Your veterinarian can help you locate a cat with a good character, or try any good breeding farm, or if in the city, try a reputable cat house.

5. Beware of cowardly ducks. If the duck discovers that you are using the cat to stay upright, she will refuse to leave without the cat. Ducks are no better on instruments than you are.

6. Be sure that the duck has good eyesight. Nearsighted ducks sometimes fail to realize they are on the gauges and will go flogging off into the nearest hill. Very nearsighted ducks will not realize they have been thrown out and will descend to the ground in a sitting position. This maneuver is quite difficult to follow in an airplane.

7. Use land loving ducks. It is very discouraging to break out and find yourself on final for a rice paddy, particularly if there are duck hunters around. Duck hunters suffer from temporary insanity when they are sitting in freezing weather in their blinds and will shoot at anything that flies.

8. Choose your duck carefully. Many water birds look very much alike and if you are not careful you may get confused between ducks and geese. Geese are very competent instrument flyers, but are very seldom interested in going the way you want to go. If your duck heads off for Canada or Mexico, then you may be sure you have been given a goose.

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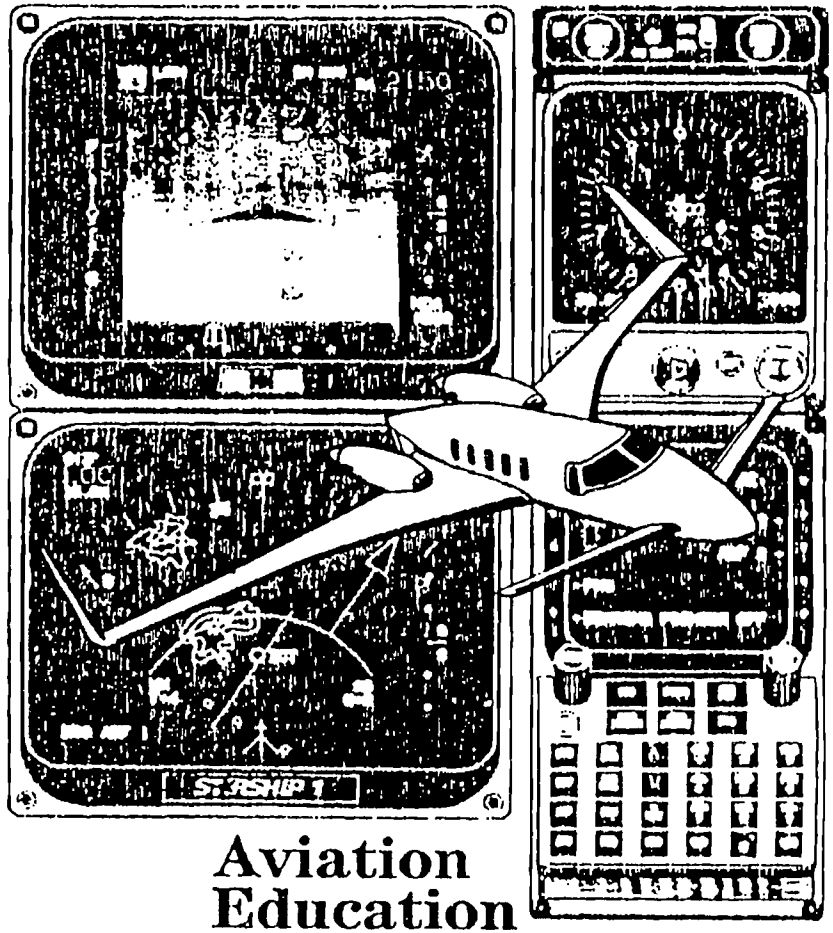

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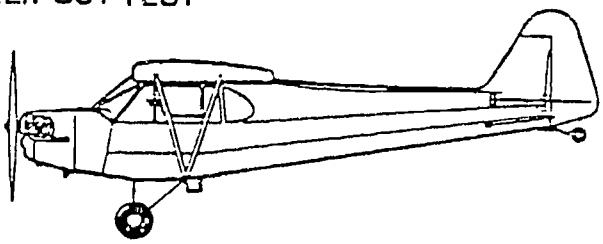


Define/explain/identify the following.
If unsure make your best guess.

1. GOONEY BIRD
2. SEXTANT
3. ANGLE OF ATTACK
4. PITOT TUBE
5. AERONAUT
6. KITTY HAWK
7. PROP WASH
8. DEAD RECKONING
9. E6B
10. JENNY
11. CEILING
12. WIND SHEAR
13. COCKPIT
14. HOOD
15. CFI
16. FAR
17. GLAMORUS GLENNIS
18. UNDUCTED FAN
19. RED BARON
20. LTA
21. DRONE
22. RHUMB LINE
23. SCRAM JET
24. COMPASS ROSE
25. FOKKER

name_____

AERONAUTICS PRE/POST TEST ANSWERS

Define/explain/identify the following. If unsure make your best guess.

1. GOONEY BIRD - a Douglas DC-3, Air Force designation is C-47, the plane that put the world on wings
2. SEXTANT - a device used by navigators for measuring the angular distance of the sun, or star, from the horizon, to find position
3. ANGLE OF ATTACK - the angle between the wing and direction of flight, actually the angle between the chord line and relative wind
4. PITOT TUBE - a device on an aircraft to detect ram air pressure, the ram air pressure compared to the static air pressure gives indicated airspeed
5. AERONAUT - archaic term for a pilot
6. KITTY HAWK - the place on the outer banks of North Carolina where the Wright brothers first flew a heavier-than-air aircraft
7. PROP WASH - the old term for the turbulence created by the rotating propeller of an aircraft, actually the most dangerous turbulence is wing tip vortices
8. DEAD RECKONING - actually navigating by deductive reasoning, meaning to go in a predetermined direction, for a predetermined time, at a predetermined speed, at the end of the time you look down and you are there, you hope
9. E6B - a pilots hand held, manually operated, analog computer, a flight computer
10. JENNY - a Curtiss JN-4, a WW I trainer aircraft, made famous by barnstormers, affectionately called a Jenny
11. CEILING - in aviation weather, the lowest layer of clouds designated broken or overcast, the distance in feet from the ground to where a pilot would fly by reference to instruments instead of visual references
12. WIND SHEAR - a condition where one body of air is moving relative to another body of air, the interface where air changes speed or direction, either horizontal or vertical
13. COCKPIT - the space in an aircraft where the pilot and copilot operate, the place where the flight controls and instruments are located
14. HOOD - a device to block all but the forward vision of a pilot, used for instrument training
15. CFI - certificated flight instructor, the person who teaches people to fly
16. FAR - Federal aviation Regulation, the rules, actually federal laws, pertaining to flight
17. glamorous GLENNIS - the name on the Bell X-1 that was piloted through the "sound barrier" by Capt. Chuck Yeager 14 Oct 47, Glennis is the name of Yeager's wife
18. UNDUCTED FAN - a new type of turbine engine where most of the thrust is provided by a fan-like propeller instead of jet thrust, the speeds are equal to jets and they use considerably less fuel
19. RED BARON - popular name for Baron Manfred Von Richthofen, the most famous WW I ace
20. LTA - a Lighter Than Air craft, a balloon or airship
21. DRONE - a pilotless aircraft flown by someone on the ground or in another aircraft, often used for airborne targets and reconnaissance flights
22. RHUMB LINE - a course that keeps a constant compass direction, a straight line from point A to point B on a map, for long flights a great circle route is flown
23. SCRAM JET - a Supersonic Combustion RAM jet engine, it will be used for the X-30 or National Aerospace Plane (NASP)
24. COMPASS ROSE - the compass card market with degrees, and/or points of direction, often ornate on ships compasses
25. FOKKER - Anthony Fokker was a Dutch aircraft designer who went to Germany in WW I when no one else would buy his aircraft, after WWI Fokker built aircraft in Holland and the USA, the company is still in business

CLASSICS FROM THE CLASSROOM

WHO WAS THE FIRST LADY AVIATOR ?– KITTY HAWK

"IN A UNIFORM OR NOT, BARON VON RICHTHOFEN WAS A DASHING FIGURE."

"SPINNING JENNIES WERE FLYING JENNIES THAT DID NOT WORK."

"PEOPLE TALKED ABOUT FLYING IN BALLOONS FOR CENTURIES. FINALLY THERE WAS ENOUGH HOT AIR TO GET THEM OFF THE GROUND."

ON HIS FIRST FLIGHT, HOW LONG WAS ORVILLE WRIGHT IN THE AIR? – "I'M NOT SURE. FIVE FEET OR SOMETHING WITH HIS SHOES ON."

"EUCLID THOUGHT OUT HOW TO MAKE GEOMETRY HELP PEOPLE TO FLY. HE WAS BORN IN THE 300'S AND DIED IN THE 200'S. THAT IS ANOTHER THING HE THOUGHT OUT HOW TO DO. HE THOUGHT HOW TO DO IT BY USING B. C.'S."

"CHARLES LINDBERGH IS THE MOST FAMOUS PERSON IN FLYING HISTORY AND SO ARE THE WRIGHT BROTHERS.

"THE WRIGHT BROTHERS MADE THEIR FIRST FLIGHT IN 1903. 1903 WAS REALLY IN THE 20TH CENTURY, BUT EVERYBODY WAS BEHIND THE TIMES IN THOSE DAYS."

"DURING THE TWENTIES PEOPLE STARTED WALKING ON AIRPLANE WINGS AND THINGS LIKE THAT. I KNOW IT WAS CRAZY , BUT THIS WAS BEFORE TV OR ANYTHING SO WHAT ELSE WAS THERE TO DO.."

"BACK IN 1924, EIGHT MEN TRIED TO FLY AROUND THE WORLD, BUT THEY ONLY ENDED UP WHERE THEY STARTED."

"CHARLES LINDBERGH WAS THE FIRST TO FLY TO PARIS. HE DID IT BY THE AIRPLANE METHOD."

"THE NAVIGATOR FIGURES OUT THE LATITUDE AND LONGITUDE. LATITUDE TELLS HIM WHERE HE IS AND LONGITUDE TELLS HIM HOW LONG HE CAN STAY THERE."

"THE THREE MAIN CREW MEN ON A PLANE ARE THE PILOT, NAVIGATOR, AND PERCOLATOR."

"I KNOW WHAT A SEXTANT IS, BUT I HAD RATHER NOT SAY."

"A VISA IS A PASSPORT PERMITTING AN AIRPLANE TO LEAVE THE COUNTRY. FOR ROUND TRIPS YOU NEED A VISA VERSA."

"THE NUMBER OF AIRCRAFT TODAY IS AN ADSURBLY (SIC) LARGE FACT OF A NUMBER."

"THE WAY RAMJETS WORK, AS I UNDERSTAND IT, IS NOT VERY WELL UNDERSTOOD."

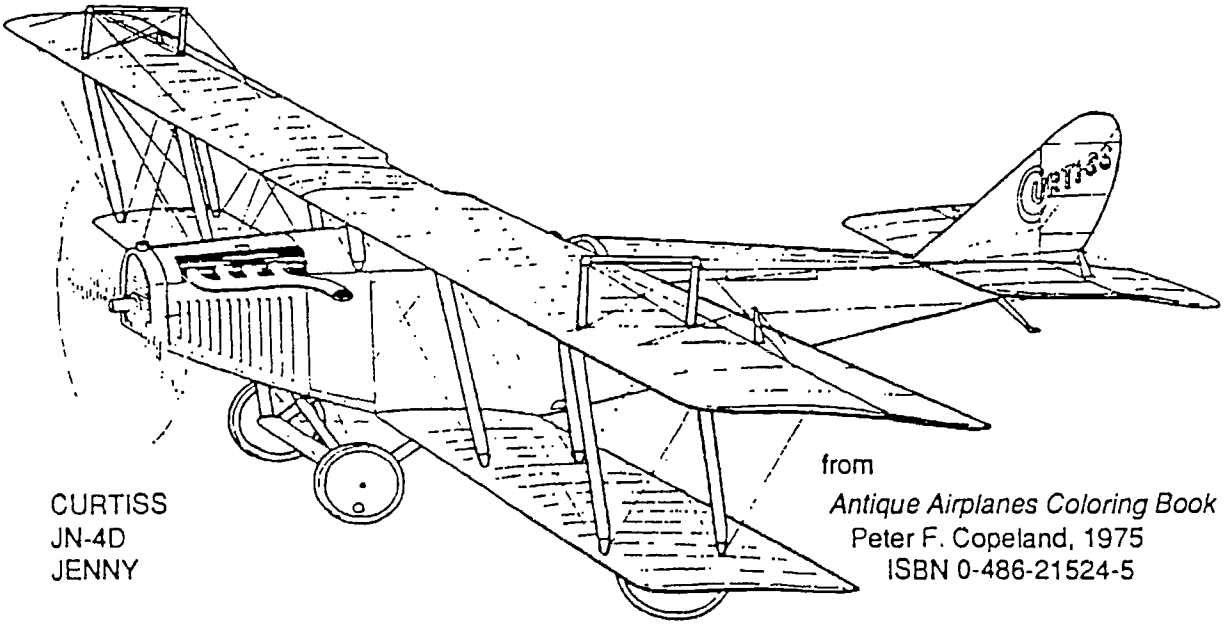
"SO FAR PLANES HAVE BEEN ABLE TO FLY IN CIRCLES OF 360 DEGREES. THIS COULD BE THE NEXT BIG BREAKTHROUGH IN AIR TRAVEL."

"THANKS TO WHAT WE ARE LEARNING FROM AVIATION, WE SHOULD SOON BE ABLE TO LOOK FORWARD TO HAVING CEILINGS MADE OUT OF FOG."

"FROM NOW ON I WILL PUT BOTH GLADNESS AND WONDER IN MY SAME THOUGHT ABOUT AIRPLANES."

The U.S. Army Air Service
1919 FLYING REGULATIONS

1. Don't take the machine into the air unless you are satisfied it will fly.
2. Never leave the ground with the motor leaking.
3. Don't turn sharply when taxiing. Instead of turning short, have someone lift the tail around.
4. In taking off, look at the ground and the air.
5. Never get out of a machine with the motor running until the pilot relieving you can reach the engine controls.
6. Pilots should carry hankies in a handy position to wipe off goggles.
7. Riding on the steps, wings, or tail of a machine is prohibited.
8. In case the engine fails on takeoff, land straight ahead regardless.
9. No man must taxi faster than a man can walk.
10. Do not trust altitude instruments.
11. Learn to gauge altitude, especially on landing.
12. If you see another machine near you get out of its way.
13. No two cadets should ever ride together in the same machine.
14. Never run motor so that blast will blow on other machines.
15. Before you begin a landing glide see that no machines are under you.
16. Hedge-hopping will not be tolerated.
17. No spins on back or tail slides will be indulged in as they unnecessarily strain the machine.
18. If flying against the wind, and you wish to turn and fly with the wind, don't make the sharp turn near the ground. You might crash!
19. Motors have been known to stop during a long glide. If pilot wishes to use motor for landing he should open throttle.
20. Don't attempt to force machines onto the ground with more than flying speed. The result is bouncing and ricocheting.
21. Aviators will not wear spurs while flying.
22. Do not use aeronautical gas in cars and motorcycles.
23. You must not takeoff or land closer than 50 feet to the hangar.
24. Never take a machine into the air until you are familiar with its controls and instruments.
25. If an emergency occurs while flying, land as soon as possible.
26. It is advisable to carry a good pair of pliers in a position where both pilot and passenger can reach them in case of an accident.
27. Joy rides will not be given to civilians.

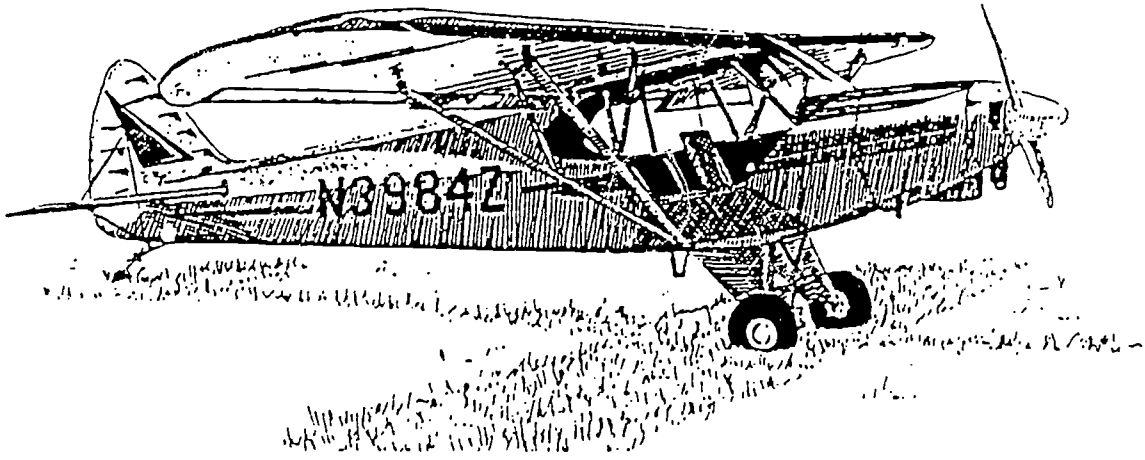


CURTISS
JN-4D
JENNY

from
Antique Airplanes Coloring Book
Peter F. Copeland, 1975
ISBN 0-486-21524-5

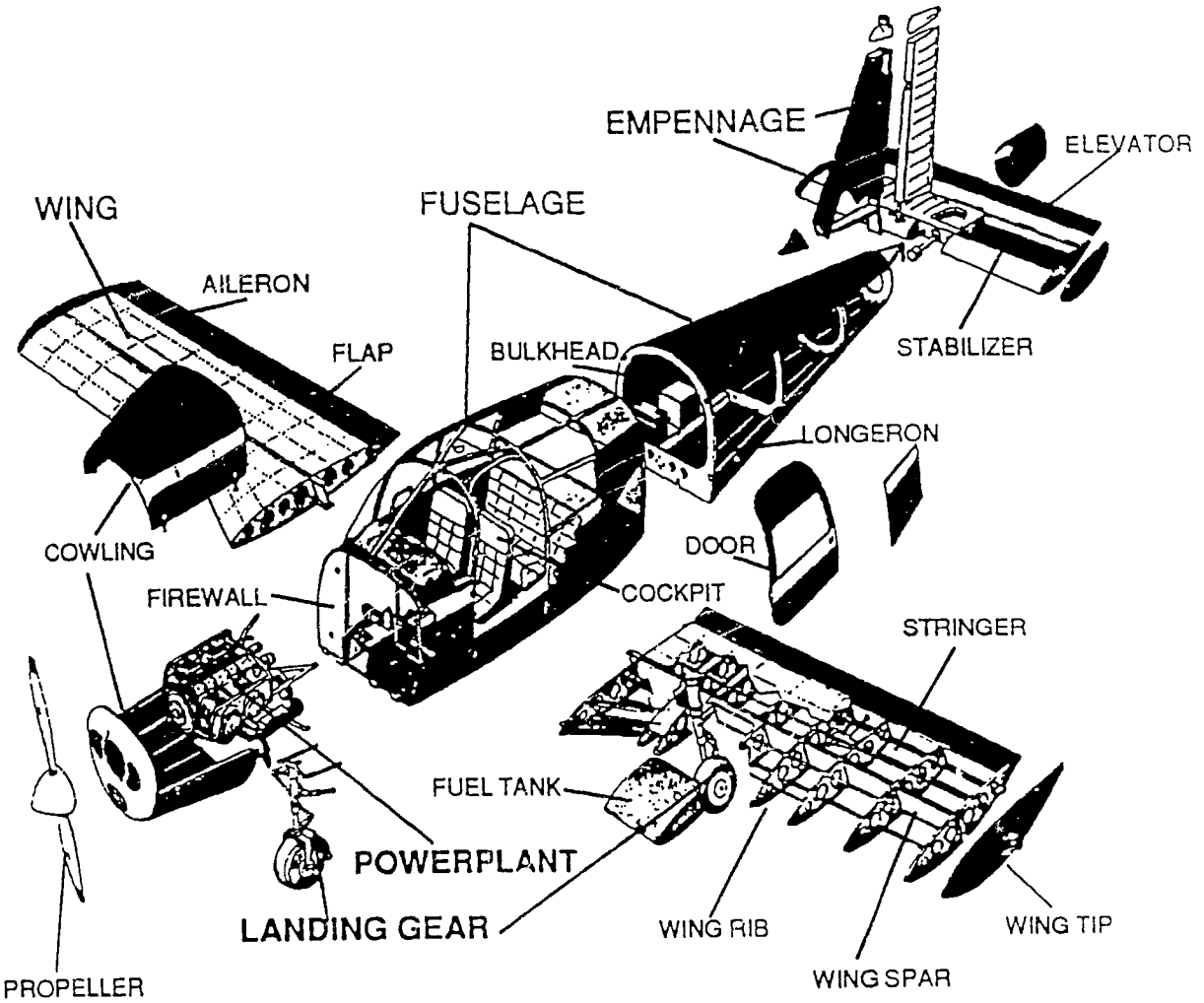
BASIC AERONAUTICS

INTRODUCTION	
VOCABULARY	WHY AN AIRPLANE
BASIC AERODYNAMICS	FLIES
HISTORY OF FLIGHT	
PRE WRIGHT BROTHERS	THE INCREDIBLE
EARLY FLIGHT	SHRUNKEN
THE GREAT WARS	WORLD
JET AGE	
PRE-FLIGHT I	
WEATHER THEORY	WHEN TO STAY HOME
WEATHER REPORTS/FORECASTS	WHEN TO GO
PRE-FLIGHT II	
WEIGHT AND BALANCE	HOW WELL WILL THE
AIRCRAFT PERFORMANCE	AIRPLANE FLY
NAVIGATION	
CHARTS	WHERE AN AIRPLANE
PLOTTER	FLIES
COMPUTER	
AIDS TO NAVIGATION	
VOR/DME	WHAT KEEPS THE PILOT
ADF	ON COURSE
ILS	
TRANSPONDER	
LAWS PILOTS LIVE BY	
FAR'S	REGULATIONS
NTSB	OF FLIGHT



