Aeronautics and Aviation Science: Careers and Opportunities Project

Educational Activity Report: July 1, 1995 - June 30, 1998

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submitted by

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NASA - Education, Training and Lifelong Learning in Aeronautics Program

I. Introduction

The National Aeronautics and Space Administration funded project, ***Aeronautics and Aviation Science: Careers and Opportunities*** has been in operation since July, 1995. This project operated as a collaboration with Massachusetts Corporation for Educational Telecommunications, the Federal Aviation Administration, Bridgewater State College and four targeted "core sites" in the greater Boston area.

In its first and second years, a video series on aeronautics and aviation science was developed and broadcast via "live, interactive" satellite feed. Accompanying teacher and student supplementary instructional materials for grades 6-9 were produced and disseminated by the Massachusetts Corporation for Educational Telecommunications (MCET).

In the MCET grant application it states that project Take Off! in its initial phase would recruit and train teachers at "core" sites in the greater Boston area, as well as opening participation to other on-line users of MCET's satellite feeds. "Core site" classrooms would become equipped so that teachers and students might become engaged in an interactive format which aimed at not only involving the students during the "live" broadcast of the instructional video series, but which would encourage participation in electronic information gathering and sharing among participants. As a *Take Off!* project goal, four schools with a higher than average proportion of minority and underrepresented youth were invited to become involved with the project to give these students the opportunity to consider career exploration and development in the field of science aviation and aeronautics. The four sites chosen to participate in this project were: East Boston High School, Dorchester High School, Randolph Junior-Senior High School and Malden High School. In year 3 Dorchester was unable to continue to fully participate and exited out. Danvers was added to the "core site" list in year 3.

In consideration of Goals 2000, the National Science Foundation standards for quality of teaching, and an educational agenda that promotes high standards for all students, ***Aeronautics and Aviation Science: Careers and Opportunities*** had as its aim to deliver products to schools, both in and outside the project sites, which attempt to incorporate multi-disciplined approaches in the presentation of a curriculum which would be appropriate in any classroom, while also aiming to appeal to young women and minorities.

The curriculum was developed to provide students with fundamentals of aeronautics and aviation science. The curriculum also encouraged involving students and teachers in research projects, and further information gathering via electronic bulletin boards and internet capabilities. Though not entirely prescriptive, the curriculum was designed to guide teachers through recommended activities to supplement MCET's live telecast video presentations. Classroom teachers were encouraged to invite local pilots, meteorologists, and others from the field of aviation and aeronautics, particularly women and minorities to visit schools and to field questions from the students.

External Evaluation

Massachusetts Corporation for Education Telecommunications
Project *TAKE OFF!*

Final Report

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July 17, 1998

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The video series developed by MCET and the accompanying supplemental materials were crafted to assist classroom instruction by engaging students in knowledge comprehension, application, analysis, synthesis and evaluation of aviation and aeronautics content. The intent was to go beyond the level of information sharing by inviting students to think about themselves as potentially involved in aviation science and aeronautics career related fields.

Take Off! Project Goals

As stated in MCET's grant application to NASA, the project goals included:

1) Developing and delivering live, interactive educational programming, using digital computer, telecommunications, and desktop videoconferencing technologies, that introduces students to concepts, careers and applications in aeronautics;

2) Engaging teachers and students in the use of emerging information technologies by involving them in on-line educational exchange in aeronautics using MCET's digital computer network, the Mass On-line LearnNet, which offers direct access to the Internet;

3) Creating an aeronautics curriculum kit, including software, print materials, manipulatives, and video, that models previous successful initiatives, designed to encourage learning in non-traditional settings such as homes and community-based organizations and ensure the life of the project beyond its period of funding;

4) Developing bilingual and close-captioned programming appropriate to the audience served, as is MCET's practice;

5) Promoting learning objectives of GOALS 2000 in mathematics and science.

II. Executive Summary:

In June, 1996, The Education Alliance at Brown University responded to a request for proposals and submitted a plan to conduct an external evaluation of the Take Off! Series for the Massachusetts Corporation for Educational Telecommunications, located in Cambridge, Massachusetts. By October, 1996, the workscope for the evaluation for Year 1 was negotiated after The Education Alliance was selected to conduct the evaluation. Over the course of this three-year evaluation, the workscope has been revised, with mutual agreement, to address the formative nature of this work.

In preliminary discussions with the MCET staff the focus of the evaluation workscope centered on three areas: 1) determining the status of access to the technology at the "core sites"; 2) eliciting feedback on the quality of satellite telecasts and systems; 3) and conducting a review of user feedback (teacher and student). The Evaluation team also recommended that the focus of the evaluation include 4) a review of the video series and curriculum packets to determine the efficacy of approaches used in pedagogy and curriculum content as it applied to the target audiences: grades 6-12 (particularly young women and minorities).

The Education Alliance was hired as external evaluator almost one year after the project's implementation. Therefore the agreed upon evaluation plan consolidated Years One and Two. The contract on the evaluation was divided into segments: Year 1,(January, 1997) and Year 2 (in June, 1997) and Year 3 (June, 1998). Section IV of this report takes a look at work conducted during Year 3. This Final Evaluation report also summarizes the work that has been completed for Year 1 through Year 3. This evaluation is both formative and summative in design.

The Evaluation team from The Education Alliance at Brown University consisted of four members: Roger Blumberg, who is involved in hypermedia systems design, usage and evaluation for The Scholarly Technology Group at Brown University; Brian Marcotte is a scientist with extensive research and teaching experience, who is also executive director of Strategic Analysis, Inc., Providence, RI; Maria Pacheco is an educator with extensive bilingual education training and teaching and Director of the New England Desegregation Assistance Center at Brown University; and Don Bouchard is a Senior Coordinator with the Northeast and Islands Regional Educational Lab at Brown University with teaching and professional development experience. The combination of individuals was proposed so that multiple perspectives of the project could be dealt in an interdisciplinary manner. As needed, evaluators called upon other Education Alliance staff to assist in the work of conducting this evaluation.

While MCET and the Education Alliance worked to develop the evaluation design, some features of the design such as student feedback in year 2 and focus group sessions with teachers and students in year 2 did not occur owing to difficulties in getting teachers to participate in the student data collection and in negotiating a common day for teachers and students to participate in focus group activities.

In year 3, however, two teachers cooperated in submitting student feedback forms (Malden and East Boston), and at least one teacher from East Boston, Malden, Randolph and Danvers along with at least two students each from Randolph and Malden did participate in the focus group session on April 27, 1998. In an effort to insure participation in the focus group on April 27,1998, Dr. Casella offered to cover the expenses for teacher substitutes. Dr. Casella also offered to take students and teachers to the Boston Museum of Science as a prelude to the focus group discussions.

In year 3 Dorchester did not participate in any discussions with the Evaluation team regarding their participation or lack of it. Dr. Casella has kept the Evaluation team apprised of the difficulties at Dorchester High School and their need to exert total focus on remaining in operation, pending a re-accreditation review. Danvers initiated its involvement with Take Off! during Year 3 and was included in the focus group teacher discussion at the request of Dr. Casella.

III. A Review and Summary of Findings for Years 1 and 2

Section III is a review of the evaluation work with major commendations and recommendations which were presented to the Project Director for *Take Off!* from Year 1 and 2 Evaluation reports.. Teacher interviews in Year 1 were conducted for all school sites. Student feedback was provided to the evaluation team from the NASA forms, however only Malden was diligent in returning an adequate number of surveys to make the sample useful. Generally, Malden's student feedback on the Take Off! project was favorable for teacher engagement of students in classroom and extra-curricular activities, including aviation science and aeronautics. Generally, students reported finding the video series as less than stimulating, but also reported that they enjoyed the work they did with their teacher(s) and other students in researching information about aviation science or aeronautics and learning about career opportunities. The following are excerpts from the technology and video reviews which were the major components of Years 1 and 2:

Technology Commendations:

1) Technologically, the project provided high quality satellite feeds.

2) Video production in Year 2 showed marked improvements over Year 1 broadcasts both in terms of content and presentation formats.

3) MCET implemented changes recommended by the evaluation team at the end of Year 1. This was done at some sacrifice to the production team and to the project director in terms of time and diversion from other work of the project.

Technology Recommendations:

In our Year 1 evaluation, we noted that the core sites were not making significant use of electronic mail, either to coordinate their activities with MCET, or to collaborate with teachers and students at other sites. As the use of electronic mail has been irregular in Year Two, we wish to repeat here two of our Year One recommendations:

1) The Project must continue to provide and to require that each participating teacher at the core sites have an electronic mail account, and know how to use that account. Teachers at the core sites should be encouraged to communicate with each other about the Project, using electronic mail and perhaps a listserv maintained by the Project.

2) The Project should consider giving every student at the core sites, who participates in the entire Take Off! series, an electronic mail account, so as to facilitate community and communication between students interested in aviation and aviation careers. A listserv for students might be maintained by the Project as well.

Commendations and Recommendations for Take Off! Broadcast Series

Broadcast Commendations:

David (the presenter) combines skill in aviation and aeronautics with playfulness, a quick sense of humor and a genuine enthusiasm for his subject and guests. All these attributes are communicated well through the video medium.

Guest presenters leavened several of the broadcasts and might be used more in the future.

The guests in the Career Corner segments were generally excellent. Their excitement and enthusiasm for flight was observed as infectious judging from student feedback. This was especially true of interviews conducted by David.

The "Piloting the Net" segments were on the whole clear and very informative. The graphic listing of URL's was very important. These segments should be pre-recorded with crashes and slow internet accesses edited out. Dead air in a middle or high school class is not a comfortable thing.

Listing a contact at MCET at the end of each video was an excellent suggestion to encourage student inquiries and in allowing students to interact with experts from the field.

Broadcast Series Recommendations:

The script writers and presenters must improve their discussion of biological structures and processes in the Human Factors video.

Each show should be rehearsed before broadcast to avoid mis-statements and mishaps and to improve camera movements.

The script writers and presenters must be more explicit about various physical processes at issue in this series. This is especially true of recurrent concepts such as turbulence.

The program scripts and demonstrations should be better reviewed before another broadcast is undertaken to avoid obvious misstatements and mishaps.

While improvements over year one have been made in the use of video and PIP, some broadcasts seemed poorly coordinated. PIP can still be better used as indicated in the detailed critique. Efforts should be made to coordinate presenters and their demonstrations with the movement of the video cameras

Conclusions of Broadcast Review:

Overall, the Year 2 broadcasts incorporated previously recommended suggestions to improve not only production quality, but program format (shortened time frame) and more emphasis on information on the careers available in aeronautics and aviation science. This was done in spite of the fact that budget restrictions were greater for Year 2 than Year 1.

IV. Year 3 Evaluation:

The Evaluation team met with Dr. Casella in August 1997 to discuss the Combined Year 1 & 2 reports and to review MCET's response to the points covered in the evaluation recommendations from The Education Alliance report.

In October 1997, Dr. Casella and Don Bouchard met to discuss the Year 3 evaluation activities and agreed upon the following workscope:

1. **A review and analysis of MCET's *Take Off!* web site for both content and usage.**

Due to revisions and updates of the *Take Off!* web site, the web site analysis took place during the later part of Year 3, in early to late Spring, 1998.

2. **Conduct Pre and Post Student Surveys with analysis.**

The Evaluation Team had recommended in the Year Two evaluation and then subsequently agreed with MCET to conduct the pre- and post-viewing surveys for the video series on site during Year 3, as a way to assure that student feedback would be received. The series was scheduled for telecast with Part II in September-October and Part I from January 15-26, 1998. Core site teachers did not indicate whether they would participate in viewing this broadcast with their students so the Evaluation Team was not able to be present for the opening series telecast to conduct the pre-viewing survey (on-site) with the students. As an alternative to the broadcast, tapes (Take Off!) were offered by MCET to each school leaving teachers the option to show the video series at their discretion in scheduling for classroom viewing. The Evaluation Team sent letters to each "core" site with instructions and surveys stressing the need for receiving student feedback. The *Take Off!* series was shown in the winter (1998) at each of the "core" sites but in different time frames.

3. **Conduct Student and Teacher Focus groups.**

With the assistance and coordination from Dr. Casella, the focus groups for teachers and students were scheduled and conducted on April 27, 1998. The Evaluation team led the discussion and recorded notes form both sessions. These notes are included in the appendices.

Here are the findings from the Year 3 evaluation activities:

A. Year 3 Evaluation: Review/Analysis of MCET's *TAKE OFF!* Web Site

Methods:

MCET's *Take Off!* web site (http.//www.mcet.edu/nasa/) was viewed on all major platforms (Macintosh, Windows, and Unix), using several major browsers (Netscape, Internet Explorer, and Lynx). For the purposes of this review, the web site was memorialized, using a Macintosh Performa 6360, operating with MAC OS 8.1 and Netscape 3.0 (window dimensions: 20 X 22 cm.), on **March 5, 1998**. While the core sites were outfitted with 15" monitors, the 20" screen used by the reviewer was done to allow for easier navigation and to assure that the content of the pages is fully captured with ample room.

All pages were printed on that date using default settings (see Appendix 1). All links contained on the *Take Off!* web site were visited to assure that they were active and accurate; the first page of all linked sites were printed (Appendix 1a). These printed pages and on- line windows were used in the evaluation presented here. The Evaluation Team recognizes that web sites are most often changing. March 5, 1998 is the time the web pages were reviewed. The Evaluators did go back to check changes to the web site in May, 1998 and saw no significant revisions by MCET which would change the nature of the review.

Content Evaluation: the web site was evaluated with regard to usability, content (quality, scope, accuracy), data density, presentation (including layout and consistency), text style, graphics style, print performance, navigation, links, and educational value given the target audience's age and grade level (grades 7-12).

Benchmarks: Access to the MCET *Take Off!* web site using each of five common Internet search engines (Infoseek, Lycos, Yahoo, Excite and AltaVista) was tested on **March 5, 1998** using five search terms and combinations of search terms: aviation; aeronautics; aviation + aeronautics; aviation + aeronautics + careers; and aviation + aeronautics + education. When the search engines located more than 100 sites, only the first 100 were visited to determine if MCET's *Take Off!* was among them. Following the failure of these initial searches to locate the *Take Off!* web site, the term "MCET" was added to each search term and combination of search terms and resubmitted to Infoseek; the percentage of relevance for the *Take Off!* web site was then recorded. This evaluation also considers the Log Analysis for the *Take Off!* site, produced by MCET using WebTrends. We acknowledge that web sites do change over time and that accessibility could yield different results given the stage of web site development at differing times.

Web-Site Review

(Each page of the MCET and *Take Off!* web site are discussed below. Pages are discussed in the order printed in Appendix 1.)

MCET Home Page

Contrast between text and colored backgrounds was insufficient; texts in the left margin and bottom were illegible. There was no notice on the page of the existence of a NASA component at the web site. More than half of the home page was empty. Notice of special project names (at the very least) could be fitted easily on the home page. This might improve hits coming from search engines.

Special Projects Home Page

The top and left sides (about one-third of this page) was occupied with uninformative company logos, navigational tools and empty space. Navigational tools and text bled off the right side of the printed page. The linear listing of projects forced inefficient scrolling and printing of an extra blank page.

Take Off! Home Page

The black background caused poor printing of links. The animated logo was interesting, but slow to load. Links to Netscape and Microsoft were active and helpful should a visitor not have these programs.

Welcome to *Take Off!*

Four pages were printed. This section of the web site is divided into four parts: a general introduction to MCET, *Take Off!* and project collaborators; job titles and descriptions for MCET administrative, creative and managerial staff involved in the project; Job titles and descriptions for the three aviators and educators collaboratively involved in the project; and job titles and project involvement of two staff members at NASA Langley Research Center. It is important that web site creators and developers be credited with their efforts on the <u>front</u> page of the web site, if possible. This has not been done because the splash front, which is slow to download, cannot be accessed from within the site.

History

Project logo, navigational tools, company/government logos and empty space occupy the left third of the page. Layout was inefficient: less than 50% of the remaining space on the page was occupied with data. The animated illustration was interesting, but resulted in printing only one picture (Janet Harmon). Text and illustrations bled off the right side of the printed page.
The framed version prints correctly so instructions to a "visitor" should include using the framed version for printing.

Timeline

Seven pages were printed. Small dense text was printed on the right two-thirds of the page within a stack of boxes. The left third of the page contained dates and relatively large areas of blank space. There were no graphics or other illustrations. All but three links to external web sites were active. These links demonstrated the width and depth of the resources concerning aviation available on the World Wide Web. They are very useful to an interested visitor. As above, the framed version prints correctly using the framed version.

Paragraph 5: Roger Bacon lived from about AD 1214-1294. This paragraph should be moved below the entry for "1162, Constantinople".

Notable People in Aviation

Eight pages were printed. Small dense text was printed on the right two-thirds of the page within rigid boxes. The left third of the page contained names of notable people in aviation and usually relatively large areas of empty space. Eight illustrations were provided in the left column. The rigid boxed layout caused very unequal spacing especially in rows with illustrations. We suggest looking at a less rigid layout such as that at http://www.cigaraficionado.com/ which is spatially more efficient, easier on the eye, and is more interesting.

Activities Index Pages

Six pages were printed. Only files for Level 1 Activities could be found on the server. These were given in a long linear listing which required much scrolling. About half of each page was empty space. Conceptual content of each Activity was listed and was very helpful. Each activity was designed by MCET to be printed on a separate page so that teachers and/or students would print to use in the classroom. Activities were placed on separate pages for internal consistency.

* Changes were made to the Activities Pages after this review was conducted and may be different from the March 5, 1998 printing.

Activities: Properties of Air

Activities 1-6, 11-17 and 19 could be found on the server. The activities were clearly written; instructions and procedures were easy to follow. Two activities had illustrations. Over two-thirds of each activity page was empty space. More illustrations would be helpful. Both the existing text and existing and new illustrations could be more efficiently presented on a single page (e.g. see http://www.cigaraficionado.com/).

Activities: Weather in Aviation

All 15 activities could be found on the server. The activities were clearly written; instructions and procedures were easy to follow. Five activities had illustrations. An extra page was printed on the first activity. Over two-thirds of most activity pages was empty space. More illustrations, text or the addition of "fact boxes" would be helpful. Otherwise, the existing illustrations are simple and could be reduced in size and integrated more fully with the text with an eye to reducing the number of separate pages required to display all activities.

Activities: Aviation History and Literature

All five activities were located on the server. Activity number four was mis-numbered (repeated #3) on its page. Activity number one was vague: what is meant by "myths of flight". The description of all activities was short and with the exception of #1, clearly written. All five activities could be efficiently listed on a single page.

Activities: What Makes an Airplane Fly

The title of the activity is a question. A question mark should end this title. Eight of the nine activities in this section were located on the server; number eight could not be located. Five of the activities had illustrations. The narratives of these activities are longer than those of preceding sections. Though the illustrations are simple and probably would not suffer from size reduction, it is difficult to see how the text and illustrations could be presented in a more efficient manner.

Activities: Navigation and Flight Planning

Thirteen of sixteen activities were found on the server. Activities 6, 15 and 16 could not be found. One activity included one illustration. Eight activities contained either tables of data or templates for students to complete. Extra blank or mostly blank pages were printed on activities 1,4, 10 and 12. Instructions in all activities were clearly written and contained a small number of necessary technical terms. The templates prepared for students to complete with experimental results clearly and directly focused attention on variables of interest. This is an excellent educational tool.

Broadcast

Index page was clearly written and all links were active. An unnecessary blank page was produced when the index page was printed. Six of the seven broadcast "sessions" contain useful illustrations. About 50 % of each session page printed was blank space. The existing text and existing and new illustrations could be more efficiently presented on a single page using the layout format of, for example, http://www.cigaraficionado.com/

Glossary

The Glossary consists of a multi-paged table. The table is divided into two columns of equal width; technical terms are listed in the top left corner of the left column and its definition is provided in the right column. The definitions are always greater in length than the technical terms they describe. The result is a large amount (about one-third of each page) of empty space. Nineteen illustrations are provided under technical terms in the left column. The layout of these illustrations increased the amount of empty space on the page. The first page of the Glossary was printed twice. On one of these, the top and left sides (about one-third of this page) was occupied with uninformative company logos, navigational tools and empty space. The table was printed next to this column; the definitions bled off the printed page. The framed version prints fine.

Career Cards: Cover Page

The top and left sides of the Career Cards cover page (about one-third of this page) was occupied with uninformative company logos, navigational tools and empty space. Much of the page was uninformative or empty space. The "open" button worked well.

Career Card: Denise Duff

The first page (picture) of this career card could not be located. The second page contained 34 words and numbers; the rest was uninformative empty space.

Career Card: Sharon Havers

The first page (picture) of this career card could not be located. The second page contained 33 words and numbers; the rest was uninformative empty space.

Career Card: Eddie Tyson

Only the second page of this career card could be located. This page contained 29 words and numbers; the rest was uninformative empty space.

Career Card: Co-Pilot

The first page of this career card contained one 7.0 X 7.75 cm photograph; the rest of the page was uninformative empty space. The second page of this career card contained 29 words and numbers; the rest was uninformative empty space.

Career Card: Air Traffic Controller

The first page of this career card contained one 7.0 X 7.0 cm photograph; the rest of the page was uninformative empty space. The second page of this career card contained 91 words; the rest was uninformative empty space. The text of page two contains a quotation, not a job description or salary range.

Career Cards: Meteorologist

The first page of this career card contained one 7.0 X 7.0 cm photograph; the rest of the page was uninformative empty space. The second page of this career card contained 78 words; the rest was uninformative empty space. The text of page two contains a quotation, not a job description or salary range.

Career Cards: Kite Builder

The first page of this career card contained one 7.0 X 7.0 cm photograph; the rest of the page was uninformative empty space. The second page of this career card contained 94 words; the rest was uninformative empty space. The text of page two contains a quotation, not a job description or salary range.

Career Cards: Graduate Research Assistant

The first page of this career card contained one 7.0 X 7.0 cm photograph; the rest of the page was uninformative empty space. The second page of this career card contained 58 words; the rest was uninformative empty space. The text of page two contains a quotation, not a job description or salary range.

Career Cards: Chief Operations Shift Mgr.

The first page of this career card contained one 7.0 X 7.0 cm photograph; the rest of the page was uninformative empty space. The second page of this career card contained 43 words and numbers; the rest was uninformative empty space.

Career Cards: Operating Manager

The first page of this career card contained one 7.0 X 7.0 cm photograph; the rest of the page was uninformative empty space. The second page of this career card contained 30 words and numbers; the rest was uninformative empty space.

Career Cards: Station Operation Rep.

The first page of this career card contained one 7.0 X 7.0 cm photograph; the rest of the page was uninformative empty space. The second page of this career card contained 36 words and numbers, the rest was uninformative empty space.

A page with navigational tools and project and company logos in the left column was printed after the last career card. There was no information on this page.

The Forum: Visitor comments

Eighteen messages were available on the server:
It is unclear from the format and contents of the messages how the forms are to be used. It is also unclear why each original message appears twice on its respective page. Messages and replies could be placed on the same page to achieve greater efficiency.

1. Greetings
2. Runway Design
3. Re: Runway Design (reply)
4. Drag Coefficient of a Car
5. Space Careers
6. Re: Space Careers (reply)
7. Aviation
8. Diagrams
9. Re: Diagrams (reply)
10. Tutoring Information
11. Re: Tutoring Information (reply)
12. Re: Great Site! (Reply)
13. Cool Link & Great Instructional Aid
14. Geometry
15. Integrated Units on Flight
16. Re: Integrated Unites on Flight (reply)
17 Project 26
18. Aviation Links
19 ALLSTAR NASA Project

Analysis of Web site:

As indicated by the URLs of many of the pages at the *Take Off!* web site, the site has been redesigned in the third year of the program in an effort to provide better content in a more engaging manner. The *Take Off!* homepage gives a clear indication of the categories of information available at the site, and in general we found that the content throughout the site was thematically very rich and accurate. The design of the site is principled and clear, and consistent with much of the literature on web site design. The text style was generally clear and unambiguous, and in addition to supporting the *Take Off!* broadcasts, the site offered useful and interesting content to visitors interested in aviation but unfamiliar with the broadcasts. The *Take Off!* Site exists in four different versions to accommodate multiple browsers and platforms. Navigation within MCET's *Take Off!* web site was generally clear and helpful. During the period of our review, the site was maintained aggressively, although there is currently no indication to users when revisions are made to the pages at the site.

Although most of our analysis concerns the general design and usability of the *Take Off!* web site, we must begin by noting that the redesign of the *Take Off!* site did not seem particularly well-suited to the technologies available to the participants at the core schools in the *Take Off!* Project, which was the focus of this evaluation. Those schools were supplied with appropriate computers and graphical web browsers, but they relied on dial-up connections with modems of speeds of 33,000 bps or less. Based on interviews with the participants in the *Take Off!* project and an analysis of the log files from the MCET server, we conclude that the graphics-intensive nature of the *Take Off!* site made download times an issue in the usability of the site. The Evaluation team recognizes that the scope of the NASA grant was not to provide T1 or ISDN Internet connections, but the design of the web site was to further the goals of the project.

We applaud MCET for making sure that a version of the site can be viewed with text-only browsers (such as Lynx), but we note that the core schools were generally not equipped to run text-only browsers, but only the graphical browsers available on the Windows platform. An option not taken by the *Take Off!* project, but used widely by content providers on the Web (e.g. most newspapers including the New York Times at http://www.nytimes.com/) was to make available a "low graphics" option on the homepage or main index page, especially for users not using Ethernet, T-1, or other strong connections to the Internet. We also note that some of the most innovative uses of hypertext in the redesign of the *Take Off!* site, such as the use of multiple browser windows in the History section, may be unusable by participants in schools with computers with limited RAM screens large enough to comfortably accommodate multiple windows.

While there are numerous guides to the principles of site design, and no firm consensus about what constitutes the most effective design principles for an educational site aimed at teachers of, and students in, grades 7-12, we think several design decisions implemented in the current *Take Off!* site may have detracted from its usability and usefulness for a school audience. In addition to not offering a "low-graphics" option, the site makes extensive use of the HTML frames feature, while not offering a "no-frames" option (see the Eisenhower National Clearinghouse, http://www.enc.org/, for an example of how this option can be fruitfully employed). We think Jakob Nielsen has made a strong case against the use of frames in his *Alertbox* column of December, 1996 (see "Why Frames Suck (Most of the Time)" at http://www.useit.com/alertbox/), and would add only that frames take up valuable screen space on core site school computers that were rarely larger than 15" in diameter. While there may be some concern over Nielsen's case against the use of frames, it is suggested that MCET give users a choice for both framed and unframed versions.

A second principle that might have been adhered to more adamantly, was that of flattening hierarchies (see Blumberg and Reville, "The NetTech Web: Preliminary issues and questions,"
at http://www.stg.brown.edu/pub/NetTechWeb.tr97.2.html). With the exception of Timeline pages, the density of data per page was generally low, far below the density of data in a newspaper (cf. Edward R. Tufte's *Visual Explanations*. Graphics Press, Cheshire, 1997); sections like the Activities pages might have been collapsed into fewer pages, requiring less clicking and downloading of new pages.

Finally, based on interviews with the project participants, we think important contact and revision information needs to be displayed clearly on the homepage, main index page, or at least in a section clearly marked and designed for users seeking to contact someone at the *Take Off!* program or to know whether the site has undergone any revisions since their last visit.

Further Comments:

1) MCET's *Take Off!* web site was not located in the first 100 sites found by each of the five web browsers using the five search terms above. This may have been caused, in part, by the fact that MCET's *Take Off!* web site is located three pages below the front page of MCET. Browser hits may increase if the web site had its own domain name with a cover page with links back to MCET's *Take Off!* web site.

2) The WebTrends log analysis files provided by MCET for year 3 of the project, and interviews with participants at the core schools, indicated that the *Take Off!* site was not used primarily or significantly by the participants at Dorchester, East Boston, Malden, and Randolph High Schools. The reasons for this are not entirely clear, but participating teachers noted that few if any of their students had access to the Web outside of school and that a "one-computer classroom" situation did not encourage significant use of any web site, including MCET's *Take Off!*

3) Page layout in parts of the Take Off! site was not as efficient as it might have been (see Tufte's *Visual Explanations*, and V. Flanders and M. Willis, *Web Pages That Suck*., SYBEX, San Francisco, 1998). The top and left sides of most pages (about one-third of these pages) was occupied with uninformative company logos, navigational tools and empty space. Page layout too often consisted of blocks of text unleavened by illustrations, diagrams, etc. (e.g. Timeline).

4) Graphics style was variable and generally good. More illustrations are needed especially in the Timeline pages.

5) Printing using default settings was problematic on many pages. Text and graphics often ran off the right side of the printed page. Blank pages or pages with only one line of data were often printed. As Jakob Nielsen notes (see above), the use of HTML Frames may also interfere with or complicate printing. The pages print fine in the framed version.

6) Most links were available on the host server. Some exceptions are noted in the specific page comments (below).

7) The text and illustrations were generally appropriate given the web site's target audience.

8) "© Copyright 1996, MCET. All rights reserved" appeared at the bottom of many of the pages, and we wonder whether this was intentional.

B. YEAR 3 Evaluation: Pre and Post *Take Off!* Viewing Student Surveys

Take Off! Student Survey

METHODS:

Teachers at the core sites were asked to obtain student responses to two sets of survey questions: the first set administered before beginning the *Take Off!* series and the second, after. The questions were designed to determine the students' use of and access to educational technologies, students' prior knowledge of careers in aeronautics and aviation science, students' response to the *Take Off!* broadcast/videos and the effect of *Take Off!* on students appreciation/interest in aviation and aeronautic career opportunities. The questions are listed below.

QUESTIONS BEFORE VIDEO VIEWING

1. Do students use computers at your school?
2. Do you use computers at your school?
3. Is it easy to use the internet at your school?
4. Do they teach you about computers at your school?
5. Have you communicated with other students through e-mail, chat rooms or internet bulletin boards?
6. Have you used the computer to learn more about careers?
7. Have you used the World Wide Web (WWW)?
8. If yes, for what?
9. List three careers you know of that are associated with aviation science and aeronautics.
10. Have you ever thought of a career in aviation science or aeronautics?
11. If yes, what career?
12. Do you think there are career opportunities in aviation science and aeronautics for young women and minorities?
13. Do you know anyone in an aviation science or aeronautics career?
14. Do you think a career in aviation science or aeronautics is available to most people?

QUESTIONS AFTER VIDEO VIEWING

1. Do students use computers at your school?
2. Do you use computers at your school?
3. Is it easy to use the internet at your school?
4. Do they teach you about computers at your school?
5. Have you communicated with other students through e-mail, chat rooms or internet bulletin boards?
6. Have you used the computer to learn more about careers?
7. Have you used the World Wide Web (WWW)?
8. If yes, for what?
9. List three careers you know of that are associated with aviation science and aeronautics.
10. Have you ever thought of a career in aviation science or aeronautics?
11. If yes, what career?
12. Do you think there are career opportunities in aviation science and aeronautics for young women and minorities?
13. Do you know anyone in an aviation science or aeronautics career?
14. Do you think a career in aviation science or aeronautics is available to most people?

15. Did you watch at least four of the *Take Off!* series broadcasts / videos?

16. Did you find the series interesting?

17. Did you learn more about careers in aviation science or aeronautics than before you started watching the series?

18. Would you recommend this series to a friend?

19. Please write a few comments telling what you liked or disliked about the series.

A Performa 6360 with OS 8.1was used for all statistical analyses. Responses to all questions were digitized using spreadsheet facilities in CA-Cricket Graph III. These data were then statistically analyzed using JMP Start Statistics by the SAI Institute.

Student Survey Results:

Malden Middle School teacher, Beth Massey, provided completed sets containing both pre and post viewing surveys for 74 students. The first survey was recorded as having been administered on March 19, 1998. The second survey was administered on May 8, 1998. The *Take Off!* curriculum was given to the students across the disciplines and involved science, social science and literature classes. Descriptive statistics for this survey group are provided in the appendices. Although the three students involved in the April 27, 1998 focus group reported seeing all *Take Off!* Videos on the same day, the survey was administered both before and after viewing the series.

East Boston High School provided completed surveys for 10 students. Seven of these ten were in the ninth grade, two were in the tenth grade and one did not disclose his grade level. Both surveys were administered on the same day, June 11, 1998: the first before the students viewed the *Take Off!* video series and the second, after. Six of the ten students did not complete the surveys in full. Because of the methods used to administer the surveys, the small number of responding students, and because of the incomplete nature of responses, this sample was not used in the statistical analysis which follows. Descriptive statistics were performed on this survey group however and do appear in the appendices.

Both Randolph Junior Senior High School and Dorchester High School failed to return any completed surveys, despite several requests to do so. As earlier indicated, Dorchester High School did not participate in Year 3 activities.

Summary of Malden Middle School Surveys

All the students surveyed were in the seventh grade. There were 43 males and 31 females in the sample.

Question 1: 100 % of the students surveyed indicated that students in their school used computers both before and after the *Take Off!* series.

Question 2. 93 % of females and 88 % of males personally used computers before the *Take Off!* Series and 100 % of both males and females had personally used computers after the *Take Off!* Series.

Question 3. Before the *Take Off!* Series, 32 % of females and 55 % of males considered the Internet easy to use at their school. After the series, 100 % of females and 95 % of males considered the Internet easy to use at their school. Gender differences in responses were statistically discernible before the series ($p>0.05$) but were not statistically different after.

Question 4. Before the *Take Off!* Series, 100 % of females and 95 % of males indicated that computer use was taught at their school. After the series, 93 % of females and 95 % of males indicated that computer use was taught at their school. Gender differences were not statistically discernible either before or after the *Take Off!* Series.

Question 5. Before the *Take Off!* Series, 35 % of females and 44 % of males had used e-mail, chat rooms or Internet bulletin boards to communicate with other students. After the series, these numbers rose to 58 % for females and 46 % for males. Gender differences were not statistically discernible either before or after the *Take Off!* Series. A two-way analysis of variance indicated that the differences before and after the *Take Off!* series were statistically indiscernible.

Question 6. Before the *Take Off!* Series, 25 % of females and 21 % of males reported using computers to learn more about careers. After the series, 58 % of females and 65 % of males reported using computers to learn more about careers. Gender differences were not statistically discernible either before or after the *Take Off!* Series. A two-way analysis of variance (males/females versus before/after) indicated that there were no statistically discernible differences in responses before or after the series

Question 7. Before the *Take Off!* Series, 22 % of females and 48 % of the males had used the World Wide Web (WWW). After the series, 83 % of females and 86 % of males had used the WWW. These differences were statistically discernible between genders in a one-way ANOVA. The differences between genders before / after the series were marginally discernible ($p>0.06$).