PIPER PA-18 SUPER CUB

AIRPLANE KIT
PARTS IS PARTS



International Phonetic Alphabet and Morse Code

International Civil Aviation Organization (ICAO)

A	-	Alfa . -	(AL - fah)	N	-	November - .	(No - vem - ber)
B	-	Bravo - . . .	(Brah - voh)	O	-	Oscar - - -	(Oss - cah)
C	-	Charlie - . - .	(Char - lee)	P	-	Papa . - - .	(Pah - - pah)
D	-	Delta - . .	(Dell - tah)	Q	-	Quebec - - . -	(Keh - beck)
E	-	Echo .	(Eck - oh)	R	-	Romeo . - .	(Row - me - oh)
F	-	Foxtrot . . - .	(Foks - trot)	S	-	Sierra . . .	(See - airrah)
G	-	Golf - - .	(Golf)	T	-	Tango -	(Tang - go)
H	-	Hotel	(Hoh - tell)	U	-	Uniform . . -	(You - nee -form)
I	-	India . .	(In - Dee -aH)	V	-	Victor . . . -	(Vik - tah)
J	-	Juliett . - - -	(Jew - lee - ett)	W	-	Whiskey . - -	(Wiss - key)
K	-	Kilo - . -	(Key - loh)	X	-	X ray - . . -	(Ecks -ray)
L	-	Lima . - . .	(Lee - mah)	Y	-	Yankee - . - -	(Yang - key)
M	-	Mike - -	(Mike)	Z	-	Zulu - - . .	(Zoo - loo)

0	-	(Zee-ro)	5	-	(Fife)
1	-	(Wun)	6	-	(Six)
2	-	(Too)	7	-	(Sev-en)
3	-	(Tree)	8	-	(Ait)
4	-	(Fow-er)	9	-	(Niner)

International Aircraft Markings
(Incomplete Listing)

Registration markings of civil aircraft

B	-	China	CCCP	-	U.S.S.R.
C, CF	-	Canada	C6	-	Bahamas
D	-	Germany	EP	-	Iran
F	-	France	G	-	United Kingdom
HB	-	(Swiss emblem) Switzerland	I	-	Italy
J3	-	Granada	00	-	Belgium
PH	-	Netherlands	4X	-	Israel
9K	-	Kuwait	N	-	USA
5A	-	Lybia	VH	-	Australia

above followed by letters or number letter combinations

examples:

N30428	a Cessna C-172, USA registration
D-LZ129	the Zeppelin Hindenberg
C-FOTO	Canadian registration seen on a balloon advertising Minolta
HK-206	Avianca Flight 52, Columbian registration

From Aviation Fundamentals Jeppesen Sanderson, Inc. and AOPA's Handbook for Pilots 1987

AIRPORT IDENTIFIERS

You see the airport identifier on your baggage claim stubs when you check luggage to those romantic far away places. All airports have a three or four character identifier, airports with airline service usually have a three letter identifier, other airports often have combinations of letters and numbers.

Some airports are known by their identifiers. The most famous is **LAX** in Los Angeles. In movies and on television people in the Los Angeles area don't go to the airport, they go to **LAX**. Two other airports known by their identifiers are **DFW** between Dallas and Fort Worth and **JFK** in New York.

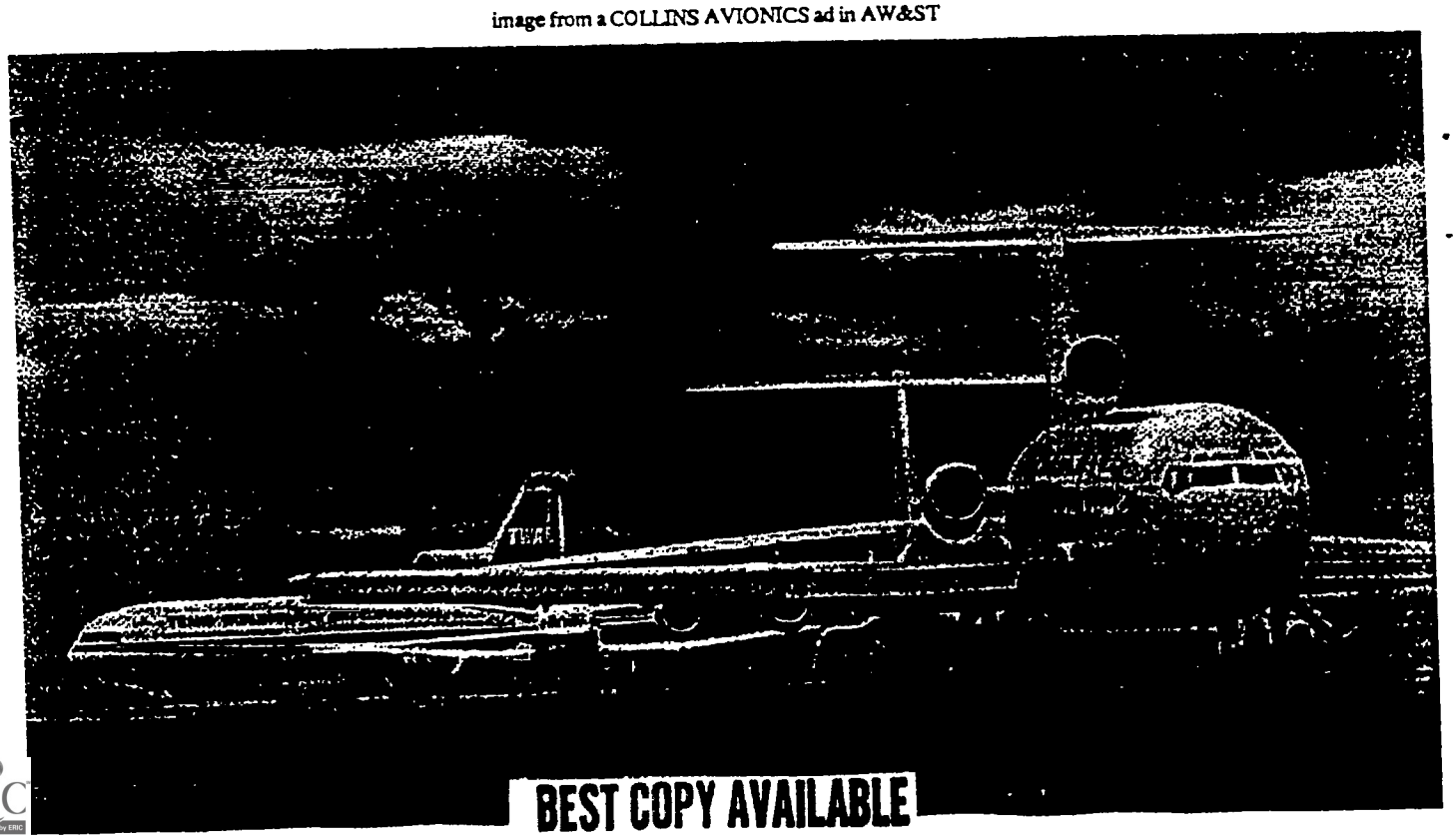
Some identifiers make sense, but others seemingly do not. Houston's Hobby airport has **HOU** for its identifier, but Houston Intercontinental is **IAH**. Often airports have a name change, but the identifier remains the same, sometimes both name and identifier change. Kennedy Airport , **JFK**, in New York formerly was Idlewild with **IDL** as the identifier. Orlando's airport was formerly McCoy AFB and **MCO** is still the identifier.

A knowledge of airport identifiers once saved this author's luggage from heading in the wrong direction. Leaving San Juan, PR airport (**SJU**) heading for Dallas, the baggage handler put **DCA** , Washington National tags on the baggage instead of **DFW** tags. Knowledge and alertness saved lost time and frustration.

Some airports with their identifiers are listed below.

DCA	National, Washington, DC	IAD	Dulles, Washington, DC
MKC	Kansas City Airport, KC, MO	MCI	International, KC, MO
CDG	Charles DeGaulle, Paris, France	ORY	Orly, Paris,France
MSP	Minneapolis/St Paul, MN	MSY	New Orleans, LA
DAL	Love Field, Dallas, TX	DFW	Dallas/Fort Worth, TX
DET	City Airport, Detroit, MI	DTW	Metropolitan, Detroit, MI
CLE	Hopkins, Cleveland, OH	BLK	Lakefront, Cleveland, OH
MDW	Midway, Chicago, IL	ORD	O'Hare, Chicago, IL
SFO	San Francisco, CA	OAK	Oakland, CA
JFK	Kennedy, New York City	LGA	LaGuardia, New York City
MIA	Miami, FL	MIO	Miami, OK
40J	Perry, FL	F22	Perry, OK

image from a COLLINS AVIONICS ad in AW&ST



FLIGHT PLAN

You see aircraft accidents reported in the news. Quite often it is reported that 'the pilot did not file a flight plan.' Sometimes this is a factor in how long it takes to find the downed aircraft, but it is not a factor in causing an accident.

A flight plan is not required if you fly under visual flight rules (VFR), but is required to fly under instrument flight rules (IFR). Under VFR a flight plan informs the FAA of your intended route of flight, and the altitude you plan to fly. For VFR you open your flight plan when you take off, and close it when you land.

IFR is another matter. You file a flight plan telling the FAA what you would like to do, and they may or may not approve. If the route and altitudes you request cannot be fitted in with other traffic, the FAA may amend your flight plan. You still get to go where you are going, but by way of different routes or altitudes.

For IFR you usually file the flight plan an hour or so before takeoff, then you are given your clearance, in the plane just before take off. If there are no changes you are cleared "as filed." If the FAA cannot accommodate your request, the clearance delivery controller will usually say "advise when ready to copy clearance." This warns you to have a pencil and paper ready. Once at Chicago's O'Hare airport we heard a controller warn the pilot to have a couple of sharp pencils handy. This was a polite warning that the clearance was going to be long and involved.

Form Approved: OMB No. 2120-0026

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION FLIGHT PLAN	(FAA USE ONLY) ☐ PILOT BRIEFING ☐ VNR ☐ STOPOVER	TIME STARTED	SPECIALIST INITIALS

1. TYPE	2. AIRCRAFT IDENTIFICATION	3. AIRCRAFT TYPE/ SPECIAL EQUIPMENT	4. TRUE AIRSPEED	5. DEPARTURE POINT	6. DEPARTURE TIME		7. CRUISING ALTITUDE
VFR / IFR / DVFR			KTS		PROPOSED (Z)	ACTUAL (Z)	

8. ROUTE OF FLIGHT

9. DESTINATION (Name of airport and city)	10. EST. TIME ENROUTE		11. REMARKS
	HOURS	MINUTES	

12. FUEL ON BOARD		13. ALTERNATE AIRPORT(S)	14. PILOT'S NAME, ADDRESS & TELEPHONE NUMBER & AIRCRAFT HOME BASE	15. NUMBER ABOARD
HOURS	MINUTES		17. DESTINATION CONTACT/TELEPHONE (OPTIONAL)	

16. COLOR OF AIRCRAFT	CIVIL AIRCRAFT PILOTS. FAR Part 91 requires you file an IFR flight plan to operate under instrument flight rules in controlled airspace. Failure to file could result in a civil penalty not to exceed $1,000 for each violation (Section 901 of the Federal Aviation Act of 1958, as amended). Filing of a VFR flight plan is recommended as a good operating practice. See also Part 99 for requirements concerning DVFR flight plans.

FAA Form 7233-1 (8-82) CLOSE VFR FLIGHT PLAN WITH _____ FSS ON ARRIVAL

Flight plan: fill in the boxes. Always done in this same order.

1. check type of flight plan
2. complete aircraft identification including the "N" number
3. aircraft type including equipment (ex. C-182/U, a Cessna 182 with encoded transponder)
4. computed true airspeed (usually not computed, but is what the operator's manual says)

5. departure airport identifier code (ex. SWO, Stillwater, OK)
6. proposed time of departure in UTC or zulu time
7. altitude intended if VFR, or altitude requested if IFR
8. route of flight after departing the airport, to the last fix or route segment before landing
9. destination airport identifier (ex. TUL, Tulsa, OK)
10. calculated time enroute
11. only remarks needed by air traffic control (ATC)
12. computed from fuel in the tanks
13. only if desired or needed
14. enough information to identify home
15. traditionally called souls on board (SOB's)
16. ex. blue on white
17. optional

OK Mister its an airplane
BUT HOW DO IT FLY?

Forces of Aircraft, Airfoils, Induced Drag
Winglets, Boundary Layer, Lift
Stall, Angle of Attack

Norman O. Poff NASA/AESP 85/90

If you start reading this epistle and run across something you don't understand read "Wind Tunnels" by the same author. If that doesn't help, reach out and touch someone.

Forces on Aircraft

There are four major forces acting on an aircraft:

lift	upward
drag	backward
weight	downward
thrust	forward

All of these forces can and do act on the lifting surfaces of an aircraft as well as other parts of an aircraft.

Airfoil

Airfoils are the curved streamlined cross-sectional shapes of wings that create lift due to differential pressures on top of the wing relative to the bottom. Lift also comes from deflection of the air downward due to the angle at which the wing penetrates the air. This downward deflection along with the downward reaction to the differential pressures on the surfaces is the lifting force on the wing. Very simply the wing pushes downward on the air with a force equal to the weight of the aircraft if said aircraft is going to fly. One must be careful telling a pilot this fact since most will look at you as if you were crazy and some will tell you so. As you might expect this considerable down force on the air creates a sizeable downwash in the wake of the aircraft.

Parasitic Drag

Parasitic drag is caused by the friction of everything stuck out into the airstream from landing gear to rivet heads and antennas. The larger the frontal area the larger the parasitic drag. Parasitic drag varies with the square of the airspeed. You go twice as fast there is four times the parasitic drag. Considering all that stuck out on WWI type aircraft you can see why they did not go faster even with relatively high horespower engines.

Induced Drag

Near the tip of a wing the air flow is span-wise outward on the bottom of the wing and this flow spills around the tip and flows inward on top into the relatively lower pressure region found on top of the wing. All the while, the aircraft is moving forward so the flow continues its circular motion in an ever widening vortex behind the wing. The wing, therefore, is doing work (in a physics sense) on the air, the reaction to this is the induced drag due to lift. You cannot get something for nothing.

Winglets

Winglets take advantage of this side force on top of the wing by deflecting some of this flow rearward. The reaction to this is actually thrust, the same force forward you get from engines. The thrust is not great, but every little bit helps. Also, the winglets extend the wing span and have a smaller tip chord, both of which make the wing more efficient. i.e., less induced drag. Fuel savings can be two to ten percent.

Boundary Layer

When a fluid flows over a surface, all of the fluid does not slip relative to the surface. For an airplane, even traveling at several hundred miles per hour, the air at the surface is not moving at all relative to the surface. Thus, the air must go from 0 to several hundred miles per hour in a distance of a fraction of an inch. The viscous forces are tremendous in this region. On an airfoil, this boundary layer grows from the leading edge to trailing edge. Because this is true most aircraft have flush riveting near the leading edge. Back where the boundary layer with its slowly moving air is thicker, round head rivets can be used because they do not stick up into the free flow of air. The viscous forces at high Reynold's Numbers (explained in "Wind Tunnels") are relatively unimportant EXCEPT in the boundary layer. Remember at the surface the air speed is zero. The pressure distribution comes from the main body of non-viscous air. So the air in the boundary layer is affected by the pressure distribution of the main body of air, not the other way around.

Lift

Ok, what about the pressure on an airfoil? On top of the airfoil, from the leading edge to about the high point, the speed increased and the pressure decreases, and from the high point to the trailing edge the speed decreases and the pressure increases back to atmospheric pressure at or near the trailing edge. This followsBernoulli's Principle, which really is another statement of conservation of energy. The pressure increases some on the lower surface, due to a bound vortex that starts as soon as the aircraft starts moving. The bound vortex, moves leading edge to trailing edge on top increasing the speed of the air over the top of the wing, and trailing edge to leading edge on the bottom of the wing decreasing the speed on the bottom. Bernoulli's Principle stated simply is that with an increase in speed there is a decrease in pressure on top of the wing, and a decrease in speed results in an increase in pressure on the bottom of the wing. So there is more push upward on the bottom of the wing than there is downward on the top of the wing. The net pressure force is upward and this net upward pressure force is called lift. The lift increase with increased speed or increased angle of attack. (Explained below)

The speed up of air is often explained INCORRECTLY by saying that two particles of air, one above the other, in front of the wing must meet again behind the wing. According to this INCORRECT explanation the top particle must travel faster since it has farther to go. The top curvature (camber) is usually greater than the bottom one. Smoke tunnels show quite convincingly that the particles do not meet, the top one actually arrives at the trailing edge first because the air slows below the wing.

Stall

Going from leading edge to about the high point, the air particles in the boundary layer are pushed downstream by decreasing pressure which increases speed. The momentum of the particles at the high point is less than it should be as a result of the viscous forces. From the high point to the trailing edge, pressure increases and speed decreases. The momentum of the particles already reduced by viscous forces is reduced further by the pressure forces. As a worst case: if the retarding forces are too large because of too large an angle of attack, the flow stops and may even be pushed back by higher pressures from the back of the airfoil. This produces a large region of rolling, tumbling, eddy flow which intercourses-up the main flow. This stagnant air is pushed forward by the pressure from the rear until it causes the main flow to separate from the surface. Ain't it obvious that the wing now is NOT lifting? This was a necessarily long explanation of a STALL and what ever stalls falls. It probably will not surprise you that there is also a tremendous increase in drag when this happens. The stall results not because of an airspeed that is too low, but because the angle of attack is too high.

Angle of Attack

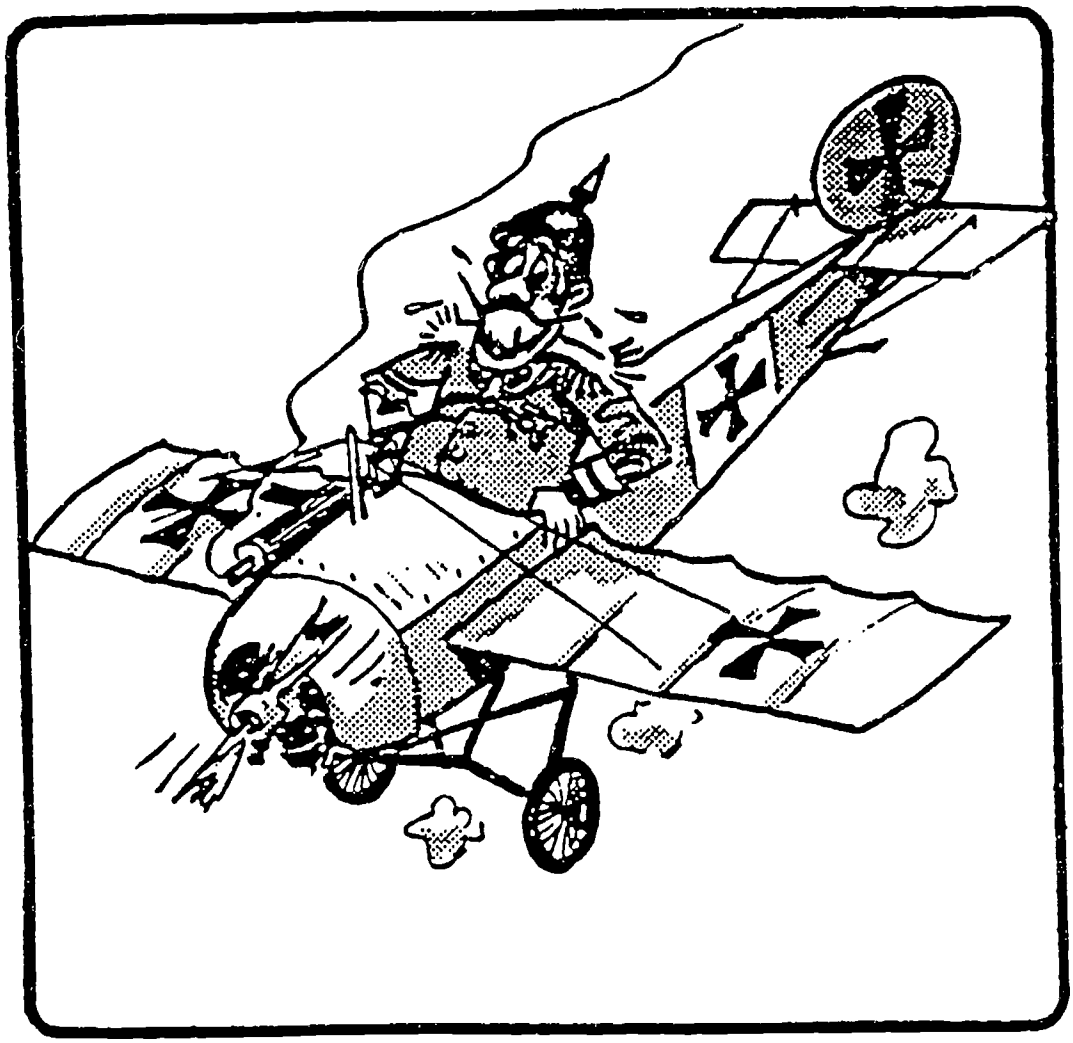
Lift and drag increase as the angle the wing makes with the line of direction of motion increases. This angle is called Angle of Attack. Actually, it is usually defined as the angle the chord of the wing makes with the relative wind. The chord of an airfoil is a line between the leading and trailing edge. Relative Wind is the direction opposite the motion of the aircraft. When you ride a bicycle you perceive a wind opposite your direction of movement even in a no wind condition, i.e., relative wind. If the angle of attack gets too large, the wing stalls. As a rule, pilots are very careful to avoid stalls because they can lead to spins and other problems. Of course, in aerobatics and training, stalls are a normal occurrence. Many pilots believe that stalls occur because of too low an airspeed, but angle of attack is the whole thing.

Stall Speed

Airplanes have a stall speed, don't they? Pretend you are a pilot flying along at a constant altitude and you decide to slow down. When the aircraft slows, less lift is generated by the wing and you get it back by applying up elevator which increases the angle of attack. Generally, you can get more lift by more speed or more angle of attack, up to a point. Still trying to maintain altitude if the aircraft is slowed further, more angle of attack--up elevator--is necessary. Finally, the angle of attack is the angle where the wing stalls and the airspeed where you get this critical angle of attack is the stall speed shown on the airspeed indicator. An aircraft could stall heading straight down if enough elevator were available to get the critical angle of attack. So the stall speed shown on airspeed indicators is the slowest level flight speed the airplane will fly without the angle of attack being at the stall angle.

PROPELLER
Bob Stevens definition
editors favorite cartoon

from
Prop Wash: A Fractured Glossary of Aviation Terms
Bob Stevens
The Village Press
P.O. Box 310, Fallbrook, CA 92028
ISBN 0-910497-01-X



PROPELLER—Fan up front that keeps the pilot cool . . . turn it off and watch him sweat.

Wind Tunnels

Laminar Flow, Turbulent Flow, Reynold's Numbers
Dynamic Similitude

Norman O. Poff NASA/AESP 85

When this epistle on a "single" explanation of wind tunnels started, it became obvious that the explanation would only be simple if you first know something about fluid dynamics.

So first things first. Well, sort of anyway. Actually the topics will be introduced when something needs explaining.

Laminar Flow

One can think of a fluid as being able to flow smoothly in layers (lamina). You can think of the flow as stream-lines of fluid where there is no mixing of molecules between layers. This means also that there is no exchange of energy and momentum and all that stuff. Examples are water flowing slowly from a faucet, or smoke when it first rises from a (choke, choke) cigarette in an ashtray.

Turbulent Flow

This occurs when the fluid does not flow in layers, when there is mixing of clumps of fluid, when there is intermixing of energy and momentum and all that stuff. Examples are water flowing at a brisk speed from a faucet and cigarette smoke at the end of the laminar stream where the smoke swirls and mixes with the surrounding air.

Reynolds Numbers

In 1883, Osborne Reynolds experimented with laminar and turbulent flow. His basic experiment was to inject a dye in a small section of fluid flowing in a tube and find where the flow changed from laminar to turbulent flow. He found that the flow could change abruptly and always happened where the following ratio occurred.

$$\frac{\text{density x speed x length (see below)}}{\text{viscosity (see below)}}$$

(The length of Reynolds was tube diameter but can be any characteristic length such as wing chord.)

(The viscosity of a fluid is the tendency to resist shear deformation. It is then the friction resistance to distortion of shape.)

If the right set of units is chosen, then this ratio is dimensionless, and is called a Reynolds Number.

$$\text{R.N.} = \frac{D \times S \times L}{V}$$

This ratio is also proportional to the ratio of inertial forces to viscous forces or:

$$\frac{\text{inertial forces}}{\text{viscous forces}} \quad \text{is proportional to} \quad \frac{D \times S \times L}{V}$$

Dynamic Similitude

Two experiments involving fluid dynamics are DYNAMICALLY SIMILAR if and only if the Reynold's Numbers are equal. This means that it is possible for an experiment with a helium filled balloon 100 cm in diameter rising in air to be dynamically similar to a 0.60 cm plastic ball falling in water if the Reynold's Numbers are the same. But an experiment with an exact scale three meter model of a Boeing 747 in a wind tunnel----IS NOT DYNAMICALLY SIMILAR---to a real, flying Boeing 747 if the Reynold's Numbers are not equal.

Simply stated, air doesn't flow around models as it does around the real thing. Models generally have R.N.'s in the hundreds of thousands while real planes have R.N.'s in the several millions.

WHAT HAS ALL THIS GOT TO DO WITH WIND TUNNELS??

For experiments in wind tunnels, the principle of dynamic similarity allows interpretation of the test and the test becomes applicable to the real aircraft. It would be even better if you could make a wind tunnel that had full-scale R.N. capability or a full scale wind tunnel where you can test the full size aircraft. Full Scale Reynold's Numbers have been a goal of tunnel designers almost from the beginning. There are other problems, such as wall interference effects, but they are explained well in Wind Tunnels of NASA SP-440.

NASA has two full-scale tunnels: a 30' x 60' full scale tunnel at Langley: a 40' x 80' full scale tunnel at Ames; and if they can piece it back together a 80' x 120' tunnel add on at Ames.

Langley also has the National Transonic Facility and even though the test section in only 2.5 meters it achieves full scale Reynold's Numbers by being able to increase the density to 9 atmospheres and decrease the viscosity by reducing the temperature with the use of cryogenic nitrogen at -300° Fahrenheit. Increased density increases the numerator of the R.N. formula while decreased viscosity decreases the denominator together raising the Reynolds' Numbers achieved.

references: Wind Tunnels of NASA SP-440, Shape and Flow , Ascher H Shapiro, Anchor

FAMOUS PLANES

from a word search program by MECC

suggestion:

For a matrix this size use about half the number of words.
The MECC program is so good that the key looks
like the puzzle.

H	D	T	Q	S	P	I	T	F	I	R	E	J	P	H	A	N	T	O	M	S
E	G	H	M	I	I	N	L	W	S	P	A	D	H	A	R	R	I	E	R	T
R	M	U	U	N	P	F	M	A	R	A	U	D	E	R	S	A	B	R	E	U
C	O	N	S	T	E	L	L	A	T	I	O	N	H	V	F	I	S	K	T	K
U	S	D	T	R	R	Y	H	C	A	W	G	D	U	A	C	G	K	B	A	A
L	Q	E	A	U	C	I	F	U	I	X	M	H	S	R	A	A	Y	L	L	H
E	U	R	N	D	H	N	O	R	R	C	A	B	T	D	T	L	R	A	O	P
S	I	B	G	E	E	G	K	T	A	R	T	L	L	F	A	A	A	C	N	W
B	T	O	U	R	R	F	K	I	C	U	I	A	E	J	L	X	I	K	V	N
L	O	L	D	V	O	O	E	S	O	S	G	C	R	E	I	Y	D	B	A	L
E	R	T	D	C	K	R	R	S	M	A	E	K	A	N	N	R	E	I	L	A
R	M	O	A	O	E	T	T	R	E	D	R	W	V	N	A	P	R	R	K	N
I	I	H	U	U	E	R	R	O	T	E	M	I	G	Y	E	T	J	D	Y	C
O	T	E	N	G	M	E	I	B	B	R	O	D	A	K	O	T	A	Y	R	A
T	C	L	T	A	S	S	P	I	R	I	T	O	F	S	T	L	O	U	I	S
C	H	L	L	R	Q	S	L	N	D	C	H	W	V	L	E	A	R	J	E	T
P	E	C	E	S	S	N	A	S	K	Y	H	A	W	K	M	I	R	A	G	E
P	L	A	S	G	B	O	N	A	N	Z	A	Y	F	C	O	R	S	A	I	R
Q	L	T	S	L	I	B	E	R	A	T	O	R	F	A	L	C	O	N	D	J

Can you find these words?

SPIRITOFSTLOUIS
CONSTELLATION
CURTISSROBIN
BLACKWIDOW
DAUNTLESS
AIRACOMET
CRUSADER
MOSQUITO
CATALINA
HUSTLER
BLERIOT
HELLCAT
BONANZA
COUGAR
STUKA
COMET
MIG

FLYINGFORTRESS
PIPERCHEROKEE
THUNDERBOLT
BLACKBIRD
SKYRAIDER
LANCASTER
HERCULES
INTRUDER
MITCHELL
HARVARD
LEARJET
CORSAIR
MIRAGE
FALCON
TALON
JENNY

FOKKERTRIPLANE
CESSNASKYHAWK
WRIGHTFLYER
TIGERMOTH
HURRICANE
LIBERATOR
VALKYRIE
MARAUDER
SPITFIRE
PHANTOM
HARRIER
MUSTANG
DAKOTA
GALAXY
SABRE
SPAD

LOOP PUZZLE

DR. HARRY B. HERZER III FOUND THIS PUZZLE IN ONE OF THE
WASHINGTON, DC NEWSPAPERS.
WHICH ONE,
WE DO NOT KNOW.

suggestions:

Make several copies the puzzle before you start. It looks easy, it is not.

Use a pencil with a good eraser. It looks easy, it is not.

If you get airsick remember, it looks easy, it is not.

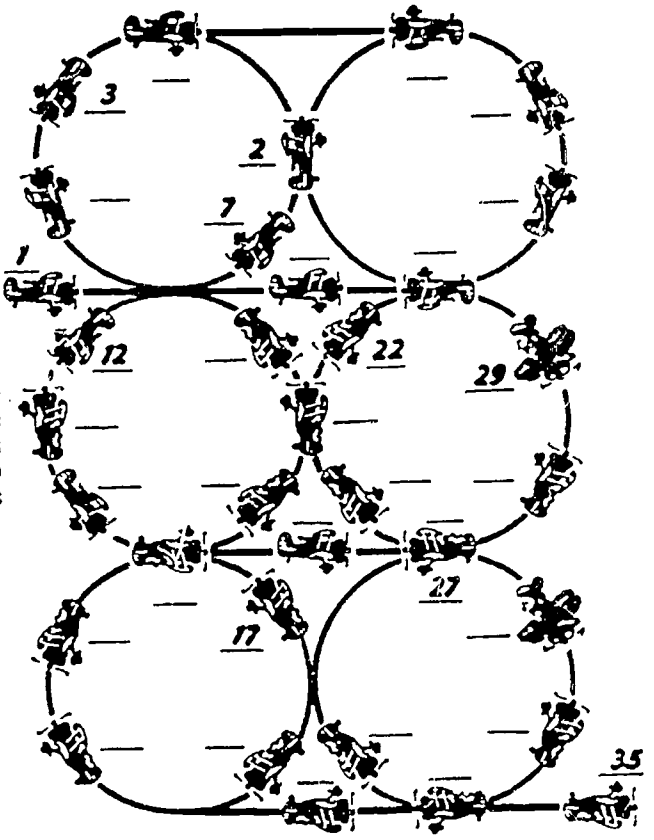
Puzzle

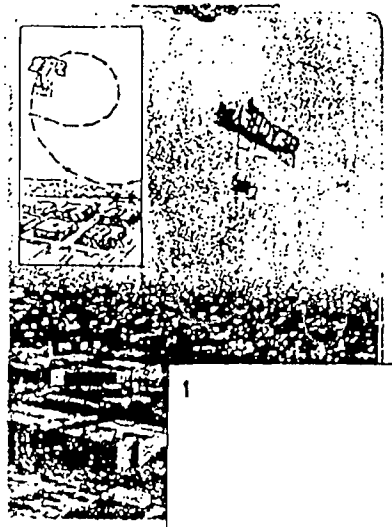
Flying Start

By Don Rubin

For your comfort and safety, please extinguish all smoking materials and make sure that all seat backs and tray tables are in their full, upright-and-locked positions. At this time, we'd like to call your attention to the small white bag in the seat pocket directly in front of you.

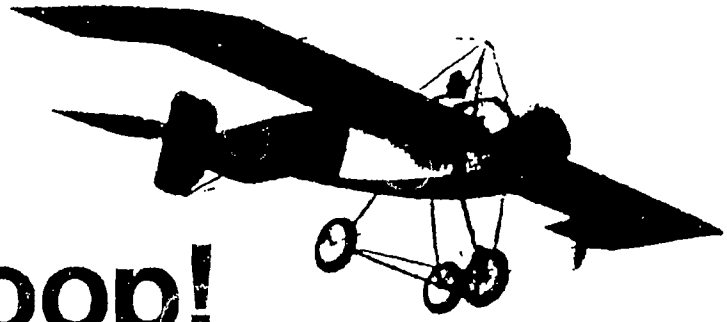
This puzzle is sort of an aerobatic connect-the-dots. Using our time-lapse illustration as a guide, and the numbers as clues, try to retrace the plane's stunts from start to finish.

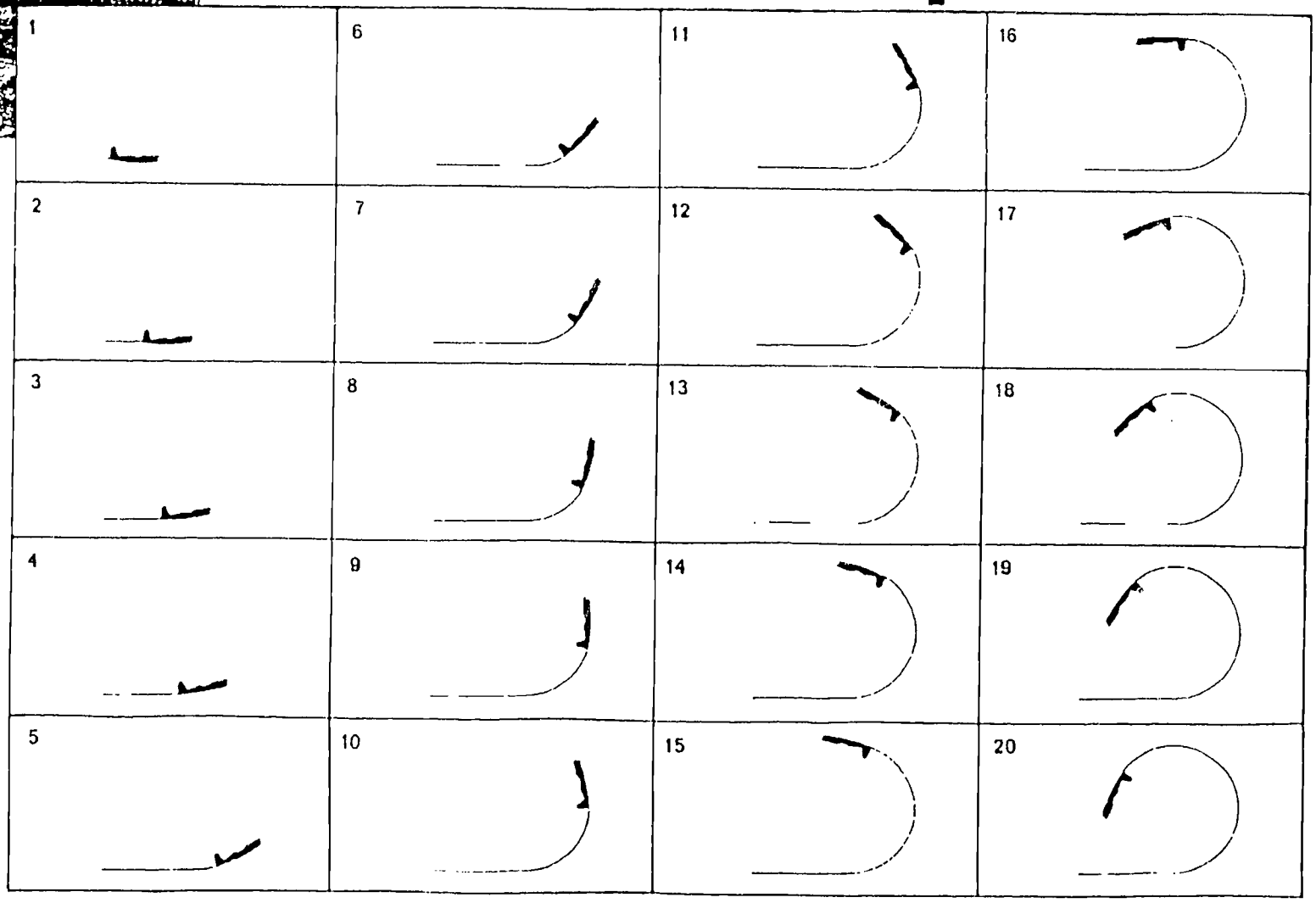




American exhibition pilot Lincoln Beachey (shown over San Francisco in his "Little Looper," Jan. 3, 1914, left) performed "death dives" and loops that earned him a reputation for utter fearlessness—and as much as $4,000 per week. Beachey was killed March 14, 1915, when he overstressed the wings of a new monoplane (right).