Question 8. Before the *Take Off!* Series 4 females indicated that they had used the WWW for four different purposes and f14 males indicated that they had used the WWW for four purposes. After the series, 25 females indicated that they had used the WWW for eight different purposes and 36 males used the WWW for 12 different purposes. Gender differences were statistically discernible before but not after the students participated in the *Take Off!* Series. A two-way analysis of variance indicated a marginally discernible effect of the series on gender differences in responses. Before the series, student reported that their use of the WWW was mostly school related research. After the series, the students reported using the WWW not only for class projects (social studies geography projects) but also for everything from downloading software to viewing "The Simpson's" web site.

Question 9. Before the series, students reported that careers associated with aviation included marine biologists, biologists, chemists and veterinarians as well as pilots, astronauts, aviation mechanics, flight attendants and military aviators. After the series, the vast majority of student responses were clearly focused on aviation careers. The number of times females listed pilot as a career rose from 15 times before the series to 29 after;

males listed pilot 23 times before the series and 41 times after. Females listed astronaut 20 times before the series and 27 times after while males listed astronaut 22 times before and 32 times after the series. Both males and females listed flight attendant five times before the series and 11 times after. Military aviation careers were listed by females five times before the series and once after; while males listed military-related careers eight times before the series and three times after.

Question 10. Before the *Take Off!* series only 10 % of females responded that they had ever thought of a career in aviation science or aeronautics while 20 % of males had thought of such a career. Gender-specific responses were statistically indiscernible before the series but marginally discernible after ($p>0.06$). After the series, 26 % of females and 46 % of males had thought of an aviation-related careers. A two-way analysis of variance indicated that there were no statistically discernible gender-specific differences in responses before or after the series.

Question 11. Before the *Take Off!* series, three females listed three different careers and nine males listed four different careers. After the series, 5 females listed five different careers and 20 males listed eight different careers.

Question 12. Before the *Take Off!* Series, 83 % of females and 86 % of males indicated that there are career opportunities for women in aviation science and aeronautics. After the series, 100 % of females and 95 % of males thought there were career opportunities for women. There were no statistical differences in these responses.

Question 13. Before the *Take Off!* Series, 16 % of females and 25 % of males indicated that they knew an aviator. After the series, 41 % of females and 34 % of males indicated that they knew an aviator. No statistically discernible differences in these responses were observed.

Question 14. Before the *Take Off!* Series, 58 % of females and 62 % of males thought there were career opportunities for most people in aviation science or aeronautics. After the series, 76 % of females and 78 % of males thought most people could find a career opportunity in aviation/aeronautics. These differences were not statistically discernible.

Question 15. 76 % of both males and females saw at least four of the *Take Off!* videos.

Question 16. 16 % of females and 26 % of males thought the *Take Off!* Series was interesting.

Question 17. 56 % of females and 59 % of males responded that they had learned more about careers in aviation science or aeronautics through viewing the *Take Off!* videos.

Question 18. 16 % of females and 42 % of males responded that they would recommend the *Take Off!* series to a friend.

Individually Written Student Responses

Question 19. Students wrote the following comments indicating what they liked and disliked about the *Take Off!* series

FEMALES (27/31 responded with written comments.)

"This was one of the most boring video(s) I've seen. I would never recommend this series to any living soul. It probably would help if there were some music and better graphics. Please update your series. It contained a lot of useful information but it was presented to viewers very "boringly". But I can tell that your corporation worked very hard on this series. Thank you."

"I liked the show and I hated the (?)."

"I think it was boring but still learn more things about planes and how much money someone could get from a job."

"I think that the *Take Off!* series didn't spark any interest in my classmates. It would help if you upgraded the program."

"I thought the show was very boring. It was hard to understand."

"Dislike: talked too much, boring
Liked: didn't have to do school work, the suction cup (demonstration)."

"It was not exciting. It was OK. It was different."

"The experiments were interesting but I found the tape too long. The video quality was not well."

"What I liked about the series was that they did experiments. What I didn't like was that there wasn't enough movement and noise, the(y) just kind of sat there."

"I disliked the movie series because it was too long but I liked the lab report we did in class because I had fun doing it."

"I liked some of the experiments and going to the Expo. I disliked the movies we saw because it was fuzzy sounding, long and I personally found it boring."

"What I disliked was the sound, you couldn't hear clearly, it didn't catch my attention, it wasn't very interesting to watch."

"I went on a field trip and thought it was boring. I liked the airplane, though."

"They were interesting. I liked it. It was ok."

"I liked the experiment. I sort of like(d) the show. I didn't like the people."

"I liked learning about air. I disliked everything else."

"I disliked the series because it wasn't very good or interesting. It was very boring."

"Disliked: they talk too much instead of doing an experiment, boring. Liked: experiments."

"What I liked about this series was you can ask questions over the phone. What I disliked was it was dull; it needs more color and a person who talks loud and clear."

"I disliked the films because I didn't enjoy sitting through them. It was kind of boring because they used a lot of words I didn't know. They spoke unclearly and it was hard to understand."

"I liked going to the airport. I liked going outside and flying planes, and I also didn't like that movie we watched."

"I liked that it gave a lot of information. It shows examples of what it means. I did not like that we had to sit there for hours and watch it, It became boring after a while."

"I liked the experiments. I disliked the way the people did the experiments. My friends and I disliked the Take Off videos."

"I like the way how they explain it because then we can understand about it better. But sometimes they only explain a little."

"I disliked watching the movie series because the sound on the tape wasn't loud enough. I liked watching and learning about aviation in the series. I liked going to the EXPO and learning about careers in aviation. I liked the things and examples in the movie."

"I liked the planes people invented and I didn't like the series."

"I went on a field trip on aviation and learned about what first class seats are like. I found it kind of fun but I didn't think I will go again."

MALES (34 /43 responded with written comments.)

"I didn't like the movie because it was boring and the hosts made lot(s) of mistakes. The thing that I liked was that when it showed how to fly a plane."

"I disliked the series because it is old and then was low volume and it was so, so, so, so, so, so, so, so, so boring."

"I liked when they did the activities. I disliked the people because they were weird. The episodes weren't interesting. I fell asleep during one of them."

"I didn't find it interesting."

"The thing I disliked about the broadcasts was that is was too long. I liked the models they gave."

"I liked about the aviation series is that they showed you activities you could do. What I didn't like about the series is the poor sound and is too boring."

"I thought it was interesting and boring. I learned more jobs that you could have, But some of it was senseless to me. I only liked some things in the movie."

"In the series, I liked the experiments they performed and the children calling and answering questions."

"(I)..Didn't like the movie or cartoons."

"I really liked it. I want to be a pilot now because it looks like fun."

"It was fun to learn and the take off videos were interesting."

"I liked the way the plane experiment went and I didn't think it was interesting. I thought it was a very boring video."

"I disliked that the series of movies because they were long. I liked the activities."

"I liked the airplanes and activities and all of that."

"I liked all the stuff that they taught me. I didn't know stuff before that they taught me."

"I liked the way they took us up in an airplane. I disliked it because it was too detailed."

"The things that we did in aviation I liked a real lot. For example, I liked going to the hanger and flying the wooden planes. So I conclude that the experience was pretty fun."

"It was boring and it was hard to understand. It was too long."

"I couldn't hear it well and it was a little boring."

"I liked how the pilots showed experiments. I disliked the music. I liked the information."

"I like their experiments but the people were kind of boring."

"The series were really boring but they taught us a little."

"I liked that it told a lot of information. I liked watching the activities. Everything else was boring. I didn't find it interesting. I liked flying planes."

"I liked the instrument. I hate when they talk."

"The movie was boring but the activities were pretty good. The movie needs to be louder."

"Boring. Repeats the same things."

"I didn't like it because it was too long."

"I disliked everything except for the activities that they did (some)."

"It was boring and not that worthwhile but the good part is I actually learned something. It was a lot better that sit around and do work."

"In the series I liked the mini wind tunnel and the photos and videos from the airplane."

"I did not like anything about the series because I found it very boring."

"I liked the experiments. I hate the people. They were weird."

"The video was interesting about the lifts and the experiments. It was boring when they just kept talking. Most of the things we already knew."

"It was long and boring."

Analysis of Student Pre and Post *Take Off!* Surveys

The students at Malden Middle school were taught about computers and had used computers before the MCET-NASA Take Off! project. The project, as implemented at Malden Middle School (across the curriculum), had large, positive effects on student use of new educational technologies and on their understanding of aviation science and aeronautics and their appreciation of careers in these fields. After the MCET-NASA Take Off! Project:

1) The number of students reporting that the internet was "easy to use" doubled.
2) Student use of the internet and the World Wide Web more than doubled
3) Student use of e-mail, chat rooms and internet bulletin boards to communicate with other students more than doubled.
4) Student use of the internet to obtain information on careers doubled.
5) The number and diversity of purposes for which students used the WWW almost quadrupled.
6) Student focus on and understanding of the range of career opportunities in aviation science and aeronautics increased markedly.
7) Student interest in careers in aviation science and aeronautics almost tripled.
8) Student knowledge of career opportunities for women and minorities in aviation science and aeronautics increased to near unanimity.

These substantial achievements of the MCET-NASA Take Off! Project notwithstanding, the vast majority of students indicated that they did not find the video series interesting nor would they recommend the series to a friend. From the written comments provided by the students, it seems clear that they found the videos "too long" and "boring" and they disliked the presenters. Many (most) liked the activities described on the videos and done at school.

C. Year 3 Evaluation: Summary of Teacher Focus Group

The teacher focus group was convened on April 27, 1998 following a trip with teachers and students to the Boston Museum of Science. After explaining the purpose of the focus group as a component of the external evaluation, teachers were led in a discussion of several questions facilitated by Roger Blumberg. Brian Marcotte recorded the teacher's responses. Overall, the feedback on the part of teachers was favorable about the concept of a hypermedia approach to complimenting classroom instruction. Teachers indicated that they were appreciative of the computers they received as part of the *Take Off!* project.

Teachers uniformly reported that their first year of involvement with Take Off was the most active. One teacher stated that his administrator's were supportive of his involvement in *Take Off!* The four teachers cited the Massachusetts Statewide Assessment as dictating the school's focus during Year 3 on curriculum standards and improving test scores, resulting in less instructional time utilizing the Take Off videos or curricular materials. Teachers stated that they felt pressured to focus on curriculum content to prepare students for those statewide assessments, however, two of the four teachers indicated that they did attempt to integrate aviation into their curriculum.

Teachers were in agreement that *Take Off!* had an impact for instruction. They reported that *Take Off!* provided: "practical applications for abstract scientific concepts"; "practical applications of physical concepts (that) led students to new insights"; "the greatest impact was in math class where pattern recognition using graphs is important"; and "The program's emphasis on aviation careers...for directing student career choices...". Teachers reported that they found the demonstrations in the videos to be one of the best features of the videos with one teacher stating that she was able to repeat demonstrations with her classroom audiences.

Teachers agreed that the project exposed students to career choices though they varied on the extent of impact with one teacher stating that "students involved were too young for much interest, but it (*Take Off!*) did diversify their interests and provoked some questioning."

The role of technology is a critical component of *Take Off!*. Teachers reported mixed reviews to their use of the technology provided. Some teachers reported using the web site only occasionally. Another teacher stated that the website had changed little in content over a year's time, and that while it contained much information, other sites were more fun to visit. Teachers expressed some frustration with their school's lack of resources to make computers more generally available to students. One teacher suggested that the web site needs an "answer" person who can talk in the language of the consumer.

When asked about the *Take Off!* curricular materials teachers agreed that materials were good, though one recommended "better graphics and print materials". Teachers were in unison in their reporting that despite good quality, that time constraints caused by schools' focusing on curriculum implementation directed at improving student test scores caused a reduction (elimination) of time devoted to *Take Off!* activities and materials.

Respondents indicated that the highlight for teachers and or students were: "the first year contest was very exciting. The students loved it!" ; "Students found the Balsa plane experiments very interesting...the visit to the Volpe Transportation Center with its simulator was of the greatest interest."; "the computer and concepts of aviation were most interesting...the Challenger Center at Framingham State College was an excellent activity"; and one teacher summed it up in saying, "a wider world opens for students in *Take Off!*".

When asked if these teachers would continue to use the *Take Off!* video series, the three teachers who have used the series responded "yes". Some qualified their response with reference to time and or viewing particular segments with their students.

Overall, teachers expressed their satisfaction with their and their students' involvement in Project *Take Off!*. They cited external factors to the project (lack of school equipment, resources, time, etc.) as obstacles which prevented them from fully utilizing the project.

D. Year 3 Evaluation: Summary of Student Focus Group

The student focus group was convened on April 27, 1998 following a trip with teachers and students to the Boston Museum of Science. After explaining the purpose of the focus group as a component of the external evaluation, five students (3 from Malden and 2 from Randolph) were led in a discussion of several questions which they had been provided earlier in the morning to acquaint them with what would be discussed. The teacher focus group was convened on April 27, 1998 following a trip with teachers and students to the Boston Museum of Science. After explaining the purpose of the focus group as a component of the external evaluation, teachers were led in a discussion of several questions. One of the students participating in the focus group from Randolph had not yet seen the video series and therefore was unable to answer some of the discussion questions. (This student indicated that while he had not seen the videos or been involved with the web site, his teacher's use of aviation related activities has made him want to participate in other spin-off activities.)

Don Bouchard facilitated the discussion and Maria Pacheco recorded the student responses.

Students expressed a gain in their own knowledge about aviation science and aeronautics as a result of their class and teacher's involvement in *Take Off!* All stated that they learned about careers and broadened their awareness of what types of choices are open to them. Two students expressed their enthusiasm in recommending the Take Off! project to their friends. All students rated the interest level of classroom activities carried out by their teachers as HIGH; four students rated *Take Off!* for the career awareness as MEDIUM; feedback on the videos varied from 1 LOW, 1 LOW/MEDIUM, 1 MEDIUM, and 1 HIGH. One student reported that now he intends to become an officer in the Air Force and then work in the private sector.

Four students had seen the video as earlier reported. When asked what they liked about the video series they responded: "I liked to see all the instruments", ; "I liked how she got into things (lift, drag) and the demonstrations. I liked how they explained different careers."; "I liked how she demonstrated instead of just telling us. I also liked how we could ask questions over the internet and she could answer us."; another commented, "I liked to see the history of airplanes- how technology has advanced."

When asked what they might change about the video series one student said "I wouldn't change anything."; Another student reported that "We watched it all in one day. It was hard to follow after a while." Other comments included: "Change the graphics."; and "...maybe add different music to get our attention."

Four of the five students reported that they have computers at home. Both Malden and Randolph students stated that they had not communicated with other students or schools via e-mail or the internet as a result of *Take Off!* One student with a home e-mail/internet account reported that he often communicated with others about aviation in his spare time as well as during school time. When asked how teachers utilized computers in their work with *Take Off!* one student indicated they used the computer for research...another student reported using CD-ROMs for research. Two others said they did not use computers whatsoever in *Take Off!*.

Students expressed interest in studying aviation science or aeronautics. They stated that teachers involved students in a number of activities...even in English and writing activities. One student reported that his favorite was planning a trip from Boston to Montana and checking the computer to guide their planning. They were especially complimentary of teacher use of activities to support what had been seen on the videos. Students reported that they became familiar with aviation and aeronautics terminology and that they learned about careers which are available to them.

It is clear from the discussion with students that teacher interest in *Take Off!* spilled over to students. Teacher use of activities which engaged students and reinforced aviation science or aeronautics concepts worked effectively with these learners.

V. Summary Findings for Year 3

The *Take Off!* project generated considerable student interest in activities which helped students learn about careers in aviation science and aeronautics. The students reported that they did not find the video series of interest to them nor would they recommend them to their friends. While there was no video review in Year 3 evaluation design, it is worth repeating that there was considerable improvement from Year 1 to Year 2. MCET staff have expressed their commitment to integrate the "best" of Year 1 and Year 2 series to produce a high quality product for dissemination to schools interested in utilizing the series.

The degree to which teachers expressed enthusiasm and interest in aviation science and aeronautics seems to be linked with the degree to which individual schools and teachers were successful in utilizing the *Take Off!* materials and in participating in extra-curricular activities both under the sponsorship of MCET, or initiated by schools or teachers themselves. On occasion, the Evaluation team made efforts to communicate with core site teachers, but the response was sparse and this fact was troubling for the Evaluation Team. Teachers did not always respond to electronic communications despite repeated attempts.

Suggestions to increase teacher participation in the evaluation process were made to MCET staff over the two years of work. MCET made good-faith efforts to encourage more teacher involvement with the evaluation process, but teachers indicated that they had competing agendas playing out in their respective schools and time was a critical factor in their inability to become more actively involved above and beyond instruction.

MCET is to be commended for succeeding in the utilization of technology by students and teachers despite some limitations in equipment and upgrades available at the core sites. While some students and teachers had prior access to computers, the project was the initiating point for some students, and gave teachers more opportunities to integrate technology into their teaching or after-school activities with students.

MCET is to be commended for submitting monthly status reports to the evaluation team to keep the team informed about project activities, school/MCET communications, etc. Dr. Casella's approach to the project subject matter was characterized by high levels of interest and investigation. The development of curricular materials, the oversight of the production team for the video series, as well as web page construction and maintenance were among the duties Dr. Casella undertook with the project. More technical support for this project could have benefited the *Take Off!* web site and facilitated greater technological use at the school level.

Of concern to the Evaluation team was that resources within MCET were not sufficient to carry out the full potential for this project. Whether it was a budgetary or design issue, the program was decidedly scaled back during Year 2 for production of the Year 2 video series, and in Year 3 more web-developer assistance would have created greater project cohesion.

Periodic staff development tied with specific curriculum development used in *Take Off!*, or to maximize technology usage and integration (with existing curricula) should be considered if this project is to be replicated. In addition, it appears that strong school administrative support for involvement in a project such as *Take Off!* is critical to the long term success of the "core" site involvement with the project. Participation in MCET training events should be mandatory to insure cross-site consistency and sharing.

VI. Summative Conclusions:

The evaluation of the *Take Off!* project is not as comprehensive as originally proposed and designed. The amount of student feedback received has been less than was anticipated and desired for such a novel approach in developing an interest in students about careers in aviation science and aeronautics. However, students reported that learning did occur, and we hope that this report helps to guide MCET in any future work they may engage in with schools where resources are limited.

In reviewing the five program goals originally prepared for the contract with NASA, all but goal number four were realized. MCET did not develop bilingual or close-captioned programming for the grade 6-12 audience. This can be attributed to budget constraints.

MCET demonstrated progress in the development of the video series from Year 1 to Year 2. Also, supplementary curriculum materials were cited by teachers as being very useful in building upon the concepts portrayed in the video series. More emphasis on outreach and dissemination would have benefited the "core sites" both for monitoring their use of the project materials and in troubleshooting on utilization of technology.

Both teachers and students indicated that their use of technology had increased as a result of their participation in *Take Off!* Core site schools were generally "low-end" users in terms of capability and some had difficulty with down-loading web pages and even admitted to growing impatient with the time lag in doing their web searches. The web site was not utilized significantly by the core sites. Telecommunications was the weakest component of the *Take Off!* project in that students enjoyed the curriculum and activities, but they had little or no use of e-mail to communicate across school sites. The lack of compatibility at core sites and differing teacher proficiency in technology was problematic at times.

The participation and results varied among the core sites, depending on the personal investment in technology of the individual teacher. The teachers in Malden, with no previous connection to the Internet, and little familiarity with computers, systematically used e-mail to communicate with one another. In East Boston, the teacher started a classroom web page, organized field trips, and documented it with digital photography. Dorchester's difficulties with sustaining their participation were a result of both teacher apathy and lack of administrative support. One of Randolph's major strengths was (is) its Aviation Club which acted as an excellent outlet for students interested in aviation to explore the subject of flight both in terms of hobby and career.

Overall, the Evaluation Team has agreed that MCET's *Take Off!* project completed its goals. MCET produced gains in student awareness of career opportunities for minorities and women in aviation science and aeronautics, and provided solid curriculum and activity packets to supplement the video series. The telecast quality was high. The video products improved from Year 1 to Year 2 and reflected greater attention to the intended student audience for interest level, diverse types of information and integration of content. Significant gains were made from the beginning to the conclusion of the project which demonstrate that *Take Off!* has achieved many of the programmatic goals it had planned for this project.

VII. Appendices:

A. Web Page artifacts
B. Web Logs
C. Student Survey forms: Malden and East Boston
D. Teacher Focus Group Notes
E. Student Focus Group Notes

A. Web Page Artifacts

The following pages are taken from the *Take Off!* *web-site and which were the basis for the review conducted for this report.*

B. Web Logs

Table 1

Number of web sites located by each of five search engines in response to five search term(s). MCET's *Take Off!* was not in the first 100 sites located by any of the five search engines.

Search Term(s)	Infoseek	Lycos	Yahoo	Excite	Alta Vista
Aviation	203 966	>100	No Sites Located	138 968	2 201
Aeronautics	31 029	>100	No Sites Located	32 734	109
Aviation + Aeronautics	305 842	>100	No Sites Located	170 066	145
Aviation + Aeronautics + Careers	2 278 335	>100	No Sites Located	373 167	12
Aviation + Aeronautics + Education	5 523 470	>100	No Sites Located	2 064 820	767 510

Table 2

Percent relevance of search terms which included "MCET".

Search Term(s)	Infoseek
Aviation + MCET	70 %
Aeronautics + MCET	71 %
Aviation + Aeronautics+ MCET	68 %
Aviation + Aeronautics + Careers + MCET	68 %

D. Teacher Focus Group Notes

Present: Roger Blumberg coordinator, Brian Marcotte secretary, Teachers: Issiah Floyd (E. Boston), Ed Rogers (Danvers), Ken Goldblatt (Randolf), and Beth Massey (Malden).

Q1: Describe your involvement with the *Take Off* project.

A: Three years with Take Off including aviation days. 120 students in a cluster. Math and science teachers work together, none had a background in aviation. Incentives to join *Take Off* included free computer and internet access. Involvement was easier in year one: fewer restrictions in school curriculum that year. Fitting *Take Off* into the curriculum was more difficult in years two and three, we had to be more selective in what information was presented. In year three we took an interdisciplinary approach. We used parts of the taped broadcast that the students liked most such as the timeline, and different teachers chose to use different parts of the *Take Off!* materials. Careers were covered in social studies. Other activities were dispersed throughout the curriculum. Activities such as pressure/vacuum relations, design of a plane experiment, the use of independent and dependent variables and the use of balsa planes to measure variables were very helpful to the students. Concepts of form following function were clearly communicated. In year two, all videos were given in one day; this was a very bad decision. Voice quality was poor. The second set of tapes were O.K. We took the best parts of the tapes and showed these parts to students. A quiet small group of students were very interested in aviation. Most students liked Archie.

B: Eighth grade students participated in the *Take Off* project. Activities were dispersed among the students. In year one, we had time and energy for the project. In year two, we did not have time; the computer gave us much trouble--we had little Internet access. In year two we showed the second edition of the tapes; two were played, the others ignored. In year three there was no time for *Take Off!* . The Massachusetts curriculum frameworks and tests compelled our attention. We integrated aviation across the curriculum. There was no support for *Take Off!* from our cluster colleagues. The computer was upgraded and the Randolph Aviation Club had lots of after school and weekend activities for interested students.

C: In year one we had good support from school administrators. The timing of the broadcasts in year two defeated inclusion of *Take Off!* in the curriculum; we cannot do after school activities. In year three, *Take Off!* was considered an add-on and was not integrated in the curriculum. MA curriculum standards changed in an effort to improve test results and this took energies away from the *Take Off!* program.

D: 1997-98 was the first year of Danvers' participation in the program, and the timing of live broadcasts did not permit integration of *Take Off!* in year one. In year one there were two levels of physics involved in the program. Concepts such as lift and drag and the model planes were used in physics class. The computer given must be upgraded to be useful in the future. The videotapes were good in part but of very limited value - not all have been seen yet. 60% of students have access to the Internet and regularly explore it.

Q2: What is / has been the greatest impact of *Take Off!* project from your perspective?

A: *Take Off!* provides practical applications for abstract scientific concepts and for teaching them.

B: The practical applications of physical concepts leads students to new insights. The flight simulator was the best part for the students in the program.

C: The greatest impact was in math class where pattern recognition using graphs is important; the landing and take off experiments using the balsa model airplanes was very helpful in applying abstract concepts to real life.

D: The program's emphasis on aviation careers was important for directing student career choices and helped involve students more in the program.

Q3: Did exposure to *Take Off!* change student career choices?

B: Yes! Absolutely.

A: Interested students began to wonder about aviation careers for themselves.

C: Students involved were too young for much interest but it did diversify their interests and provoked some thinking about careers.

Q4: Did teachers have e-mail and internet access before *Take Off!* ?

A: E-mail was new when *Take Off!* was introduced. Now there are 25 students sharing one computer, but the one-computer classroom is not a success. Some students do Internet research out of class and then report their findings to the class.

B: We had hard wiring before *Take Off!* . Internet access worked for about three weeks before computer problems limited its use. Now MCET as our ISP and provides e-mail accounts for us. Software to restrict student access to some sites on the Internet frequently cause users to be dumped from legitimate Internet sites for no discernible reason! This is very frustrating for the students.

Q5: Please evaluate the *Take Off!* web site.

C: I get to the web site about two times per month. Students do not have Internet access at home; computers must be used at school only and this use is limited to club meeting times twice a month. I make students use the computers that are available.

B: when the computer is working, we visit the site once a week; when the computer is down, there is no use.

A: In the first year of *Take Off!* we used it often to download activities and career cards. In year two the site became a cob-web site: there were no changes in content. There is much information at the *Take Off!* web site but it is more fun to visit other sites on the WWW.

D: there has been little or not change in the web site after year one and therefore I have not visited it recently. A Hypertext link to an applet is needed.

A&B: Further integration of *Take Off!* requires more computers. Time and equipment limit use of the program.

A&C: Career pictures and profiles are very useful and can be printed and distributed to students away from computers.

Q6: Were glossary links used?

All: No.

Q7: Has *Take Off!* changed the way teachers used technology?

A&B: Yes. It has increased computer and Internet use. It has had a major impact. We need multiple computers and Internet access to make this kind of program work well.

Q8: What was the impact of *Take Off!* on the curriculum?

All: Time constraints caused by schools focusing on curriculum implementations directed at improving student test scores caused a reduction (elimination) of time devoted to *Take Off!* . The activities in *Take Off!* were useful but time limited their implementation.

B: Curriculum materials were good.

A: *Take Off!* needs better graphics and print materials.

C: The *Take Off!* curriculum was good.

Q8: Did you have contacts with the *Take Off!* staff? Were your questions answered?

B: Yes. The tech advisor provided by MCET did not talk to Ken's level of understanding/skill/knowledge. Often issues were not resolved.

C: Yes.

Q9: What was the highlight of the program for you and your students?

B: The first year contest was very exciting. The students loved it!

C: Students found the balsa plane experiments very interesting. The trial and error approach to the activity was very good. The visit to the Volpe Transportation Center with its simulator was of the greatest interest.

A: Personally, the computer and concepts of aviation were most interesting. The model airplane experiment with its concept of experimental design was easy to do and easy for the students to learn. All variables and their measurement--clear, practical hands-on activities--were liked most by students. The Challenger Center at Framingham State College was an EXCELLENT activity.

D: A wider world opens for the students in *Take Off.*

Q10: Will you continue to use the tapes?

B: Yes - if time permits.

C: Yes, if I am still in my teaching cluster next year.

A: Yes, the careers program and a few science activities/demonstrations selected from all the tapes. *Take Off.* Should categorize activities and demonstrations on the tape series and list them with tape positions to facilitate selective use of the tapes.

Q11: What were the best parts of the tapes? What was the student response to the tapes?

A: People actually doing real things, that was the best part for me and the students. The presentation style of the in-studio presenters was a problem. One presenter was likable and the other talked down to the students and was not eighth-grade friendly. Demonstrations which can be duplicated in a real classroom were very good. The demonstration using the hair dryer, plastic tube and ping-pong ball is a good example of this. It is easy and cheap to do and makes the scientific point in understandable terms. There should be a workshop for teachers on how to make demonstrations for use with the videos. Students should be brought into the workshop to see how they would do it. Separate key concepts and provide basic activities and then build on these encouraging more exploration.

D: Polished and inexpensive demonstrations would help. Field trip opportunities should be expanded.

C: Acclimate the teachers to the concepts before they are presented.

Q12: Any additional suggestions for the *Take Off!* staff?

B: *Take Off!* needs an answer person through the web site who can talk in the language of the consumer.

E. Student Focus Group Notes

MCET Offices, Cambridge, MA
April 27, 1998

The purpose of the focus group was to discuss student ideas as they relate to each of the following questions regarding the *Take Off!* project. Students were asked to provide examples to support their answers. They were told that this focus group could be used by MCET to determine the extent to which *Take Off!* has achieved its goals and to look to ways which might increase student interest in aviation sciences and aeronautics.

The participants for this session included:
Richard (R), a 7th grade student- Malden Middle School, Malden, MA
Belda (B), a 7th grade student from Malden Middle School, Malden, MA
Matt (M), a 7th grade student from Malden Middle School, Malden, MA
Jonathan (J), a 10th grade student from Randolph High School, Randolph, MA
Simon (S), an 8th grade student from Randolph Jr. High, Randolph, MA

MCET Staff present: Dr. Francesca Casella, Project Director, Take Off!
Evaluators: Maria Pacheco, External Evaluator/Education Alliance and
Don Bouchard, External Evaluator/Education Alliance

The focus group commenced after students had been given the opportunity to look at the student focus questions which would be discussed in the 90 minute discussion. Students introduced themselves and Don Bouchard began with the following question:

Q.1 Has your interest in aviation sciences or aeronautics changed since your introduction to the *Take Off!* project? Please explain.

J. I only thought that there were pilots and stewardesses. Now I look into air traffic control, my awareness has expanded.
B. I know a lot more than I did before. Now I want to know more. Before I hadn't thought about it (aviation sciences or aeronautics).
M. I didn't know how they made them (planes) fly- now I know.
R. I want to be a co-pilot. I looked-up co-pilot, pilot, stewardesses, people who sell tickets...
J. Now I know I want to become an officer in the Air Force and then go private.

Q.2 What did you like about the video series?

R. I liked to see all the instruments.
J. I liked how she got into things (lift, drag) and the demonstrations. I liked how they would explain different careers.

M. I liked how she demonstrated instead of just telling us. I liked how we could ask questions over the internet and she could answer us.
B. I liked to see the history of airplanes - how the technology has advanced.

Q.3 What, if anything, would you change about the video series?

J. I wouldn't change anything..."my friends took it thinking they wouldn't do any work." At times the background noise interfered with my hearing or the presenter at the airport. We saw the videos once a week...I would like to see it more frequently.

B. We watched it all in one day. It was hard to follow after a while.

Q.4 Did you see the video on a regular schedule?

J. On a regular schedule.
B./M./R. All in one day.

Q5a. Imagine you are the producer, would you recommend any improvements to the video series such as: presenters, subject matter, length of time, graphics, career cards, etc.?

R. They could make it more entertainment...maybe show a clip of an airplane show.
B. Change the graphics
M. Music is elevator music; maybe add different types of music to get our attention.
J. Take more answers from sites- have more conversations among sites.(Students did projects such as building an airport, and received a flight simulator as a reward.)
B. In social studies we did a timeline of flight.

Q5b. When would you start this project (Fall, Winter, Spring)?
J. Have teachers learn it first, in the Fall,...we could also do projects in the summer. I enjoyed doing the projects and pursuing other things in the summer.

Q6. How did your teacher use the computer in your work with the *Take Off!* project?
(4 of the 5 students indicated that they have computers at home.)

J. We had a simulator after we got a better one in the contest- we researched different types of planes through the computers- used CD-ROMs and encyclopedias.

M. We had a project to do in science...if we wanted to we could go to the computer room and use it for research. I did a project on Amelia Earheart.

B. No computer used. Since we don't have study hall we can use the computer after school.
R. No computer used.

Q7. Have you communicated with other students in other classes at your school or other schools via e-mail or the internet as a result of *Take Off!* ? Please share your experiences or those of your classmates.

Both Malden and Randolph students said they had not used e-mail to communicate with other students. J. said he had e-mail addresses from other schools which he used at home to communicate with other students interested in aviation.

Q8. What activities did you and you classmates participate in that involved aviation science or aeronautics?
J. My teacher had us do a number of activities on just aviation- most of them were in science and field trips...in math imaging)?), English we learned their names in code...learning the language of aviation. Weather- learning about the effects of flying through the rain, snow, clouds- turbulence. Writing activities too. We planned our own flight from Boston to Montana- checked the computer.

S/R/B/M did not respond to this question as such. R/B/M did say that their teachers incorporated several activities about aviation science and aeronautics into their classes.

Q9. What about *Take Off!* would you recommend to your friends who have not participated in the project?
J. I would tell them that there are lots of dun activities they can do. ..watch videos, and do activities.
S. I did not do anything with the videos this year. I have not seen them. Maybe they could help calm (someone's) fears of flying.

Q10. (This question was answered in the conversation with the students indirectly and directly.)

Q11. What careers did you learn about as a result of Take Off!. Are you considering a career in aviation science or aeronautics?

J. (Has answered this already...Air Force then private piloting)
B. Pilot, stewardess. I am not sure about it.
R. Co-pilot, air traffic controller, mechanics. I want to be a co-pilot.
M. Pilot, co-pilot, maintenance.
S. No.

Q12. Did you know how to use, or have access to, the internet in your home or school before *Take Off!*. If your answer is yes, have you discovered new uses for the internet since your involvement with *Take Off!*?

Most students said they were familiar with the internet before the *Take Off!* project. Four of the five reported that they have computers at home. One student said he had access to internet at home but that his privilege had been taken from him.

Q13. Please rate the *Take Off!* project in the following areas: (high, medium, low)

	S.	J.	B.	R.	M.	
Career Awareness:	-	H	H	M	M	
Connection to curriculum	-	M	M/H	M	M	
Access to website/e-mail	-	H	-	-	-	
Interest level of videos		-	H	M	M/L	L
Interest level of classroom activities	H	H	H	H	H	

S. said that while he had not seen the videos or been involved with the website, his teacher's use of aviation related activities has made him want to participate in other spin-off activities.
No one complained about studying aviation science or aeronautics. Students were especially complimentary of teacher use of activities to support what had been seen on the videos. Students reported that they became familiar with aviation and aeronautics terminology and that they learned about careers which are available to them.

VII.Appendices:

A. Web Page artifacts
B. Web Logs
C. Student Survey forms: Malden and East Boston
D. Teacher Focus Group Notes
E. Student Focus Group Notes

A. Web Page Artifacts

The following pages are taken from the *Take Off!* *web-site and which were the basis for the review conducted for this report.*

Massachusetts Corporation for Educational Telecommunications

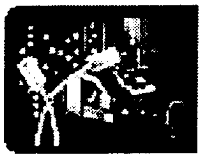
cambridge, massachusetts • u. s. a.