Fly a Perfect Loop!





Air & Space, Nov.-Dec. 1979

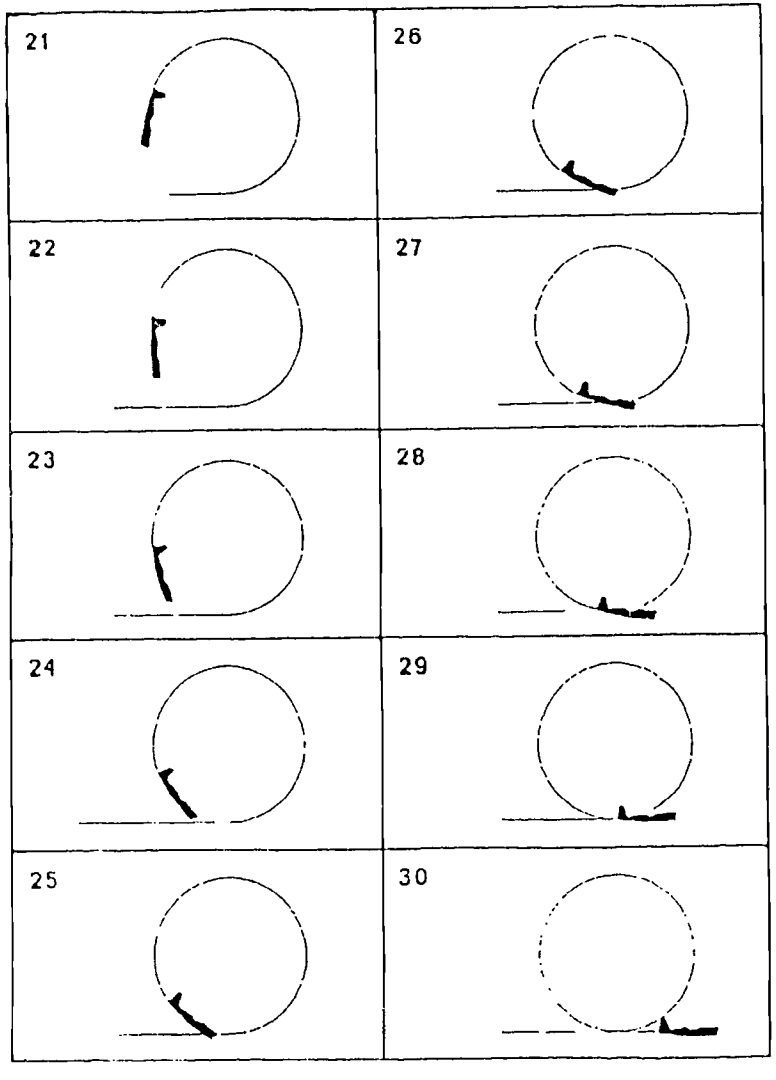
Air & Space, Nov.-Dec. 1979

The loop is one of the basic four aerobatic maneuvers (loop, roll, spin, and hammerhead or stall turn), and was one of the first aerobatic maneuvers successfully completed. Aerobatic pilots often use the loop in combination with other maneuvers to create complex three-dimensional patterns in the sky.

Flying a basic loop is easy. Flying a *perfect* loop, on the other hand, is nearly impossible. Most loops flown by beginners, or in less powerful airplanes, come out egg-shaped. The airplane flies through the beginning and the end of the loop at higher speed, so the bottom is rounder and larger. But by the time the airplane reaches the top of the loop, gravity and the high drag of maneuvering have slowed it considerably, so it loops more tightly at the top.

If the pilot keeps the airplane from drifting right or left during the loop, the airplane will tremble slightly at the bottom of the loop as it flies through the turbulence created by its propeller at the start of the loop.

Make this flip book—and "fly" a perfect loop, "flight" after "flight."



On your next visit to the National Air and Space Museum, see the mutascopes in the World War I gallery and the Social Impact of Flight gallery. These machines, popular early in the twentieth century, animate photographs like the flip book to illustrate aircraft maneuvers.

Student Activity

1. Make two copies of these pages by tracing, duplicating, or photocopying. (Two copies make a much smoother animation.)

2. Carefully cut the numbered pictures apart along the solid lines.

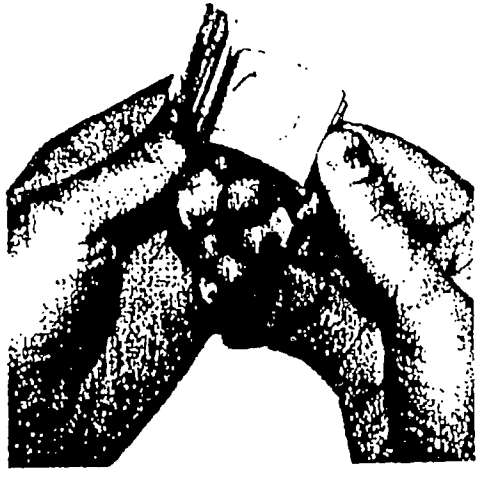
3. Stack the pictures in sequential order, with the two copies of Picture 1 on top, the two copies of Picture 2 next, and so forth.

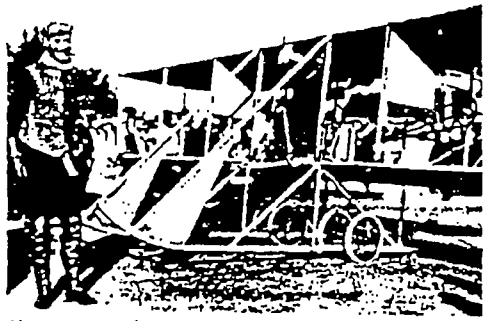
4. Tap the right edge of the stack of pictures on a hard flat surface to align them. Be sure that the right edge of the stack is as even as possible.

5. Staple the stack on the left margin. Try to keep the stack from shifting while stapling.

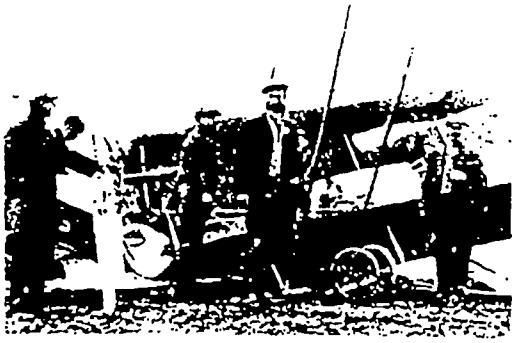
6. Hold the left side of the flip book in one hand. Flip the pages between the thumb and finger index of your other hand to see how an airplane performs a loop.

7. Look up other aerobatic maneuvers in the books listed elsewhere in this issue. Make your own flip book to show such maneuvers as the vertical roll, hammerhead turn, half roll, Immelmann turn, and chandelle.

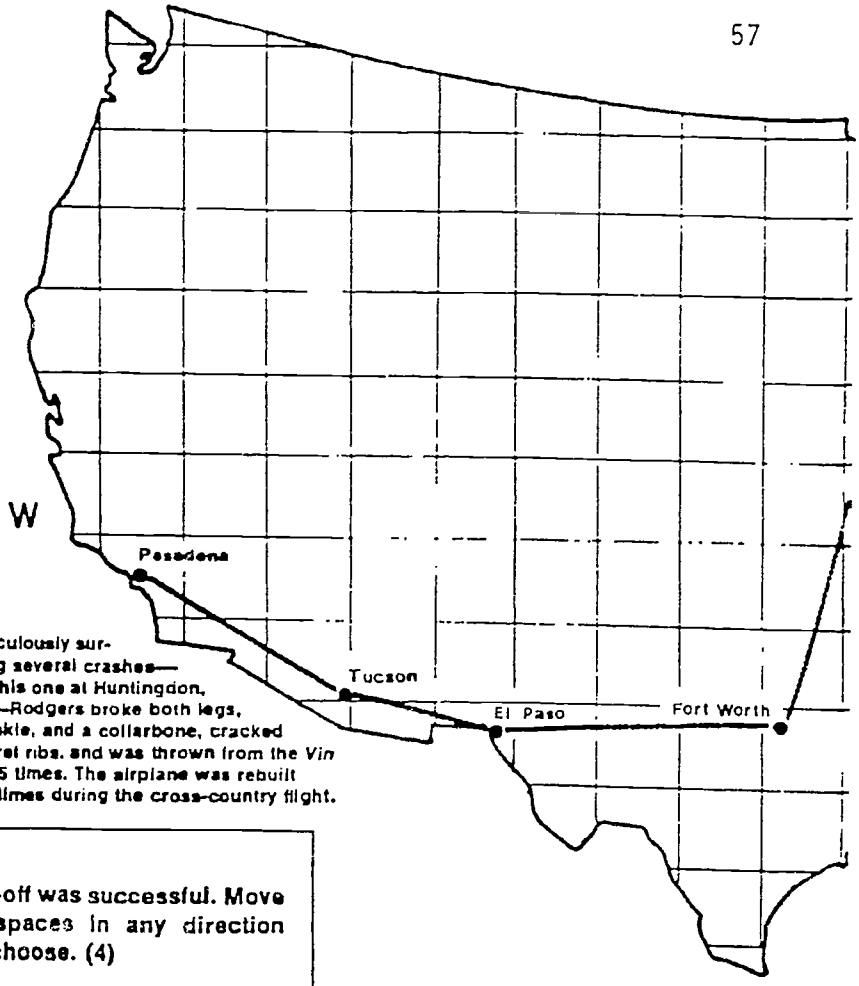




Newspapers jammed under his vest for extra warmth, Cal Rodgers enjoyed a seemingly ever-present cigar between flights. Here a mechanic makes last-minute adjustments to the *Vin Fiz*.



Miraculously surviving several crashes—like this one at Huntingdon, Ind.—Rodgers broke both legs, an ankle, and a collarbone, cracked several ribs, and was thrown from the *Vin Fiz* 15 times. The airplane was rebuilt four times during the cross-country flight.



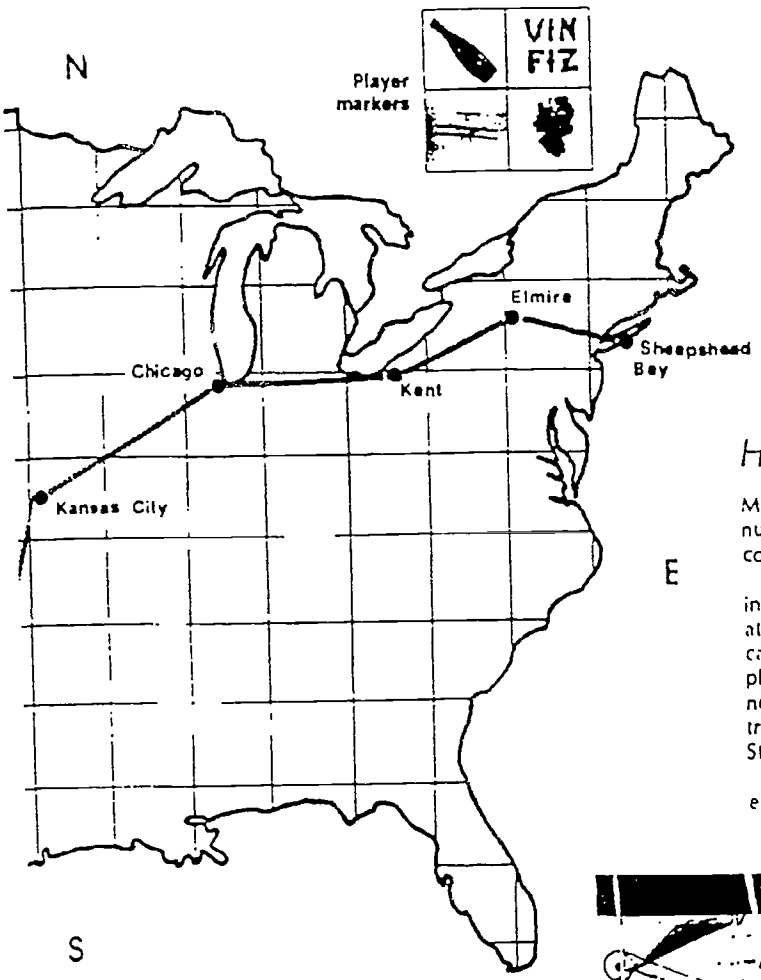
Souvenir hunters damage your airplane. Lose one turn. (2)	Take-off was successful. Move two spaces in any direction you choose. (4)
You recognize a landmark along the railroad tracks. You know you are on course. Move one space in any direction you choose. (3)	Move to Kent, Ohio. (1)
There is no safe place to land. Move one space south. (2)	The J. Ogden Armour Company gives you a bonus. Move two spaces in any direction you choose. (4)
The winds are in your favor. Move two spaces in any direction you choose. (4)	Move to Fort Worth, Texas. (1)
You are injured when a connecting rod in your engine breaks in flight. Move one space east. (2)	Good weather. Move one space in any direction you choose. (4)

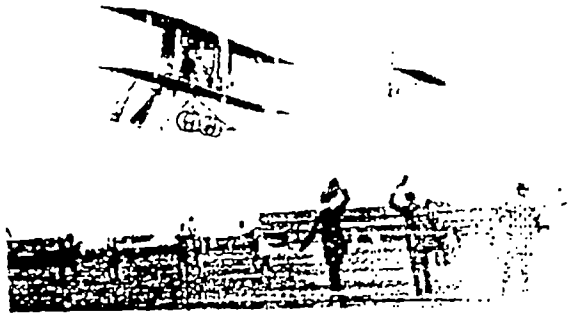
VIN Board

by JANET RUFF
NASA GSFC

Few men have met and conquered the obstacles that Calbraith Perry Rodgers faced in accepting the challenge of a coast-to-coast flight across the United States in 1911—fewer than 8 years after the Wright brothers made the first successful flights in an airplane.

William Randolph Hearst, publisher of the Los Angeles *Examiner*, offered a $50,000 prize to the first pilot to cross North America by air in 30 days. "Cal" Rodgers planned to compete for the prize by flying a Wright EX biplane. He received financial support for airplane parts, fuel, mechanics, a special





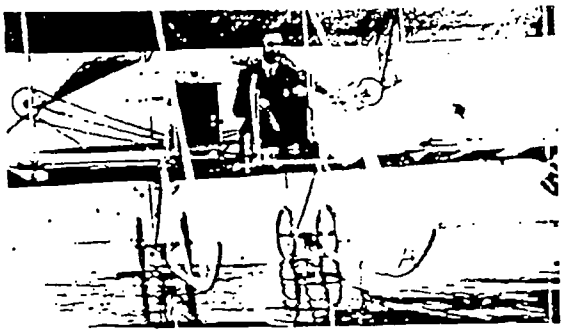
Well-wishers cheered Cal Rodgers as he lifted off from a grassy field in Sheepshead Bay, Long Island, on September 17, 1911.

How to Play the Game

Make photocopies of the flying cards and player markers. The number in parentheses on each flying card tells how many copies of that card to make.

Shuffle the flying cards. Place them face down on the playing surface. Two to four players can play. Each player begins at Sheepshead Bay. At each turn, the player selects a flying card and moves according to the directions on the card. Each player tries to arrive at Pasadena before the others. It is not necessary to try to follow the railroad tracks as Cal Rodgers tried to do. Keep markers inside the continental United States.

The game ends when a player reaches Pasadena, or at the end of 30 minutes.



Cal Rodgers felt his transcontinental trip would not be complete until he actually flew to the Pacific Ocean. On December 10, 1911, he taxied the *Vin Fiz* into the ocean off Long Beach, Calif. Note the crutches lashed to the top of his lower left wing; Rodgers was still recovering from a recent crash.

FIZ Game

railroad train, and other expenses from the J. Ogden Armour Company. In return for this financial support, Rodgers agreed to advertise the Armour Company's Vin Fiz grape soda drink. He painted the Vin Fiz name on the tail and wings of his airplane.

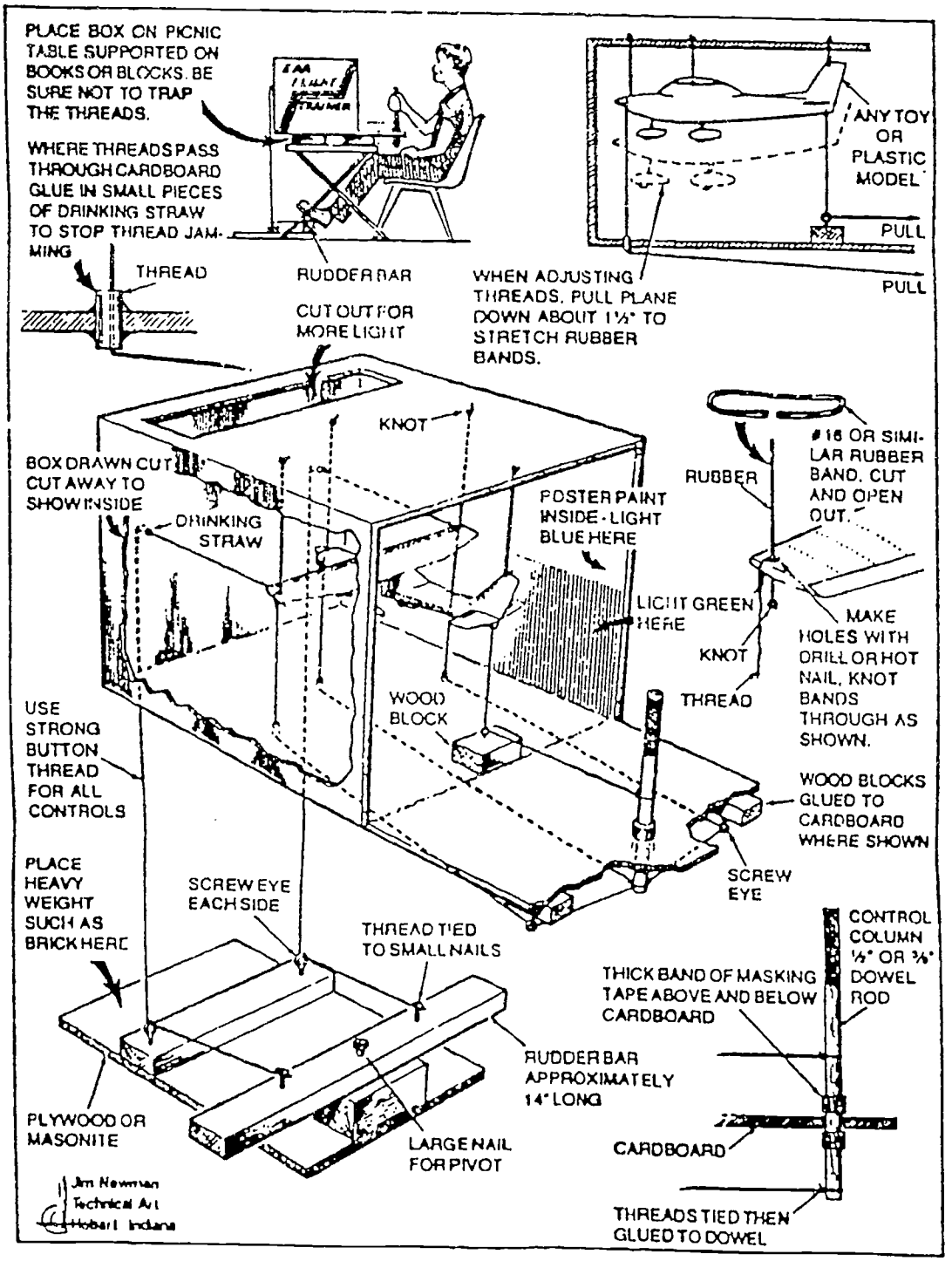
Rodgers took off from Sheepshead Bay, Long Island, N.Y., on September 17, 1911. Because of numerous crashes and other delays, his transcontinental flight to Pasadena, Calif., took 49 days, too long to win the Hearst prize. Nevertheless, Rodgers did become the first to fly across the continent, reaching Pasadena on November 5, 1911. Today the restored *Vin Fiz* hangs in the Pioneers of Flight gallery at the National Air and Space Museum.

Air & Space, Jan.-Feb. 1980

Your train with spare parts meets you near your landing spot—on time! Move one space in any direction you choose. (4)	You are attacked by an eagle in flight. Move one space north. (2)
Move to Kansas City, Missouri. (1)	You receive no advance weather reports. You are caught in the storm and must delay your flight. Lose one turn. (3)
You crashed on landing. You need a new wing and landing skids. Lose one turn. (3)	You are following the wrong railroad tracks. Move one space east. (2)

EAA FLIGHT SIMULATOR

From EAA Project Schoolflight News, February 1986
modified by Jim Newman, Hobart, IN



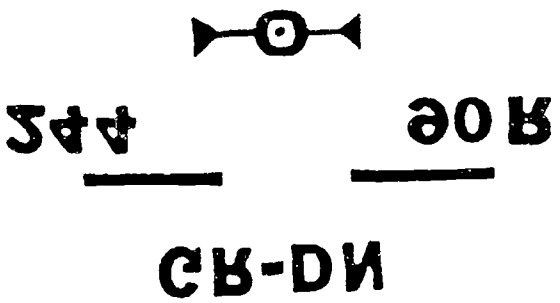
HEADS UP DISPLAY (HUD)

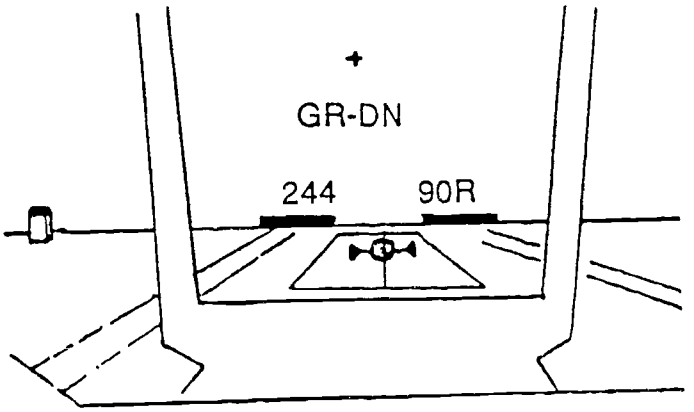
Heads Up Displays are devices that project information from an aircraft panel on to the windscreen so that a pilot can fly using visual **AND** instrument references at the same time. Some airlines and most if not all fighter aircraft use HUD's. For airliners in areas around airports pilots can watch for traffic and see the "numbers" at the same time. Fighter pilots receive target information and can see the target at the same time.

The Space Shuttle Orbiter also uses HUD for airspeed and altitude information. Attitude, heading, flair, as well as landing gear and horizon indications are also shown on the Shuttle HUD.

To see for yourself how a HUD works put this paper on the dash of a car with the top toward the front and at the same time you can see through the windshield and the numbers from an actual Shuttle simulator landing. You probably will not be able to focus on what you see outside and the HUD information at the same time. Past about 20' your eye focuses at infinity and the windshield is considerably closer. Real HUD's are focused at infinity.

244	airspeed in knots
90	altitude above ground (agl) in feet
R	rotation from 20° to 1.5° glide slope
GR-DN	landing gear is DOWN, pilots say "3 in the green"





COMPASS ROSE GAME
MAGNETIC COMPASS ACTIVITY

originally developed by
Mary Jo Oliver

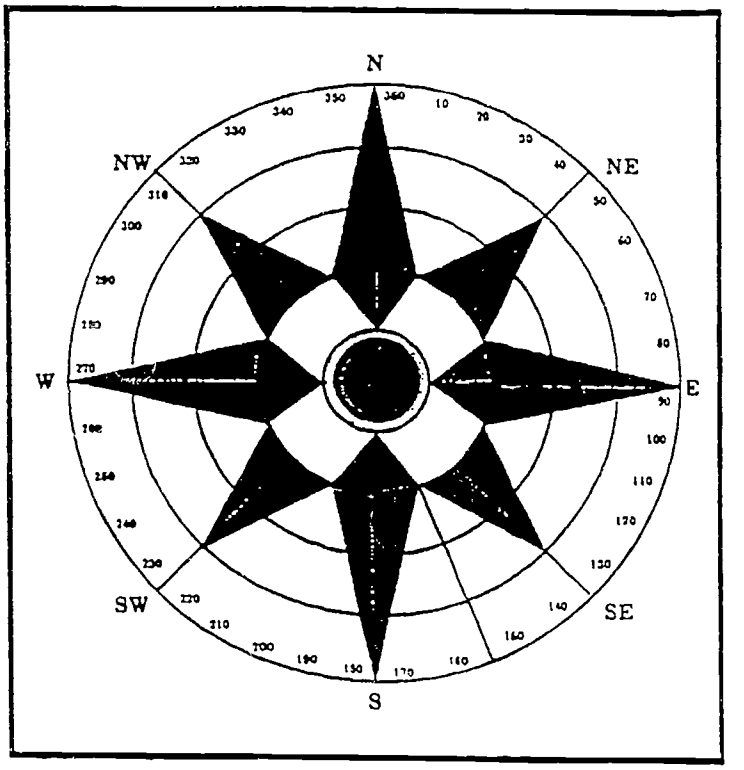
To find where one is, on or above the earth's surface, one needs to know about the magnetic compass. The compass has been used from aincent times, and today is still the primary instrument for air navigation. This activity is designed to help students gain a basic understanding of cardinal directions in coompass terms, and to transfer that knowledge into understandings of the circle, angles, and skills in identifying compass directions.

THE GAME

Draw a large compass rose on a large piece of butcher paper, or draw with chalk directly on the floor. Align north or 360° with true north. The students stand in the center of the compass rose.

Divide the cl;ass into teams and alternate members of each team in the center of the compass rose. Members of the other teams call out compass headings from 001° (one degree) to 360° to the student in the compass rose. The student in the compass rose turns RIGHT to face the direction called for. A circle is measured in degrees starting with 0° at the north, or top of the circle, and 90° is east, 180° south, 270° is west, and north is 0° or 360°.

Variations can b made for other skill levels. A student can be told to turn left or right a certain number of degrees from where he or she is standing. For example if the student is facing east or 090°, and is told to turn left to 020° he will turn 70° to his left. A good example is turning 180°, which faces the student in the opposite direction. Doing "a 180" often gets a pilot out of trouble, away from weather, etc..



compass rose

note:

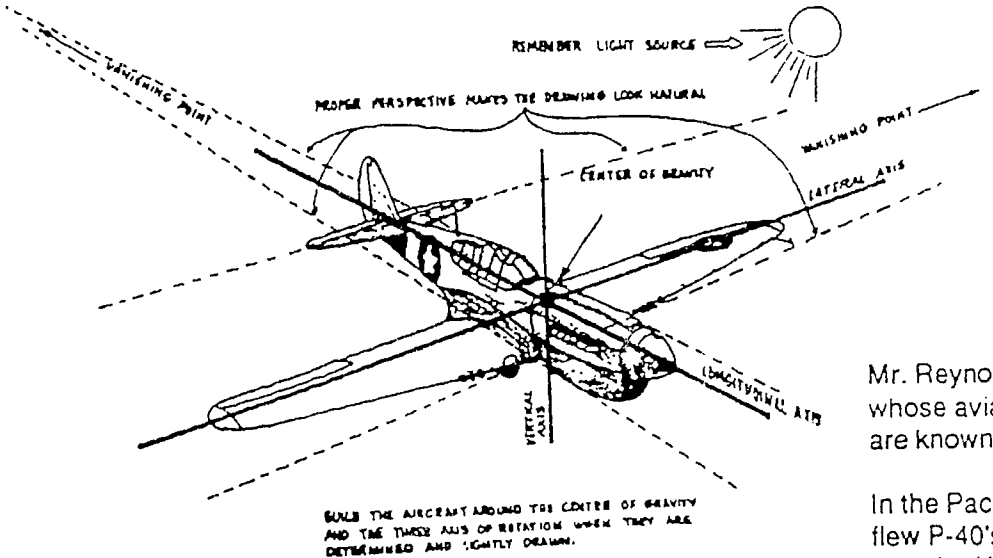
Compass headings are always written with three digits. One degree is written 001°, forty five degrees is 045°, and any heading above 100, such as 260°, just has the degree symbol "°" added. Orally the directions would be zero-zero-one degrees, or zero-four-five degrees, and two-six-zero degrees.

extended vocabulary:

magnetic variation	32 point compass
magnetic deviation	"box the compass"
magnetic dip	magnetic lines of force

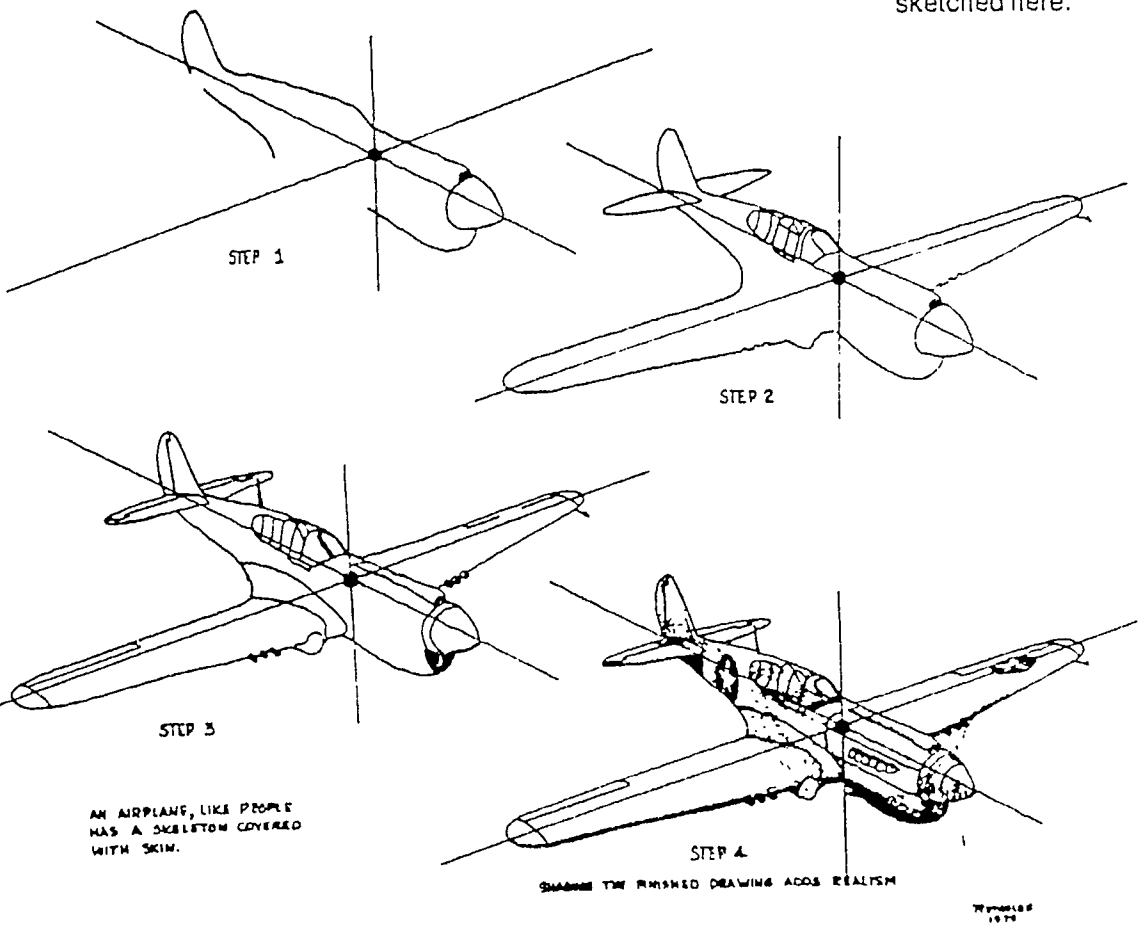
THE SECRET OF SKETCHING AIRCRAFT

Bill Reynolds, artist, fighter pilot, flight instructor, aerospace educator, has taught many a teacher how to awe the class by nonchalantly chalking a fine, full-bodied aircraft on the blackboard. The way to do it is herewith revealed.



Mr. Reynolds is an artist whose aviation paintings are known world wide.

In the Pacific in WWII he flew P-40's, the plane sketched here.



Air & Space, May-June 1979

Buoyancy

The principle of BUOYANCY is easily explained but often misunderstood.

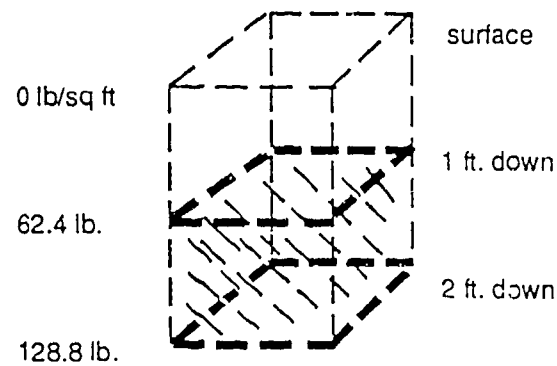
A submarine submerged in water, or the Goodyear Blimp submerged in air, or a boat floating in water, or a toy helium filled balloon submerged in air all have an apparent loss of weight due to buoyancy (It is either that or gravity has been reduced or eliminated).

This phenomenon is due to an upward "buoyant force" that is a consequence of pressure increasing with depth. Simply stated the push upward on the bottom of the object is greater than the push downward on the top. If the net upward force is greater than the weight of the object it will rise, a toy balloon for example. If the forces are equal, the object stays at the same place—a submarine for example. If the upward force is less than the weight of the object the object falls—Jimmy Hoffa with concrete overshoes for example.

To find the amount of the buoyant force you need to know the volume of fluid (water, air, etc.) displaced. A submarine displaces a volume of water equal to its volume. The Goodyear Blimp displaces a volume of air equal to its volume. And if you think about it for a second, maybe a minute, an hour?————————EU-REKA!!————————the buoyant force on the submerged (or floating) object is equal to the weight of the displaced volume of fluid. Of course, it is Archimedes Principle.

For example:

One cubic foot of water weighs 62.4 lbs. so one foot down the pressure on one sq. ft. is 62.4 lb. Go done one more foot now you have two cubic feet of water above you so the pressure on one sq. ft. is 124.8 lbs. Now displace the cubic foot of water with a cubic foot of frog hair the pressure on top of the frog hair is 62.4 lbs. and the pressure on the bottom is 124.8 lbs. so the frog hair is buoyed up with a force of 62.4 lbs. (Since frog hair is weightless it rises.) Make up your own example at any depth and the buoyant force for water is 62.4 lbs. per cu. ft.



For air the value of the buoyant force is 1.2 ounces per cubic foot. Air has no definite surface but the pressure decreases with altitude thus the buoyant force decreases with altitude. For a balloon, a gas (eight helium or low density hot air) is inside so the outside pressure will not cause it to collapse. With increased altitude the inside pressure relative to the outside pressure increases and the balloon expands. This is why high altitude balloons appear under-inflated at launch.

reference:

Conceptual Physics, Paul G. Hewitt, Little Brown and Company, N.Y., 1977. (This is the best "conceptual" physics book ever written.)

BALLOONS: AS EASY AS LTA
Hot Air Balloons: Quick & Easy

LTA stands for lighter-than-air, and refers to hot air balloons, gas balloons, aerostats, and blimps. This hot air balloon is easy to make and is a good indoor demonstration balloon.

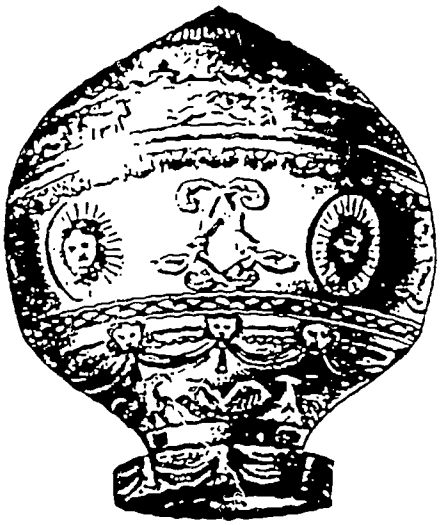
directions:

1. The balloon bag is made from a dry cleaner's plastic bag. Most any other plastic bag is too heavy. The bags from dry cleaners come off a roll and the top has perforations which must be sealed. A hot iron will do a good job if you do not put the hot iron on the plastic itself. Make a newspaper sandwich with the top of the plastic bag between two sheets of newspaper. Iron through the newspaper and the heat will melt the plastic enough to seal the top of your balloon.

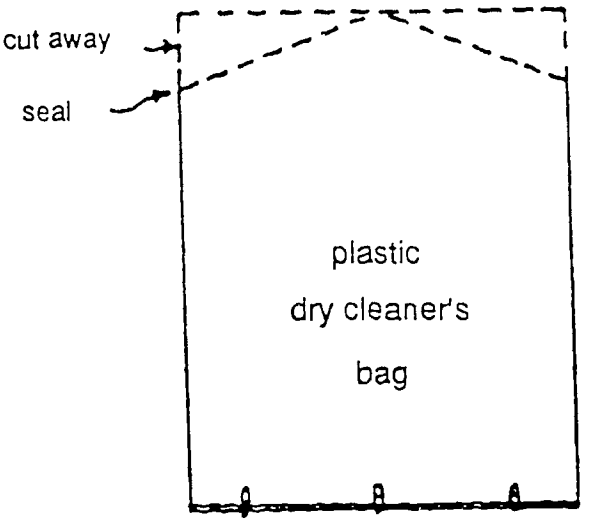
2. Using cheap cellophane tape, put a layer around the bottom edge of your balloon. This does two things, it makes the balloon easier to handle, and it adds weight to the bottom to provide a gravity gradient. You know, the heavy end falls.

3. Add four paper clips evenly around the bottom of the balloon. They can be moved to balance out any mass anomalies. One side of the bag is often heavier than the other. And again the mass of the clips adds to the gravity gradient.

4. Using some heat source, fill the balloon with hot air. A propane torch works well if you don't let the flame get close to the plastic. When the air inside the balloon is warmed the balloon will ascend, then descend when the air cools, and it cools quickly. If you are careful, very very careful you can reheat the air inside the balloon as it descends.



First manned flight, 21 Nov 1783
Francois Pilatre de Rozier and the Marquis d'Arlandes, in a Montgolfier hot air balloon



tape & paper clips

A Montgolfi....What? (Hot Air Balloon)

1. Use posterboard or other stiff material to make a gore template as shown in figure 1.

2. Put template on top of 10 sheets of tissue each at least nine (9) feet long. Cut around the template to make the ten gores needed.

3. Decorate the balloon using felt tip pens and/or designs cut from colored tissue. WARNING. Do not use pens with water soluble ink, it dissolves the tissue. The rule is, if the ink stinks, it is OK.

4. Slide the top gore #1 about a half inch to the side of gore #2 as pictured in figure 2.

5. Carefully, I repeat CAREFULLY fold the margin of gore #2 OVER gore #1. Now glue that fold of #2 to #1. A glue stick works best. ROSS Pritt works well.

6. You have one edge of gore #1 bonded to one edge of gore #2. Now slide the 1-2 combination about a half inch to the side of gore #3, moving in the opposite direction as before to alternate glued edges. As before, fold the open edge of #3 over #2 and glue. Be careful here to NOT glue the free edge of #1 to #3. BE CAREFUL TO KEEP THE FREE EDGE OF #1 FREE. (figure 3)

7. Continue alternating and gluing 4 over 3, 5 over 4, etc. until the only free edges are one on #1 and one one #10. Glue these together. Congratulations you have made a paper bag.

8. Grab about six inches of the ragged looking top, the small end, and tie it with string. Also tie a loop in the string.

9. Use two all wire coat hangers to make a loop that will fit inside the base and glue it in by overlapping the tissue about one inch.