Broadcasting & Connectivity

LearnPike educational TV and @meol Internet access

Products

Resources for educators and students



Services

Networking, videoconferencing, television production

Projects

Home pages for partnerships and funded programs

Projects

- News
- Support
- Contact
- Corp. Info
- Site Map

Special Projects

The following are special projects produced by MCET in collaboration with other agencies Annenberg/CPB Channel programs broadcast by MCET. We invite you to explore these sp programs online, through satellite broadcasts, and through products that are developed for projects. Many of the products may be purchased independently of the particular program

Fall '97 Special Events

- The Massachusetts Summit: The Promise of Our Youth
- Think Twice. Your Life. Your Decision.
- Team Harmony

Peace it Together: Strategies for Violence Prevention

- Peace it Together Home page
- Related Links: Healthlinks, Reginald

HealthLinks Project

- HealthLinks Home Page
- Cybertimes of Reginald
- Integrating Technology and Health into your Curriculum
- YouthLinks: Youth Empowering Youth to Improve Health

Annenberg/CPB Channel

- Annenberg/CPB Channel Home Page
- Annenberg/CPB Channel program schedule
- Register for the Annenberg programs
- Broadcast information

The Human Genome Project

- About the Human Genome Project
- The Zone
- Chat Room
- Student Showcase
- Teacher Resources

NASA Take Off! Project

- Take Off! Home Page
- Take Off! program listing
- Register for Take Off! programs

Page last updated: 1/28/98
webmaster@mcet.edu

Broadcast Glossary

Activities

TAKE OFF!

Career Cards

History

Forum

Cool Links

Teachers' Lounge

NETSCAPE Now! 3.0

FREE Microsoft Internet Explorer

Welcome to Take Off!

Aeronautics and Aviation Science: Careers and Opportunities Project

The Massachusetts Corporation for Educational Telecommunications (MCET) offers teachers a chance to hook students on math and science through exciting work in aviation. This three-year project offers an aviation science curriculum presented via multiple technologies: live, interactive video broadcasting, written curriculum materials, and Internet activities. Teachers may choose to participate in the broadcasts and/or Internet activities.

The aim of the program is to create projects to inform students about aviation and aeronautics both as an academic focus and a career path. Known as Aeronautics and Aviation Science Careers and Opportunities (AASCO), the project reaches students nationwide.

Developed in collaboration with the New England Regional Office of the Federal Aviation Administration and Bridgewater State College, the program is supported through a cooperative agreement (NCC 2-915) from the National Aeronautics and Space Administration (NASA), High Performance Computing and Communications Office (HPCC), as part of the Learning Technologies Program (LTP), to MCET.

Who's Who

- MCET
  - Cardie Texter
  - Francesca Casella
  - Joanna Lu
- Collaborators
  - Shelia Bauer
  - Veronica Cote
  - David Price
- NASA Langley Research Center
  - Dr. Samuel Massenberg
  - Dr. Marchelle Canright

MCET

CardieTexter
Principal Investigator
Aeronautics and Aviation Science: Careers and Opportunities
Massachusetts Corporation for Educational Telecommunications (MCET)

Dr. Texter has oversight of the Aeronautics and Aviation Science: Careers and Opportunities Cooperative Agreement awarded by NASA High Performance Computing and Communications Office, Information nfrastructure Technology and Applications Program to MCET. The project is developed by MCET in collaboration with Bridgewater State College and the FAA. Dr.Texter has broad responsibilities over the implementation of the budget, and the hiring of personnel on this project. She ensures that the goals of the grant are included in the many aspects of this project, and that both personnel and informational resources at MCET and NASA are integrated into project planning.

Dr. Texter's previous experience includes teaching at the elementary, high school, and college level, work with museums coordinating fundraising efforts for educational and outreach programs, and initiating and overseeing sponsored Research & Development programs for Special Projects at MCET.

Francesca Casella
Project Director

Dr. Casella is in charge of the hands-on administration of the project. She researches the technology specifications for various components : satellite, data and phone links and equipment needed for schools to participate successfully in the broadcast and the Internet activities. She oversees the budget, pours over line items and is constantly trying to find additional resources to support project goals and classroom activities. She communicates with the project oversight personnel at NASA, and with other educators developing technology-based aeronautics curriculum.

Dr. Casella joined the MCET staff pursuing the opportunity to combine professionally her interests in both education and science. Her previous experience includes many years of research culminating in receiving a PhD in Environmental Sciences and Chemistry, and training and tutoring experience at the high school and undergraduate level.

Joanna Lu
Producer

Ms. Lu is in charge of producing the entire Take Off! interactive television series. With help from the board of advisors, hosts, and MCET staff, she plans the broad goals of each broadcast and determines specific content within these goals. She translates the educational goals and content of the series into the visual medium of television in a way which is both useful to teachers and engaging to students in this age group. With help from the associate producer she plans and executes the extraordinary number of details involved in preparing a series of successful 50 minute interactive broadcasts, and, from the studio control room, supervises the progress of each program as it unfolds live in the studio and the classrooms.

Ms. Lu's previous work includes producing a wide variety of educational programs, such as the three-year series, "The Human Genome Project: The Scientific and Humanistic Dimensions," and other programs for students on subjects like dinosaurs, neuroscience, the history of Ellis Island, and bookmaking. She has directed many local and national programs for public television, including the award-winning "Frontline."

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Collaborators

Shelia Bauer
Manager, Aviation Education Programs
Federal Aviation Adminstration

Ms. Bauer's enthusiastic support is integral to the success of this grant. She meets regularly with other collaborators and the MCET staff to critique content, offer suggestions, and plan activities on the broadcasts, in the classrooms and on the Internet. Ms. Bauer brings to the project years of experience in aviation education and a broad knowledge of resources available to pilots, teachers, and anyone interested in pursuing activities in aviation, from flying lessons to educational seminars to classroom teaching. She also coordinates the Aviation Expo at Boston's Logan airport and is providing many of the Expo's resources to the project.

Ms. Bauer serves as a program manager for the Federal Aviation Adminstration's aviation education program in the New England region. She actively promotes aviation and aerospace education through programs such as the Aviation Education Resource Centers, which are located throughout New England, and the Careerports at regional airports. She has initiated aviation career education academies and an aviation career education counselor's program. She received her private pilot's license at age 16, owns her own plane (but doesn't fly as often as she'd like to!) and contributes to a number of aviation and civic associations, among them the National Council for Women in Aviation/Aerospace, to which she is a regional representative.

Veronica Cote
Aviation Coordinator
Bridgewater State College
Bridgewater, Massachusetts

Veronica Cote, co-host of the TakeOff! series, loves flying. After she began taking flying lessons, she set her sights high and just kept going...eventually becoming a flight instructor, a corporate pilot, a charter pilot, and finally an airline pilot. More recently she has worked in different aspects of aviation research, including the safety of human subjects in research trials, the effect of automation on pilots, and airport security. She received her Masters Degree in Aeronautical Science from Embry-Riddle Aeronautical University, with an emphasis on human factors in flight operations. Acting as the co-host of the series allows Ms. Cote the opportunity to combine her love of flying with her professional interest in education. Additionally, she hopes to reach out to girls who may not realize they can have significant careers in aviation..

Ms. Cote currently serves as Chair of the Aviation Department, Bridgewater State College, performing both administrative duties and serving as Chief Ground Instructor. She teaches both beginning and advanced flight courses.

David Price
Aviation Educator
Federal Aviation Administration

David Price is the host and curriculum developer of the Take Off! series and has been intimately involved in planning the curriculum for the broadcasts. He has had a lifelong enthusiasm for aviation and loves teaching students at all grade levels about the intricacies, the history, and the wonder of flight. Mr. Price, with help from other collaborators and the MCET staff, has designed the curriculum for the series, with a focus on aviation principles, outreach to students who aren't yet excited about science, and particularly, the presentation, level of difficulty, and elements which appeal to middle school students with whom he has extensive teaching experience.

He has taught aeronautics for the past three years at schools in New Hampshire and the Boston area. Mr. Price holds degrees in Aviation Technology and Flight Operations, is a licensed pilot and flight instructor, a member fo the Civil Air Patrol, and an aviation educational counselor with the FAA.

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NASA Langley Research Center

Dr. Samuel Massenberg
Director, Office of Education
NASA Langley Research Center

Dr. Massenberg oversees four areas of NASA's Office of Education at the Langley Research Center: Educational Technology and Distance Learning, University Affairs, Precollege Education, and Institutes. He coordinates all education-related efforts and has responsibility for university research and training grants, scholarships and fellowships to students and educators, support for research centers and institutes, and program evaluation.

His previous experience includes many years of work in science education and minority research and education. Dr. Massenberg has a personal love for aviation and started flying at the age of 14 at the City Airport in Detroit, Michigan. He joined the US Air Force at age 21, completed his flight training, and flew 20 types of aircraft during active duty. When he retired from the air force he was wearing the wings of a Command Pilot. This requires at least 3,000 hours of flying time and at least 15 years as an Air Force Pilot. He is currently a member of the Air Force Association, the American Society for Engineering Education, and the Tuskegee Airmen, Inc.; a trustee with the Sara Bonwell Hudgins Foundation, Inc., and the Association for Retarded Citizens of the Peninsula, Inc.; and involved in other educational and civic organizations.

His numerous awards include the NASA Outstanding Leadership Award, the Selection for Senior Executive Service, the Virginia Tech Distinguished Alumnus Award, and the NASA Exceptional Service Medal.

Dr. Marchelle Canright
Education Programs Specialist
NASA Langley Research Center

Dr. Canright serves as the Precollege Officer at the Langley Research Center, and is responsible for providing services to a five-state service region (KY, NC, SC, VA, and WV) to precollege level teachers and students, teacher education colleges, and universities.

She is responsible for the management of the following major programs at the local, state, and national levels: Professional Education Conferences, Teacher Preparation and Enhancement Services, Intructional Curriculum Support and Resource Development, Student Programs, and Educational Technology and Distance Learning Initiatives.

Dr. Canright serves as the technical monitor to the NASA Education, Training, and Lifelong Learning in Aeronautics project awarded to MCET. She communicates regularly with the Principal Investigator on the project to ensure that grant goals are met and to make NASA resources available to the project.

Dr. Canright's professional experience includes classroom teaching, educational television production, distance learning projects, and management of educational programs. She works closely with state and national educational institutions to identify educational problems and to research innovative technological solutions to challenges in science teaching.

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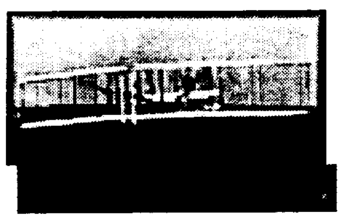
History

Aviation Timeline

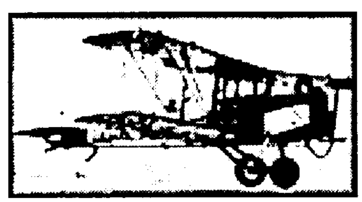
Notable People in Aviation

Leonardo da Vinci
(1452-1519)

Janet Harmon
Waterford Brag



Kitty Hawk, 1903



US Mail Airplane
(ca. 1920)

Concorde - First flight 1969

Pending permission for images

Timeline

Before Recorded History	People have probably always dreamed of flying. Discoveries of some flight principles may have occurred in ancient times. For instance, a child's toy (dating from about 300 B.C.) was discovered in Egypt: a bird with tapering wings carved in a distinct airfoil pattern, with evidence that it had a horizontal tail.
Myths and Legends	Many cultures have had myths of people or gods that fly. In ancient Greek legend, Daedalus built a great labyrinth for King Minos of Crete. King Minos imprisoned him so that he would not reveal the secret of the labyrinth. Daedalus escaped with his son Icarus by making feather and wax wings and flying away. But in the joy of soaring Icarus flew too close to the sun, the wax on his wings melted, and he plunged into the sea.
3,000 years ago, China	The Chinese invented and flew kites at least 3,000 years ago. Kites eventually reached Europe in the 14th century. Although we think of them primarily as toys, they have been used to lift people for serious observations, for measurement or weaponry in war, and today for meteorological work. Marco Polo witnessed kites carrying humans in China in the 1300s.
400 B.C., Greece	Archytas of Tarentum, a Greek mathematician, scientist, and philosopher who lived in Italy, may have designed a small flying "dove" balanced so as to fly by means of a whirling arm which provided lift.
The Middle Ages (and earlier), Europe	Roger Bacon, an English Franciscan monk, suggested the use of large, hollow globes of thin metal, filled with rarefied air or "Liquid fire" (perhaps hydrogen gas) to achieve flight. Most experimenters, however, just designed wings, strapped them on, and jumped. None of them worked well even as gliders; most didn't work at all. Some of the would be aviators died. Children played with flying toys with whirring blades. This may have been true of children on many continents.
1010, England	An English monk, Eilmer, jumped from Malmesbury Abbey equipped with flapping wings. He broke his legs.
1162, Constantinople	A man in Constantinople tried to fly from the top of a tower using sail-like wings made of pleated fabric. He did not survive.
1400s, Italy	Leonardo da Vinci applied his extraordinary mind to understanding flight by carefully studying birds. He realized human arms are too weak to flap wings for long, so he sketched designs for machines with wings that would flap. The power was supplied by a person winding levers with the hands and pushing on pedals with the feet. Leonardo never built his ornithopter. It would never have flown; Leonardo didn't understand enough about how birds fly, and the materials available in his time were far too heavy. However his was among the first scientific efforts to design a flying machine. He invented the airscrew and designed the first real parachute (a hand-held size) in history.
1600s, Turkey	Hezarfen Celebi leapt from a tower at Galata and flew some distance before landing safely in the market place of Scutari.
1678, France	A French locksmith named Besnier tried to fly with wings modelled after the webbed feet of a duck. He was lucky - he survived.
1709, Portugal	Father Bartolomeu de Gusmao demonstrated a model hot air balloon to King John V and others. It was made of paper and inflated by heated air from burning materials carried in a suspended earthenware bowl.
1783, France	The world's first balloon flight occurred on November 21, 1783 over Paris, astonishing the population. The balloon was designed by the brothers Joseph and Jacques-Etienne Montgolfier. Francois de Rozier and the Marquis d'Arlandes rode in it. It was made of linen and paper and powered by heated air. (There is some evidence, however, that in China in 1306 a balloon ascent was made during a coronation.)

1783, France	Brothers Jacques Charles and Maurice Robert made the second balloon flight in history, also over Paris. Their balloon was made of rubberized silk and filled with hydrogen gas instead of hot air. Hydrogen gas was more practical since it didn't have to be heated in flight.
1797, France	Andre Jacques Garnerin landed safely by the use of a parachute after jumping from a balloon at approximately 2,000 feet (600 m).
1799, England	Sir George Cayley invented the concept of the fixed-wing aircraft. Modern airplane design is based on his ideas.
1809, Paris	Marie Madeleine Sophie Blanchard wife of balloonist Jean-Pierre Blanchard, a capable aeronaut in her own right and chief of Napoleon's air service, lost her life when her hydrogen balloon caught fire as she watched a fireworks display. She was the first woman to lose her life while flying.
1804, England	Sir George Cayley conducted experiments with kites to understand how things fly. While many people believed that flying would develop through lighter-than-air craft, he was convinced that one day wings would carry people in the air. One of his great contributions was to separate the ideas of lift, propulsion, and control (a bird's wings provide all three, unlike man-made aircraft). From his work with kites he learned so much about how things are lifted in the air that he was able to build a glider. His glider is the basis for modern aircarft design.
1845, England	William Henson and John Stringfellow built a working model of a plane powered by a specially made, lightweight steam engine. No one knows whether it flew. Over the next decades many imaginative people tried to build steam-powered flying machines. But the engines were either too weak or too heavy. Powered flight wasn't possible until the invention of the powerful, compact, gas engine.
1852, France	Henri Giffard addressed the great limitation of balloons - they would float wherever the wind took them. He made a cigar-shaped ballooon and powered it with a steam engine to make it "dirigible", that is, steerable. This was the first manned, powered, steerable aircraft.
1853, England	Sir George Cayley built a full size glider. It supposedly carried his terrified coachman across a small valley.
Late 1800s, Western Europe	Balloons became fashionable and popular. Men competed for distance and height records. Balloon races were generally thought unsuitable for women (considered too delicate for this sport). People who raced balloons also had to be well off - it took time and money to indulge this hobby.
1890s, Germany	Otto Lilienthal built a series of small, fragile gliders. He adopted a scientific approach: he studied each problem carefully and tested each solution. In his gliders he supported himself on his forearms, and steered by swinging his legs to shift his center of gravity. He succeeded in making the first regular, controlled flights with his gliders. Lilienthal discovered that a curved, or "cambered" wing surface creates the best lift. He corresponded with the Wright brothers and offered them many ideas. He was killed in 1896 when a gust of wind threw his glider out of control.
1890, France	French engineer Clement Adler built a steam plane - an airplane powered by a lightweight steam engine. It flew 164 feet (50 m). Notably, this plane took off from level ground, not needing a slope to gain speed.
1896, United States	Samuel Langley achieved sustained, powered flight (without a pilot on board) in his heavier-than-air Aerodrome. He was racing with the Wright brothers to be the first with controlled, piloted flight. His attempt, just nine days before the Wright's historic flight, suffered a structural failure.

1903, Kitty Hawk, North Carolina, USA	Orville and Wilbur Wright flew a gasoline powered flying machine about 120 feet (37 m), for 12 seconds, over the sands at Kitty Hawk, North Carolina, and returned safely to the ground. It was the world's first successful, piloted, powered flight. Orville was the pilot. That short flight is widely considered the starting point of modern aviation. The Wright brothers made four flights that day. The last, with Wilbur as pilot, flew 59 seconds and 854 feet (260 m). Their aircraft, the Flyer, can now be seen at the Smithsonian Air and Space Museum, Washington, D.C. The Wright brothers' success came about in part because of their thorough preparation. Wilbur once wrote: "Having set out with absolute faith in the existing scientific data, we were driven to doubt one thing after another, until finally, after two years of experiment, we cast it all aside, and decided to rely entirely upon our own investigations." They tested many designs, and improved their flying skill with each one. They were the first to use a wind tunnel to do practical tests of their propellers, wings, and engines. For a brief time they were far ahead of all other pioneers, but so many people were interested in flying that progress was rapid everywhere.
1906, France	Alberto Santos-Dumont made the first sustained airplane flight in Europe: 197 feet (59 m) in a straight line, about 10 feet (3 m) above the ground. Only a few months later, he flew 722 feet (217 m) in 21 seconds, winning a prize for the first European flight covering more than 100 meters.
1907, France	Paul Cornu, a French mechanic, flew briefly in a primitive aircraft which was lifted by two horizontally rotating wings - the first helicopter. Helicopters proved so unstable that they were not reliable aircraft until the flight of the first autogiro in 1923.
1908, Italy	Madame Therese Peltier was the first woman to fly solo in an airplane.
1908, England	Muriel Matters, a suffragette and balloonist, flew over the British Houses of Parliament dropping hundreds of flyers urging "votes for women". It was possibly the first use of the air for political lobbying and publicity.
1909, France	Louis Bleriot flew a small aircraft 26 miles (42 km) over the channel from France to England. His aircraft were monoplanes (single wing) with a separate tail. He adopted the Wright brothers' technique of 'warping' the wings - using wires to twist the wings and lift one side or the other. This allowed controlled turns. After his crossing of the Channel, Bleriot became a celebrity. He was cheered in London, and by a crowd of over 100,000 people when he returned to Paris. His flight fired the public imagination and also immediately began to worry governments, which became concerned about the power and protection of their navies. Bleriot set a speed record in 1909 of 48 mph (77 kph). More than 100 of Bleriot's Type XI aircraft were ordered. He became the world's first large-scale aircraft manufacturer.
1909, France	The world's first international air show was held in Reims. The planes were mostly made of wood. They could climb as high as 500 feet (150 m) above the ground. The fastest airplane in the show flew 47 mph (75 kph). Within four years, aircraft were flying over 120 mph (192 kph), climbing as high as 20,000 feet (6,000 m), and performing aerobatics feats such as loops and rolls.
1908, England	Famous author H. G. Wells wrote War in the Air, a story envisioning the colossal destruction wrought by aerial bombing.
1909, United States	The U.S. Army buys its first plane.
1910, France	The colorful, self-styled Baroness Raymond de Laroche, an artist and car driver, became the first woman officially qualified as a pilot. She received pilot's certificate #36.
1910, Europe	Jorge Chavez, a Peruvian, became the first to fly an airplane over the Alps. Unfortunately just as he was about to land and complete his great feat one of his aircraft's wings buckled. He crashed and did not survive.
1911, United States	Harriet Quimby became the first American woman to receive a pilot's license. She was one of the most celebrated stunt pilots of the early years of flight. The second woman to receive a license was her good friend, Mathilde Moissant.

1911, United States	Calbraith Rodgers became the first person to cross the continent in a plane. He was followed by a train carrying a mechanic, his wife, and spare parts for his plane. The plane crashed 19 times. The trip took 49 days and Rodgers arrived with one leg in a cast. He was cheered by a crowd of 20,000 people in Pasadena, California, when he arrived.
1911, France	The first women's flying school was founded in France, run by qualified pilot Jane Herveux.
1911, United States	Eugene Fly, test pilot for the Curtiss Company, did the first landing on a warship at sea. In order to stop fast enough, a system of ropes stretched across a platform and secured to sandbags was used to aid in braking.
1911, Ireland	Lilian Bland designed, built, and flew a plane - the first powered aircraft to be built in Ireland. She had always been fascinated by birds and flight. After Bleriot's famous crossing of the English channel, she became determined to learn to fly. She attended an aviation meeting and studied the flying machines there. Later, she returned home and built her airplane, which she whimsically named the Mayfly.
1911, Germany	Melli Beese was about to take her test flight to gain her pilot's license when she discovered that some of her male colleagues so disliked the idea of a woman learning to fly that they drained her aircraft's fuel tanks and even tampered with the steering mechanism. She managed to take her test that day, however, and gained her license in spite of them.
1913, China	China buys its first fleet of aircraft and opens a flying school for pilots in Beijing.
1914, United States	The first regularly scheduled passenger service began operation, operating between St. Petersburg and Tampa, Florida. The fare was $5.00 one way for up to 200 pounds of both passenger and baggage.
1914 - 1918 World War I	Desire for observation planes and later for fighters for use in war drove development of airplanes. This was the first major conflict involving the use of air power. By the end of the war, the airplane had become a fairly reliable, maneuverable machine. Hinged flaps on the wings called ailerons were used for banking the planes, instead of the 'wing warping' technique. Because of a wood shortage, manufacturers began to experiment with using metal in making airplanes. Biplanes were still popular, because the second wing gave them more lift and stability. However, as monoplanes improved, they became more popular because they produced less drag. During this time, dirigibles were also developed and used, particularly by Germany. However, they became less important as airplanes developed.
1916, United States	The Boeing Aircraft Company was founded by William Boeing, a timber merchant. It was called the Pacific Aero Products Company. It is still a highly successful airplane manufacturer today.
1916, United States	Ruth Law broke the American nonstop distance record, flying 590 miles from Chicago to Hormel, New York. To survive the cold in her open cockpit, she wore four complete suits of wool and leather clothes.
1917, United States	Katherine Stinson broke the Ruth Law's distance record by flying 610 miles (976 km) nonstop..
1918, United States	The first attempt to transport mail by air in the United States occurred on May 15th of this year. It was not a success - the pilot got lost. However, within a few years, U.S. mail was regularly transported by air.
1918, United States	Congress formed NACA, which later became NASA, the National Aeronautics and Space Administration.
1918	Louis C. Candelaria of Argentina made the first successful flight of an airplane over the Andes, the highest mountain range in the western hemisphere. He took off from Zapala in Argentina and landed in Cunco, Chile.
1919, Canada/Ireland	First successful, nonstop, transatlantic flight by Captain John Alcock (pilot) and Arthur Whitten-Brown (navigator) of Great Britain. They flew from Newfoundland to Ireland, braving darkness, clouds, sleet and snow.
1919, U.S./Canada	First international mail flight between the United States and Canada.
1919 U.S./Cuba	Aeromarine Airways became the first international airline flying scheduled flights out of the United States. It flew between Key West and Havana.

1910 - 1929, United States The Barnstorming Era.	Stunt flyers and exhibition teams put on shows and introduced thousands of people to the idea of flying. For a fee, they would take passengers up for a brief flight. Their shows included loops, rolls, daredevil stunts close to the ground, parachute jumping, and wingwalking. The career was genuinely dangerous; many pilots lost their lives. Among the pilots some of the better known names are Harriet Quimby, Bessie Coleman, Katherine and Eddie Stinson (Eddie was the first pilot to discover how to recover a plane from a spin), Charles Lindbergh.
1921, Argentina	Adrienne Bolland became the first woman to fly over the Andes. She took off from Mendoza, Argentina, and landed 10 hours later in Santiago de Chile. Huge crowds greeted her arrival. She had flown at an altitude of 14,750 feet, braving the bitter cold and having to avoid mountain peaks that were higher than the altitude her airplane could fly.
1923, Spain	Juan de la Cierva of Spain crossed the English Channel in the world's first autogyro a craft using a propeller for forward movement and a rotor for lift.
1925	The trial of Col. William 'Billy' Mitchell. A hero of the great war (World War I), he was court-martialled for making public statements 'contrary to military order and discipline.' The outspoken Mitchell angered his superiors not only because of his brusque manner, but because he insisted that the U.S. Armed Forces devote more resources to the U.S. Army Air Service and make it a separate arm equal to the Army and the Navy. The U.S. secretary of the Navy claimed that the U.S. was not vulnerable to attacks from the air, because several Navy aircraft had crashed on long flights. Mitchell responded that the crashes arose from 'incompetence, criminal negligence, and almost treasonable' actions by members of the Army and Navy. Years after his trial he was posthumously honored for his vision and achievements.
1926, North Pole	First flight over the North Pole by Commander Richard Byrd and Bennet of the United States
1927, United States/France	Charles Lindbergh flew the first non-stop, solo flight from New York to Paris (although this was not the first crossing of the Atlantic) in his plane, the Spirit of St. Louis. He was cheered by huge crowds in Paris when he landed. A few weeks later when he returned to the United States, over a million people lined the streets to cheer him during a ticker tape parade.
1930	Ellen Church became the world's first airline stewardess, flying for United Airlines. She was a registered nurse, as were the next eight stewardesses hired by United. They wore white nurses' uniforms while on duty.
1930, United States	Ruth Nichols set a transcontinental speed record of 13 hours and 21 minutes, beating a previous record set by Charles Lindbergh.
1930, India	Amy Johnson, an Englishwoman, set a speed record flying from London to India in 13 days. She then continued her flight and eventually reached her destination in Australia, where she was greeted by cheering crowds. When she saw the crowds from the air, she thought she must have arrived during an air pageant - not realizing they were there to greet her.
1933, Around the World	Wiley Post of the U.S. set a record flying the first solo flight around the world - 15,596 miles (24,954 km) in 7 days, 19 hours. Post and his navigator Harold Gatty flew around the northern hemisphere, crossing the Atlantic, parts of Europe, the USSR, Alaska, and Canada.
1933, United States	The first modern airliner came into service, the Boeing 247.
1933, Spain/Cuba	Marion Barberan and Joaquin Collar made the first non-stop flight between Seville, Spain, and Cuba. It was the first crossing of the Atlantic to the West Indies.
1937, United States	The luxury airship Hindenburg exploded in Lakehurst, New Jersey. The dramatic conflagration and the deaths of 36 people on board marked the end of the era of huge dirigibles.
1937, Japan/England	To mark the coronation of England's King George VI, Japanese pilot Masaaki Iinuma and navigator Kenji Tsukagoshi flew from Japan to England in just under four days. Eager crowds welcomed the aviators.
1937 - 1945 World War II	Need for aircraft for military superiority fueled development of faster and more efficient fighter planes, transport planes, radar and navigation systems, helicopters, and jets. Air power, as predicted by Billy Mitchell so many years before, was a decisive factor in the waging of this war.

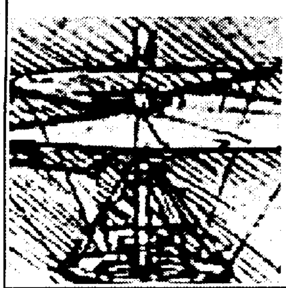
1937, Spain	The town of Guernica, Spain, was the scene of massive bombing from the air by German aircraft. The raid, which lasted four hours and left much of the population dead and most of the town destroyed, was ostensibly to destroy a bridge. The bridge was undamaged. It was the worst such attack in history up to that date.
1939, Germany	Test pilot Erich Warsitz made the first jet flight, in a German Heinkel He 178. World War II provided impetus for the rapid development of jets.
1941, United States	Formation of the Tuskegee Airmen, the first black fighter squadron in the United States armed forces. Until that time, blacks had been forbidden from receiving pilot training.
1943, U.S.	Formation of the Women's Airforce Service Pilots (WASPS) to ferry military planes and perform other non-combat operations for the U.S. military in World War II. They flew with distinction but were disbanded as the war ended because opposition to women military pilots was so great.
1947, United States	U.S. Air Force test pilot Chuck Yeager broke the sound barrier flying in a Bell X-1 roket powered aircraft. He flew at 670 mph (1072 kph), or Mach 1.015, at an altitude of 42,000 feet (12,600 m).
1948, United States	The world's first flying car is flown. The Hall flying automobile was an automobile with a detachable airplane wing and a tail.
1948, United States	Record for the decade for speed set by Amy Johnson, flying 671 mph (1,073 kph).
1948 United States	President Harry S. Truman signed the executive order desegregating the armed forces of the United States.
1953, United States	Jacqueline Cochran became the first woman to fly faster than sound. She was one of the most admired aviators in the United States. By the time of her death in 1980 she held more records for speed and distance than any other pilot before or since.
1959, USSR	Speed record for the decade set by Mosolov flying 1,483.51 mph.
1959, Around the World	First around the world jet passenger service was offered by Pan American Airways in a Boeing 707.
961, United States	Ross and Prather set a balloon altitude record of 113,740 (34, 122 m) feet.
.963, United States	NASA pilot Joseph Walker flew the experimental X-15 rocket airplane to a record altitude of 67 miles (108 km). The X-15 was launched from beneath the wing of a modified B-52 bomber.
1964, United States	Jerrie Mock is the first woman to fly solo around the world. The flight, in a Cessna 18, lasted 29 days.
1967	First automatic landing by a jet (a Boeing 707).
1969, United States	The test flight of the 747, the first wide-bodied jumbo jet. It has been a highly successful commercial aircraft. The challenge in its design was the scale-up of an aircraft to this size. 747s typically carry 420 passengers. They have a maximum range of 8320 miles (13,390 km).
1969, France and Great Britain	Flight of the Concorde, the first commercial airplane capable of travelling faster than the speed of sound. The plane travels at Mach 2.2 They are used primarily by business travellers.
1971, Great Britain	Sheila Scott made the first flight equator to equator over the North Pole.
1971, United States	Long makes the first around the world flight over the poles in a Piper Navajo, travelling 38,896 miles (62,234 km) in 215 hours.
1979, English Channel	First human-powered flight across the English Channel by MacCready in the Gossamer Albatross. The aircraft weighed only 200 lbs. (90 kg), and had wings nearly 100 feet (30 m) long.
1981, United States	U.S. Astronauts John Young and Robert Crippen piloted the space shuttle Columbia on its maiden flight from Kennedy Space Center in Florida, marking the first flight into orbit of America's reusable "space plane" - part rocket and part glider. The flight ended with a perfect reentry and landing at Edwards Air Force Base in California.
986, United States	Dick Rutan and Jeana Yeager set a distance record for airplanes and made the first (and so far, the only) nonstop, non-refueled, around-the-globe flight in their frail plane, the Voyager. They flew 24,987 miles (39,979 km) in 9 days, 3 minutes, 44 seconds.

1987, United States	First over-the-poles, around-the-world flight by a single-engine plane made by Norton and Rosetti in a Piper Malibu, flying 34,342 miles (54,947 km) in 185 hours, 41 minutes.
1988, United States	Longest flight by a human-powered aircraft made by Kanellopoulos in his aircraft the Daedalus. He flew 74 miles (118 km).
1988, Austria	Distance record set for an ultralight, by Lischak, flying 1,011 (1618 km) miles.
1991	Longest balloon flight ever, by the Virgin Otsuka Pacific Flyer, 6,761 miles.
1994	Vicki Van Meter was twelve years old when she flew a Cessna 210 across the Atlantic, becoming the youngest pilot to ever make a transatlantic flight..
1994	Test flight of the Boeing 777, the first aircraft designed entirely on a computer.

Notable People in Aviation

Aida de Acosta	Miss de Acosta, born in Cuba and reared in the United States, soloed in a dirigible near Paris in 1903 - five months before the Wright brothers' historic flight. The press severely criticized her instructor, Alberto Santos-Dumont, for allowing a woman to fly. Her parents believed a woman's name should only appear in a newspaper upon her marriage or her death, and were horrified at the publicity. They made Santos-Dumont promise never to reveal her identity. He reluctantly agreed, but recorded the event in his book "Dans l'Air" so the story would be recorded in the history of flight.
Charles A. Anderson	A member of the illustrious Tuskegee Airmen, the all black fighter squadron of World War II. Charles Anderson became fascinated by flight as a child. When he could not find a white instructor willing to teach him to fly, he saved his money, borrowed from his relatives, and bought a second hand airplane. He taught himself to fly, first listening to others and observing what they did from the ground, then trying it by himself in his airplane. He became a good enough pilot that in a few years he and a few friends became the first black aviators to fly the United States, state by state, from coast to coast. He got a license to teach flying and taught black Americans, then was selected to be part of the experimental 99th fighter squadron (the Tuskegee Airmen) which distinguished itself in World War II.
Richard Bach	An author and pilot who has written a large number of popular books on flight, including "Jonathan Livingston Seagull."
Anne Baumgartner	First American woman to pilot a jet aircraft. As a test pilot for the armed services, she tested the then top-secret experimental YP-59 jet in 1944.
Lincoln Beachey	One of the best known stunt pilots in the pre World War I era. He staged airshows promoting Glenn Curtiss aircraft. He was killed, like so many pilots of the era, when a stunt went wrong.
Admiral Richard E. Byrd	The first, along with pilot Floyd Bennett, to fly over the North Pole, in 1925.
Edith Berg	The first woman to go up in an airplane. She was a passenger in the Wright's Flyer in a demonstration in France in 1908.
Jean Blanchard	One of the first balloonists, famous for a balloon flight across the English Channel from Dover, England, to Calais, France.
Marie Madeleine Sophie Blanchard	One of the first balloonists, and wife of Jean Blanchard. She was appointed air service chief to Napoleon Bonaparte. Napoleon planned on invading England by launching an invasion in balloons across the English Channel. Madame Blanchard understood that the flight would occur against prevailing winds and be unsuccessful. She warned him against it, and said that if his generals doubted her word because she was a woman, they should first try it themselves. Napoleon took her advice.

Louis Bleriot	A Frenchman, Bleriot was the first person to fly the English Channel. He flew from the coast of France to the coast of England at Dover. He flew without a compass or any other navigational instrument. Caught in a mist as he approached England, he spotted some ships and followed them to the cliffs of Dover.
Jack Boeing	A timper baron who became interested in aviation in its early years. The company he founded, the Boeing Company in Seattle, Washington, is one of the most successful airline companies in the world today.
Janet Harmon Waterford Bragg 	An African American who studied at Spellman College in Atlanta, became a nurse, and then in 1933 pursued her fascination with flight and took flying lessons. She and her friends purchased an airplane and formed a flying club, the Challenger Pilots Association. Because few air fields would accept blacks, the group cleared their own land to make a runway. Janet faced many battles in aviation because of her gender and race, but persevered. She compares herself to a bumble bee, "an insect who on paper is aerodynamically incapable of flying, but in reality flies merrily along. In a way, society placed its aerodynamic limits and restrictions on Janet and her ability, but like the bumble bee, she never let it stop her from completing her flight plan." At 80 she still lectures at national aviation events.
Sir George Cayley	Researcher and scientist. Conducted experiments with kites to understand how things fly. While many people believed that flying would develop through lighter-than-air craft, he was convinced that one day wings would carry people in the air. One of his great contributions was to separate the ideas of lift, propulsion, and control (a bird's wings provide all three, unlike humanly built aircraft). From his work with kites he learned so much about how things are lifted in the air that he was able to build a glider. This model glider, with an up-angled front with and a tail for stability, is the basis for modern aircraft design Sir George built a full size glider which supposedly carried his terrified coachman across a small valley. The coachman gave notice, saying he had been hired to drive, not fly.
Octave Chanute	A pioneer in glider design. His gliders, which used vertical struts and bracing wires, were exceptionally stable. He corresponded regularly with the Wright brothers at Kitty Hawk in 1901 and 1902.
Willa C. Brown Chappell	After she heard about Bessie Coleman's tragic death, Willa decided to learn to fly. She felt that another woman should carry on Bessie's campaign to encourage blacks into aviation. Willa gained her pilot's license and master mechanic certificate, and taught flying. She persuaded the Civil Aeronautics Authority that blacks could become pilots and be accepted into the Army Air Corps. She then lobbied the Army Air Corps to train blacks as pilots, which led to the legendary program at Tuskegee Institute. She and her husband, Lt. Cornelius Coffee, opened the Coffee School of Aeronautics in 1942, fulfilling Bessie Coleman's dream of an aeronautics school. This school taught the men who became pilots in the 99th Pursuit Squadron - the highly decorated all-black fighter squadron of World War II.
Jacqueline Cochran 	The first woman to fly faster than the speed of sound. Jackie won an extraordinary number of air races, starting with the Bendix Trophy in 1938. At the time of her death in 1980 she held more speed, altitude, and distance records than any pilot, male or female, in the world. She started out as a highly successful beautician, later trained as a nurse, and finally became interested in flying. She got her pilot's license after two and a half weeks of flight lessons in 1932. She served as a test pilot to many companies, flying to test airplane components, wing designs, and airplane fuel. She was instrumental in organizing the Women's Airforce Service Pilots in World War II, and was awarded the Distinguished Service Medal and the U.S. Air Force Distinguished Flying Cross.

Bessie Coleman 	Also known as "Queen Bess," she began her flight training in 1921, the same year as Amelia Earhart. Bessie became the first black woman to learn to fly, and the first African-American - man or woman - to earn a license from the Federation Aeronautique Internationale. A manicurist from Chicago, she could not get anyone in this country to teacher her to fly because of her gender and race. Coleman took French language lessons, found a backer, and went to France where she received both flight instruction and license. Although her achievements were largely unacknowledged except in the black press of the time, her air shows drew thousands of spectators.
Paul Cornu	A French engineer who designed and built the first helicopter to complete a free flight, 20 seconds long, with a person on board, in 1907. Although a helicopter design had lifted of the ground previous to Cornu's, it had been held in place by people standing on the ground.
Douglas "Wrong Way" Corrigan	Douglas Corrigan was a welder who worked on the making of the Spirit of Saint Louis for Charles Lindbergh, and became interested in flying. He is remembered for his flight to Ireland in 1938. He lacked official permission to fly the Atlantic, but flew to Ireland anyway. He made sure he did not have a radio on board so he couldn't be contacted and told to turn back. After arriving, he claimed he had intended to fly across the United States, but that a compass error had sent him in the opposite direction... his claim earned him national renown in the United States along with his nickname, Wrong Way Corrigan.
Leonardo da Vinci 	An Italian painter, sculptor, architect and engineer who lived from 1452-1519. His writings and drawings include the first scientific studies of flight. He was a careful observer and experimenter. He designed (but never built) a simple helicopter, ornithopter, parachute, and propeller.
Benjamin O. Davis, Jr.	The commander of the first black pilots' unit to fly for the armed forces of the United States. The unit, the Tuskegee Airmen, proved to the satisfaction of the U.S. military that blacks could pilot planes in combat for the United States. They served as fighter escort pilots, earning an excellent reputation amongst both Allied and enemy pilots (most of whom did not know they were black). Benjamin Davis was described by his men as "hard but fair... with a mind like a steel trap. He had to please the blacks and convince the whites." An extraordinarily disciplined man who was the second black cadet at West Point in the 20th century. He earned the loyalty of his men, fought for the existence of his unit when the armed forces considered disbanding it because of racial prejudice, and insisted on a discipline that made the Tuskegee Airmen one of the best squadrons in the service. The airmen collectively earned 850 medals, and never lost a bomber under escort.
de Bothezat, George	A Russian born engineer who in 1922 developed the first successful experimental helicopter in Dayton, Ohio. The machine made approximately 50 flights, proving that with further development it had great potential as a useful aircraft.

Lt. Col. James Doolittle	A World War I aviator, speed record setter, and flight instructor who went on to study engineering. He developed instruments for "blind" flying so that pilots could fly with poor or no visibility. He made the first completely "blind" instrument flight in history in 1929. He took off, flew a predetermined course, and landed, exclusively by instruments (his cockpit was hooded so he could not see outside). He held the speed record in the GeeBee airplane, and was the instrumental figure behind the first bombing raids on Tokyo in World War II.
Amelia Earhart	Among the most famous pilots of all time. She was an aviation pioneer who became the first woman to cross the Atlantic solo in 1932
Phoebe Fairgrave	An early aviator, in the 1930s she organized a group of women fliers who barnstormed the country urging communities to paint the name of their town or city in large white letters on a rooftop to aid pilots in navigation. She was the first woman to hold a government aviation post, serving as technical advisor to the National Advisory Committee for Aeronautics under President Franklin D. Roosevelt.
Lt. Harold Harris	In October of 1922 he jumped from his plane moments before it crashed. Using a parachute saved his life. Until then, most pilots considered parachutes mere novelties or something for sissies. Harris' experience did much to change this attitude. He became a member of the Caterpillar Club - composed of anyone who had made an emergency jump from an airplane.
Lady Mary Heath	First woman to solo from Capetown, South Africa, to London, England. She made her 12,000 flight in a series of short "puddle jumps."
Amy Johnson	An Englishwoman who was the first woman to fly from England to Australia in 1930.
Valeria Ivanova Khomyakova	First woman pilot in history to shoot down an enemy bomber. She flew for the Russian armed forces during WW II.
Samuel P. Langley	U.S. astronomer, physicist and aeronautics pioneer. Langley did many aeronautic experiments. He was in intense competition with the Wright Brothers to launch the first controlled, piloted flight. He persuaded the Government to fund his development of a heavier-than-air flying machine, which he launched from a houseboat in the Potomac. Unfortunately, a problem developed in the launching and the flight was not successful. There is still controversy today over whether his design was workable. Langley was the first head of the Smithsonian Institution.
Ruth Law	Among the first American women to fly, Ruth Law held the record for greatest distance flown in 1916, until it was broken by another daring aviator, Katherine Stimson. Ruth was a stunt pilot and air racer. She flew at night during a time when night flying was dangerous. In 1916 she flew an illuminated aerial salute, setting off magnesium flares from her plane, to celebrate the installation of a permanent lighting system at the Statue of Liberty
Otto Lilienthal	A German aeronautical researcher. He studied the flight of birds, and became interested in gliders. he built monoplane and biplane gliders and achieved controlled glider flights. He did extensive research on increasing the stability of aircraft, which greatly helped later experimenters. Lilienthal shared much of his experiment results and information with the Wright brothers. He was killed when a wind gust flipped over one of his gliders.

Charles Lindbergh, Jr. 	First person to fly solo across the Atlantic Ocean. He left New York on May 22, 1926, and landed in Paris 33 hours later. He is possibly the most famous aviator in the world.
Anne Morrow Lindbergh 	Well known author, wife of Charles Lindbergh, and a pilot in her own right. She earned her glider's license in 1930, and later a pilot's license.
Lilya Litvyak	A Soviet combat pilot who flew in W.W.II. She was repeatedly successful in flying missions, although finally killed on a war mission in 1943. In 1990 she was conferred the title of Hero of the Soviet Union.
Grover Loenig	Received one of the first degrees in aeronautical engineering in 1911. He learned to fly from the Wright brothers. After working for them, he formed his own airplane company which became Grumman Aircraft. Among his notable achievements were the development of retractable landing gear.
Paul MacCready	Designed and built a successful humanly powered aircraft, the Gossamer Albatross. In 1979 Bryan Allen pedaled the aircraft in the first human-powered flight across the English Channel. MacCready also build the Solar Challenger, the first solar-powered aircraft capable of sustained flight. He has devoted himself to developing aircraft and autos which improve air quality and conserve energy.
Lester Maitland	The first pilot to fly from the United States to Hawaii, in 1927.
Beryl Markham	An Englishwoman who lived in Kenya, she became famous for her solo flight across the North Atlantic from England to Cape Breton Island, Canada.
August Martin	A Tuskegee Airman.
Billy Mitchell	Outspoken and sometimes abrasive, asserted that surface ships are doomed when faced with air power. His supporters believed he was a visionary ahead of his time; his detractors called him fanatical. He saw the future of the armed forces depending on aviation, and insisted that the Navy could no longer be considered the chief defender of the United States, because ships were vulnerable to aircraft dropping bombs. He staged a demonstration of this by sinking the "unsinkable" warship, the German Ostfriedland. Bombing strategies which he developed (and which were opposed by many people in the armed forces at the time) were later used in World War II. He was eventually court-martialed for his public criticism of the armed forces and resigned his commission. However, he never stopped working to persuade people of his views on he importance of aviation. In 1946 Brigadier General Billy Mitchell was posthumously awarded the Congressional Medal of Honor for his work.

Jerrie Mock	The first woman to fly successfully around the world, in 1964. During the flight she set seven new records, including: a woman's speed record for a round-the-world flight, a speed record for men and women in a round-the-world-flight in a single-engine plane in the 2,204-3,858 pound weight class, the first woman to fly the North Atlantic from the U.S. to Africa, the first woman to fly both Atlantic and Pacific oceans, the first person to fly the Pacific in a single-engine plane, and the first woman to fly around the world as pilot in command.
Joseph-Michel and Jacques-Etienne Montgolfier	These brothers launched the first large scale hot air balloon in history in 1783. It was fueled by burning straw and wool in a furnace below the envelope. They also conducted the first untethered launch with people aboard; that flight went 5.5 miles.
Mary Myers	The first American woman to pilot a balloon. Her first flight was in 1880. She became a famous balloonist, and set an altitude record of 20,000 feet (without the benefit of supplemental oxygen). Between 1880 and 1890 she completed more balloon ascents than any other living person.
Night Witches	The 588th Night Bomber Regiment of the Soviet Union in World War II. It was made up entirely of female pilots. They were nicknamed night witches because they flew their missions in wooden biplanes at night. Many of the mechanics and bomb loaders of this regiment were women, also.
Dr. Ninomya	Invented "White Wings."
Joan Osterud	A pilot for United Airlines who also is an aerobatics pilot who flies in air shows every year. She set the record for the greatest number of outside loops in 1989 (208) and in 1991 set a record for distance and endurance in inverted (upside down) flight.
Jeannette Piccard	Holds the women's record for height flown in a balloon when she and her husband, Jean, sailed to 57,579 feet over Lake Erie. The Piccards were scientists who studied atmospheric conditions. Jeanette's record remained until Valentina Tereshkova went into space in 1963. Jeanette Piccard also became the fist woman to be ordained a minister in the Episcopal church.
Harriet Quimby 	A successful journalist, she became the first American woman to receive a pilot's license. She took lessons disguised as a man, but a reporter discovered her secret and from then on she didn't bother with the disguise. She received her license in 1911. Officials were doubtful about granting a flying license to a woman until she proved she could fly by breaking a record for landing accuracy. She was the first woman to pilot an aircraft across the English channel
Wiley Post	First person to fly an airplane around the world, in 1931. He was an adventurer, blind in one eye, and one of the most colorful figures in the early history of aviation. A farmer's son who left school after the eighth grade, he set speed and distance records, designed and used the first pressurized flight suit, tested the first autopilot, furthered the use of navigational instruments, and confirmed the presence of jet-stream winds which significantly increase an aircraft's speed when flying east across the United States. He was killed in a plane crash in Alaska in 1935.

Marina Raskova	A famous Soviet navigator who set many records during the 1930s. She and two others were the first women to be awarded the Hero of the Soviet Union medal in 1938 when they completed a dangerous Moscow-Far East flight that broke the international women's distance record. Her influence helped to bring about the creation of the women's aviation unit which flew combat missions for the Soviet Union in W.W.II.
Manfred von Richthofen	The Red Baron: Germany's top aviator and leading ace in World War I. He commanded the Jagdstaffel 11, known as Richthofen's Flying Circus because of its fancifully decorated scarlet planes. He shot down 80 enemy aircraft.
Eddie Rickenbacker	The most celebrated U.S. ace of World War I. He was an auto racer who became a fighter pilot for the United States in 1917. Although the U.S. entered the war late, Eddie had 26 air victories. After the war he became involved with commercial airlines, eventually becoming the president of Eastern Air Lines.
Calbraith Rogers	The first U.S. aviator to make a transcontinental flight, in 1911. His flight took 49 days. He crashed 19 times, and arrived at the end of his journey with one leg in a cast. A crowd of about 20,000 people came to cheer his arrival in Pasadena, California.
Dick and Burt Rutan	Burt is an aircraft designer and Dick is a retired Air Force colonel. They designed, and Dick copiloted with Jeana Yeager, the Voyager, the plane that made the first round-the-world, non-stop, non-refueled flight in 1986. Burt's design work has influenced commercial and homebuilt airplane designs, and shown that canards can be used in modern aircraft.
Alberto Santos-Dumont	A Brazilian-born sportsman and scientist. He was important in making aviation popular in its early years. He was the first European to achieve sustained flight in a powered airplane. He was an enthusiastic experimenter and self promoter. When he lived in Paris, he was known for landing balloons on the sidewalk of the Champs-Elysees and going upstairs to his apartment for coffee.
Igor Sikorsky	Russian born pioneer in aircraft design. He is best known for successfully developing the helicopter. He moved to the United States and became a citizen in 1928. His first U.S. helicopter flew on a test flight in 1939. His company built the successful helicopters which were widely used by the U.S. military in World War II and Vietnam.
Betty Skelton	The "First Lady of Firsts" has had a distinguished flying career as a racing and aerobatics pilot. She was the first woman to do the inverted ribbon cut - cutting a ribbon strung between two poles, ten feet from the ground, upside down. She twice set the world light-plane altitude record (29,050 feet in a Piper Cub in 1951). She also raced autos and today holds more combined aviation and automotive records than anyone else in history.
Soviet Women's Aviation Units	The 586th fighter aviation regiment, the 46th night bomber regiment, and the 125th dive bomber regiment were almost completely composed of women pilots. They flew in combat for the Soviet Union in World War II with excellent service records. The 46th, which had no male members at all, had the largest number of pilots in the nation to receive the "Hero of the Soviet Union" medal. (Information from "Wings, Women, and War" by Reina Pennington in Air and Space December 1993/January 1994.)
Antoine de Saint-Exupery	Among the most famous aviators in the world, this pioneering French mail pilot was author of Wind, Sand, and Stars and other writings.

Katherine Stinson	A well known flier before World War I. In 1912 she became the fourth licensed female pilot in the world. In 1913 she became the first woman to fly the mail. She won both speed and distance records, and was most famous for her daredevil stunt flying. She was the first woman to loop the loop, and the first to loop the loop at night. Her sister Marjorie was also a celebrated aviator.
Valentina Tereshkova	First woman in space (June, 1963). She completed 48 orbits in the Vostok VI. (During this time, NASA found pretexts to avoid including any female astronauts in its space program, in spite of 12 women successfully passing all the qualifying tests - some with better results than male astronauts who were selected for the program.)
Bonnie Tiburzi	First woman to fly as a pilot for a major U.S. airline (a handful of women flew for smaller airlines). She overcame many obstacles on the way to getting her job with American Airlines, including friends who told her to give up her desires because airlines would never hire her. American Airlines, the first major US airline to hire female pilots, accepted her application for employment in 1973. Bonnie's autobiography, "Takeoff!" describes her love of flying and how she finally achieved her dream. Of modern flying Bonnie wrote, "Don't let anybody kid you. Flying is still magic. Flying jets is exhilarating."
Tuskegee Airmen	The famous 99th and 322nd fighter squadrons of World War II. Before World War II no blacks were trained as U.S. military pilots, due in part to the irrational belief that they were not capable of learning to fly a plane. A need for pilots during the war helped to change this. The Tuskegee Airmen were carefully chosen for their abilities. They had to meet standards higher than those demanded of white aviators. They were rigorously trained, and watched to determine whether African Americans could perform as pilots in combat. They were sent to fight in Africa. The Tuskegee Airmen gained an outstanding reputation for their achievements as fighter escort pilots. Most of the bombers they escorted had no idea the pilots were black. The 322nd painted the tails of its planes a distinctive red. One bomber pilot said, "they were always right out there where we thought they should be... we thought they were the best of the fighter escorts... we had no idea these red-tailed escorts were black." Not one bomber plane they escorted was ever lost to the enemy during the war. The collectively won 850 medals. 66 were killed in action. Their achievements were largely unacknowledged by the military services and the country at large at the time. However, their first class service helped to bring about the desegregation of the military. It now allows all qualified men, regardless of color, to receive pilot training.
Patty Wagstaff	She entered her first aerobatics competition in 1984 and made the US Aerobatics team in 1985. In 1991 she won the US National Aerobatics Championship. She gives air shows all over the country.
WASPS	Women's Airforce Service Pilots flew for the United States Air Force in World War II. In spite of some opposition to women pilots within the armed forces, they flew every aircraft in America's fleet, from the P-51 Mustang fighter to the B-29 Superfortress. They transported airplanes around the country, flew as test pilots in experimental craft, towed targets to train air- to-air and ground-to-air gunners, and flew simulated smoke laying, strafing, radar-jamming, and searchlight-tracking missions. They did not fly in combat. They flew longer hours, with a lower accident rate, than male pilots performing the same duties. By the end of the war they were transporting 3/4's of the country's military airplanes in the United States. Although unfairly dismissed from the Army without veteran's status, they were finally accorded veteran's status by the Federal Government in 1977.

Wanda Whitsitt	The founder of Lifeline Pilots, which volunteers pilots and planes to fly medical emergency missions. She learned to fly for fun in 1979, and then wondered how she could use her new skill to help others. Lifeline flies patients, organs, and medical supplies. Wanda recruits pilots, coordinates missions, writes a newsletter, and flies some of the missions herself.
Sir Frank Whittle	British aeronautical engineer who invented a design for the jet engine. His design was used in the first operation jet engine.
Wilbur and Orville Wright 	Designed the first successful flying machine - a biplane which could fly in a controlled fashion and land safely. Their famous flight at Kitty Hawk, North Carolina, in 1903 marks the beginning of modern aviation. Their aircraft, the Flyer, can now be seen at the Smithsonian Air and Space Museum. The Wright brothers' success came about in part because of their thorough preparation. They tested many designs, and improved their flying skill with each one. They were the first to use a wind tunnel to do practical tests of their propellers, wings, and engines. For a brief time they were far ahead of all other pioneers, but so many people were interested in flying that progress was rapid everywhere.
Chuck Yeager	Air Force test pilot Chuck Yeager was the first pilot to exceed the speed of sound. He did this in 1947 while testing the Bell X-1 aircraft.
Jeana Yeager	Set a record, with Dick Rutan, when they copiloted the longest round-the-world, non-stop, non-refueled trip in the Voyager. The flight took nine days and 13 minutes. Jeanna additionally holds five world aviation records in speed and distance. She and Dick cofounded Voyager Aircraft, Inc.
Count Ferdinand von Zeppelin	The most famous airship designer and manufacturer. Count Zeppelin visited the United States and observed the use of army balloons in the American Civil War. He returned to Germany to build airships, and launched the first one in 1900. Over 100 zeppelins were used by the Germans in World War I. The era of rigid airships ended in 1937 with the explosion of the Hindenburg.

Activities

The design of these activities was a collaborative effort by MCET and the FAA Many were adapted from the FAA publications "Aviation Science Activities fo Elementary Grades" and "Aviation Curriculum Guide for Middle School Level Secondary School Level." They complement the list of activities described in t Take Off! Teacher's Resource Guide, but can be used independently of the broadcast series.

Level 1 indicates a level of complexity corresponding to elementary school, **Level 2** to middle school, and **Level 3** to high school. These levels serve as general guide only. Classes may require levels of difficulty which differ from our assigned levels.

Also available are pages that list only the activities of a single level. These page can be reached by clicking on the image displayed farther down this page.

Aviation Science Activities

PROPERTIES OF AIR

Air Occupies Space
Air Has Weight
Air Has Pressure
Air Moves
Heat Causes Air to Expand
Air Contains Moisture
Air Holds Some Things Up

WHAT MAKES AN AIRPLANE FLY?

Wings
Propellers
The Jet Airplane
How is a Plane Controlled?
The Wind Tunnel

WEATHER IN AVIATION

General Weather Conditions
Wind
Temperature
Moisture in the Air
Atmospheric Pressure

NAVIGATION AND FLIGHT PLANNING

Aeronautical Charts & Flight Planning
Aircraft Instruments
Time in Aviation
Communications

HISTORY AND LITERATURE

Activities

The activities on this page are exclusively the **Level 1** activities. This indicates a level of complexity corresponding to elementary school. The levels assigned to various activities are subjective and a general guide only. We urge you to consider activities in levels other than the "recommended" level for your students.

Aviation Science Activities

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HISTORY AND LITERATURE

Historical Research
Aviation Timeline

LEVEL 1	LEVEL 2	LEVEL 3

PROPERTIES OF AIR

Air Occupies Space

- activity 1. Invert a glass in water

Air Has Weight

- activity 2: Weigh two balloons
- activity 3: Weigh a ball, empty and full

Air Has Pressure

- activity 4: How a suction tube works
- activity 5: Tug of War
- activity 6: A partial vaccuum with tin can and hot water

Air Moves

- activity 7: Use perfume to detect convection
- activity 8: Use smoke to detect convection
- activity 9: Trees reveal air in motion
- activity 10: Create wind

Heat Causes Air to Expand

- activity 11: Create a partial vaccuum through heating and cooling
- activity 12: Why do soap bubbles float?
- activity 13: Compare air temperature near the ceiling and floor
- activity 14: Detect air movement through an open window

Air Contains Moisture

- activity 15: Evaporation from boiling water

Warm Air Holds More Moisture Than Cold Air

- activity 16: Condensation on a glass of ice water
- activity 17: Make clouds with a teakettle and ice

Air Holds Some Things Up

- activity 18: Make a handkerchief parachute
- activity 19: Air pressure makes a kite fly

WHAT MAKES AN AIRPLANE FLY?

Wings

- activity 1: Compare powered and unpowered balsa gliders
- activity 2: Illustrate Bernoulli's principle with paper strips
- activity 3: Illustrate Bernoulli's principle with a pin, spool, and cardboard

Propellers

- activity 4: Demonstrate lift with a handmade propeller

The Jet Airplane

- activity 5: Use a balloon to demonstrate thrust

How is a Plane Controlled?

- activity 6: Demonstrate the effects of rudder, elevator, and ailerons
- activity 7: Make a styrofoam glider
- activity 8: How to suspend a paper glider in a wind tunnel

The Wind Tunnel

- activity 9: Make a simple wind tunnel

WEATHER IN AVIATION

General Weather Conditions

- activity 1: Keep a weather log
- activity 2: Make a chemical hygrometer

Wind

- activity 3: Observe convection currents near hot and cold objects
- activity 4: Show that heat rises
- activity 5: Show that cold air is heavier than warm air
- activity 6: Make a simple anemometer
- activity 7: Make a weather vane

Temperature

- activity 8: Make an air thermometer
- activity 9: Observe light rays striking a surface at different angles
- activity 10: Show how the angle of the sun's rays affects temperature

Moisture in the Air

- activity 12: Make a Wilson cloud chamber
- activity 13: Detect moisture in the air with a hair hygrometer

Atmospheric Pressure

- activity 14: Observe differences in water pressure
- activity 15: Use a siphon to observe an effect of atmospheric pressure

NAVIGATION AND FLIGHT PLANNING

Aeronautical Charts & Flight Planning

Aircraft Instruments

Time in Aviation

Communications

- activity 15: The ICAO Phonetic Alphabet
- activity 16: Talking to the Tower

HISTORY AND LITERATURE

Historical Research

- activity 1: Gain Historical Knowledge
- activity 2: Read "High Flight"
- activity 3: Have a famous aviator come "in person" to your school
- activity 4: Write a biography of Daniel Bernoulli
- activity 5: Collect aviation stamps

Aviation Timeline

Source Material

PROPERTIES OF AIR

WHAT MAKES AN AIRPLANE FLY?

WEATHER IN AVIATION

NAVIGATION AND FLIGHT PLANNING

HISTORY AND LITERATURE

LEVEL 1

LEVEL 2

LEVEL 3

Activities

Properties of Air

Air Occupies Space

Activity Number 1: Invert a glass in water
Level 1

EQUIPMENT

Clear cup or glass
Bowl, tub, or aquarium

PROCEDURE

Fill the bowl with water. Turn the cup upside down and put it in the bowl. No matter how far down you push it, water can't get in the cup. The air is taking up the space, so water can't get in.

Activities

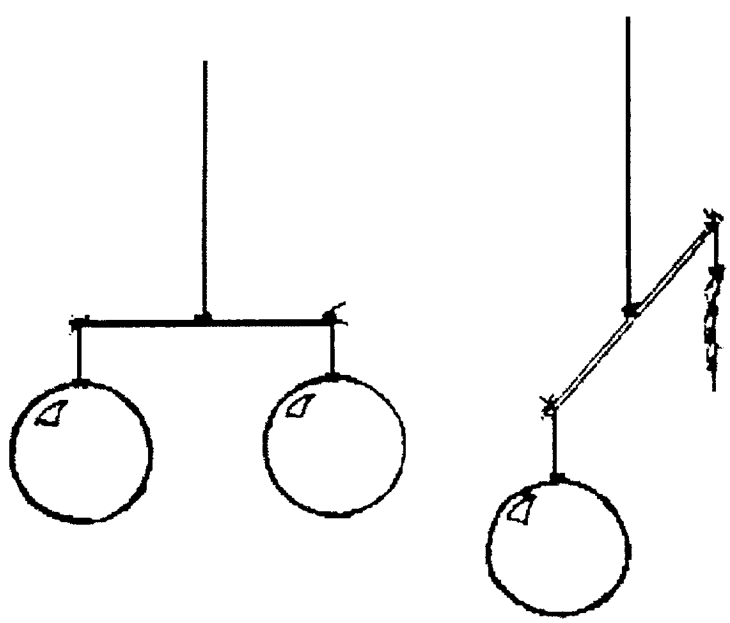
Properties of Air

Air Has Weight

Activity Number 2: Weigh two balloons
Level 1

EQUIPMENT
Wooden dowel stock, or tinker toy stick about a foot long
1 yard of string
2 balloons of the same size

DESCRIPTION
Blow up the balloons to the same size, and tie them at their necks with a piece of string. Tie one balloon to each end of the dowel stock. Attach another piece of string to the center of the dowel stock and suspend it from some convenient place. Balance the dowel stock. Prick one balloon with a pin. As the air rushes out, the pricked balloon shoots up and the heavier, air-filled one drops down.



Activities

Properties of Air

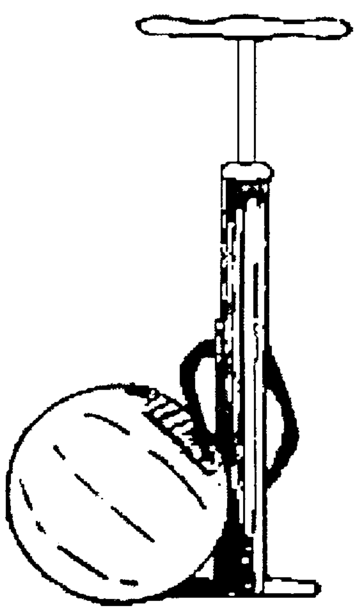
Air Has Weight

Activity Number 3: Weigh a ball, empty and full
Level 1

Air weighs something, and the higher its pressure in a given volume, the more it weighs.

EQUIPMENT
Football, basketball, or soccer ball
Good scale

PROCEDURE
Squeeze all the air possible out of the ball; then weigh the ball. Blow the ball up again and weigh it. The air in the inflated ball is under pressure. The ball should weigh a few ounces more.



Activities

Properties of Air

Air Has Pressure

Activity Number 4: How a suction tube works
Level 1

EQUIPMENT
Large medicine dropper or any kind of a tube with a suction bulb

DESCRIPTION
Put the dropper or tube in a pan of water and squeeze the attached bulb, forcing the air out of the tube. Release the bulb. Water now rushes into the tube. Lift the tube out of the water. The water does not run out. Air pushes on the water in the tube and holds it there.

Activities

Properties of Air

Air Has Pressure

Activity Number 5: Tug of War
Level 1

EQUIPMENT
2 large, flat, rubber sink-stoppers

DESCRIPTION
Air pressure tug-of-war: After wetting their surfaces, press the two sink-stoppers together so that no air is between them. Ask a friend to pull on one while you pull the other. You can't pull them apart. But just let the air get in between the pads or plungers, and presto! they separate.

Activities

Properties of Air

Air Has Pressure

Activity Number 6: A partial vacuum with tin can and hot water
Level 1

EQUIPMENT
Tin can with a screw-on metal cap, such as a maple syrup can
Hotplate or burner
Potholders

DESCRIPTION
Make sure the can is clean. Pour about an inch of hot water into the can. Put it on the burner and heat it until you see the steam coming out of the opening. Wait another few seconds and turn off the heat. Screw the cap on tightly and wait for it to cool. The can suddenly begins to cave in.

When it was heated water turned into steam, driving out most of the air. Now as the can cools, the steam turns back into water, leaving neither air (not much air, anyway) nor steam inside the can. A partial vacuum has been created. The pressure of air outside the can, being greater than that inside the can, crushes the can.

Activities

Properties of Air

Heat Causes Air to Expand

Activity Number 11: Create a partial vacuum through heating and cooling
Level 1

EQUIPMENT
Balloon
Water glass
Pan of hot water
Scissors

DESCRIPTION
Cut the neck off a balloon. Heat an empty glass in a pan of hot water. Slip the opening of the balloon over the mouth of the glass. Let the glass cool. The cool air contracts and sucks the balloon into the glass.

Activities

Properties of Air

Heat Causes Air to Expand

Activity Number 12: Why do soap bubbles float?
Level 1

EQUIPMENT
Bubble pipe
Soapy water

DESCRIPTION
Blow soap bubbles. Discuss why they float. (The breath is warm; as the bubbles begin to cool they begin to settle. Observe what happens when you blow bubbles over a hot radiator.)

Activities

Properties of Air

Heat Causes Air to Expand

Activity Number 13: Compare air temperature near the ceiling and floor
Level 1

EQUIPMENT
Ordinary thermometer

DESCRIPTION
Measure the temperature of the air near the ceiling and near the floor. Compare the readings. Discuss why the warmest air is near the ceiling.

Activities

Properties of Air

Heat Causes Air to Expand

Activity Number 14: Detect air movement through an open window
Level 1

EQUIPMENT
Strips of paper
Thumb tacks or scotch tape

DESCRIPTION
Open a window at the top and at the bottom. Fasten strips of paper so that they will hang in the openings and be moved by the air currents. Notice where the air is moving into the room and where itis moving out. The air coming in at the bottom of the window is cooler than the air in the room. It forces the warm air to rise. This activity works best if performed in cold winter months.

Properties of Air

Air Contains Moisture

Activity Number 15: Evaporation from boiling water
Level 1

EQUIPMENT
Shallow pan
Water

DESCRIPTION
Boil a small amount of water in a shallow pan. Observe what happens. Discuss what happens when water evaporates. Help the students to understand that water evaporates from rivers, lakes, streams, and ponds and that when water evaporates it goes into the air as water vapor.

Activities

Properties of Air

Warm Air Holds More Moisture Than Cold Air

Activity Number 16: Condensation on a glass of ice water
Level 1

EQUIPMENT
2 water glasses
Ice cubes

DESCRIPTION
Fill one glass with warm water. Fill another glass with water and ice cubes. Water collects on the outside of the glass which has the ice cubes in it. This is because the cold glass comes in contact with the warm, moist air of the room. As the warm air touches the glass and cools, it can't hold as much water vapor. Some of the water vapor is released and appears as water on the outside of the glass (condensation). This experiment works better on warm, moist days in the spring, summer, and fall than in dry, artificially heated rooms in the winter; explain why.

Activities

Properties of Air

Warm Air Holds More Moisture Than Cold Air

Activity Number 17: Make clouds with a teakettle and ice
Level 1

EQUIPMENT
Teakettle with a spout
Hot plate or burner
Large strainer
2 trays of ice cubes
Medium-sized pan with handle

DESCRIPTION
Boil water in the teakettle until steam comes from the spout. Notice that the steam disappears into the air almost immediately. Fill the strainer full of ice cubes and hold it near the spout of the teakettle so the steam will go through it. Clouds form as the steam cools. Help the students understand why.

Fill the pan with ice cubes and hold it where the steam from the teakettle will hit the sides of the pan. When the hot vapor or steam hits the sides of the pan, little drops of water gather on the outside of the pan and drip like rain.