10. Using the loop in the string hang the balloon and inflate it with a hair dryer or small fan. Check for unglued seams, holes, and tears and reglue or repair with small bits of tissue.

11. Inflate the balloon using a propane cook stove with a piece of six inch diameter stove pipe over the burner. Two or more people are required for this step. Indoors. three good hair dryers will fly the balloon in a gym. Four is better. and three heat guns is even better.

12. When the balloon inflates and begins to be buoyant, you are holding it DOWN, not up, do the most important thing of all.....let it go.

NOTES:

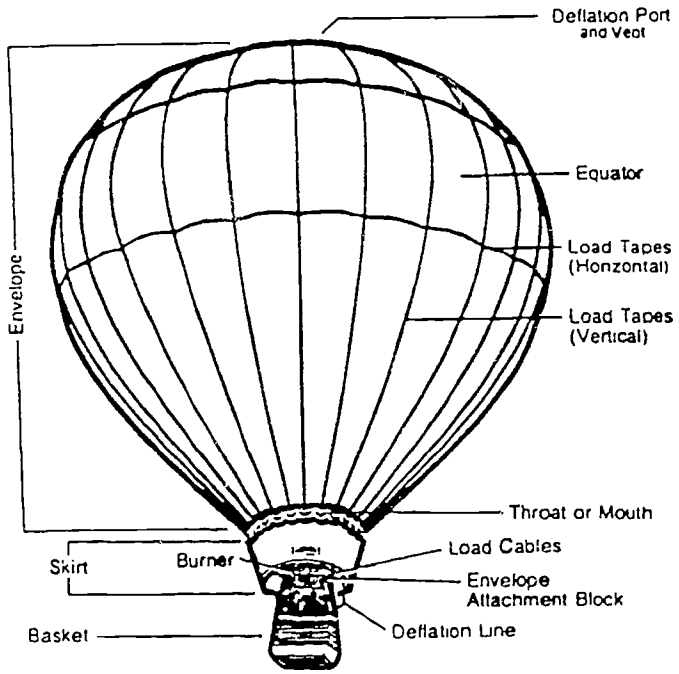
Tissue can be found most anywhere in packs of 10 sheets 20" by 28" These come in many colors but must be joined to form the 9' gores. It is easier to buy a roll of jewelers tissue20" wide by a hundred or more feet long. You can have any color you wantas long as it is white.
Order from:

Mr. Darryl Clark
Crystal Tissue Company
Middletown, OH 45042
513-423-0731
(a 20" x 9" dia roll costs
about $35)

If the order takers at Crystal Tissue give you a hard time. Ask for Mr. Clark, he will clear your order.

The hoop is made by cutting away the really bent parts bending circular and taping together to fit. Size varies with glue joint overlap.

After the first three gores are bonded the others are easy. The learning curve drops rapidly.



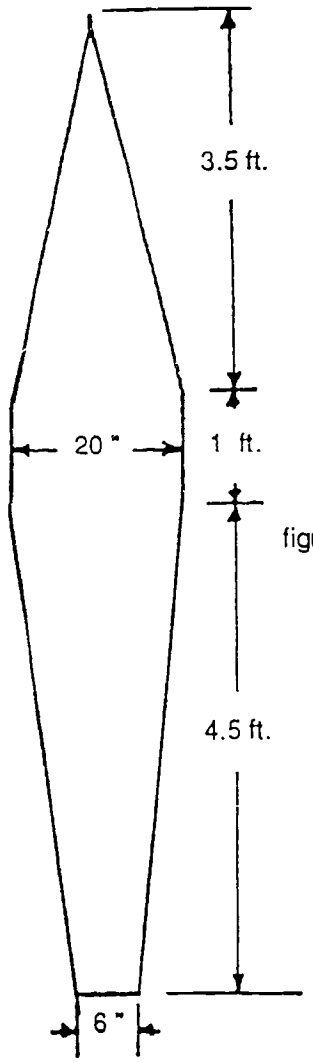


figure 1

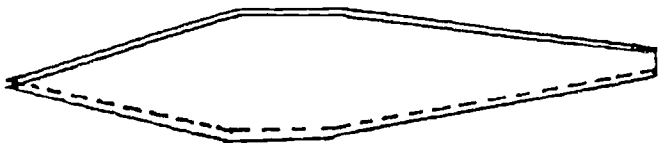


figure 2

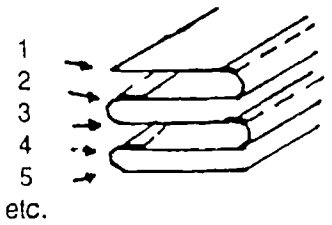
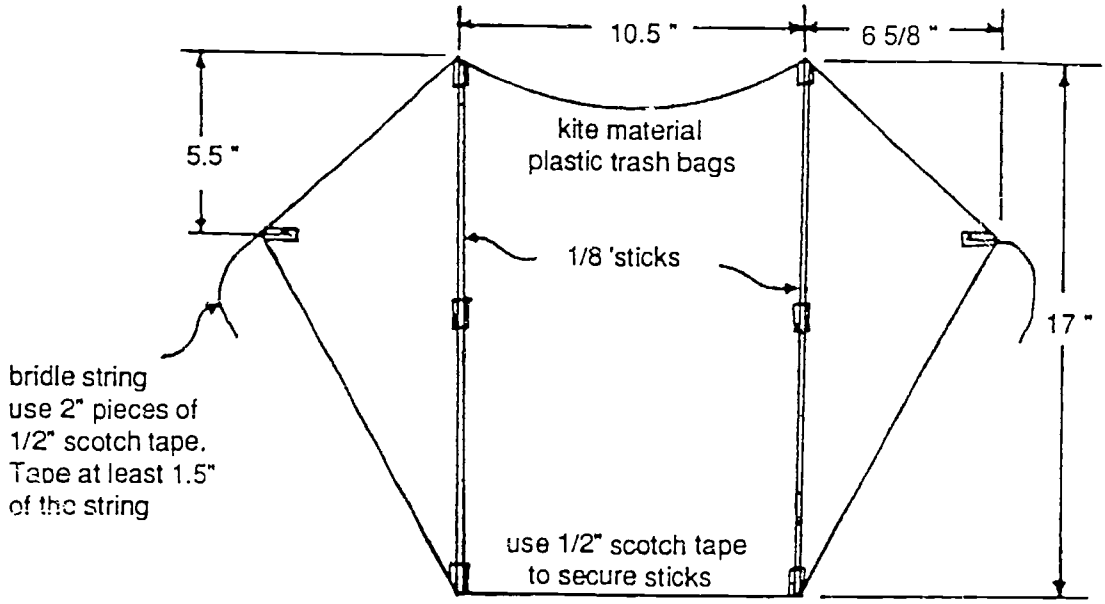


figure 3

SLED KITE
snow
optional

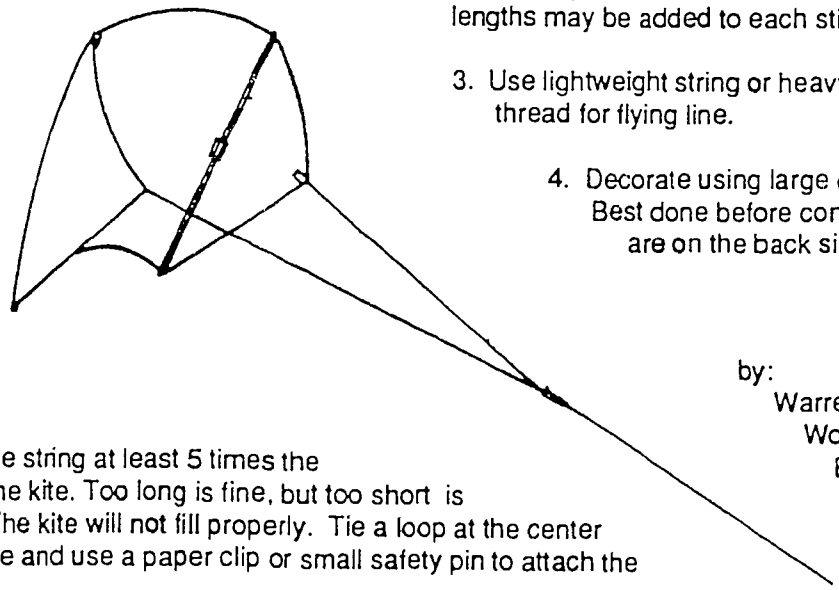


notes: 1. Drawing is not to scale.

2. Tails not required, but colorful 2 to 3 feet lengths may be added to each stick.

3. Use lightweight string or heavy thread for flying line.

4. Decorate using large designs on front face. Best done before construction. The sticks are on the back side.



Bridle:
Make Bridle string at least 5 times the length of the kite. Too long is fine, but too short is a no no. The kite will not fill properly. Tie a loop at the center of the bridle and use a paper clip or small safety pin to attach the flying line.

by:
Warren Bailey
World Wide Games, Inc.
Box 450
Delaware, OH 43015
614-369-9630

Fold here and tape

HARRINGTON HAWK

HOTEL HARRINGTON, WASHINGTON, D.C.

Tape along here

PUT FOLDED-UP ROLL ON TOP FOR STEADY FLIGHTS OR BOTTOM FOR LIVELY FLIGHTS

WATCH OUT FOR THE FOURTH FOLD!

Twist here to cure turns in finished plane

Tape along here

Fold here and tape

Cut all along this line

Bend up (or down) on this line

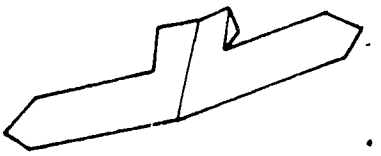
Bend up on dotted lines for loops

Bend up slightly on this line

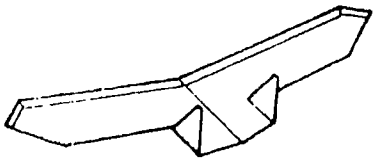
Bend up on dotted lines for loops

Bend up (or down) on this line

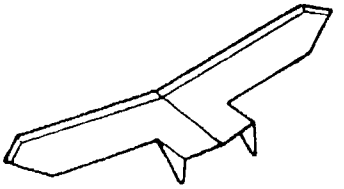
first fold second fold third fold fourth fold fifth fold sixth fold seventh fold eighth fold ninth fold tenth fold



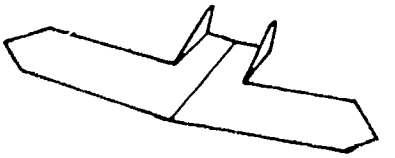
Leading edge roll on underside gives livelier flights



Fins-up is more durable



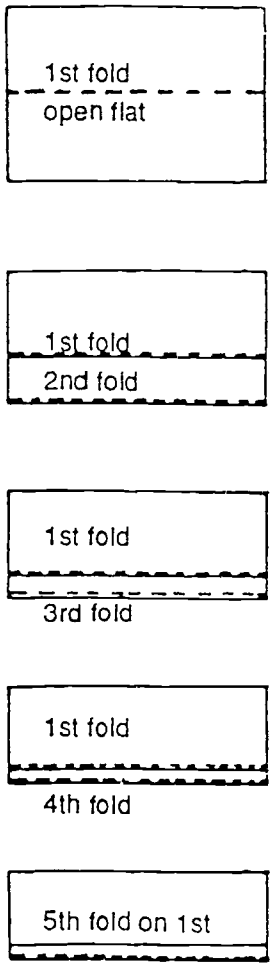
Fins-down flies better



SPINNER GLIDER

AERO DIGEST JULY 1932

This is a simple glider made from a single 8.5 by 11 inch sheet of paper. Start by floding the paper in half the long way, then what is left in half. Make four folds this way then the fifth fold on the original fold.



Bend the trailing edge up slightly, then bend the center to give a "vee" shape, called **DIHEDRAL**, to the glider. (fig. 1) Dihedral usually gives **STABILITY** to an airplane, but when you fly this model, and it starts to turn, you will find out why it is called the "**SPINNER.**"

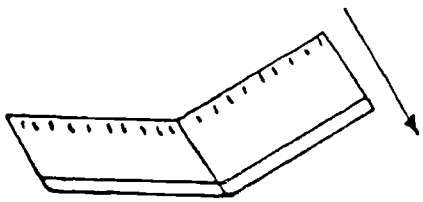


Fig. 1 unstable form

Refold as shown in fig. 2 to have a stable glider.

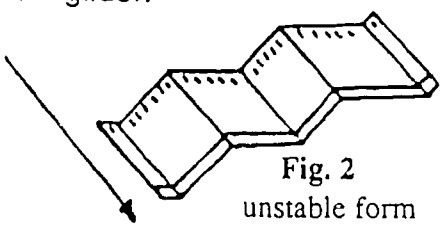
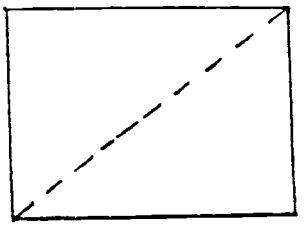


Fig. 2
unstable form

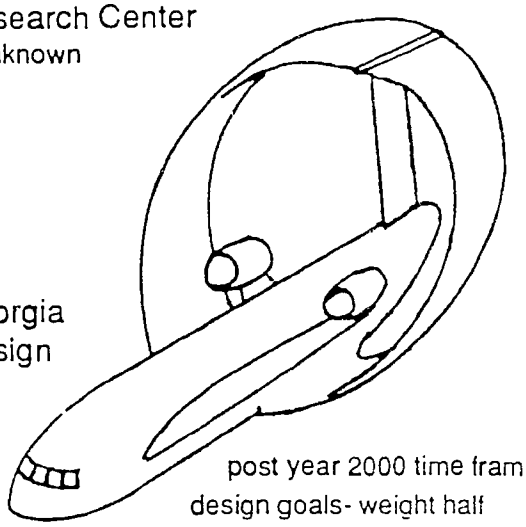
RING WING AIRCRAFT

Model made famous by George Allison
NASA Langley Research Center
developer unknown

1.

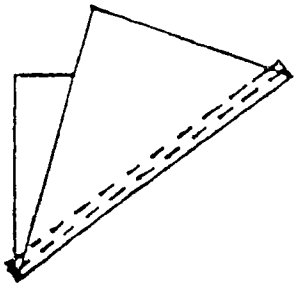


NASA
Lockheed-Georgia
Ring Wing design



post year 2000 time frame
design goals- weight half
conventional aircraft, better payload

2.



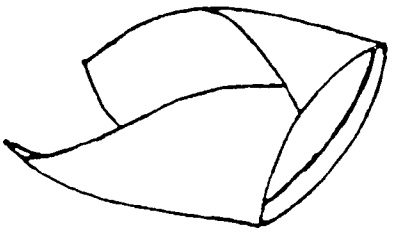
Construction:

1. Fold typing or similar size/weight paper diagonally

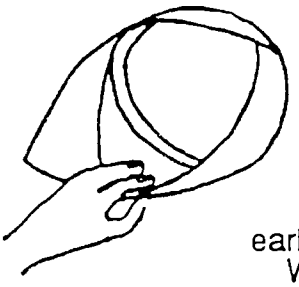
2. Make two or more folds on front, each about one half inch wide.

3. With the fold on the inside, form the paper into a circle. Slip one pointy end into the other.

3.

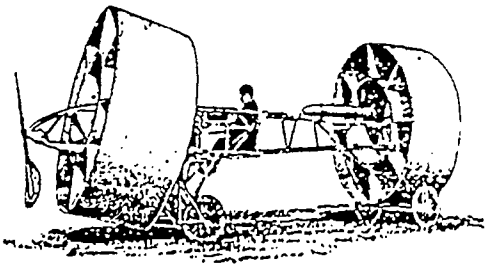


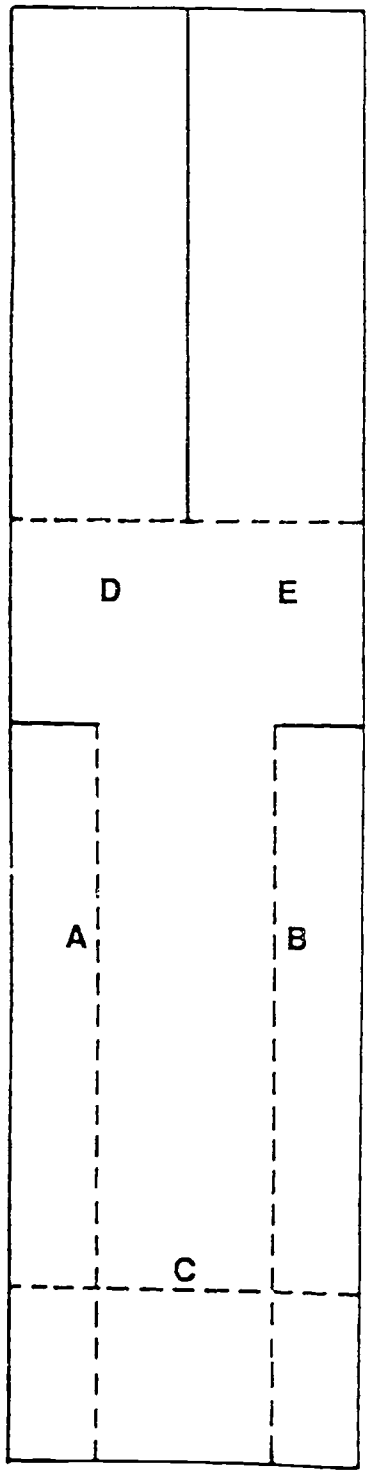
4.



To fly the ring wing hold with two fingers on top of the "vee", the thumb on the bottom, and toss with a smo-o-o-th follow through. Too much speed or the lack of a follow through are no no's.

early French Ring
Wing design





PAPER GYROGLIDER

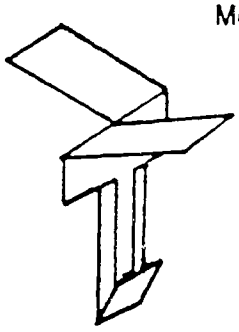
designer/developer **GKW**

instructions:

Cut all solid lines.
Fold all dotted lines.

A & B fold inward.
C folds upward.
D folds forward.
E folds backward.

Mother Nature's GYRO
maple seed



When it looks like this, then hold this puppy up by its floppy ears and drop it from the highest place you can find, or are comfortable being on the edge of.

The model will **AUTOROTATE** to the ground, as does a maple seed in the Spring.

Fine print:

1. This type model is usually called a helicopter, but a helicopter has a powered rotor to generate lift. If a helicopter loses power the helicopter is able to land safely because the rotor autorotates.