Activities

Properties of Air

Air Holds Some Things Up

Activity Number 19: Air pressure makes a kite fly
Level 1

EQUIPMENT

1 stick, 1/4" x 3/8" x24"
1 stick, 1/4" x3/8" x 24"
Paper, strong, 16"x24"
Glue
Long, narrow strip of cloth
String

DESCRIPTION

The forces acting on a kite: Wind pressure beneath the kite tends to hold it up. The string keeps the kite headed into the wind. The tail keeps the kite upright. Gravity tends to pull the kite down.

Wind helps a kite fly, unless the kite is being pulled through the air. A kite should be held at an angle to the wind. This allows the air to strike against the under surface of the kite. This air pushes the kite upward and at the same time is deflected downward off the under surface of the kite.

If you release the kite string, the kite will fall to the earth. It falls because the angle at which the surface of the kite has been held toward the wind has been changed. The lift upward caused by the angle at which the kite attacked the air is now less than the pull of gravity downward.

Activities

Weather In Aviation

General Weather Conditions

Activity Number 1: Keep a weather log
Level 1 & Level 2 & Level 3

EQUIPMENT
Calendar/chart/log/journal/notebook

- Level 1
- Level 2
- Level 3

DESCRIPTION

Level 1
Keep a weather calendar or weather chart for a specific length of time (minimum one week). Note the varied weather conditions. Measure temperature, wind speed, humidity, barometric pressure, and wind direction. Observe and record cloud formations and what they mean. Note the degree of visibility - is it clear, or is there haze, fog, or other precipitation?

Level 2
Keep a calendar as described above. Each day:

1. Measure temperature, wind speed, humidity, barometric pressure, and wind direction.
2. Describe what the flying conditions might feel like to a pilot and to a passenger.
3. Describe safety precautions a pilot might observe on those days (for instance, not flying in fog without an instrument rating and VFR flight plan, or not flying at all when thunderstorms are expected).

Level 3
Keep a calendar as described in levels 1 and 2. In addition, for each day and set of conditions:

1. Describe how conditions might affect the scheduling or operations of an airport. For example, do airport approach patterns change with wind direction? Does snow require not only snow removal, but rescheduling of flights?
2. Describe what legal restrictions there are for a private pilot flying in those conditions in a small private plane. A pilot, flight school, flight instructor, FAA education office, or library may have a private pilot manual in which you can look up this information, or search for it on the world wide web.
3. Call an ATIS recording to hear what conditions the tower is describing for your local airport. (Call the airport to find out whether that airport supports this service and what the telephone number is.)

Activities

Weather In Aviation

General Weather Conditions

Activity Number 2: Make a chemical hygrometer
Level 1 & Level 2 & Level 3

EQUIPMENT
Gum arabic...1/2 ounce
Cobalt chloride...1 ounce
Sodium chloride...1/2 ounce
Calcium chloride...75 grains
Distilled water...1 ounce
Cotton cloth
Optional:
Cardboard cutouts, such as a doll, aircraft, rabbit, etc., any size

DESCRIPTION
Mix the chemicals into one solution.
Dip the cotton cloth into the solution; let dry.
Use the treated cloth to give a general indication of humidity. Cloth will be blue on dry, clear days; lavender on days when the weather is changing; and pink when it is raining or humidity is high.

Students can have fun using cardboard and treated cloth to make hygrometers in different shapes. For instance, students might cut out a rabbit and attach ears of treated cloth, or create similar dolls or cartoon figures.

Level 3
Extra credit for science buffs: find out why this hygrometer works. Why is each ingredient needed?

Activities

Weather In Aviation

Wind

Activity Number 3: Convection currents near hot and cold objects
Level 1 & Level 2

Convection currents are caused when heated air rises and cold air falls.
Why is ventilation in a room better when the window is open both at the top and the bottom?

EQUIPMENT
Stick of punk, incense, or cigarette paper
Candle or other source of heat
Ice or other source of cold

DESCRIPTION
Light a stick of punk, incense, or cigarette paper rolled so that it will not burn too quickly. Hold the smoking punk near hot objects (stove, radiator, lighted candle, hot brick, lighted electric bulb, etc.) and watch the path of the smoke.

Activities

Weather In Aviation

Wind

Activity Number 4: Show that heat rises
Level 1 & Level 2

EQUIPMENT
Glass lamp chimney
Candle
Cover glass
Wood splinter
Small sticks

DESCRIPTION
Light the candle and place the chimney over it, resting the chimney on sticks so that air can circulate under the edge. Put the cover glass over the top of the chimney. Light the splinter and hold it near the base of the candle so that the smoke will circulate inside the chimney.

Watch the path of the smoke. Remove cover glass and note changes in the path of the smoke. As warm air rises, cold air falls to replace it.

Activities

Weather In Aviation

Wind

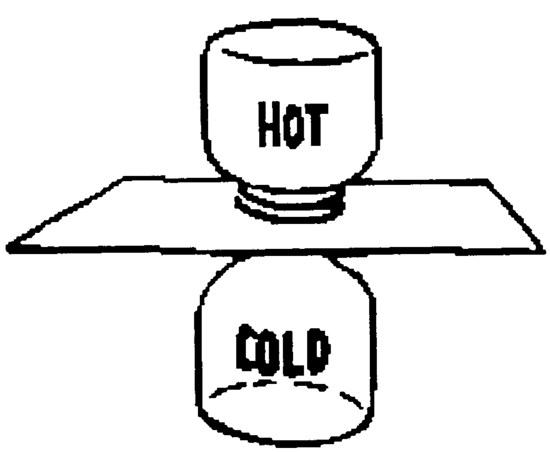
Activity Number 5: Show that cold air is heavier than warm air
Level 1 & Level 2

EQUIPMENT
2 dry, glass, quart jars
piece of punk or incense
Sheet of paper
Hot water

DESCRIPTION
Put one jar into the refrigerator for 20 minutes. Put the other jar upside down under running hot water.

Remove the cold jar from the refrigerator. Light the punk or incense and let the smoke flow into the cold jar. Immediately cover the jar mouth with a flat piece of paper. Carefully pick up the hot jar and place it's open end over the paper covered open end of the cold jar.

Remove the paper, and watch the path of smoke (convection currents). Keep the jars together, but turn them upside down. Watch the path of smoke as the cold air descends.



Activities

Weather In Aviation

Wind

Activity Number 6: Make a simple anemometer
Level 1 & Level 2

The force or velocity of the wind is measured by an instrument called the anemometer.

EQUIPMENT

Thin aluminum sheet
Dowel stock
2 glass beads
2 thin wooden sticks, 18"x1/2"
Aluminum solder
metal shears

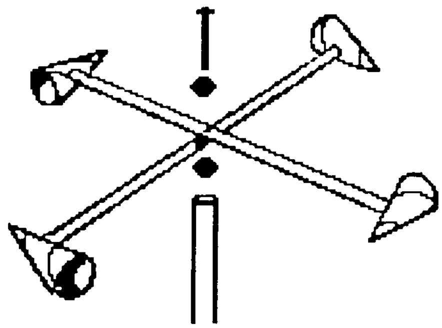
DESCRIPTION

The cups of the anemometer are made from the aluminum. Cut 2 circles about 4" in diameter. Cut these in half so you have 4 half circles of equal size.
Join (or overlap) the straight edges with aluminum solder, making 4 small cups.
Attach the cups to the ends of 2 crossed sticks, so that all are heading in the same direction.
Join sticks to dowel stock as follows: Nail, bead, crossed sticks, bead, dowel stock. Beads will act as bearings so the wind will turn anemometer freely.

The spinning is faster as the force of the wind increases. Two people working together can calibrate the anemometer with a fair degree of accuracy as follows: Hold it out the window of an automobile moving at a constant rate of speed. Note the speedometer reading, the distance traveled and the revolutions per minute (rpm) of the anemometer. Drive the car back along the same road and note the same readings, being sure the speed of the car and the distance traveled are the same as before. Average the 2 rpm counts to allow for the effect of any wind.

Again drive along the same road the same distance, holding the anemometer out the window of the car, but this time increase the speed to a steady rate 5 or 10 miles an hour faster than before. Repeat in the opposite direction, recording the rpm each time, as was done before, and average them. On the basis of these counts make a table of the anemometer's rpm's corresponding to different wind speeds.

Do not try to drive and calibrate the anemometer simultaneously. You need a driver who can concentrate on driving, while the other person observes the anemometer and records data.



Activities

Weather In Aviation

Wind

Activity Number 7: Make a weather vane
Level 1

EQUIPMENT

Thin wood strips (white pine is good):
1 20"x 4"
2 12"x 1"
2 8"x 3"
Long, slender nail
Small nails
Wooden or glass bead
narker
ι directional compass

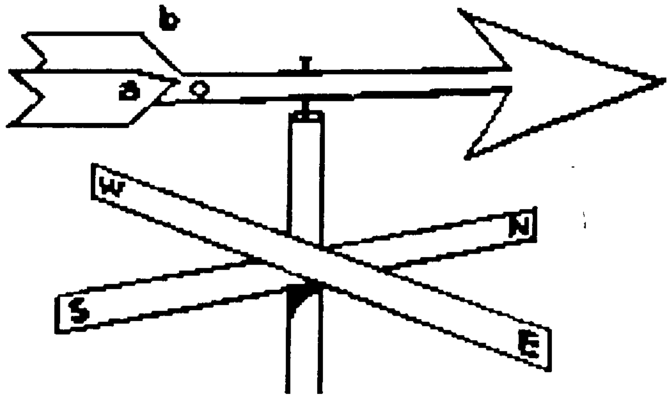
DESCRIPTION

Post about 10' high (or exposed corner of a building or garage)

Cut an arrow and shaft from 20" strip. Cut tailpieces from 8" strips. Nail them to the shaft of the arrow on each side; spread them apart to form a 20 degree angle in order to catch the wind easily, using a protractor to measure the angle AOB (see illustration). Find the balance point by resting shaft on extended finger until arrowhead and tailpieces balance level; drill a hole at this point. Insert the long nail in the hole. Place bead on nail to act as bearing. Mount the vane on a post or the exposed edge of a building where it can turn freely.

With a compass, determine north. Using the 12" strips, one marked N and S, and the other E and W, as pointers, nail the pointers to the post to show the direction from which the wind is blowing.

Use the weather vane to record wind direction for other aviation activities, such as keeping a weather log or determining the best layout for a runway in that area.


b
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Activities

Weather In Aviation

Temperature

Activity Number 8: Make an air thermometer
Level 1

EQUIPMENT

Glass bottle, 1-pint size
Rubber stopper with 1 hole
Glass tubing to fit hole, 24" long
Water
Dye or colored ink (to color the water)
Sealing wax or paraffin
Scotch or masking tape
Cardboard strip, 10" x 2"
Ordinary thermometer
Ruler or measuring tape

DESCRIPTION

Make some colored water with the dye.
Fill the glass bottle about one fourth full of the colored water.
Seal the glass tubing at one end, then place it through the stopper.
Fill the tube full of colored water. Quickly invert the tube, placing the lower end in the glass bottle (the bottle which you filled one-fourth full of colored water). Press the stopper firmly in the bottle.
Adjust the liquid in the tube by loosening the stopper or pressing it further into the bottle until the liquid is about half way along the exposed portion of the tube above the stopper. Then seal with wax the tube in the stopper and the stopper in the bottle.
Tape the cardboard to the tube above the stopper.

Note the temperature on an accurate thermometer. Record this temperature on the cardboard, which will act as a temperature scale.

Place the two thermometers in a different temperature situation and leave them long enough to allow the thermometers to register the new temperature. Note the new reading and mark it on the cardboard scale. Carefully measure the distance between the two readings on the cardboard scale, and mark other degrees of temperature on it, as all other changes will be in the same proportion.

Discuss how the air thermometer works.

Activities

Weather In Aviation

Temperature

Activity Number 9: Observe light rays striking a surface at different angles
Level I

EQUIPMENT
Flashlight
Paper tube large enough to fit around the flashlight
Large sheet of paper
Table

DESCRIPTION
Lay the paper on a table. Put the paper tube around the flashlight. Turn on the flashlight and direct its rays straight down so they strike perpendicular to the paper. Draw a circle around the outline of light. Notice the brightness of the reflected light.

Now hold the flashlight at an angle of about 45 degrees. Draw around the light reflected on the paper. Notice its brightness. Compare the area of the circle with that of the oval.

Have students experiment with different angles and directions and record what they observe.

Activities

Weather In Aviation

Temperature

Activity Number 10: Show how the angle of the sun's rays affects temperature
Level 1 & Level 2

EQUIPMENT
2 small boxes filled with sand
2 thermometers
Wooden blocks

DESCRIPTION
Lay a thermometer in each box, with the bulbs lightly buried in the sand. Then put the boxes in the sun for a few minutes. Record the temperatures; they should be the same.

Raise one box off the ground with small blocks. Keep it parallel to the ground.
Tilt the other box by placing blocks under just one edge such that the sun's rays fall perpendicular to the thermometer (i.e., strike the thermometer at right angle). Leave the boxes in the sun for a few minutes and then record the temperature.

The tilted thermometer records the result of the direct rays of the sun which represent the direct rays of summer. The level thermometer records the angular rays of winter. The tilted thermometer should have a higher reading than the level thermometer.

It is possible to obtain a greater contrast of angle, and therefore of temperature readings, when this demonstration is performed in winter.

Activities

Weather In Aviation

Temperature

Activity Number 11: Temperature Changes with Differences in Altitude
Level 2 & Level 3

The average loss of heat is about 3.5 degrees Fahrenheit for each thousand feet increase in altitude up to about seven to ten miles.

Example: If the temperature on the ground is 80 degrees, what is the temperature of the air at 5,000 feet altitude?

Solution: The temperature change is 3.5 degrees per 1,000 feet. Since the altitude is 5,000 feet, multiply 3.5 by 5. 3.5 x 5 = 17.5 degrees. The temperature at 5,000 feet is 80 degrees - 17.5 degrees = 62.5 degrees.

PROBLEMS:

Ground Temperature (in degrees Fahrenheit)	Altitude (in feet)	Air Temperature (in degrees Fahrenheit)
70	3,000	?
?	4,000	56
83.5	7,000	?
?	20,000	0
88.5	?	76
0	2,000	?
74.5	11,000	?
65	12,000	?

If the temperature is 22 degrees at 21,000 ft. altitude, what is the ground temperature?

What is the temperature at 17.00 ft. altitude when the ground temperature is 92 degrees?

Activities

Weather In Aviation

Moisture In The Air

Activity Number 12: Make a Wilson cloud chamber
Level 1 & Level 2 & Level 3

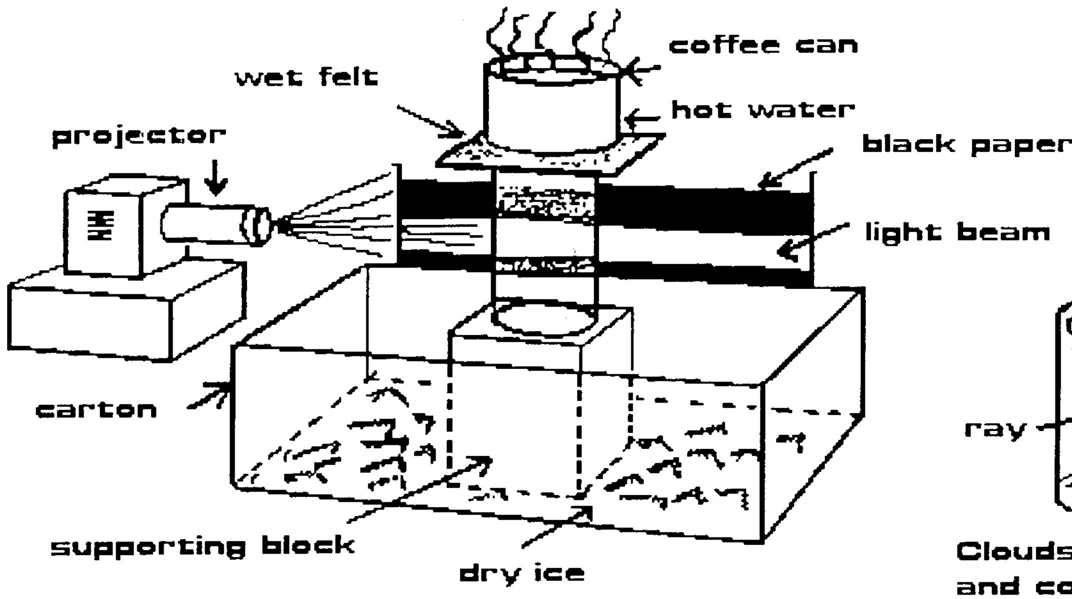
EQUIPMENT
Carton, about 20" x20" x10"
Tall jar with straight sides, such as large size peanut butter jar
Coffee can, 1-pound size, clean and empty
Piece of thick felt, cut slightly smaller than the coffee can
Box or block to support the jar
5 pounds of dry ice
Hot water
Large sheet of black construction paper
Filmstrip projector
Masking tape

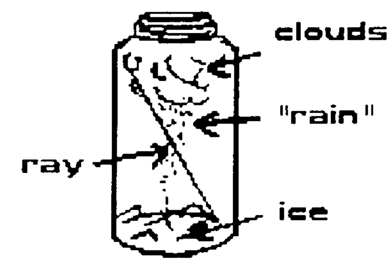
DESCRIPTION
Cut a hole in the top of the carton into which the jar exactly fits. Put the dry ice into the carton. Put a support under the hole and place the jar on it, so that about an inch of the jar is within the carton. Put masking tape around the jar so that no air can pass around it, into or out of the carton.

Place the paper behind the jar and carton so that it can be seen through the jar. Set up the projector so that the beam passes through the jar horizontally.

Glue the felt to the underside of the coffee can. Soak the felt with water. Fill the coffee can almost full with very hot water. Place the can on the jar, with the felt pressing on the jar's edge. (See diagram.)

Observe condensation: water vapor will form into clouds, and convection currents will cause them to circulate within the jar, the cold air rising along its sides and the warm air descending at its center. When the vapor clings to particles of dust within the jar, the falling of "rain" is visible. (After about 20 minutes, when the water in the jar has changed to ice at its bottom, it is possible to see streaks within the jar. These streaks indicate the passage of cosmic rays.)





Clouds forming and condensing. Slanted path of cosmic rays

Activities

Weather In Aviation

Moisture In The Air

Activity Number 13: Detect moisture in the air with a hair hygrometer
Level 1 & Level 2

EQUIPMENT
Empty milk carton
Large sewing needle
Broom straw, 2" long
Scotch or masking tape
Penny
9" human hair, wiped clean of oil
4 thumbtacks
Paper clip
Small card with scale drawn on it (see illustration)
Dishpan

DESCRIPTION
Cut the carton so as to make a small horizontal slit near the top; insert the paper clip.

Cut a vertical slit near the bottom. Then cut horizontal slits perpendicular to this cut at its end points-like an H on its side. Pry out the flaps thus made and bend them to an upright position. Insert the needle through these flaps.

Place the box on its side, flaps up. Tie the hair to the paper clip, wind it around the needle, tape the penny to the other end of the hair, and let the penny hang over the end of the box.

Push the straw through the eye of the needle. Tape the card with the scale against the side of the carton under the straw.

Place the hygrometer on a wet towel in a dishpan and cover with a damp cloth. After 15 minutes remove it from the cloths and set the straw at numeral 10 on the scale.

Since humid air causes the hair to stretch and dry air causes it to shrink, the straw should move toward the dry end of the scale as the hair dries.

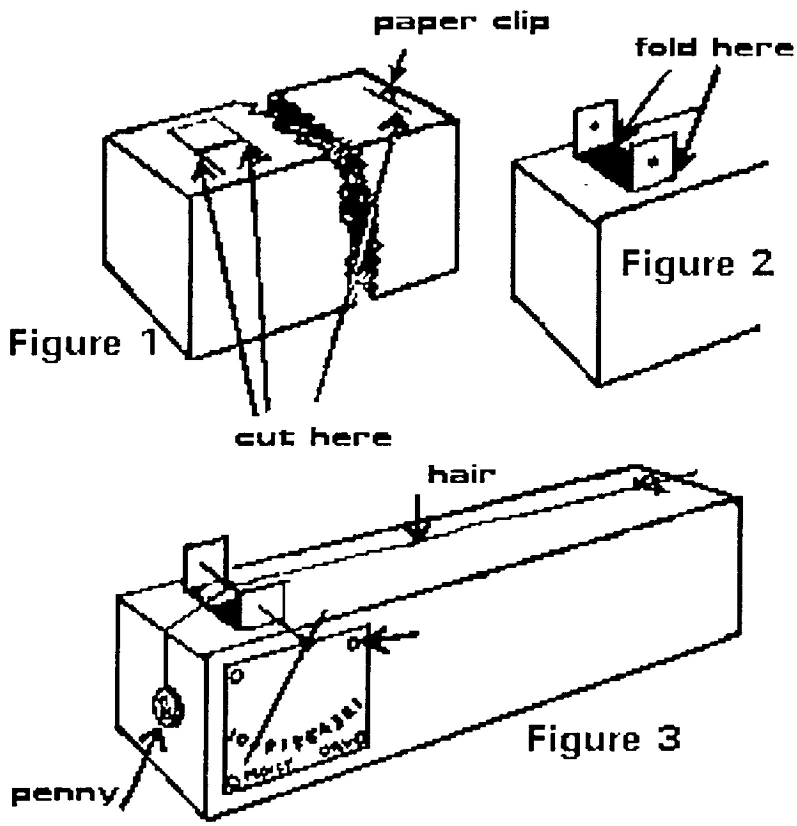


Figure 1

Figure 2

Figure 3

Activities

Weather In Aviation

Atmospheric Pressure

Activity Number 14: Observe differences in water pressure
Level 1

The deeper water or air is, the greater its pressure.

EQUIPMENT
Large fruit-juice can
Ice pick

DESCRIPTION
Puncture several holes of the same size, at different levels, in the side of a large fruit-juice can. Fill the can with water. Notice the weakness of force with which water escapes from the upper holes. The ones near the bottom, with the greater height of water above them, have water shooting out at some distance.

Watch what happens as the water runs out and the level of the water lowers. Do all the streams run with less force than they did at the start?

Activities

Weather In Aviation

Atmospheric Pressure

Activity Number 15: Use a siphon to observe an effect of atmospheric pressure
Level 1

EQUIPMENT
2 identical glass jars
Rubber tubing
Wooden block, 2" thick

DESCRIPTION
Fill one jar with water. Put the empty jar and the one filled with water side by side on a table. Fill the tube with water, cover one end with your finger, and lower the other end into the water in the jar. Put the other end in the empty jar, and remove your finger. Watch what happens to the level of water in each jar.

Raise one jar by putting the block under it. Again watch the water levels. The water remains at the same height in each jar regardless of the difference in height of the jars, because the atmospheric pressure is the same on the water surfaces in each jar.

Activities

Aviation History and Literature

Historical Research

Activity Number 1: Gain historical knowledge
Level 1 & Level 2 & Level 3

In groups or individually, research an early aviator, flying machine, or myth of flight. Use books, flight magazines, museums, videos, or the Internet for your information. You could also write and illustrate your own myths of flight. Produce your report in writing, on the World Wide Web, or as an oral presentation to your class. The resources on this web site can help you get started.

Activities

Aviation History and Literature

Historical Research

Activity Number 2: Read "High Flight"
Level 1 & Level 2 & Level 3

Read "High Flight" by John Gillespie McGee, Jr. Find out about his life and what inspired him to write the poem. Discuss what makes the poem inspiring and why it is famous. Prepare your report in writing, or pass out copies of the poem to your class and make an oral presentation. You can find the poem in books and on the World Wide Web.

Activities

Aviation History and Literature

Historical Research

Activity Number 3: Have a famous aviator come "in person" to your school
Level 1 & Level 2 & Level 3

Arrange for a famous aviator to visit your school or class, in the form of actors who will take on the persona of that aviator. To find people in your state who will do this, in New England call David Price at the FAA, (617) 238-7389. In other states you may be breaking new ground: call your state Aviation Council, explain who you are and what you would like, and see if they will help out, or call your local FAA Education Office. If they're willing to do it but haven't done it before, they may call Mr. David Price for guidance. Classes in Massachusetts have had visits by "Jackie Cochran," "Douglas Bader," "Charles Lindbergh," and others.

Activities

Aviation History and Literature

Historical Research

Activity 3: Write a biography of Daniel Bernoulli
Level 1 & Level 2 & Level 3

Research Daniel Bernoulli's life. Find out where he lived and when, and what he was like. What ideas and values mattered to him? What did he study? What advantages did he have in doing his work and what difficulties did he face? Why he is still known today? Why is "Bernoulli's principle" important to our lives?

Activities

Aviation History and Literature

Historical Research

Activity Number 5: Collect aviation stamps
Level 1 & Level 2 & Level 3

Collect stamps of people significant to aviation. A stamp of Bessie Coleman was issued recently; what others can you find? Do a brief biographical sketch of the aviators whose stamps you collect.

These activities represent a collaboration between the Massachusetts Corporation for Educational Telecommunications (MCET) and the Federal Aviation Adminstration (FAA). Many activities were taken or adapted from "Aviation Science Activities for Elementary Grades" and "Aviation Curriculum Guide for Middle School Level, Secondary School Level" published by the Federal Aviation Administration.

Activities

What Makes An Airplane Fly

Wings

Activity Number 1: Compare powered and unpowered balsa gliders
Level 1

EQUIPMENT
Toy airplane with rubber band motor
Balsa glider

DESCRIPTION
Compare a toy airplane having a rubber band motor with a balsa glider. The toy airplane has wings, a propeller, and a motor (the rubber band). The glider does not have a propeller or a motor. Fly them several times and compare their flights as carefully as possible. Why do they fly? What are the similarities in how they fly? What are the differences? What gives them thrust? Is there an advantage to the motorized plane? Is there an advantage to the glider?

Activities

What Makes An Airplane Fly

Wings

Activity Number 2: Illustrate Bernoulli's principle with paper strips
Level 1

The force that lifts an airplane and holds it up comes in part from the air that flows swiftly over and under its wings.

EQUIPMENT
Strip of notebook paper or newspaper, about 2 inches wide and 10 inches long
Book
Paper clips

DESCRIPTION
Make an airfoil (wing) by placing one end of the strip of paper between the pages of the book so that the other end hangs over the top of the book. Move the book swiftly through the air, or blow across the top of the strip of paper. It flutters upward.

Hold the book in the breeze of an electric fan so the air blows over the top of the paper.

Take the strip of paper out of the book. Grasp one end of the paper and set it against your chin, just below your mouth. Hold it in place with your thumb and blow over the top of the strip. The paper rises. Try the same thing after you have fastened a paper clip on the end of the strip. See how many paper clips you can lift in this way.

Hold the strip of paper in your hands and run around the room. It doesn't matter whether you move the air over the strip of paper by blowing or whether you move the paper rapidly through the air - either way it rises.

Bernoulli's principle states that an increase in velocity of any fluid is always accompanied by a decrease in pressure. Air is a fluid . If you can cause the air to move rapidly on one side of a surface, the pressure on that side of the surface is less than that on its other side.

Activities

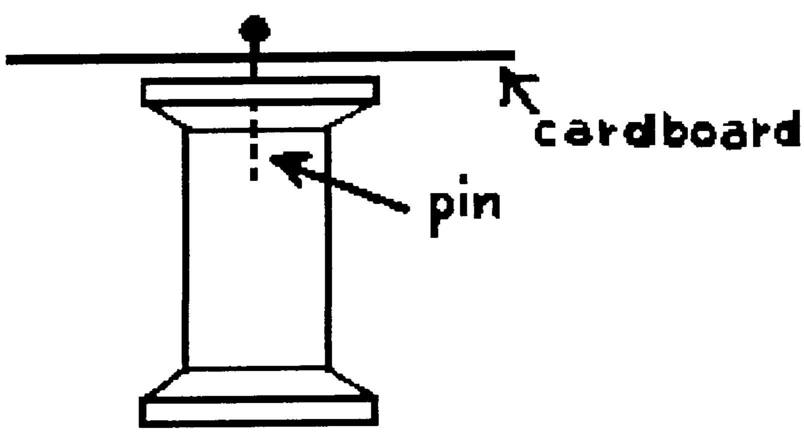
What Makes An Airplane Fly

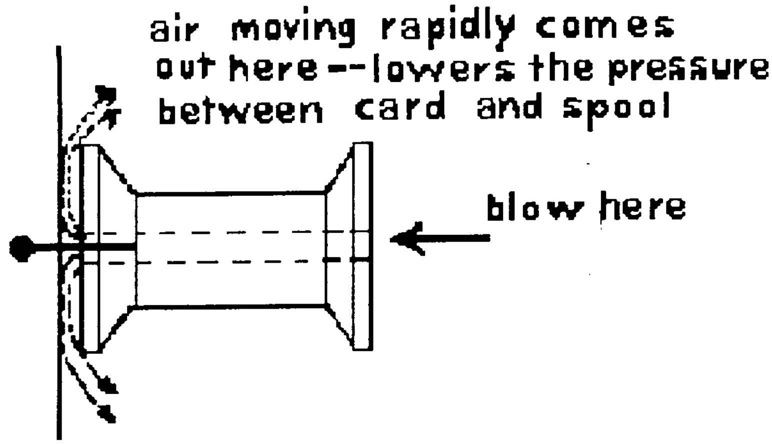
Wings

Activity Number 3: Illustrate Bernoulli's principle with a pin, spool, and cardboard
Level 1

EQUIPMENT
Pin
Spool
Cardboard, 3"x3", lightweight but firm

DESCRIPTION
Place the pin through the center of the cardboard. Place the spool over the pin so that the pin goes into the hole in the spool. (See illustration below). Hold the card against the spool and blow firmly through the spool. Release your hand (while still blowing). The card does not fall.




air moving rapidly comes
out here--lowers the pressure
between card and spool
blow here

Activities

What Makes An Airplane Fly

Propellers

Activity Number 4: A handmade propeller demonstrates lift
Level 1

EQUIPMENT
Spool
Knife
Strong twine
Small finish nails
Tenpenny nail
Block of balsa or other soft wood
Block of wood, 2"x2"x3"
Hacksaw
Nail cutter or large pliers

DESCRIPTION
Drive the tenpenny nail into one end of the wooden block. Cut off the head of the nail so that the nail is shorter than the length of the spool. Drive the finish nails into one end of the spool. Space them evenly between the hole and the edge of the spool. Carve a propeller from the balsa wood. Drill two holes in it to match the finish nails on the spool. Wind the string on the spool and place the propeller on it, making sure to match the holes to the finish nails. Pull the string hard and fast.

The spool and propeller are spun with great speed and the revolving propeller will fly off, high into the air.

A simpler demonstration can be done by twisting a pencil or chopstick tightly into the hub of the propeller. Hold the stick between the palms of both hands, propeller up. Roll it back and forth quickly three or four times and push it forth into the air. The prop, stick and all, will fly off into the air and attain good height, demonstrating that a revolving prop creates thrust.

Propeller

String

spool

Headless nail

Wood block

Activities

What Makes An Airplane Fly

The Jet Airplane

Activity Number 5: Using a balloon to demonstrate thrust
Level 1

Thrust in a jet airplane is provided by an application of Newton's Third Law: For every action there is an equal and opposite reaction.

EQUIPMENT
Toy Balloon

DESCRIPTION
You can see how a jet works by an experiment with a toy balloon. Blow up the balloon; pinch the neck to keep in the air. Let the balloon go. It shoots across the room. The air inside the balloon is under pressure. It is pushing in all directions to get out. Some of the air escapes through the open neck. As this shoots backward out of the balloon, an equal and opposite reaction occurs and the balloon shoots forward. Why doesn't the balloon shoot foward in a straight line, but instead loop all over the room?

Activities

What Makes An Airplane Fly

How is a Plane Controlled?

Activity Number 6: Demonstrate the effects of rudder, elevator, and ailerons
Level 1 & Level 2

- Folded Paper Glider
- Control Surfaces
- Up And Down
- Right And Left
- Balsa Glider

A car can go only right or left, but a plane must be steered up or down as well. It is steered by parts on the wings and tail called control surfaces. These can be demonstrated by the use of folded paper gliders and balsa gliders.

EQUIPMENT
Sheet of 9"x6" paper
Paper clip

DESCRIPTION
Folded paper glider: Use a piece of paper 9"x 6" and fold it following the diagram A. The finished glider can be held together at the bottom with a paper clip. The paper clip can also be used for a balance. Experiment with the glider, moving the clip up or back as needed to obtain proper balance.

Control Surfaces: Real planes have segments inserted in wings, in the vertical stabilizer, and in the horizontal stabilizer. These are called ailerons, rudder, and elevator. The pilot controls their position from the airplane cockpit. When he moves them into the airstream, they cause the plane to react to air pressure. By using them he can go to the right or left and also up and down.

Up And Down: Fold the back edges of the paper glider up, as in the diagram B. When you throw the glider, the tail should go down and the nose should point up. It may take some practice to get the controls set so the glider does what you want it to do.

When the pilot wants his plane to climb, he moves his controls so that the elevators tilt up in the same way that you folded the back edges of the glider. The air hitting the elevators pushes the tail of the plane down, tilting the nose upward, so that the plane can climb.

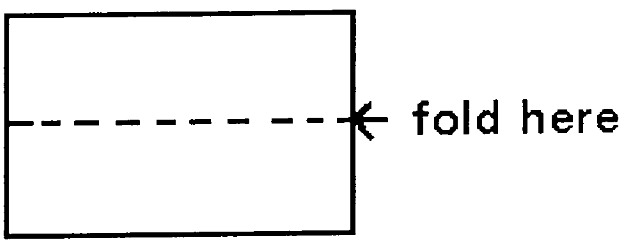
Fold the back edges of the glider down. When you throw the glider, the tail should go up and the nose should go down. This same thing happens when the pilot tilts the elevators downward.

Right And Left: Turn the vertical fin on the glider a little to the right; the glider will fly toward the right (Diagram C). The pilot moves his rudder to the right for a right turn, but he must also bank his plane for the turn, the same as you would do if you were turning on a bicycle. (You would lean to the right for a right turn.) The pilot tilts his plane to one side by using the ailerons. When one tilts up the other tilts down.

To tilt the plane to the right, the pilot tilts the left aileron down so the left wing is pushed up. The right aileron is tilted up so the right wing will be pushed down. You can do the same thing with a paper glider. (This principle can be illustrated also by suspending the glider in a wind tunnel.)

For a left turn, the pilot reverses the process described above.