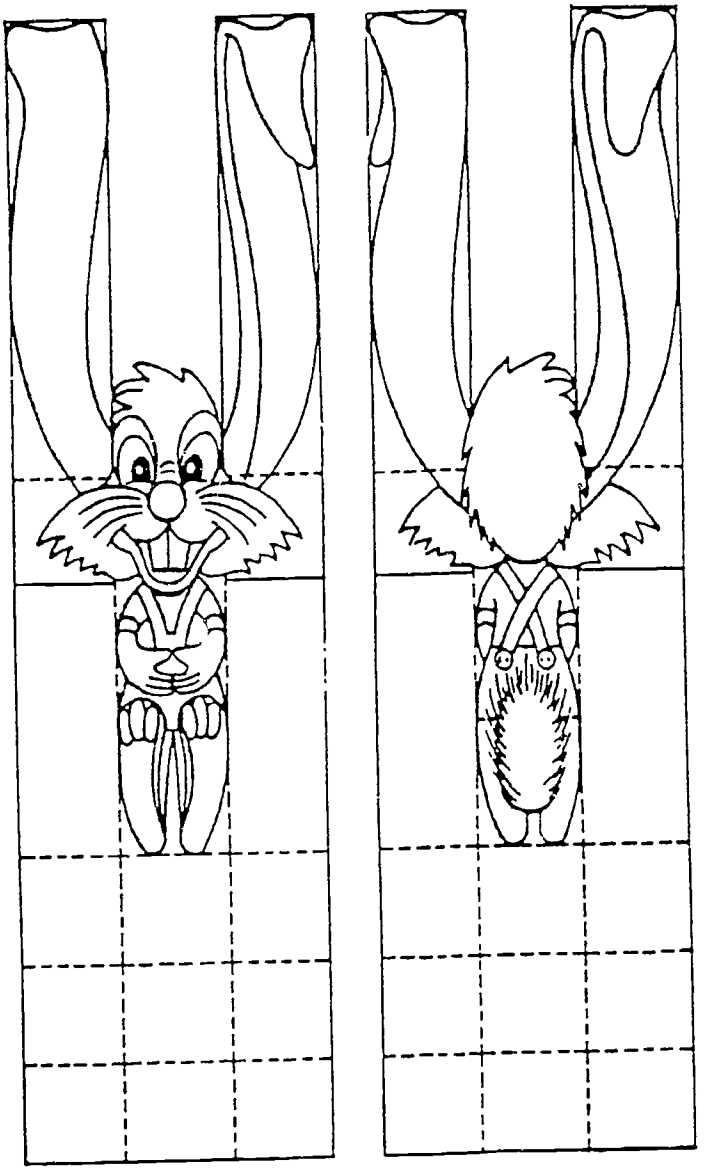
2. This model was developed in a lonely, dreary motel room, and the achieved goal was a model that needed neither weights nor tape to fly well. No ruler was available so a pilot's plotter was used as a straight edge and length measurement tool. Thus the dimensions of the model are 12 nm by 50 nm using the 1/500,000 **SECTIONAL** scale.

HOPS, the High Jumping Rabbit

designer/developer: Brian Hawkins
NASA/AESP LeRC 19??

Instructions:

1. Color Hops with crayons.
2. Cut out the rabbit very carefully. Cut only on the outside edges.
3. Paste front to back. Glue sticks work best.
4. Fold along bottom dotted lines. Staple to hold shape.
5. Bend one ear back and one ear forward.
6. Hold Hops up high and let him go. He will spin wildly to the floor.



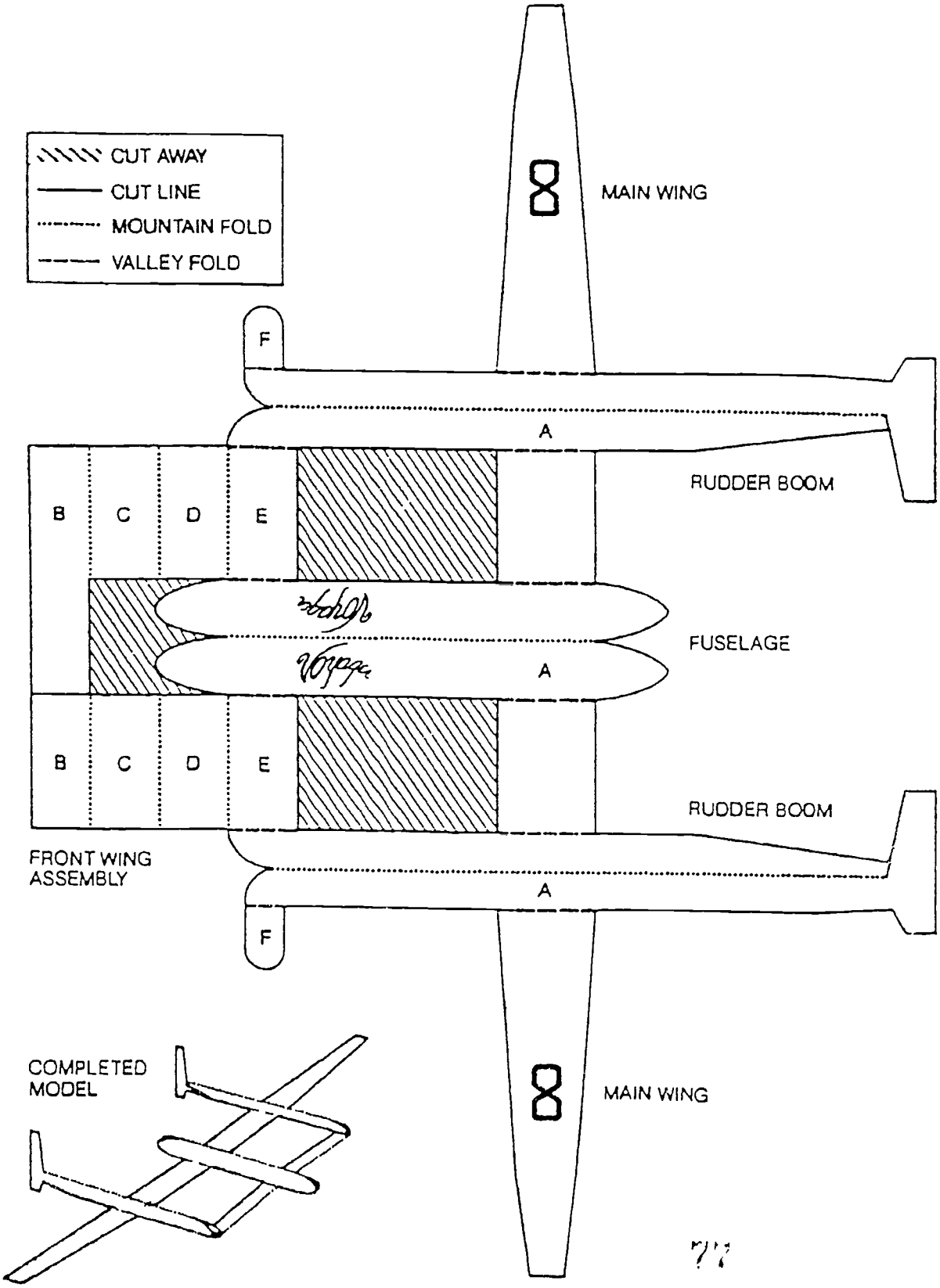
HOPS JUMPS HIGH
AS HIGH AS HIGH
CAN BE

HOPS JUST JUMPED
AWAY FROM ME.

VOYAGER

AROUND THE WORLD ON ONE TANK OF GAS

flight: 14 - 23 DEC 1986, 9 d 3 min 44 sec
pilots: Dick Rutan & Jenna Yeager
24,986.664 miles

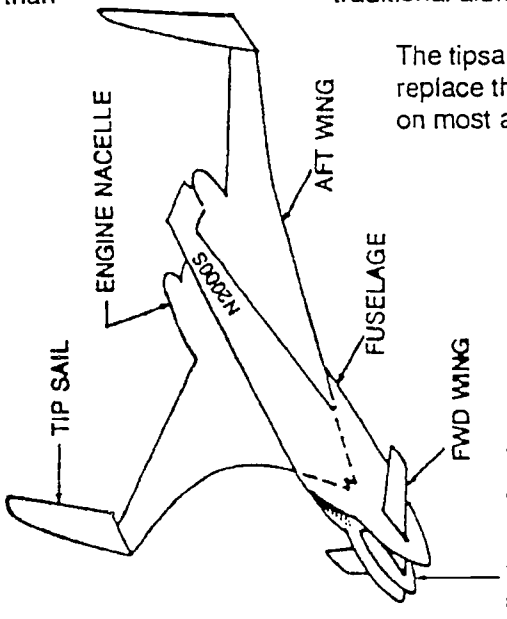


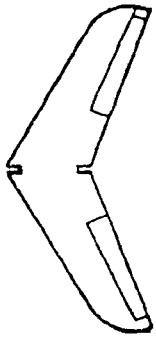
BEECH STARSHIP

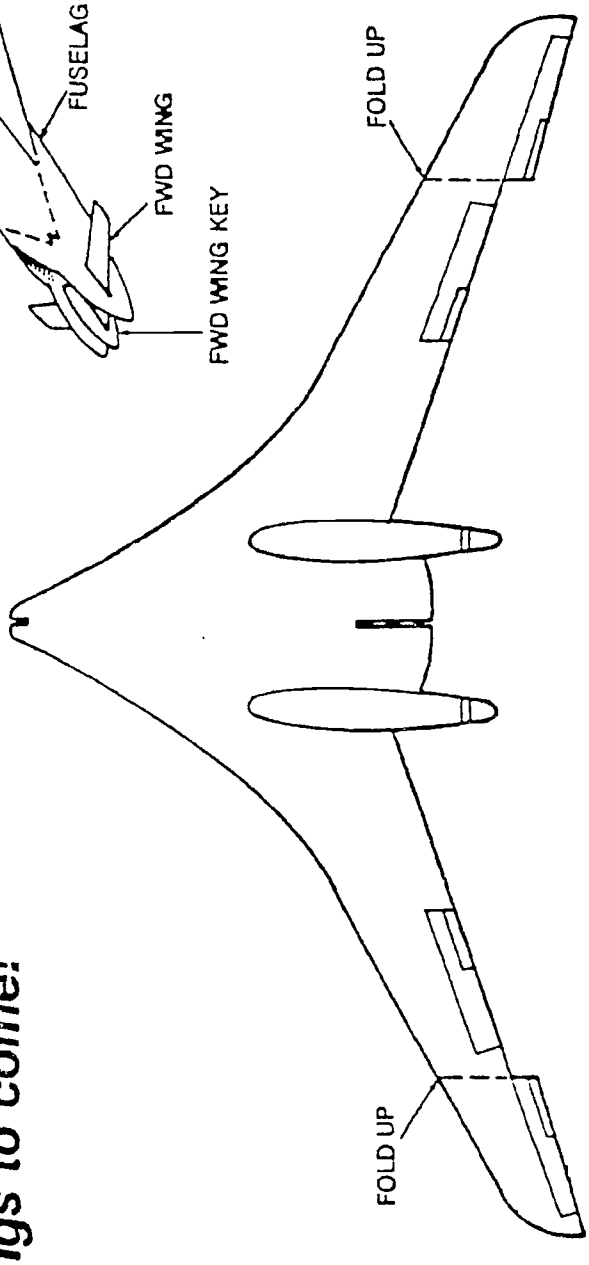
THE FIRST ALL-COMPOSITE PRESSURIZED AIRCRAFT TO GO INTO PRODUCTION

The Starship is constructed of layers of graphite fabric surrounding a core of honeycombed Nomex. Using adhesive resins and cured under high temperature and pressure, the resulting structure is stronger and lighter than traditional aluminumstructures.

The tipsails (winglets) and canard replace the conventional "tail" seen on most aircraft.



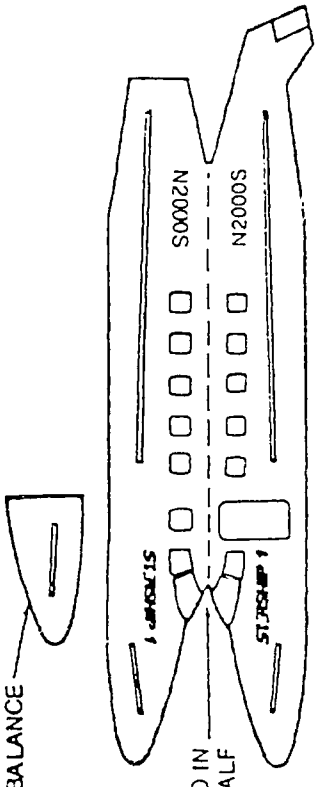




Assembling Instructions:

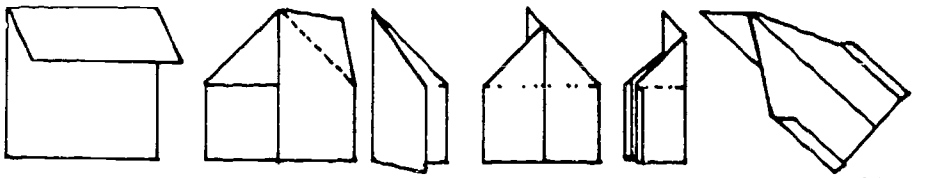
- Punch out the four pieces to the Beechcraft Starship.
- Fold fuselage in half along the dotted line.
- Insert the forward wing key between the front fuselage halves and slide the forward wing through the slots. The key will serve as a balance.
- Slide the aft wing through the aft slots.
- Squeeze the fuselage halves together and adjust the wings to lock into place.
- Fold the tip sails on the aft wing upward along the dotted line.
- The engine nacelles and/or forward wing may be adjusted for pitch trim.
- HAVE FUN!

Beechcraft
A Raytheon Company



Beechcraft
STARSHIP 1

. . . . the shape of things to come!



How To Fold Your Delta Glider

1. Fold inward along line 1.
2. Fold top corners inward along lines 2 to meet at line 3.
3. Fold inward along line 3.
4. Fold wings out from fuselage along lines 4.
5. Fold wingtips up along lines 5.
6. Have a nice flight.

TEAR ALONG DOTTED LINE

THE DELTA STORY

Delta ranks among the top five U.S. airlines in size.

The Delta route system spans the United States and reaches to Canada, the Caribbean and across the Atlantic, serving 85 places in 32 states, Puerto Rico and five foreign nations. International destinations are Canada, Bermuda, the Bahamas, the United Kingdom and Federal Republic of Germany.

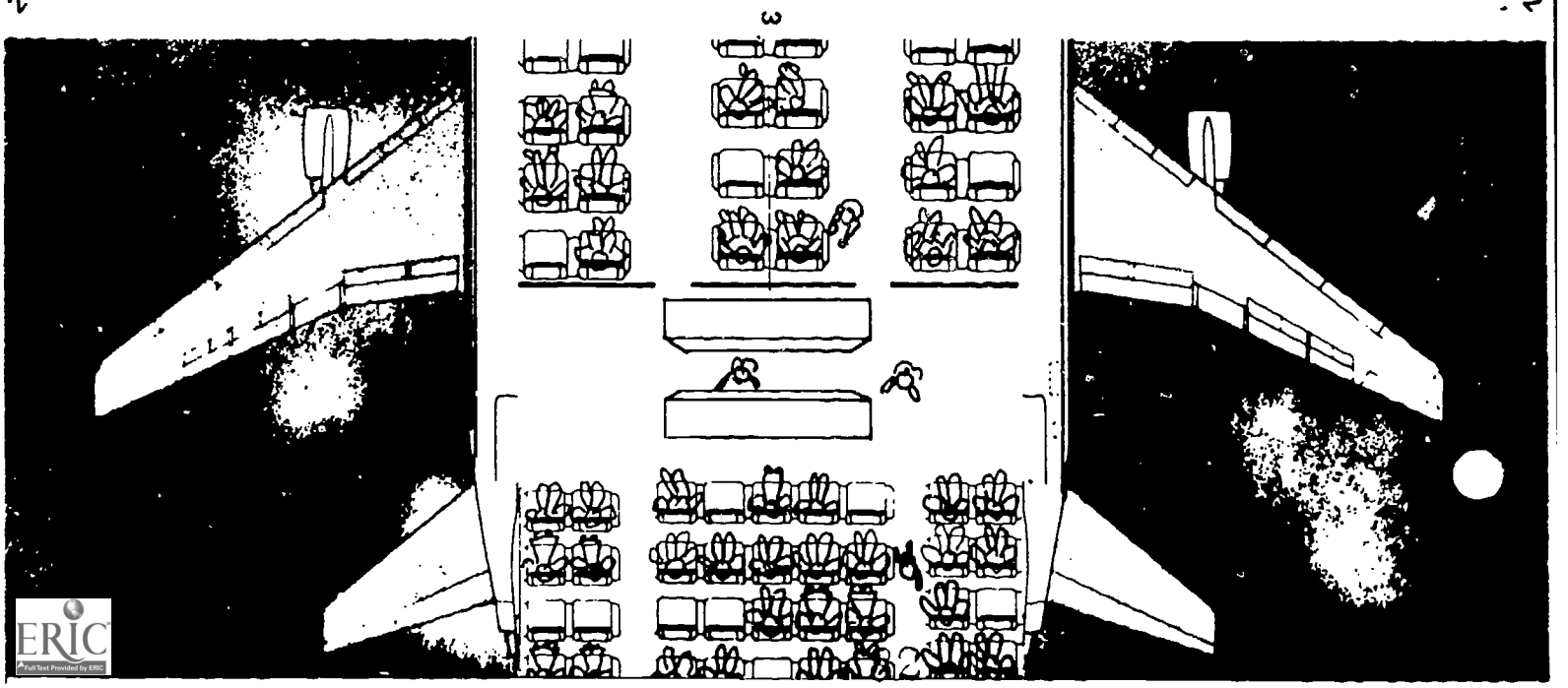
The Delta fleet of modern jets is comprised of the world's most modern aircraft. A leader in the jet field throughout the years, Delta has a fleet consisting of the:

Lockheed L-1011-1 and Lockheed L-1011-500
Douglas Super DC8-61
Boeing 727
Douglas Super DC9
In 1982 Delta will add the new Boeing 767 and in 1984 the new Boeing 757

Delta operates over 1500 flights daily.

Delta's 35,000 employees, each one a professional, are ready to provide Delta passengers the best in service, comfort, courtesy and efficiency. Delta professionals are people who know their jobs, enjoy people, and want to make friends for Delta Air Lines.

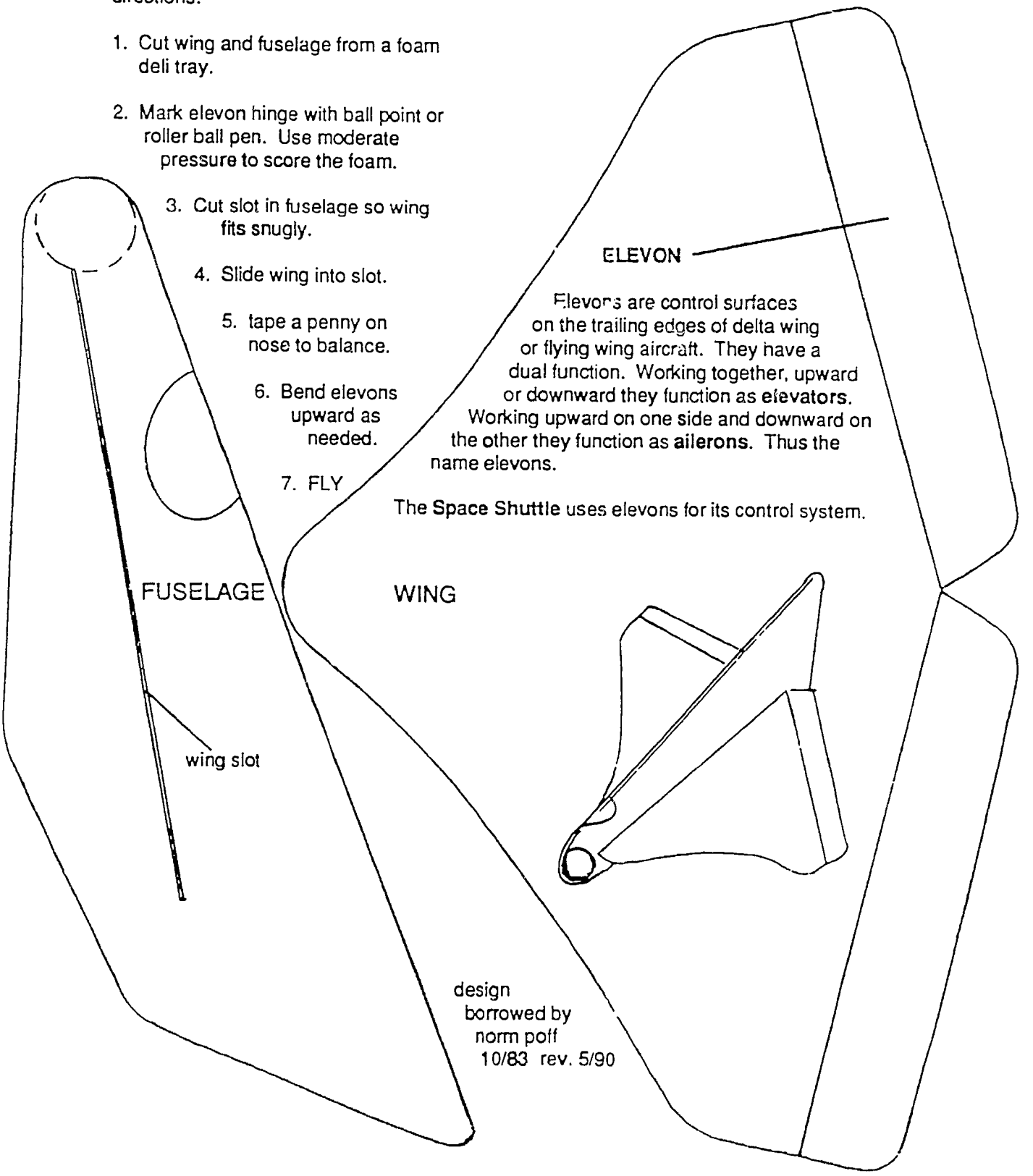
Delta is ready when you are.



STAR GLIDER

directions:

1. Cut wing and fuselage from a foam deli tray.
2. Mark elevon hinge with ball point or roller ball pen. Use moderate pressure to score the foam.
3. Cut slot in fuselage so wing fits snugly.
4. Slide wing into slot.
5. tape a penny on nose to balance.
6. Bend elevons upward as needed.
7. FLY



Elevons are control surfaces on the trailing edges of delta wing or flying wing aircraft. They have a dual function. Working together, upward or downward they function as **elevators**. Working upward on one side and downward on the other they function as **ailerons**. Thus the name elevons.

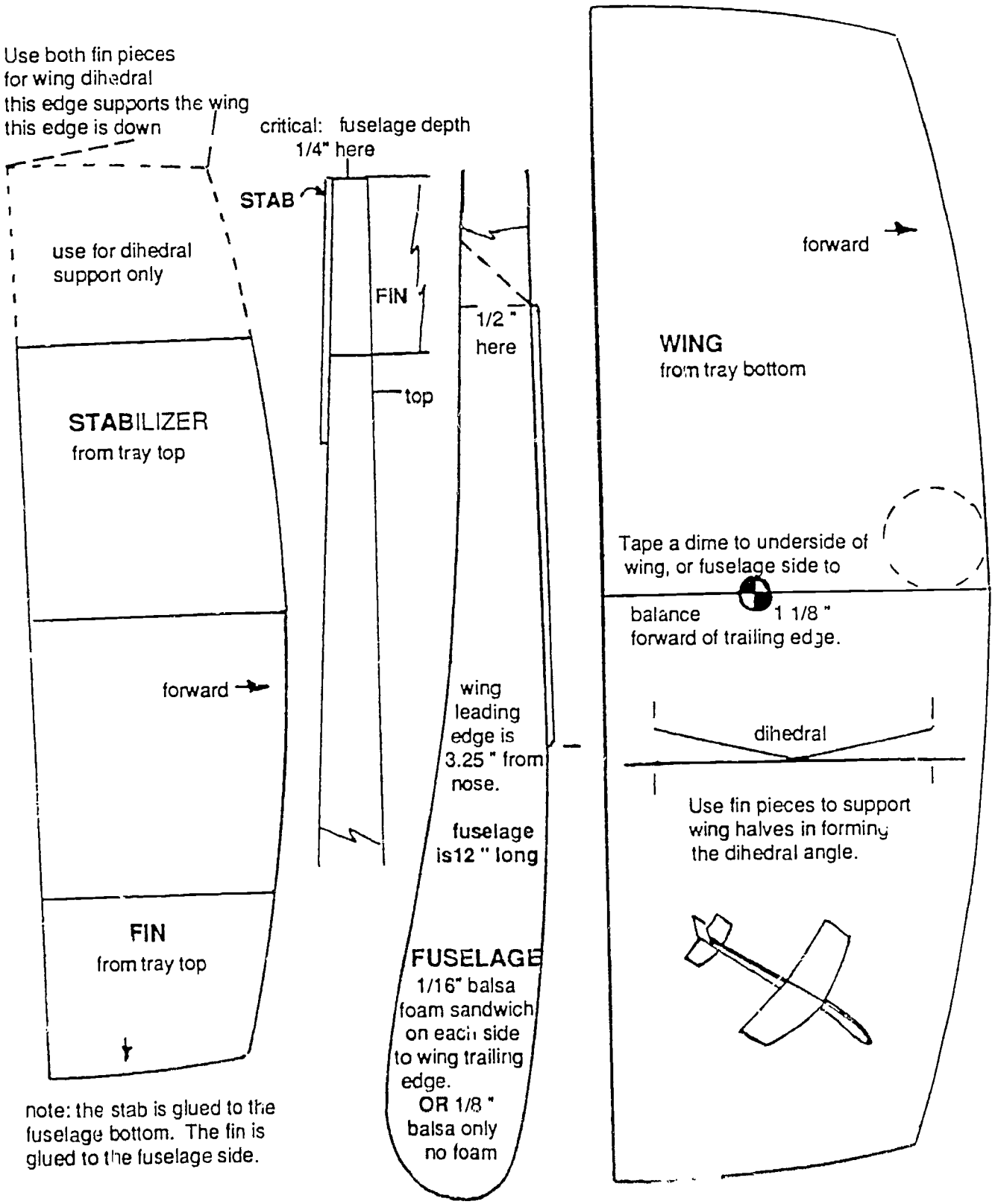
The **Space Shuttle** uses elevons for its control system.

design borrowed by norm poff 10/83 rev. 5/90

McEAGLE aka HARDEE GLIDER

Hand launched glider made from breakfast trays from **McDonalds** or **Hardees**.

One tray makes2 wings, 2 fins, and 2 stabilizers. Use balsa or 2 layers of foam for a fuselage.



ZANONIA SEED GLIDER

developed by
Paul McIlrath
in
FEB 83 Model Aviation

We all know about maple seeds that autorotate to the ground each spring. But few know about the flying zanonia seed from tropical Asia.

Seeds from the zanonia vine glide through the jungle because of their efficient swept back wing shape. Having never been to Asia one must guess that in order for the seed to germinate it must, some how, get away from under the forest cover. Mother Nature designed the seed in a way that would have made John Northrop very proud. Dr. A. M. Lippisch who designed the delta wing and pioneered the design of many tailless aircraft was said to keep a zanonia seed on his desk.

construction notes:

If you use a foam deli tray for construction material, make a template from heavy paper and place the template in the tray so that the upturned tray sides automatically form the reflex called for in instruction number 4 on the plans.

The model will fly much better if an airfoil is carefully formed. Sandpaper, emery boards, razor blades, or razor knives work well for this.

Be sure to balance at the balance point. Tailless aircraft are very particular about wh[illegible] are balanced. Be sure the model is not tail heavy.

Balance the model using a dime taped to the underside of the leading edge center. After all the real zanonia seed has a seed there. Also now the model has monetary value.

flying notes:

Test glide with gentle flights.

If the model dives, bend up the upturned trailing edges a bit more.

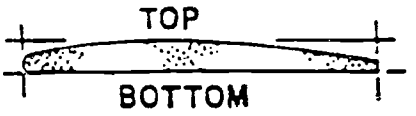
If the model swoops upward and stalls, bend them down more.

If the model "wallows" like it does not know which way to go it is probably tail heavy. Try adding a touch of weight to the nose.

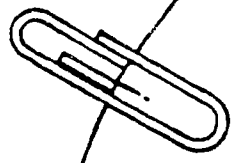
Bending one trailing edge up or down more than the other will correct or cause a turn.

1. TRACE WING OUTLINE, BALANCE POINT, AND OTHER MARKINGS ON THE BOTTOM OF A 5/32 THICK FOAM TRAY. CUT AND SANDPAPER TO OUTLINE SHAPE.

2. SANDPAPER ENTIRE WING TO AIRFOIL SHAPE ABOUT LIKE THIS:

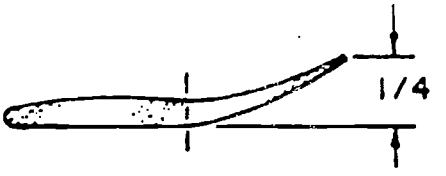


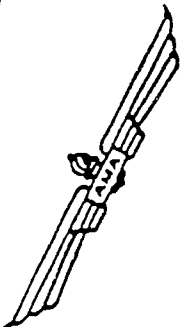
3. GLUE A PAPER CLIP SECURELY IN PLACE.



BALANCE POINT

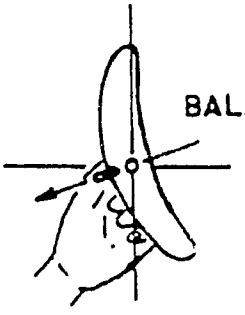
4. CAREFULLY BEND UP SHADED PART OF THE TIPS LIKE THIS:





5. ADD NOSE WEIGHT IF NECESSARY UNTIL GLIDER HANGS LEVEL OR SLIGHTLY NOSE DOWN WHEN BALANCED AT BALANCE POINT.

6. READ ADJUSTMENT TIPS IN TEXT.



BALANCING

LAUNCHING

ZANONIA SEED

A SIMPLE FOAM GLIDER
FOR INDOOR OR OUTDOOR FLYING

February 1983

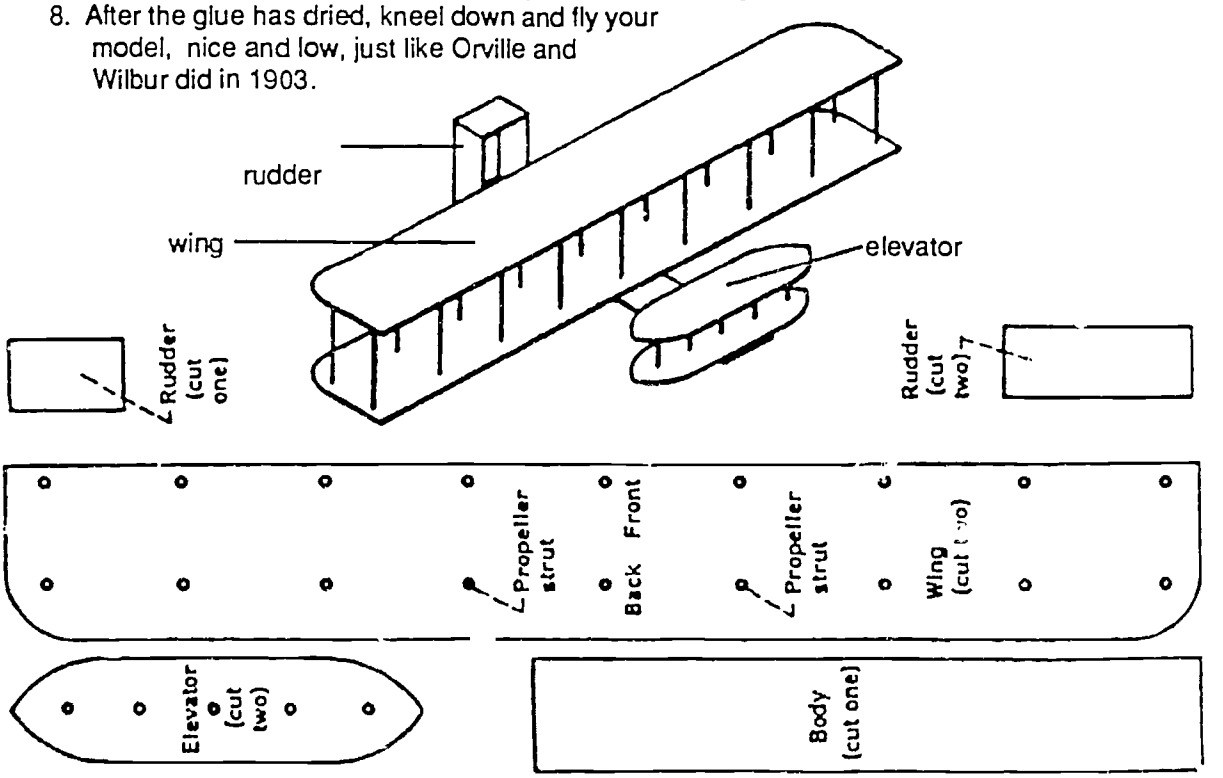
HOW TO BUILD A MODEL WRIGHT FLYER

materials:	1 styrofoam meat tray or	1 dime
	2 styrofoam egg carton tops	scissors
	carbon paper	tape
	wooden toothpicks	white glue

1. Use carbon paper to trace patterns onto the styrofoam. Also mark strut placement dots on wings and elevator.
2. Cut out all parts. Shape the wings and elevators to an airfoil. Or round rough edges.
3. Glue each rudder upright to one end of the body. One to the right edge and one to the left edge. The glue on the rudder top

notes: 1. The rudder is glued to one end of the body, the elevator to the other, and the wing is glued to the center.
2. Either wing or elevator can be top or bottom. Each is identical to the other.

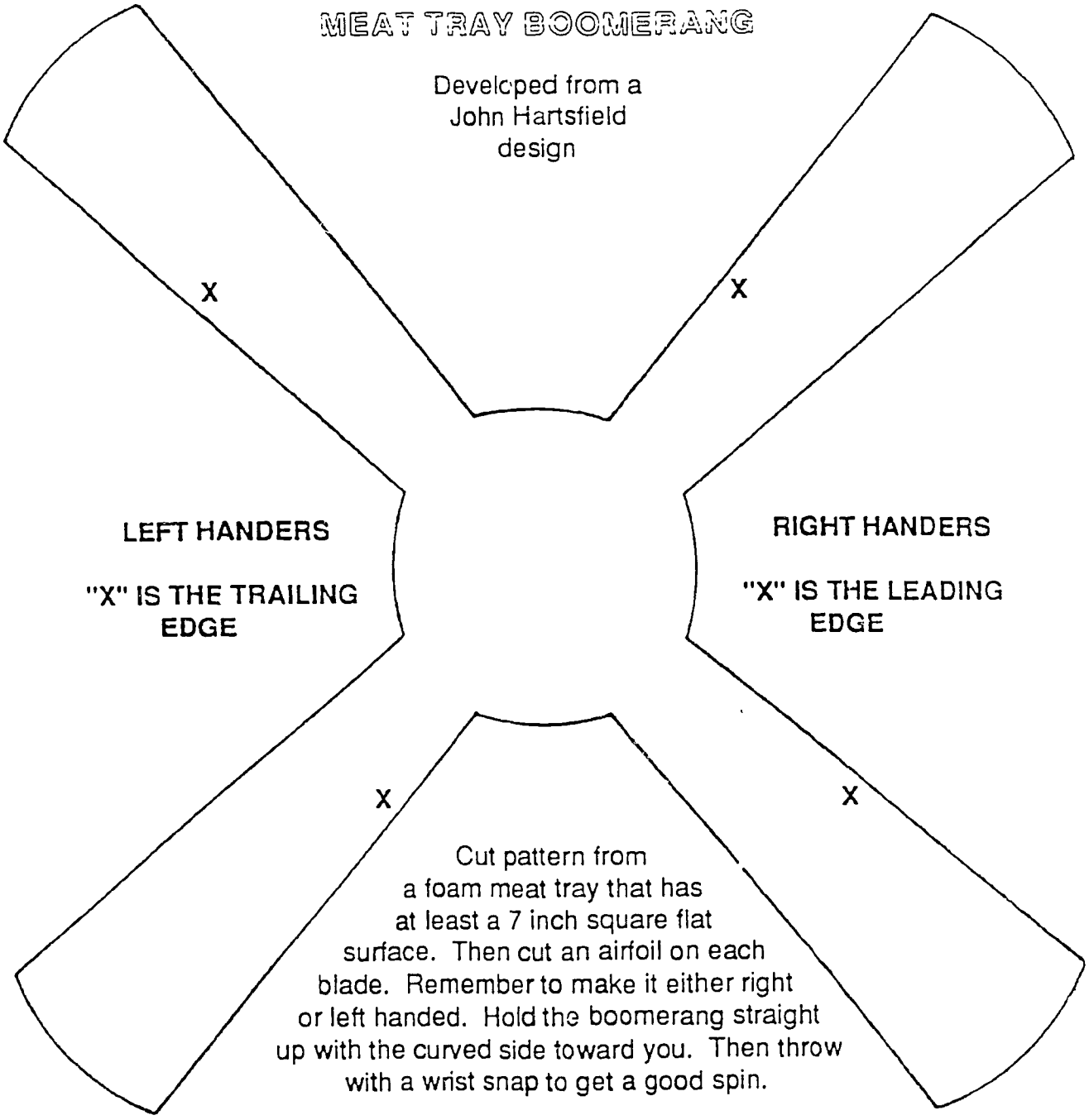
4. Assemble the elevator by putting glue on the sharp ends of 5 half toothpicks. Stick each into one of the 5 dots in the bottom elevator. Using another toothpick, slightly puncture the dot marks in the upper elevator. Fit the top elevator on the 5 half toothpicks, glue, and set aside to dry.
5. Dip 18 toothpicks in glue and push them carefully into the dot marks of the lower wing. Using a toothpick, slightly puncture each dot mark on the lower side of the upper wing. Put glue on the tops of the 18 toothpicks of the lower wing, then carefully place the upper wing over the lower wing. Each toothpick will fit into one of the punctured dots on the upper wing. Allow to dry. Glue a half toothpick to each of the indicated struts to look like propellors
6. Glue the wings to the center of the body, and the elevator to the front.
7. Tape a dime to the bottom of the body between the wings and elevator.
8. After the glue has dried, kneel down and fly your model, nice and low, just like Orville and Wilbur did in 1903.



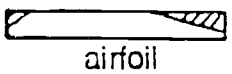
Take Me Out To The Airfield by Robert Quackenbush
Parents' Magazine Press, New York 1976

MEAT TRAY BOOMERANG

Developed from a
John Hartsfield
design



Cut pattern from
a foam meat tray that has
at least a 7 inch square flat
surface. Then cut an airfoil on each
blade. Remember to make it either right
or left handed. Hold the boomerang straight
up with the curved side toward you. Then throw
with a wrist snap to get a good spin.

leading edge  trailing edge

airfoil

NOT-SO-FAMOUS SAYINGS

TO GO UP
PULL BACK ON STICK,

TO GO DOWN
PULL BACK FARTHER

placard in a Piper J-3 Cub

ESCHEW
OFUSCATION

found on someone's wall

THINK
(IF YOU ARE ALREADY THINKING
PLEASE DISREGARD THIS NOTICE)

Frank & Ernest cartoon
12-10-88

A PERSON'S A PERSON, NO MATTER HOW SMALL.

Dr. Seuss
in
Horton Hears a Who

It is most unfortunate that too many people don't realize that persons are persons, whether they are

young
old
handicapped
graduate students
or just
'different'

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THE PROGRAMS LISTED ABOVE ARE ONLY TWO EXAMPLES OF MANY EXCELLENT PROGRAMS OFFERED THROUGHOUT THE USA. IT IS THE EDITOR'S UNDERSTANDING THAT THERE IS ANOTHER PROGRAM, IN OREGON,THAT HAS AN AERONAUTICAL EMPHASIS, BUT INFORMATION ON IT IS UNAVAILABLE TO THE EDITOR AT THIS TIME.

PLEASE

TELL US WHAT YOU THINK
OF
OF WINGS & THINGS

This is your book, not ours, please tell us what works, what doesn't, what you use, and what is worthless to you.

Some things have been added, others deleted, please let us know what you think. If we don't know what you need and what you want, it will never improve. We only print 500 or a thousand each time so changes can be made fairly quickly.

Maybe you have something to share with others, that you would like to see in OW&T's. Again please let us know.

This is at least, the fifth edition of Wings & Things, and a lot of people have helped get this thing together. Sandy Driskel entered most of the text into the word processor, Anthony Cooper proofed some material, including this page, when he had time, and Greg Vogt taught Ole Norm how to use Microsoft Word and Aldus Pagemaker so some graphics could be added. Richard Adams helped with the Apple Mac and its vagaries.

*U.S. Government Printing Office: 1991 — 548-008/20102