Balsa glider: You can also use a balsa glider to illustrate the function of control surfaces. Assemble the glider and launch it a few times for practice. Make ailerons, elevators, and rudder from paper and glue them to the wings and stabilizers. Now practice bending these paper control surfaces until you can make the glider fly where you want it to. This kind of glider is excellent to use in wind tunnels to illustrate the effects of control surfaces.



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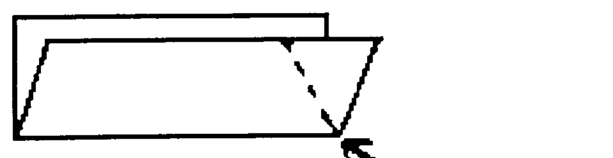

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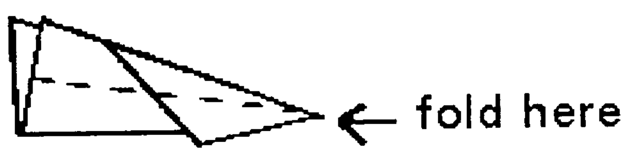

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Diagram B

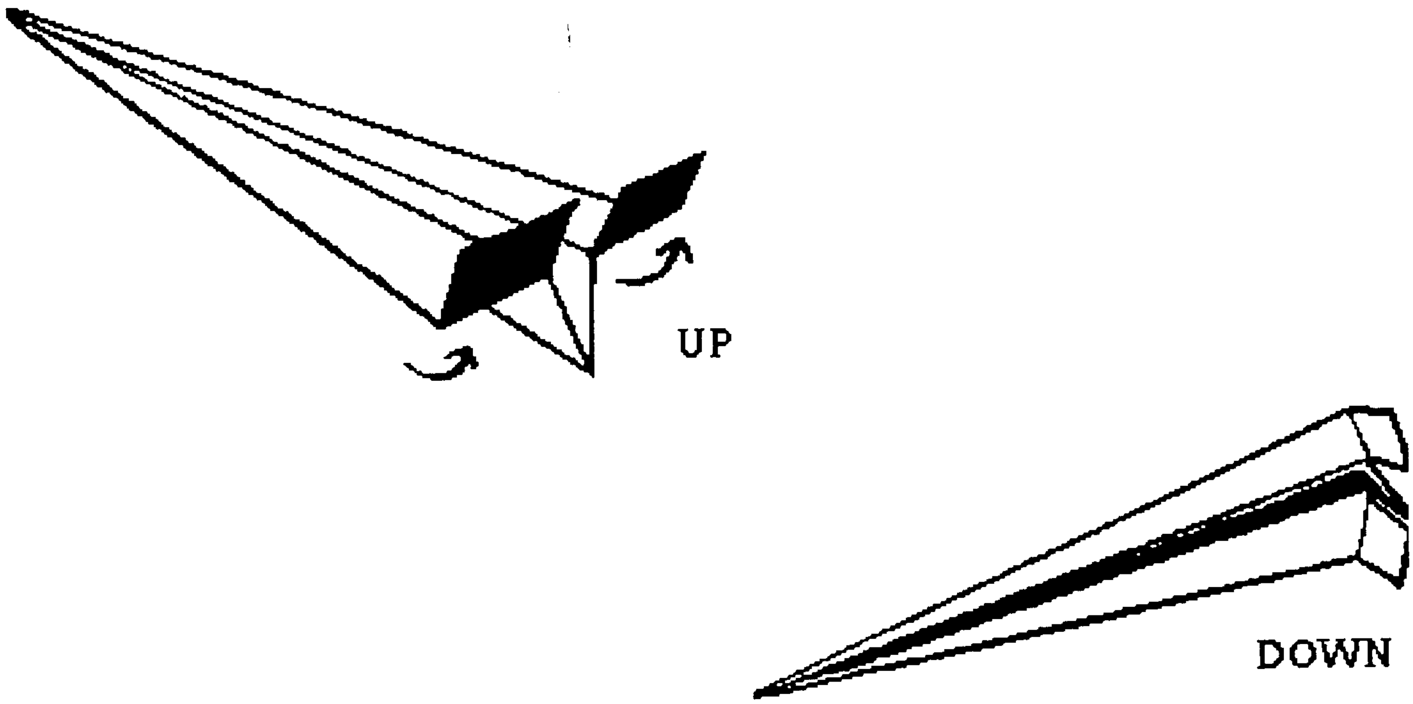
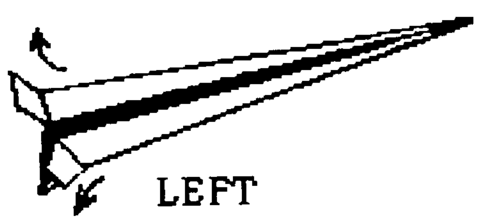


Diagram C



Activities

What Makes An Airplane Fly

How is a Plane Controlled?

Activity Number 7: Make a styrofoam glider
Level 1

Simple gliders are useful for demonstrating flight principles, such as the 4 forces, the basic parts of an airplane, or control surfaces. The instructions for making such a glider, the Cuderia Flyer, are listed below. Have students make these gliders and then use them for experiments in class. Students can compare flight characteristics of gliders when they vary different elements (such as weight, or control surface settings). For a detailed description of comparison flights, see activity 8 in this section.

EQUIPMENT

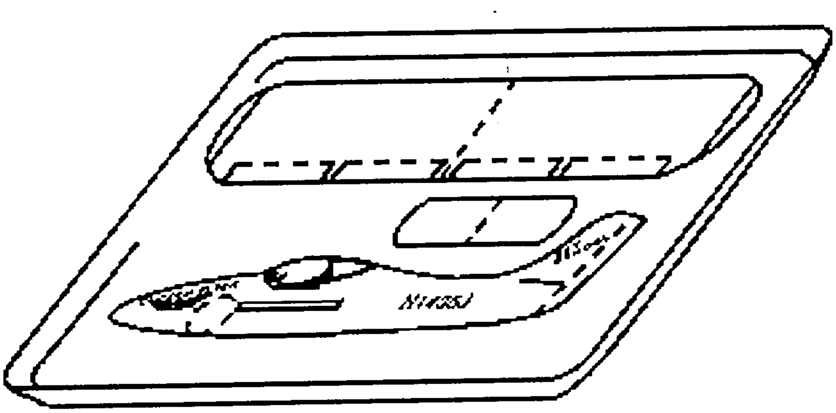
Cuderia Flyer Template
Styrofoam tray,11 in x 9 in (You can also use show card paper stock, although styrofoam is easier to handle and cut.)
single-edge razor blade or utility knife
scissors
glue stick
tape
fingernail file
ball point pen
piece of cardboard to use as a work surface

PROCEDURE

1. Go over basic flight characteristics and forces.
2. Discuss concepts of good design. Review: dihedral, fuselage, tail assembly, stabilizer, elevator, rudder, wing, winglets, aileron, flaps, aeronautical engineer.
3. Assemble the glider. Cut wing, fuselage, and horizontal stabilizer from the styrofoam tray using the template. Winglets can be formed from the factory bend of the tray edge (see illustration A).
4. Use the ball-point pen to score a line lightly from the leading edge of the wing to the trailing edge at the wing center point. Do the same for the horizontal stabilizer. Score aileron. flap. and rudder outline on both sides. Be careful not to cut all the way through the styrofoam material. Scoring will allow it to bend without breaking the control surfaces.
5. With one end of the wing on a flat surface, bend the opposite end up 1 inch. The wing now has a dihedral (illustration B):
6. Using a fingernail file round the leading edge of the wing and taper the trailing edge. Repeat for the horizontal stabilizer. Round the fuselage edges (illustration C):
7. Label the control surfaces. Apply personal and finishing touches to the fuselage by drawing canopy outline, name, aircraft number, etc.
8. Assemble the glider by inserting the wing and horizonal stabilizer into the correct slots cut in the fuselage. Friction will hold them in place.

9. Test your glider. The amount of ballast and the location and position of the elevator will determine its flight characteristics. Test fly the glider using different elevator positions, ballast locations, amount of ballast, until the best flight characteristics are obtained.
10. Use your glider to carry out some of the experiments in activity 8, Demonstrate the effects of rudder, elevator, and ailerons.

A



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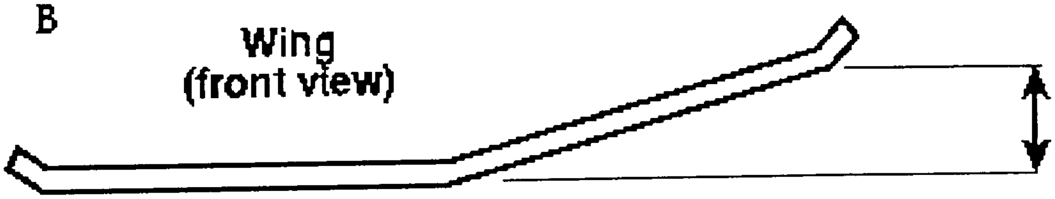

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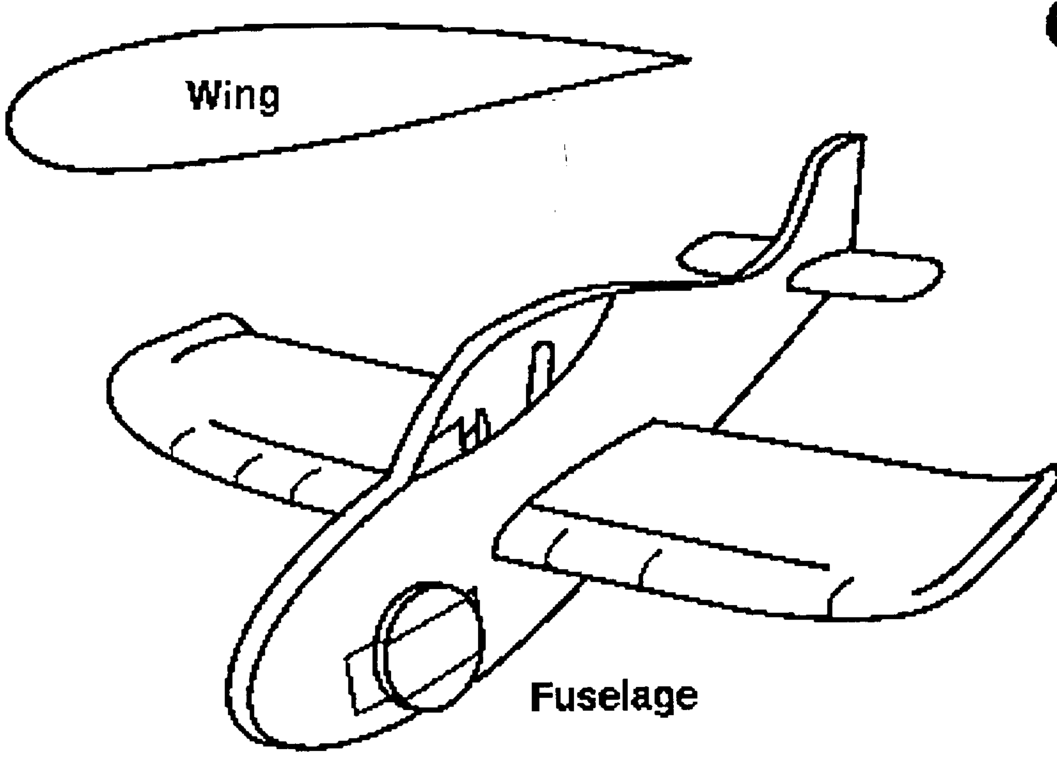

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Activities

What Makes An Airplane Fly

The Wind Tunnel

Activity Number 9: Make a simple wind tunnel
Level 1

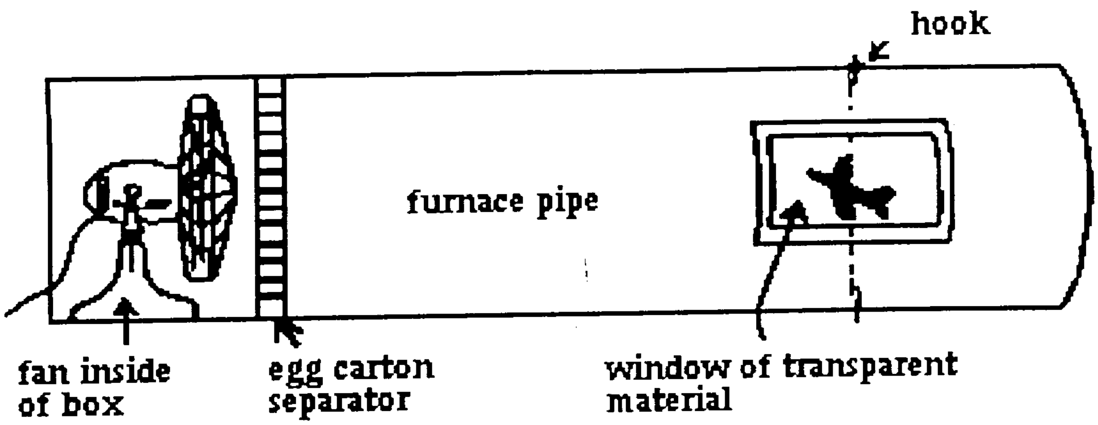
EQUIPMENT

Piece of furnace pipe about 4 feet long
Piece of pliofilm, acetate, or some other transparent material for the tunnel window
Separations from an egg carton or similar separators
Scotch tape
Corrugated box, the same size as the egg-carton separators
Small electric fan
Book-binding tape or similar adhesive tape
2 small hooks with screw ends, the kind used for hanging cups
Metal shears

DESCRIPTION

Open the egg carton separators and reinforce the corners with scotch tape. Open the corrugated box on both ends and push the flaps inside the box to make the box stronger. Fit the egg carton separators into one end of the box. They should fit snugly. With a pair of metal shears, cut a window near one end of the furnace pipe. Cover the window with the transparent material, securing it to the pipe with book-binding tape. Fasten the hooks in the pipe so that when the glider is suspended from the top hook it can be observed from the window.

Set the egg carton separators flush against the furnace pipe, at the end opposite the window. Set the electric fan inside the box containing the egg carton separators. These separators "honeycomb" or straighten the swirling air currents from the electric fan. When you suspend your glider in the wind tunnel you can examine the aerodynamic effects of control surfaces (ailerons, elevator, and rudders) and different glider designs. Also examine what happens when you change the airspeed, or add weights (pennies are good) to different positions on your glider, or change your glider's design.


hook
furnace pipe
fan inside
of box
egg carton
separator
window of transparent
material

Activities

Navigation and Flight Planning

Aeronautical Charts & Flight Planning

Activity Number 1: Introduction to aeronautical charts
Level 2 & Level 3

Aeronautical Charts are maps used by airplane pilots. Each chart represents a small part of the country. It shows the cities, highways, railroads, rivers, and lakes which the pilot can see from the air. It gives the heights of hills and mountains, and shows such things as water towers and high wires. Every landmark which can be seen from the air is shown on the charts.

EQUIPMENT
Sectional charts or terminal area charts. To acquire charts for your area of the country, call your state aviation commission, local airport, or order from one of the following:

- National Oceanographic and Atmospheric Administration (NOAA)
  1 (800) 638-8972 or
  1 (301) 436-6990
- The Aviation Book Company
  1 (800) 423-2708
- Sporty's Pilot Shop
  1 (800) 543-8633

Ruler or tape measure

DESCRIPTION
Display sectional charts or, if possible, distribute one per four or five students. Locate the Chart's symbol key. Copy the symbols for:

1. cities
2. small communities
3. single buildings
4. highways
5. railroads
6. radio towers
7. power lines
8. VOR stations
9. airports

Call attention to and discuss possible meanings of the colors on the chart. On the legend of the chart find the cale which shows colors. Practice finding locations with various altitudes. Discuss the importance to the pilot of the colors on the chart. Choose two towns or cities and "fly" the route between them. Measure the mileage with a ruler. Write it in inches and centimeters.

Activities

Navigation and Flight Planning

Aeronautical Charts & Flight Planning

Activity Number 2: Use the scale of an aeronautical chart to determine distance
Level 2 & Level 3

All aeronautical charts have been drawn to exact scale. The smallest scale is on an *aeronautical planning chart*. It is 80 miles to an inch. This is a ratio of approximately 1:5,000,000, which means that one inch on the chart represents 5,000,000 inches on the ground. A *sectional chart* has a scale of 8 miles to an inch. This is a ratio of approximately 1:500,000. A *terminal area chart* has a scale of 1:250,000, or 4 miles to the inch.

PROBLEM SET 1

1. What is the distance between two airports, if they are six inches apart on a chart which has a scale of 32 miles to one inch?

Solution: 1 inch on the chart represents 32 miles on the ground. Multiply 32x6 to find the distance. 32x6=192 miles.

2. If the scale on a chart is 80 miles to one inch, how many inches will represent a distance of 340 miles?

Solution: 80 miles on the ground is shown by 1 inch on the chart. Divide 340 by 80 to find the number of inches. 340 divided by 80 = 4 1/2 inches.

3. Find the missing number in each of the following problems:

Scale	Distance on Chart	Distance on Ground
1 in.=16 mi.	4 in.	?
1 in.=16 mi.	3 1/2 in.	?
1 in.=80 mi.	4 3/4 in.	?
1 in.=32 mi.	?	100 mi.
1 in.=8 mi.	?	75 mi.
?	9 1/2 in.	304 mi.
?	7 1/2 in.	114 mi.
1 in.=32 mi.	5 11/16 in.	?

4. If the scale of a chart is 1:1,000,000, what is the approximate number of miles on the ground which is represented by one inch on the chart?

5. If the scale of a chart is 32 miles to one inch, what is the approximate ratio of the scale?

PROBLEM SET 2: Using the Chart to Find Distances

The scale on a chart is easily used to find the distance between any two places on the chart. Use a ruler to measure between the two places. Then change the measurement to miles by the use of the scale.

1. Cameron is 1 7/8 inches from Vinson on a chart which has been drawn on a scale of 1 inch to 8 miles. What is the distance between Cameron and Vinson?

Solution: Multiply 1 7/8 by 8 to find the number of miles. 1 7/8 x 8 =15/8 x 8 = 15 miles.

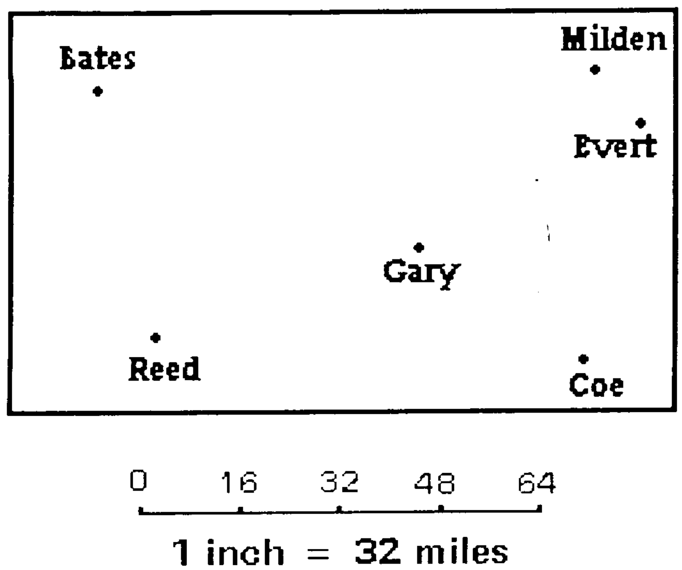
2. Practice Chart (see illustration below): Six cities are shown on a practice chart which has been prepared for use in the problems below. Notice the scale which is shown beneath the chart.

Find the distance in inches on the chart and the distance in miles on the ground for the following problems.

Flight	Distance in Inches	Distance in Miles
Reed to Evert	2 5/8 in.	84 mi.
Bates to Coe	?	?
Reed to Gary	?	?
Gary to Coe	?	?
Bates to Gary	?	?
Use the scale of 1 inch to 80 miles for the following:		
Reed to Coe	?	?
Bates to Milden	?	?
Bates to Evert	?	?
Milden to Evert	?	?
Reed to Milden	?	?

3. Use the practice chart and a scale of 1 inch = 64 miles to find the distance between Bates and Reed.

4. Use a scale of 1 inch = 16 miles to find the distance between Coe and Milden.


Bates
Milden
Evert
Gary
Reed
Coe
0
16
32
48
64
1 inch = 32 miles

Activities

Navigation and Flight Planning

Aeronautical Charts & Flight Planning

Activity Number 3: Fuel consumption problems
Level 2 & Level 3

Having plenty of gasoline is more important in aviation than in driving a car. The pilot must be able to plan the flight to have more fuel than needed. Pilots figure the amount of gasoline the plane should use, and add a reserve for emergencies. A fuel reserve of 25% is usually allowed.

Figuring the amount of fuel without a reserve:

Example: How much gasoline will be used in a flight of two hours, twenty minutes if the engine uses six gallons per hour?

Solution: Change two hours, twenty minutes to 140 minutes. Multiply 140/60 by 6 to find the amount of fuel used. 140/60 x 6 = 14 gallons.

PROBLEMS

Find the number of gallons of fuel which will be used in flights. In order to do this calculation, you will need to convert the minutes in the table below into the corresponding fractions of an hour. For example, to convert 45 minutes into a fraction of an hour, one must divide by the total number of minutes in an hour (that is, 60). As such, 45/60 = 3/4 = .75 of an hour.

Flying Time (in hours:minutes)	Fuel Consumption (in gallons per hour)	Fuel Used
3:30	6	?
5:20	12	?
4:30	5	?
4:22.5	20	?
6:24	40	?
2:24	5	?
3:12	15	?
5:05	18	?

How much gasoline will be consumed in a flight of three hours, forty minutes if the engine uses nine gallons per hour? (3.67 x 9 = ?)

An airplane makes a flight of six hours, forty-two minutes. The engine uses an average of 18 gallons of gasoline per hour. How much gasoline will be consumed during the flight?

Figuring the amount of fuel needed with a percentage reserve:

Example: How much gasoline will be needed for a flight of four hours, twenty minute if the engine uses nine gallons per hour, and a fuel reserve of 25% is desired?

Solution: Change four hours, twenty minutes to 4.33 hours. Multiply 4.33 by 9 to find the amount of fuel to be used. (4.33 x 9 = 38.97 gallons) Since a fuel reserve of 25% is to be carried, 38.97 gallons = 75% of total fuel to be carried. Divide 38.97 by .75 to find the total amount of fuel. (38.97 / .75 = 51.96 gallons)

PROBLEMS
Find the number of gallons of gasoline needed to include a 25% fuel reserve for the flights.

Flying Time (in hours:minutes)	Fuel Consumption (in gallons/hour)	Amount of Fuel Used	Amount of Fuel Needed to Include 25% Reserve
3:40	9	?	?
2:30	8	?	?
2:24	5	?	?
4:20	12	?	?
6:50	24	?	?
Find the number of gallons of gasoline needed to include a 20% fuel reserve for the flights			
4:00	6	?	?
3:30	9	?	?
3:20	15	?	?
8:20	24	?	?
4:10	18	?	?

Activities

Navigation and Flight Planning

Time in Aviation

Activity Number 4: Rate and distance problems
Level 2 & Level 3

The problems in this section are applications of the familiar TIME, RATE and DISTANCE formulas which can be used in problems of automobiles and trucks as well as aircraft. Average ground speed is the RATE in these problems:

RATE x TIME = DISTANCE

DISTANCE/TIME = RATE

DISTANCE/RATE = TIME

Example: What is the average ground speed for a flight of 400 miles in 3 hours, 20 minutes?

Solution: Divide 400 by 3 1/3 hours:
400 divided by 3/ 1/3 =400 divided by 10/3=400 x 3/10 = 120 MPH

PROBLEMS
Find the average speed for each of the flights in the following problems:

Distance (in miles)	Time (in hours)	Average Ground Speed (in MPH)
285	3	?
780	6 1/2	?
800	1/3	?
1260	4:40	?
2875	6:15	?
675	4:30	?
594	3:18	?
245	2:27	?

What is the ground speed for a flight of 595 miles in three and one-half hours?

An airplane flies 1104 miles in 4 hours, 36 minutes. What is the average ground speed?

Activities

Navigation and Flight Planning

Aeronautical Charts & Flight Planning

Activity Number 5: Plan a Flight
Level 2 & Level 3

This activity can be modified to provide greater or lesser levels of difficulty. The more realistic and detailed the planning, the harder the work.

If you are not a pilot you will need to gather some equipment and information to do this activity. An FAA educational counselor should be able to help with information and possibly with supplies. A local pilot, flight school, representative from the Aircraft Owners and Pilots Association (AOPA) or a representative from the Experimental Aircraft Association (EAA) would probably be happy to help you out, also. Any of these might even be able to arrange a flight for you or your students along the route you have planned. Finally, you might consider getting a private pilot flight manual. This should supply much of the information you need as well as some sample problems.

EQUIPMENT
For each group of students supply:

- Sectional chart
- Ruler or tape measure
- Optional: E6B flight computer (whiz wheel)
- Information on:
    - The cost of fuel for small, private aircraft
    - Airport landing fees for several airports, or instructions on how to call the airports and find out whether they have landing fees
    - Specifications for 2 or 3 different small, private aircraft:
        - Preferred cruising speed
        - How much weight it can carry
        - Its usual fuel consumption
        - How to calculate increased fuel consumption for increased weight

DESCRIPTION
Break the class into groups. Each group plans a return trip from one airport to another, choosing slightly different parameters. For instance, one group might choose to fly a Maule, another a Cessna. One group might plan a flight with only the pilot; another might plan for 6 passengers and baggage. They can choose different destinations.

Have them use a sectional chart and if possible an E6B flight computer. Students figure out:

- How far is the flight?
- What direction will they fly (outbound & return)?

- On what heading will they fly (outbound & return)?
- How long will the flight take?
- How much weight will the airplane carry?
- How much fuel is needed?
- At what altitude will it fly?
- To what air traffic control towers will the pilot tune in, on what frequencies, and when?
- What is the distance and time between these points?
- What landmarks will they fly over?
- Will they have to refuel?
- Does the airport where they intend to land supply fuel?
- How much money will they need to refuel?
- Are there any airport fees?

Activities

Navigation and Flight Planning

Aeronautical Charts & Flight Planning

Activity Number 6: Plan a flight accounting for weather
Level 2 & Level 3

This activity builds on the previous one, "Plan a Flight." Follow the instructions in "Plan a Flight," but now have students plan their flights on two days with different weather briefings. Have students describe how the weather will affect their flight plans. For example, will the flight be bumpy? Will wind affect the ground speed of the aircraft (outbound and return)?

Activities

Navigation and Flight Planning

Aircraft Instruments

Activity Number 7: Learn to read an altimeter
Level 2 & Level 3

An altimeter is the instrument in an airplane which shows the height (altitude) of the plane above sea level.

1. Display an altimeter or picture of altimeter
2. Describe the function and operation of altimeters
3. Practice reading the altimeter
4. Construct altimeter dials using paper plates. Attach construction paper hands with brass paper fasteners
5. Practice reading and setting the paper "altimeters"
6. Make rough sketches of objects such as office buildings, towers, mountains, etc. and their heights above sea level. Solve problems concerning:
   - The altitude a plane must fly in order to be 1,000 feet, 5,000 feet, etc. over each object.
   - How high over each object a plane will be if it flies at 2,000 feet; 3,200 feet; 4,500 feet, etc.

Activities

Navigation and Flight Planning

Aircraft Instruments

Activity Number 8: Learn to read a compass
Level 2 & Level 3

The Magnetic Compass is an aircraft instrument which shows the pilot the direction of flight. A magnetic compass is designed in such a way that the needle always points to the north, which is considered to be 0 degrees.

1. Display a magnetic compass or picture of compasses. Show both mounted and unmounted types.
2. Examine and discuss the pocket compass hikers carry.
3. Explain the difference between magnetic north and true north.
4. Draw a large circle. Make a vertical line through the center and an intersecting horizontal line through the vertical line. Label the points N, S, W, and E. These represent the cardinal points on a compass.
5. Intercardinal points are points between the cardinal points. Locate northwest, northeast, southwest and southeast on the circle.
6. Draw a circle. Draw a vertical line through the circle. Label the points 0 degrees and 180 degrees. Add points 90 degrees and 270 degrees by drawing a horizontal line through the circle, intersecting the vertical line. Complete the circle by marking points at intervals of 30 degrees. Determine that a circle has 360 degrees. Compare this drawing to a compass dial.
7. Use a pencil to "fly" a course or heading of 30 degrees, 150 degrees, 24 degrees, 30 degrees, etc.
8. Display pictures of a magnetic compass used in an airplane.
9. Discuss the markings on the magnetic compass. Explain that the compass card remains stationary while the aircraft rotates around it, allowing the compass heading (direction being flown) to show in the compass "window."
10. Practice reading the magnetic compass.
11. Construct simple, working compasses.

Activities

Navigation and Flight Planning

Aircraft Instruments

Activity Number 9: Find the compass reading for certain directions
Level 2 & Level 3

PROBLEMS
Find the number of degrees for each of the directions below.

Direction	Number of Degrees
North	0
East	?
South	?
West	?
Northeast	?
Southeast	?
Southwest	?
Northwest	?

What direction is shown by a compass reading of 360 degrees?

What angle of flight is taken by a plane which flies exactly halfway between west and northeast?

Activities

Navigation and Flight Planning

Aircraft Instruments

Activity Number 10: Compass angle problems
Level 2 & Level 3

The magnetic compass was one of the first instruments to be installed in airplanes, and it is still the only direction-seeking instrument in many airplanes. Because the compass is subject to variation, deviation, and errors due to flight turbulence or movement of the airplane another instrument, the heading indicator, is the primary heading reference in an aircraft in flight. However, should the heading indicator fail, the compass can still allow you to navigate properly.

When you fly under visual flight rules, you usually use aeronautical charts which are oriented to true north. Aircraft compasses, however, are oriented to magnetic north, which is in a slightly different position. You must calculate the difference between the true (geographic) north pole and the magnetic north pole. You do this by applying a correction called *variation* . This converts a true direction to a magnetic direction. Variation is the angle difference between the true and magnetic poles from wherever you happen to be standing. The amount of variation depends on where you are located on the earth's surface.

Compasses also suffer from disturbances from magnetic fields produced by metals and electrical accessories within the airplane. They can produce errors in compass indications. This is called *deviation* . A pilot corrects for deviation by using a compass correction card which gives the corrected readings and is mounted near the compass.

PROBLEMS

1. If two airplanes leave the same airport, one flying a course of 195 degrees and the other a course of 65 degrees, what is the size of the angle between their courses?

2. If a pilot flying a course of 27 degrees makes a 50 degree turn to the left, what is his new course?

3. A pilot wants his true course to be 60 degrees; variation is plus 10 degrees, and deviation is minus 3 degrees. This means that when he is headed on his true course of 60 degrees, variation (of +10) would cause his compass heading to read 70 degrees (60 +10). In addition, deviation (of -3) will finally cause his compass to read 67 degrees (70 - 3). Do the remaining problems in the following table.

True Heading (in deg.)	Variation (in deg.)	Magnetic Heading (in deg.)	Deviation (in deg.)	Compass Heading (in deg.)
060	+10	70	-3	67
325	-10	?	+5	?
165	-14	?	-4	?
355	+15	?	-3	?

Activities

Navigation and Flight Planning

Aircraft Instruments

Activity Number 11: Learn to read a tachometer
Level 2 & Level 3

A tachometer is a device for counting the number of revolutions per minute (RPM) of the aircraft engine. An airplane needs one tachometer for each of its engines.

1. Display a tachometer or pictures of tachometers.
2. Recall the automobile odometer. Discuss the similarity of its function with the function of a tachometer.
3. Construct tachometer dials from paper plates and attach hand with a brass paper fastener.
4. Practice reading tachometers at various settings.
5. Relate revolutions per minute (RPM) to speeds on a stereo turntable such as 33 1/3, 45 and 78 RPM.
6. Discuss reasons why automobiles have only one odometer, but airplanes may have two or more tachometers.

Activities

Navigation and Flight Planning

Aircraft Instruments

Activity Number 12: Tachometer problems
Level 2 & Level 3

An airplane's engines often run faster than its propellers. For example, on one airplane, the most efficient engine speed is 3,000 revolutions per minute (RPM), while the most efficient propeller speed is about 1,500 RPM. A set of reduction gears permits the engine to run at 3,000 RPM while the propeller turns at 1,500 RPM. When this happens, the ratio of engine RPM to propeller RPM is two to one (2:1). Other ratios can range from 4:3 to 3:1.

Example: If an airplane runs at 3780 RPM, and the ratio of engine speed to propeller speed is 3:1, what is the speed of the propeller?

Solution: If the ratio of engine speed to propeller speed is 3:1, divide 3780 by 3 to find the propeller speed.
3780 divided by 3 = 1260 RPM.

Example: What is the ratio between an engine speed of 3050 RPM and a propeller speed of 1220 RPM?

Solution: Divide 3050 by 1220 to find the ratio.
3050 divided by 1220 = 2.5 The ratio is 2.5 or 2.5:1. This ratio may also be written as 5:2.

PROBLEMS
Find the missing number in each of the problems.

Engine Speed (in RPM)	Propeller Speed (in RPM)	Ratio of Engine Speed to Propeller Speed
3160	?	2:1
3400	?	5:2
?	1450	3:2
?	1250	3:1
3150	1575	?
2800	1680	?
1800	?	4:3
?	1470	16:7

What is the ratio between an engine speed of 2910 RPM and a propeller speed of 1940 RPM?

If an airplane propeller turns at 1120 RPM and the ratio of engine speed to propeller speed is 12:7, what is the engine speed?

Activities

Navigation and Flight Planning

Time in Aviation

Activity Number 13: Military Time
Level 2 & Level 3

The clock is one of the most useful of flight instruments. It is used in figuring of such important items as the time required for a flight, the average ground speed, and determining the airplane's position. All these are more crucial in aviation than in ground transportation.

Military Time is measured in twenty-four hour units. The unit begins at 0001 hours after midnight and continues to the following midnight which is 0000 hours. Twelve o'clock noon is 1200 hours and continues to midnight.

Examples: The standard time in the left column is equivalent to the military time listed on the same row in the right column.

Standard Time	Military Time
9:00 a.m.	0900 hours
10:30 a.m.	1030 hours
12:00 noon	1200 hours
1:15 p.m.	1315 hours
6:49 p.m.	1849 hours
10:30 p.m.	2230 hours
12:00 p.m.	0000 hours

PROBLEMS
Convert between Standard and Military time.

Change the standard time to military time	Change the military time to standard time
1. 1:40 a.m.	1. 0430 hours
2. 5:16 p.m.	2. 1619 hours
3. 7:39 p.m.	3. 0003 hours
4. 6:47 a.m.	4. 1317 hours
5. 8:35 p.m.	5. 2148 hours
6. 12:30 p.m.	6. 2041 hours
7. 11:49 p.m.	7. 1022 hours
8. 2:32 p.m.	8. 2347 hours
9. 12:20 p.m.	9. 0103 hours
10. 11:43 p.m.	10. 1508 hours

Activities

Navigation and Flight Planning

Time in Aviation

Activity Number 14: Time required for a flight
Level 2 & Level 3

Calculate the time required for a flight

Example: What will be the length of a flight of 329 miles at an average speed of 94 MPH?

Solution: Divide 329 by 94.
329 divided by 94 = 3 1/2 hours, 30 minutes

PROBLEMS
Find the time required for flights in the following problems:

Distance (in miles)	Average Ground Speed (in MPH)	Required Time
275	110	?
180	45	?
585	130	?
2475	275	?
1875	600	?
195	65	?
230	100	?
280	120	?

What is the length of a flight of 450 miles at an average speed of 90 MPH?

A plane flies 370 miles at an average ground speed of 95 MPH. What time is required for the flight?

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Broadcast

Take Off! Part II
Program Code: 97033P

Register for Program

Audience: Teachers and students grades 9-12

Explore the exhilarating world of flight. Get students excited about math and science through an introduction to lift and drag, aircraft design, ballooning, weather, instrumentation, flight simulators and navigation, and introduce them to the possibilities for exciting work in aviation.

Presenters

David Price and Veronica Cote, with guests representing a wide range of careers in aviation.

During the seven broadcasts, the course explores both basic science and its practical technology applications, and is intended to inspire students, especially those uninterested in traditional science classes, with the possibilities of careers in aviation.

Broadcast Schedule - Fall 1997		
Session 1 - Teacher's session	Thursday, Sept. 4	2:00pm - 2:50pm
Session 2 - The Beginnings of Flight	Monday, Sept. 8	2:00pm - 2:50pm
Session 3 - How Does an Airplane Fly?	Friday, Sept. 8	2:00pm - 2:50pm
Session 4 - Instruments and Systems	Monday, Sept. 15	2:00pm - 2:50pm
Session 5 - The Human Factor	Tuesday, Oct. 14	2:00pm - 2:50pm
Session 6 - Navigation	Friday, Oct. 17	2:00pm - 2:50pm
Session 7 - Weather	Monday, Oct. 20	2:00pm - 2:50pm

Broadcast

Teachers' Session

Session 1 - Teacher's session

The first of the seven broadcasts is for teachers only. It will illustrate the topics explored during the student broadcasts, provide tips on using distance learning technologies and suggest practical strategies for involving girls and minority students in math and science classes. The course will also familiarize educators with the contents of the curriculum kit developed for the program. The kits include a teacher's resource guide and other print and non-print materials; kits will be mailed to all teachers that register for the series.

MCET staff and advisors from aviation organizations and educational institutions will provide guidance for teaching aeronautics, and will assist in integrating the content into existing science and math curricula. Teachers will have the opportunity to ask questions of the presenters and their colleagues via phone, fax, or posting their messages on the Forum.

During the six student broadcasts, the presenters will explore math and science concepts through aviation and aeronautics themes using an exciting combination of pre-produced video, live demonstrations in the studio, graphics and animations. Your students will have the opportunity to meet with our Career Guests, engineers, air traffic controllers, meteorologists, pilots, aviation psychologists and more, during the shows and here on our web site. Encourage your students to share their ideas and projects in the Forum and to communicate with our specialists via the Internet.

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Broadcast

The Beginnings of Flight

Session 2 - The Beginnings of Flight

What is so exciting about the world of aviation?

The presenters will try to answer the question throughout the series, exploring with the students the scientific basis of flight, from Newton's laws of motion, used to describe the forces acting upon the aircraft in flight, to pressure differences in a fluid resulting in an upward force on an airfoil in relative motion relative to it. Properties of fluids, such as air and water, and different types of flying objects are also covered during the show.

Archie Stewart, President of Kite Fabrications, and Vice President of Kites Over New England, is the first guest in the Career Corner. Students can contact Archie with any questions regarding kite building or kite flying.

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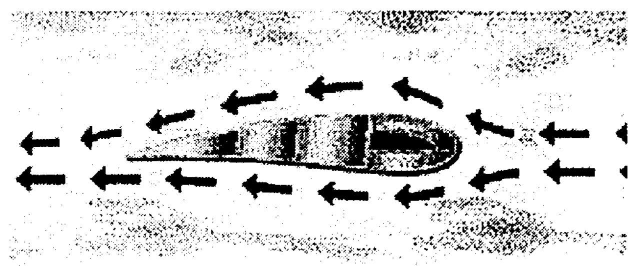
Broadcast

How Does an Airplane Fly?

Session 3 - How Does an Airplane Fly?



How do we control the movement of an airplane in flight, but first of all, how can we define the movement? In relation to what? The *three axes of rotation* , the factors affecting *lift and drag* and the principle of *conservation of energy* are the subjects of this broadcast.

The effect of the angle of attack on lift is explored using a wind tunnel model suitable for classroom use. Blueprints are available on-line at http://ldaps.ivv.nasa.gov/.

Jim Jones, Assistant Directorate Manager, Engines and Propellers Division, Federal Aviation Administration, is the guest in the Career Corner.

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Broadcast

Instruments and Systems

Session 4 - Instruments and Systems

How do pilots know where they are?

This broadcast introduces the basic instruments of the airplane: instruments based on air pressure (air and vertical speed indicators, altimeter), and instruments based upon the gyroscopic property of rigidity in space (attitude and turn coordinators, directional indicator).

The show builds upon the concept of *Systems*, from the airplane to the airport and transportation systems, (ticketing and security check-ins, luggage and cargo handling, mechanical maintenance and more). The Air Traffic Control system is introduced by John Melecio in the "Career Corner". Mr. Melecio, air traffic controller at Logan International Airport and FAA Hispanic Employment Program Manager for the New England Region, explains what air traffic controllers do, why their job is so important to ensure safety, and what he finds most exciting about his work.

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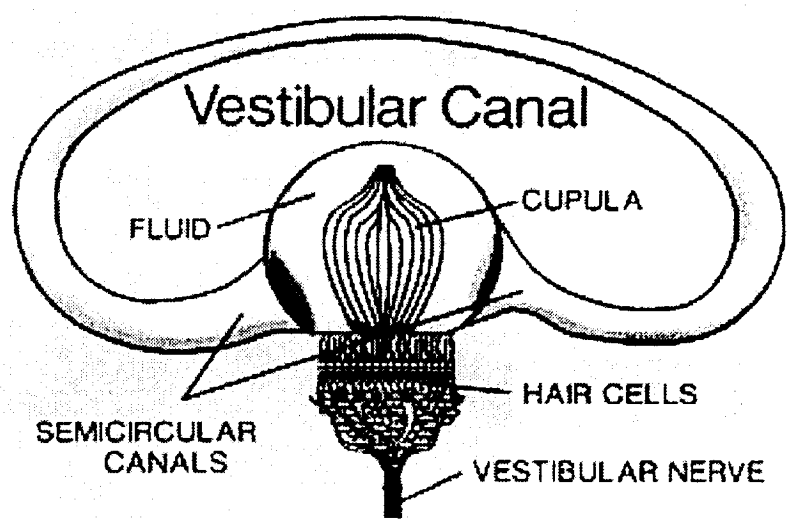
Broadcast

The Human Factor

Session 5 - The Human Factor

This session focuses on *human physiology in relation to flight*, and more specifically, on the concept of space orientation and our relationship with the surrounding environment. The show explores the visual, kinesthetic and vestibular senses - How humans achieve a sense of balance through the integration of the different nervous impulses - The difference between nighttime and daytime vision and the consequences for color interpretation and adaptation of the eye to varying light intensities.



Career Corner guest: Dr. Margaret Rappaport, psychologist and pilot of seaplanes, gliders and single engine props. Dr. Rappaport has thought Psychology at the University of Dar Es Salaam, Tanzania, and in schools in Uganda, Kenya and Ethiopia.

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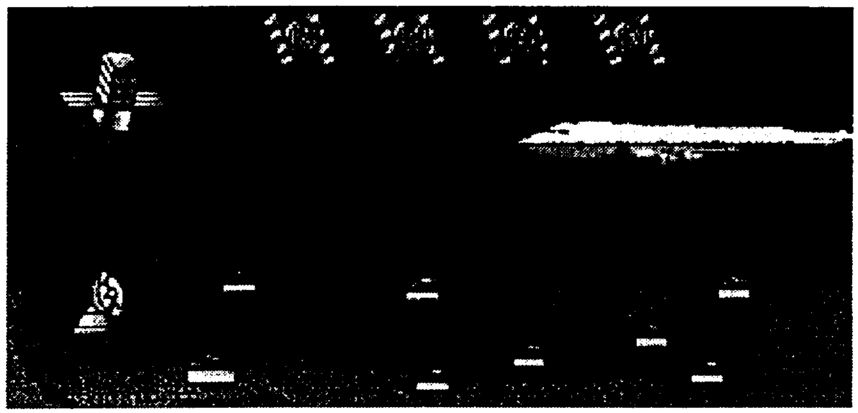
Broadcast

Navigation

Session 6 - Navigation



How do we get from here to there? - Velocity as a vector and composition of vectors - Coordinate systems on plane surfaces - Meridians and parallels on the Earth's surface - Three- dimensional frames of reference: our position relative to fixed objects in the sky, are all discussed in this broadcast. The Global Positioning System of reference is introduced by Colleen Donovan, engineering psychologist at the Volpe National Transportation Center in Cambridge, MA.

- How does GPS work?
- How many satellites are necessary to determine our position on the surface?

The program explores the past and future of navigation through the technical innovations introduced over the years.

Ann Wood Kelly, former World War II pilot, is the guest in the Career Corner. Ms. Kelly was one of 24 young US women transferred to England to work with the British Royal Air Force and contribute to the war effort as airplane pilots. Ann Wood Kelly shares some of her memories of the war years with the participating students.

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Broadcast

Weather

Session 7 - Weather

Students will see how different branches of science relate to each other by understanding how meteorology influences the design of aircraft and airport runway according to prevailing wind patterns. The show covers weather systems and meteorological factors, like air pressure, temperature variations, the structure of the atmosphere and the mechanisms of cloud formation.

Mishelle Michaels, the **7NEWS** weekend meteorologist for WHDH-TV is the Career Corner guest. Mish explains what is necessary to do to become a meteorologist,and how to plan your education. She shares with the students video clips showing her as a young TV meteorologist, at the beginning of her career. Mish will be glad to answer students questions using the e-mail.

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Glossary

A

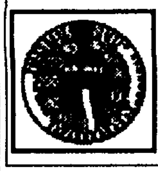
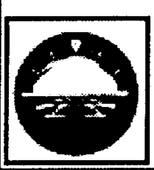
ABSOLUTE ALTITUDE	Actual height above the sur earth, either land or water.
ABSOLUTE CEILING	The altitude where a particu airplane's climb rate reache
ADVECTION FOG	Fog resulting from the mov warm, humid air over a col
AILERONS 	A control surface that exten about the midpoint of the tr of the wing outward towar tip. They move in opposite deflect airflow and create a about the longitudinal axis.
AIRCRAFT	Devices that are used or int used for flight in the air.
AGONIC LINE	Line along which no magne occurs.
AIR DENSITY	The density of the air in ter per unit volume. Dense air molecules per unit volume dense air. The density of ai with altitude above the surf earth and with increasing te
AIR ROUTE TRAFFIC CONTROL CENTER (ARTCC)	A facility established to pro traffic control service to air operating on IFR flight pla controlled airspace, princip the enroute phase of flight. equipment capabilities and workload permit, certain advisory/assistance service provided to VFR aircraft.
AIR TRAFFIC CONTROL (ATC)	A service provided by the F promote the safe, orderly, expeditious flow of air traf
AIRMASS	An extensive body of air ha

Glossary

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

A

ABSOLUTE ALTITUDE	Actual height above the surface of the earth, either land or water.
ABSOLUTE CEILING	The altitude where a particular airplane's climb rate reaches zero.
ADVECTION FOG	Fog resulting from the movement of warm, humid air over a cold surface.
AILERONS 	A control surface that extends from about the midpoint of the trailing edge of the wing outward towards the wing tip. They move in opposite directions to deflect airflow and create a motion about the longitudinal axis.
AIRCRAFT	Devices that are used or intended to be used for flight in the air.
AGONIC LINE	Line along which no magnetic variation occurs.
AIR DENSITY	The density of the air in terms of mass per unit volume. Dense air has more molecules per unit volume than less dense air. The density of air decreases with altitude above the surface of the earth and with increasing temperature.
AIR ROUTE TRAFFIC CONTROL CENTER (ARTCC)	A facility established to provide air traffic control service to aircraft operating on IFR flight plans within controlled airspace, principally during the enroute phase of flight. When equipment capabilities and controller workload permit, certain advisory/assistance services may be provided to VFR aircraft.
AIR TRAFFIC CONTROL (ATC)	A service provided by the FAA to promote the safe, orderly, and expeditious flow of air traffic.
AIRMASS	An extensive body of air having fairly uniform properties of temperature and moisture within a horizontal plane.

AIRSPEED INDICATOR 	An instrument that displays the speed of an object (aircraft) through the air.
AIRMET	In-flight weather advisory concerning moderate icing, moderate turbulence, sustained winds of 30 knots or more at the surface, and widespread areas of ceilings less than 1,000 feet and/or visibility less than three miles.
ALCOHOL	A colorless volatile flammable liquid.
ALERT AREA	Special use airspace which may contain a high volume of pilot training activities or an unusual type of aerial activity.
ALTIMETER 	The instrument that indicates flight altitude by sensing pressure changes and displaying altitude in feet.
ALTIMETER SETTING	The barometric pressure setting used to adjust a pressure altimeter for variations in existing atmospheric pressure and temperature.
ALTITUDE	Height expressed in units of distance above a reference plane, usually above mean sea level or above ground level.
ANGLE OF ATTACK 	The angle between the airfoil's chord line and the relative wind.
ANGLE OF INCIDENCE	The angle between the chord line of the wing and the longitudinal axis of the airplane.
ATTITUDE INDICATOR 	An instrument that senses an aircraft's pitching and rolling movements about the lateral and longitudinal axes.
AUTOMATIC DIRECTION FINDER (ADF)	An aircraft radio navigation system which senses and indicates the direction to an L/MF non-directional radio beacon (NDB) or commercial broadcast station.
AUTOMATIC TERMINAL INFORMATION SERVICE (ATIS)	The continuous broadcast of recorded information in selected terminal areas. Its purpose is to improve controller effectiveness and to relieve frequency congestion by automating the repetitive transmission of essential but routine information.

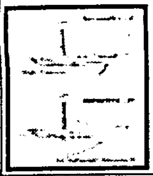
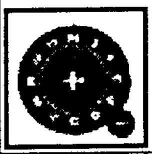
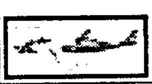
B

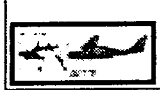
BAROMETER	An instrument used for measuring atmospheric pressure, used in weather forecasting, and in determining elevation.
BEARING	The horizontal direction to or from any point, usually measured clockwise from true north (true bearing), magnetic north (magnetic bearing), or some other reference point, through 360 degrees.
BERNOULLI'S PRINCIPLE	A theorem that relates the velocity of a fluid to its pressure.
BEST ANGLE-OF-CLIMB AIRSPEED	The best angle-of-climb airspeed (Vx) will produce the greatest gain in altitude for horizontal distance traveled.
BEST RATE-OF-CLIMB AIRSPEED	The best rate-of-climb airspeed (Vy) produces the maximum gain in altitude per unit of time.

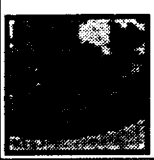
C

CALIBRATED AIRSPEED (CAS)	Indicated airspeed of an aircraft, corrected for installation and instrument errors.
CAMBER 	The curve of an airfoil section from the leading edge to the trailing edge.
CATEGORIES	Relates to the intended use of an aircraft and sets limits on its operation.
CEILING	The height above the earth's surface of the lowest layer of clouds or obscuring phenomena that is reported as broken, overcast, or obscuration and not classified as thin or partial.
CELESTIAL NAVIGATION	A method of navigation in which the stars are used to determine approximate location.
CENTER OF GRAVITY (CG)	The theoretical point where the entire weight of the airplane is considered to be concentrated.
CHORD 	An imaginary straight line between the leading and trailing edges of an airfoil section.
CLASS	(1) As used with respect to the certification, ratings, privileges, and limitations of airmen, means a classification of aircraft within a category having similar operating characteristics (single engine, multi-engine, land, water, gyroplane, helicopter, airship, and free balloon). (2) As used with respect to certification of aircraft means a broad grouping of aircraft having similar characteristics of propulsion, flight, or landing (airplane, rotorcraft, glider, balloon, landplane, and seaplane.)

CLEAR AIR TURBULENCE	Turbulence that occurs in clear air, and is commonly applied to high-level turbulence associated with wind shear. It is often encountered near the jet stream, and it is not the same as turbulence associated with cumuliform clouds or thunderstorms.
CLOUDS	A visible body of very fine droplets of water or particles of ice dispersed in the atmosphere at various altitudes.
COLD FRONT	The boundary between two air masses where cold air is replacing warm air.
COMPASS HEADING	A compass reading that will make good the desired course. It is the desired course (true course) corrected for variation, deviation, and wind.
COMMERCIAL AVIATION	An aircraft operation in which passengers and/or cargo have been carried and from which money has been transacted
CONTROLLED AIRSPACE	Airspace within which some or all aircraft may be subject to air traffic control.
CONVECTION	The circular motion of air that results when warm air rises and is replaced by cooler air. These motions are predominantly vertical, resulting in vertical transport and mixing of atmospheric properties; distinguished from advection.
CORIOLIS FORCE	A deflective force that is created by the difference in rotational velocity between the equator and the poles of the earth. It deflects air to the right in the northern hemisphere and to the left in the southern hemisphere.
COURSE	The intended or desired direction of flight in the horizontal plane measured in degrees from true or magnetic north.
CROSSWIND	A wind which is not parallel to a runway or the path of an aircraft.
CROSSWIND COMPONENT	A wind component which is at a right angle to the runway or the flight path of an aircraft.
CRUISE SPEED	The average aircraft speed at during the course of a given flight.
CUMULUS	A cloud developed from convective currents resulting from the heating of the Earth's surface.
D	
DEAD RECKONING	A technique of navigation based upon calculations of time, speed, distance, and direction.

DEFLECTIVE LIFT 	An upward force applied to the wing as a result of the airflow hitting the lower surface and being deflected downward.
DENSITY ALTITUDE	Pressure altitude corrected for nonstandard temperature variations. Performance charts for many older airplanes are based on this value.
DEVIATION	A compass error caused by magnetic disturbances from electrical and metal components in the airplane. The correction for this error is displayed on a compass correction card placed near the magnetic compass in the airplane.
DEWPOINT	The temperature to which air must be cooled to become saturated.
DIRECTIONAL GYRO 	An instrument that senses yaw movement about the vertical axis. It indicates a change in direction relative to the magnetic north pole.
DOWNBURST	A strong downdraft which induces an outburst of damaging winds on or near the ground. Damaging winds, either straight or curved, are highly divergent. The sizes of downbursts vary from 1/2 mile or less to more than 10 miles. An intense downburst often causes widespread damage. Damaging winds, lasting 5 to 30 minutes, could reach speeds as high as 120 knots.
DOWNWIND	Being in the direction in which the wind blows, leeward.
DRAG	A force that oppose an aircraft's thrust, retarding the forward motion and limiting the speed of that aircraft.
E	
EFFECTIVE PITCH 	The actual distance a propeller moves forward through the air in one revolution.
ELEVATOR 	A control surface that is attached to the back of the horizontal stabilizer and used to deflect lift upward and downward in order to cause the airplane to pitch

EMERGENCY LOCATOR TRANSMITTER (ELT)	A radio transmitter attached to the aircraft structure which operates from its own power source on 121.5 MHz and 243.0 MHz. It aids in locating downed aircraft by radiating downward-sweeping audio tone.
EMOTIONS	Agitation of the passions or sensibilities often involving physical changes.
EVAPORATION	The transformation of a liquid to the gaseous state, such as the change of water to water vapor.
F	
FATIGUE	Physical or mental weariness or exhaustion resulting from exertion.
FINAL APPROACH	A flight path of a landing aircraft in the direction of landing along the extended runway centerline from the base leg or straight in to the runway.
FIXED BASE OPERATOR	An aviation company located on an airport to provide goods and services within the aviation community.
FREEZING LEVEL	A level in the atmosphere at which the temperature is 32°F (0°C).
FRONT	The boundary between two different air masses.
G	
GENERAL AVIATION	Any aircraft operation that is neither military or commercial.
GEOMETRIC PITCH 	The theoretical distance a propeller should move forward in one revolution under perfect "conditions"
GLIDER	A light, engine-less aircraft usually with very long, narrow wings to develop lift.
GLOBAL POSITIONING SYSTEM (GPS)	A satellite-based radio positioning, navigation, and time- transfer system.
GROUND EFFECT	A usually beneficial influence on aircraft performance which occurs while you are flying close to the ground. It results from a reduction in upwash, downwash, and wingtip vortices which provide a corresponding decrease in induced drag.
GROUND SPEED	The actual speed of an airplane over the ground.
H	
HEADING	The direction in which the longitudinal axis of the airplane points with respect to true or magnetic north. Heading is equal to course plus or minus any wind correction angle.
HEAD WIND	Being in a direction that directly faces the wind's direction.
HUMIDITY	Water vapor content in the air.

HYPERVENTILATION	The excessive ventilation of the lungs caused by very rapid and deep breathing which results in an excessive loss of carbon dioxide from the body.
HYPOXIA	The effects on the human body of an insufficient supply of oxygen.
I	
ILLNESS	A sickness of the body or mind.
INDICATED AIRSPEED	The speed of an aircraft as shown on the airspeed indicator.
INDICATED ALTITUDE	The altitude shown by an altimeter set to the current altimeter setting.
INDUCED DRAG	That part of total drag which is created by the production of lift.
INSTRUMENT FLIGHT RULES (IFR)	Rules that govern the procedure for conducting flight in instrument weather conditions. When weather conditions are below the minimums prescribed for VFR, only instrument-rated pilots may fly in accordance with IFR.
INVERSION	An increase in temperature with altitude - a reversal of the normal decrease of temperature with altitude in the troposphere.
ISOBAR	A line of equal or constant barometric pressure.
ISOGONIC LINES	Lines on charts that connect points of equal magnetic variation.
ISOTACH	A line of equal or constant wind speed.
J	
JET STREAM 	A narrow band of winds with speeds of 50 knots and greater embedded in the westerlies in the high troposphere.
K	
KINETIC ENERGY	Energy associated with motion of an object and equal to one half of that object's mass and multiplied by the square of the velocity.
KNOTS	A rate of speed calibrated in nautical miles per hour.
L	
LAND BREEZE	A coastal breeze blowing from land to sea caused by temperature difference when the sea surface is warmer than the adjacent land; usually blows at night and alternates with a sea breeze which blows in the opposite direction by day.

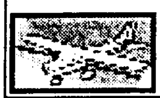
LAPSE RATE	The rate of decrease of an atmospheric variable with altitude; commonly refers to a decrease of temperature (2°C per 1,000 feet) with altitude.
LATITUDE	Measurement north or south of the equator in degrees, minutes, and seconds.
LOAD FACTOR	The ratio of the load supported by the airplane's wings to the actual weight of the aircraft and its contents.
LONGITUDE	Measurement east or west of the Prime Meridian in degrees, minutes, and seconds.
LONG RANGE NAVIGATION (LORAN)	An electronic navigational system by which lines of position are determined by measuring the difference in the time of reception of synchronized pulse signals from fixed transmitters.
M	
MAGNETIC COURSE	Course corrected for magnetic variation.
MANEUVERING SPEED (VA)	The maximum speed at which full and abrupt control movements will not overstress the airplane.
MAYDAY	International radio distress signal. When repeated three times, it indicates imminent and grave danger and that immediate assistance is requested.
MEAN SEA LEVEL (MSL)	The average height of the surface of the sea for all stages of tide; used as a reference for elevations throughout the U.S.
MEDICATION	A form of science in which the treatment or prevention of disease is accomplished through the use of drugs, diet, exercise or another non-surgical means.
MICROBURST	A small downburst with outbursts of damaging winds extending 2.5 miles or less. In spite of its small horizontal scale, an intense microburst could induce wind speeds as high as 150 knots.
MILITARY AVIATION	Any aircraft operation that is under the authority of the United States armed forces.
MILITARY OPERATIONS AREA (MOA)	Special use airspace of defined vertical and lateral limits established to help VFR traffic identify locations where military activities are conducted.
MILLIBAR	A unit of atmospheric pressure equal to a force of 1,000 dynes per square centimeter.
N	
NAUTICAL MILES	Unit of measurement of length, equivalent to 1.851852 Km
NEUTRAL BUOYANCY	A term used to describe the motion of an object as neither rising or descending.
NIGHT	The time between the end of evening civil twilight and the beginning of morning civil twilight, and published in the American Air Almanac.

NOTICE TO AIRMEN (NOTAM)	A notice containing a recent change to any component in the National Airspace System which is considered essential to persons concerned with flight operations.

O

OBSTRUCTION LIGHT	A light, or one of a group of lights, usually red or white, mounted on a surface structure or natural terrain to warn pilots of the presence of a flight hazard.

P

PARASITE DRAG	That part of total drag created by the form or shape of airplane parts.
PILOTAGE	A form of navigation by visual reference to landmarks.
PILOT IN COMMAND (PIC)	The pilot responsible for the operation and safety of an aircraft.
PITCH 	The rotation of an aircraft around its lateral axis.
PITOT TUBE	A device that funnels impact air pressure into the airspeed indicator.
POTENTIAL ENERGY	The energy of an object derived from position with respect to a specified datum and equal to that object weight multiplied by its height above said datum.
PLANFORM	A term used to refer to a wing's shape when viewed from above.
PRECIPITATION	Any or all forms of water particles, whether liquid or solid, that fall from the atmosphere and reach the surface.
PRESSURE ALTITUDE	Height above the standard pressure level of 29.92 in. Hg. Obtained by setting 29.92 in the barometric pressure window and reading the altimeter.
PREVAILING WIND	The wind direction most frequently observed during a given period.
PROHIBITED AREA	Special use airspace of defined dimensions within which flight of aircraft is prohibited.
PROPELLER 	A twisted airfoil rotated by an engine to provide thrust to an airplane or other air vehicle.

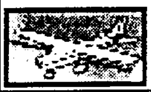
Q

R

RADAR ADVISORY	Information or advice provided to pilots based on radar observations.
RADAR CONTACT	Term used by ATC to advise a pilot that the aircraft is identified on radar.
RADIAL	A navigational signal generated by a VOR or VORTAC, measured as a magnetic bearing from the station.
RELATIVE HUMIDITY	The actual amount of water present in a given volume of air relative to the amount of water that the same volume could contain at that temperature at the saturation point.
RESTRICTED AREA	Special use airspace of defined dimensions within which the flight of aircraft, while not wholly prohibited, is subject to restrictions.
RIGIDITY IN SPACE	A term which means that once a gyroscope is spinning, it tends to remain in a fixed position in space and resists external forces applied to it.
ROLL 	A rotation of an aircraft around its longitudinal axis.
ROTORCRAFT	An aircraft that develops lift from large rotating blades above the aircraft.
RUDDER 	A control surface attached to the trailing edge of the vertical stabilizer and can be used to deflect the airflow to the left or right, causing the airplane to change direction.
RUNWAY HEADING	The magnetic direction that corresponds with the runway centerline extended, not the painted runway number. When cleared to "fly or maintain runway heading," pilots are expected to fly or maintain the heading that corresponds with the extended centerline of the departure runway. Drift correction shall not be applied; e.g., Runway 4, actual magnetic heading of the runway centerline 044, fly 044.
S	
SATELLITE NAVIGATION	A method of navigation that uses data from satellite to determine location, direction, and velocity.
SATURATED AIR	Air that contains the maximum amount of water vapor it can hold at a given temperature (relative humidity of 100%).
SEA BREEZE	A coastal breeze blowing from sea to land, caused by the temperature difference when the land surface is warmer than the sea surface.

SERVICE CEILING	The maximum height above mean sea level, under normal conditions, at which a given airplane is able to maintain a rate of climb of 100 feet per minute.
SQUALL LINE	Any non-frontal or narrow band of active thunderstorms.
STALL	The separation of the airflow from an airfoil resulting in a loss of lift, usually from an increased angle-of-attack.
STANDARD ALTIMETER SETTING	An altimeter set to the standard pressure of 29.92 in. Hg, or 1013.2 Mb.
STANDARD ATMOSPHERE	A hypothetical atmosphere based on averages in which the surface temperature is 59°F (15°C), the surface pressure is 29.92 in. Hg (1013.2 Mb) at sea level, and the temperature lapse rate is approximately 2°C per 1,000 feet.
STRATOSPHERE	The relatively isothermal layer of the atmosphere located above the troposphere and below the mesosphere.
STRATUS	A low-altitude cloud typically resembling a horizontal layer of fog.
STRESS	A mentally or emotionally disruptive influence.
SUBLIMATION	Process by which a gas is changed to a solid or a solid to a gas without going through the liquid state.
SUPERCOOLED WATER	Water that has been cooled below the freezing point, but is still in a liquid state.
T	
TAILWIND	Any wind more than 90 degrees from the magnetic heading of the runway.
THRESHOLD	The beginning of the landing area of the runway.
TRACK	The actual flight path of an aircraft over the ground.
TRAFFIC ADVISORIES	Advisories issued to alert a pilot to other known or observed air traffic which may be in such proximity to their position or intended route of flight as to warrant their attention.
TRAFFIC PATTERN	The traffic flow that is prescribed for aircraft landing and taking off from an airport. The usual components are the upwind, crosswind, downwind, and base legs; and the final approach.
TRANSPONDER	An electronic device aboard the airplane that enhances an aircraft's identity on an ATC radar screen.
TROPOPAUSE	A location in the atmosphere which lies above the troposphere and below the stratosphere.
TROPOSPHERE	The lowest layer of the Earth's atmosphere where most weather occurs.

TRUE AIRSPEED (TAS)	The speed at which an aircraft is moving relative to the surrounding air.
TRUE ALTITUDE	The actual height of an object above mean sea level.
TRUE COURSE (TC)	The intended or desired direction of flight as measured on a chart clockwise from true north.
TRUE HEADING	The direction the longitudinal axis of the airplane points with respect to true north. True heading is equal to true course plus or minus any wind correction angle.
TURN COORDINATOR 	An aircraft instrument that senses roll and yaw movement about the lateral and longitudinal axis.
U	
V	
VARIATION	The angular difference between true north and magnetic north; indicated on charts by isogonic lines.
VELOCITY	The distance an object travels per unit of time.
VERTICAL SPEED INDICATOR	An instrument that senses an aircraft's rate of ascension or descension calibrated in feet per minute.
VICTOR AIRWAY	An airway system based on the use of VOR facilities. The north-south airways have odd numbers (Victor 11), and the east-west airways have even numbers (Victor 14).
VISIBILITY	The distance one can see and identify prominent unlighted objects by day and prominent lighted objects by night.
VISUAL FLIGHT RULES (VFR)	Rules that govern the procedures for conducting flight in visual conditions. The term "VFR" is also used to indicate weather conditions that comply with specified VFR requirements.
VOR	Ground-based navigational system consisting of very high frequency omnidirectional range (VOR) stations which provide course guidance. VORTAC provides both VOR and TACAN course guidance plus distance (DME) information.
W	
WARM FRONT	The boundary between two air masses where warm air is replacing cold air.
WARNING AREA	Special use airspace which may contain hazards to non participating aircraft over international and coastal waters.
WIND	Moving air from the result of uneven heating of the Earth's surface.

WIND CORRECTION ANGLE (WCA)	The angular difference between the heading of the airplane and the course.
WIND SHEAR	A sudden, drastic shift in wind speed, direction, or both that may occur in the vertical or horizontal plane.
WING AREA	The total surface area of a wing derived from a measurement of the wing's chord multiplied by its span.
WINGTIP VORTICES	Circular patterns of air created by an airfoil when generating lift. Vortices from medium to heavy aircraft may be extremely hazardous to small aircraft.
X	
Y	
YAW 	A rotation of an object (aircraft) about its vertical axis.
Z	

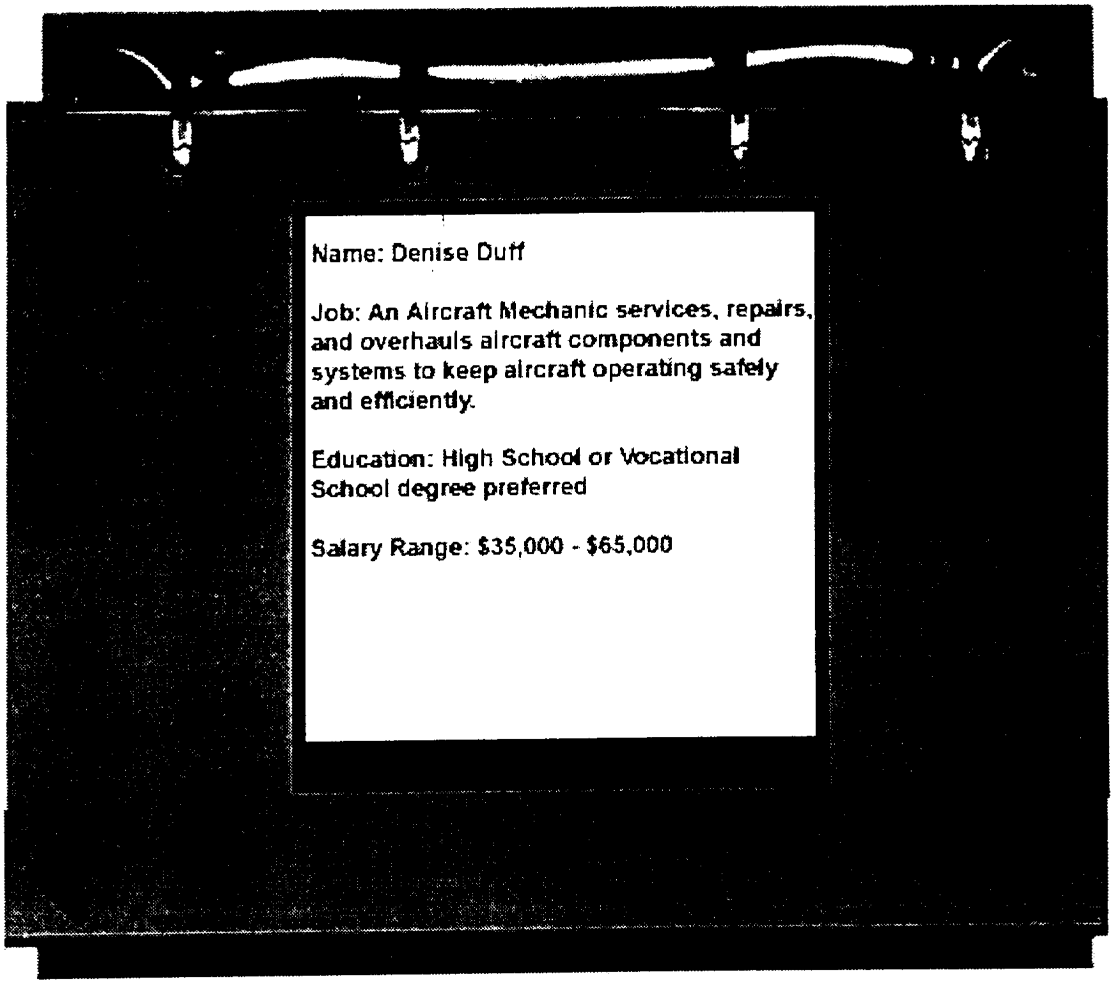
Pending Permission for Images

Career Cards

AIR TRAFFIC CONTROLLERS, MECHANICS AND ENGINEERS... AIRLINE SERVICE REPRESENTATIVES AND PILOTS... EVERY DAY THOUSANDS OF PEOPLE DO HUNDREDS OF JOBS RELATED TO AVIATION. CONSIDER FOR A MOMENT HOW MANY PEOPLE ARE INVOLVED IN GETTING JUST ONE COMMERCIAL AIRLINER TO TRANSPORT YOU AND YOUR LUGGAGE SAFELY FROM HERE TO BORA BORA! AMAZING!

EACH OF THE PEOPLE IN THIS CAREER ALBUM WORKS IN A FIELD RELATED TO AVIATION. READ THEIR PERSONAL CARDS TO CHECK OUT JUST A FEW OF THE MANY AVAILABLE CAREER OPPORTUNITIES, AND LEARN HOW MUCH THEY ALL LOVE THEIR JOBS! DOWNLOAD THE SOUND FILES AND LET THEM SPEAK DIRECTLY TO YOU!

OPEN

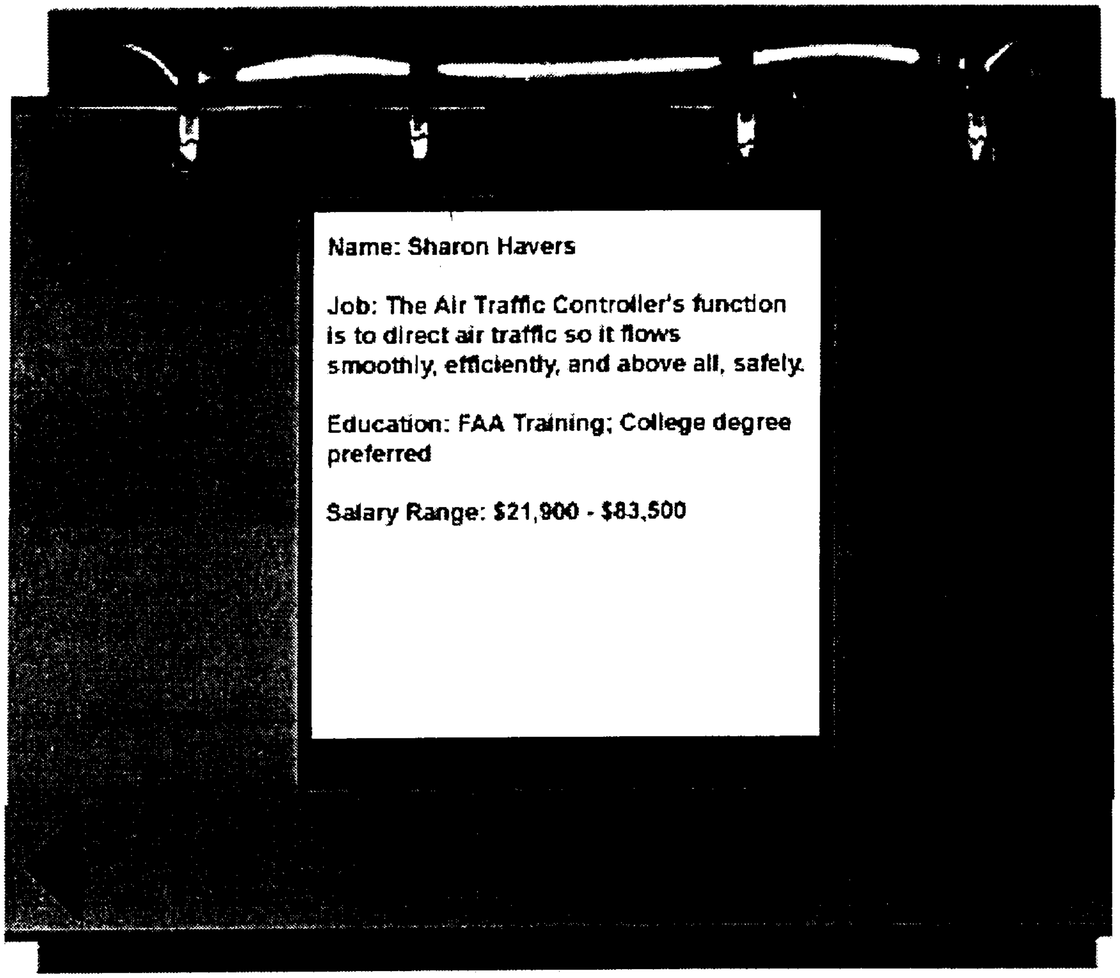


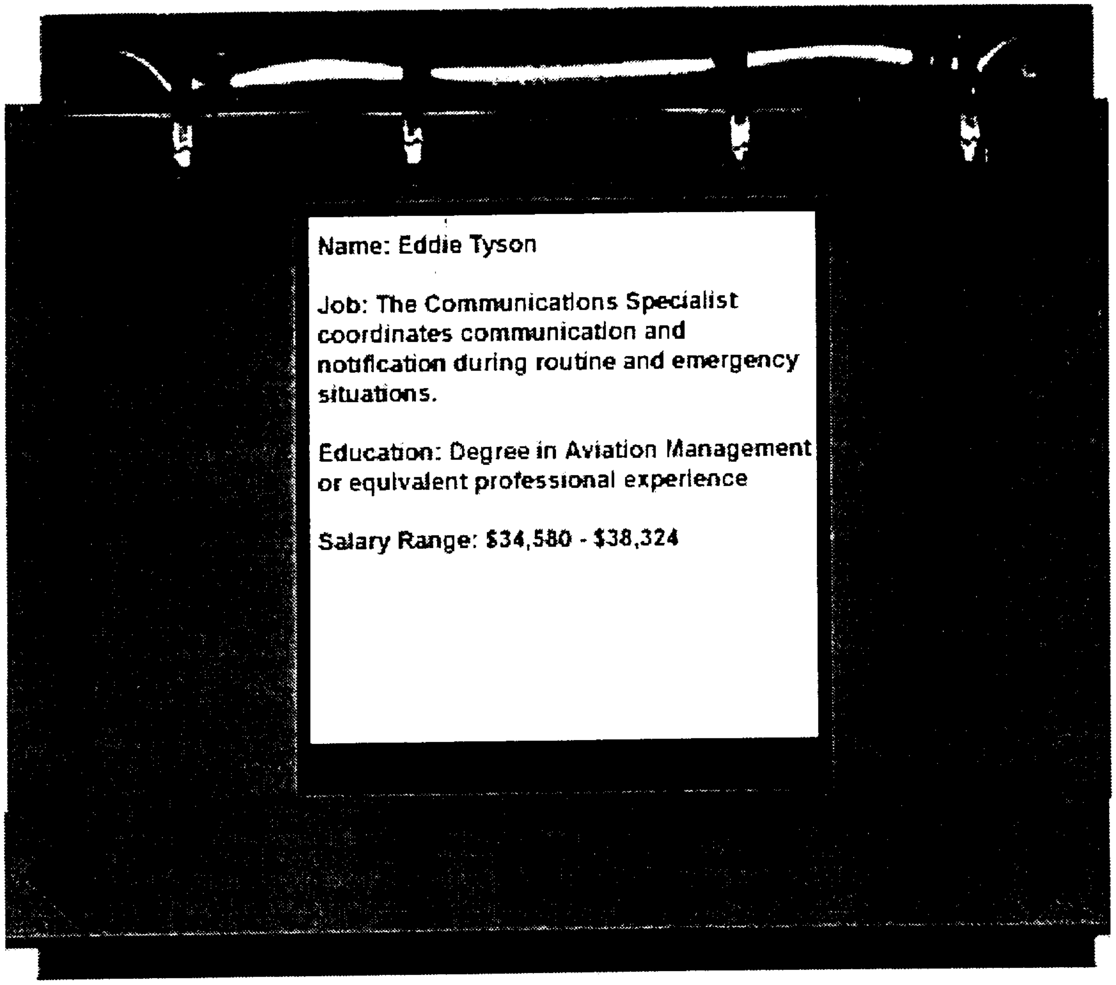
Name: Denise Duff

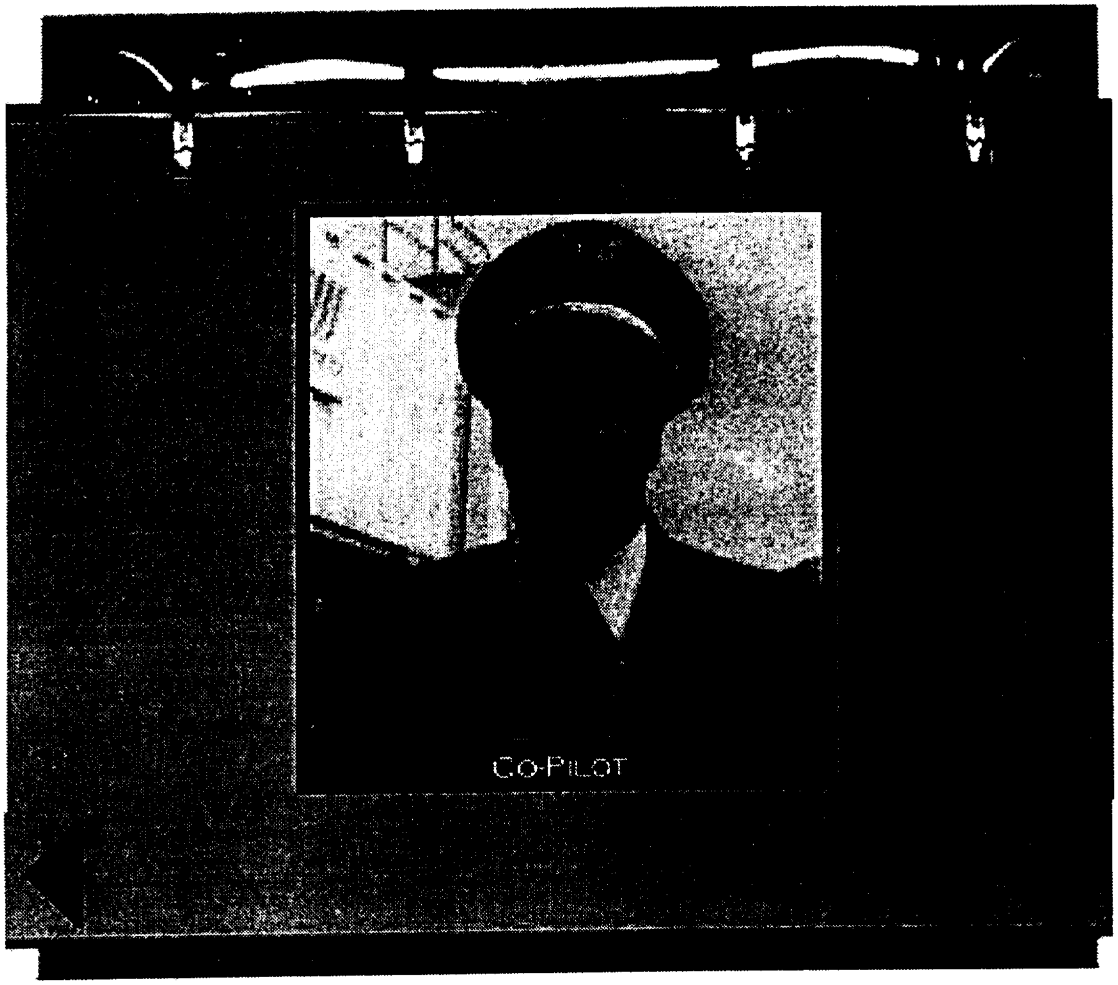
Job: An Aircraft Mechanic services, repairs, and overhauls aircraft components and systems to keep aircraft operating safely and efficiently.

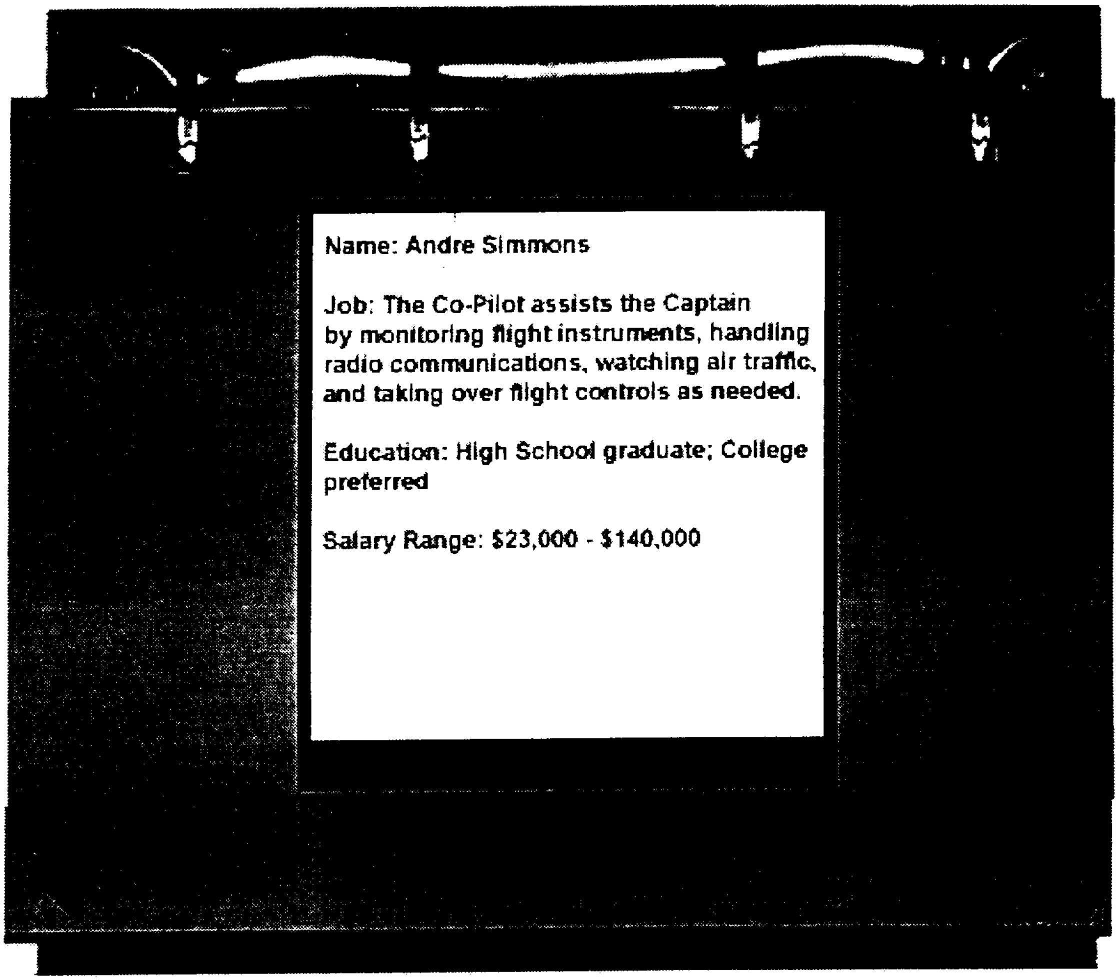
Education: High School or Vocational School degree preferred

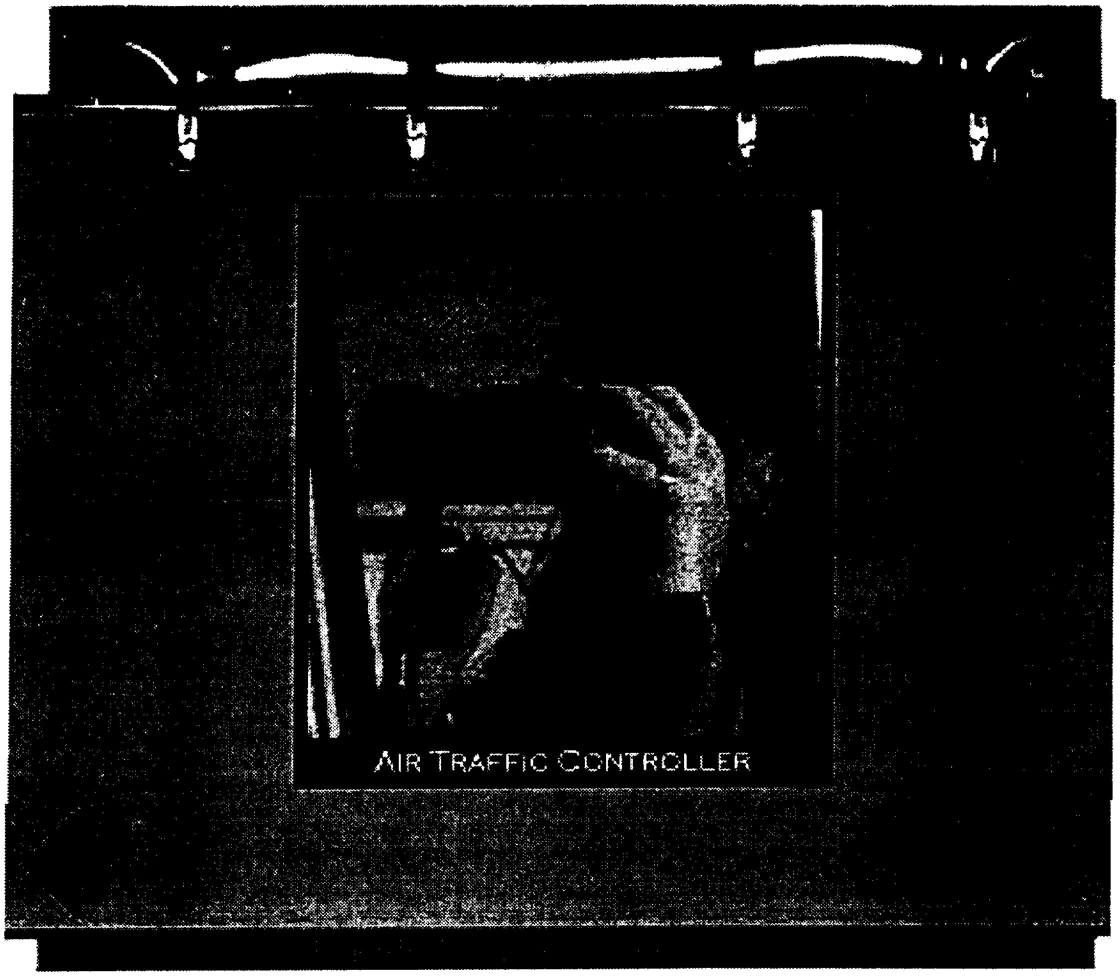
Salary Range: $35,000 - $65,000


Name: Sharon Havers
Job: The Air Traffic Controller's function is to direct air traffic so it flows smoothly, efficiently, and above all, safely.
Education: FAA Training; College degree preferred
Salary Range: $21,900 - $83,500


Name: Eddie Tyson
Job: The Communications Specialist coordinates communication and notification during routine and emergency situations.
Education: Degree in Aviation Management or equivalent professional experience
Salary Range: $34,580 - $38,324


CO-PILOT


Name: Andre Simmons
Job: The Co-Pilot assists the Captain by monitoring flight instruments, handling radio communications, watching air traffic, and taking over flight controls as needed.
Education: High School graduate; College preferred
Salary Range: $23,000 - $140,000

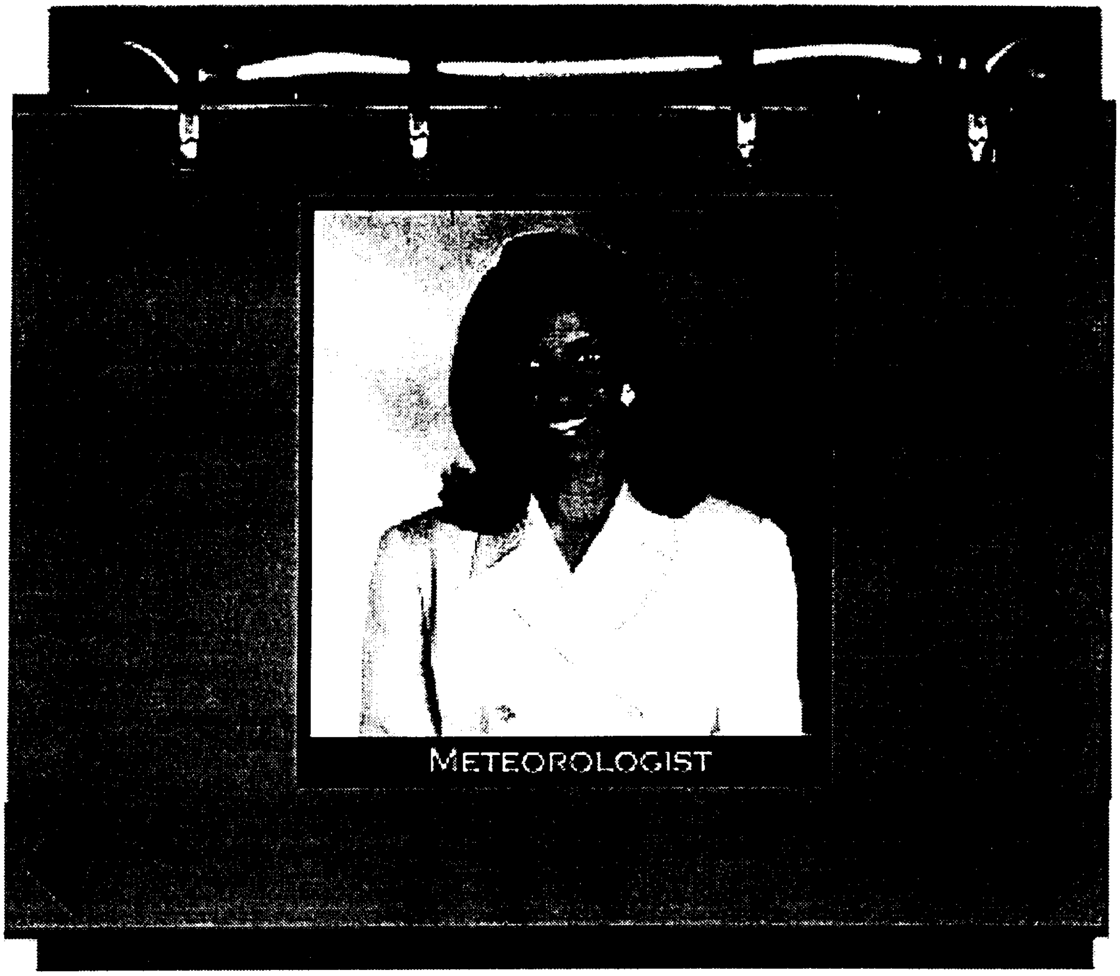

AIR TRAFFIC CONTROLLER

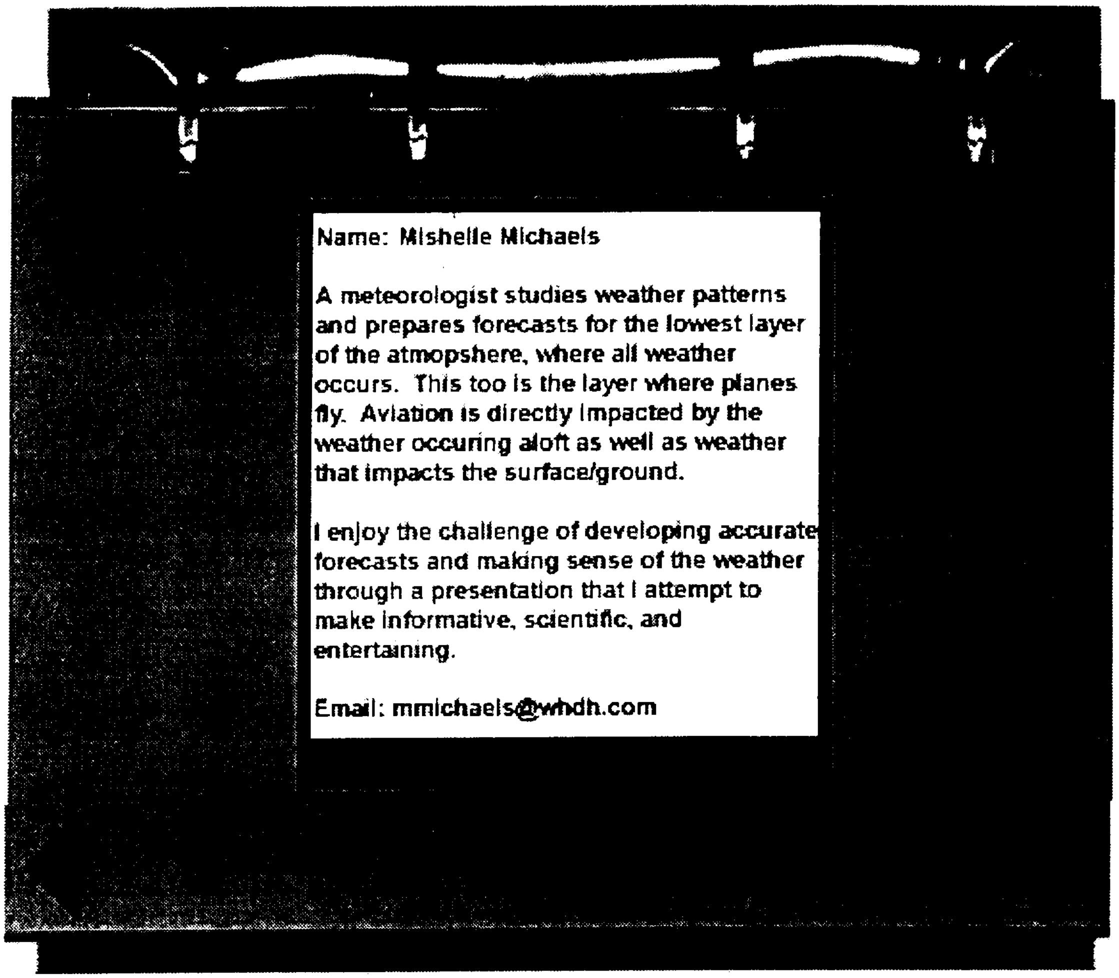
Name: Sheila Bauer

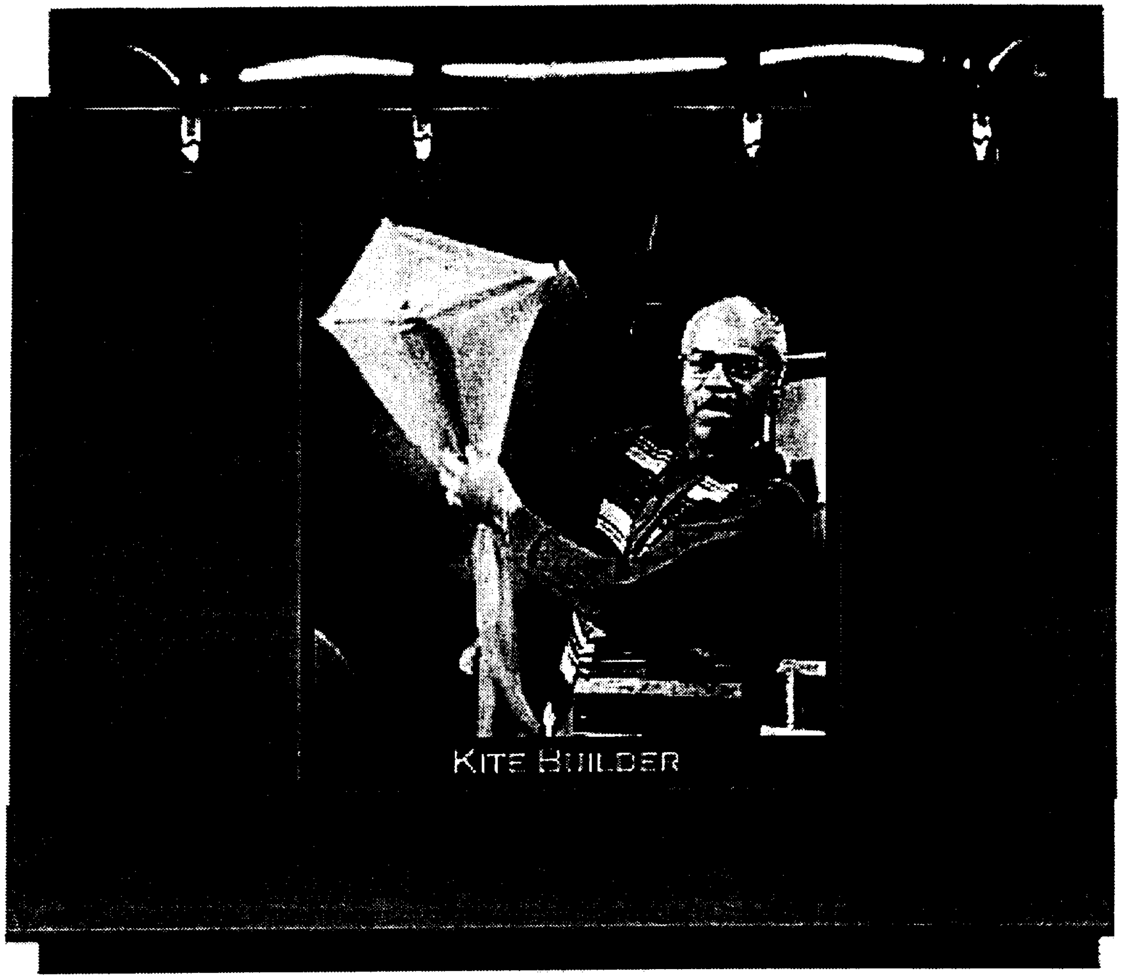
My dad owned and operated a general aviation "Fixed Base Operation" company. I began to learn a lot about the aviation business working in the maintenance shop, fuel sales and finally in the administration office. I learned much, worked hard and became president after many years.

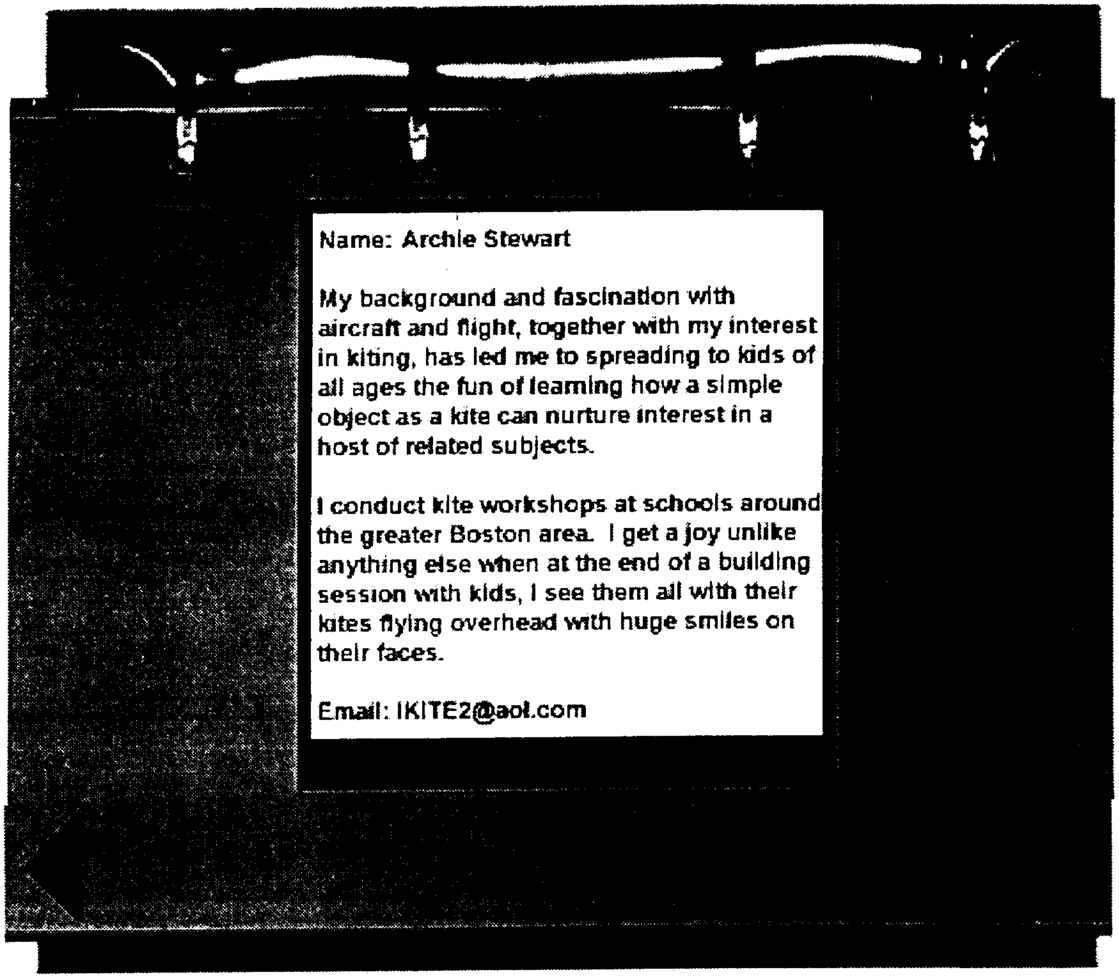
When I sold the company I went to work for the FAA. I can honestly say I love my job. It gives me an opportunity to utilize all the skills I have learned throughout my life....

Email: Sheila.Bauer@faa.dot.gov


METEOROLOGIST


Name: Mishelle Michaels
A meteorologist studies weather patterns and prepares forecasts for the lowest layer of the atmopshere, where all weather occurs. This too is the layer where planes fly. Aviation is directly impacted by the weather occuring aloft as well as weather that impacts the surface/ground.
I enjoy the challenge of developing accurate forecasts and making sense of the weather through a presentation that I attempt to make informative, scientific, and entertaining.
Email: mmichaels@whdh.com


KITE BUILDER

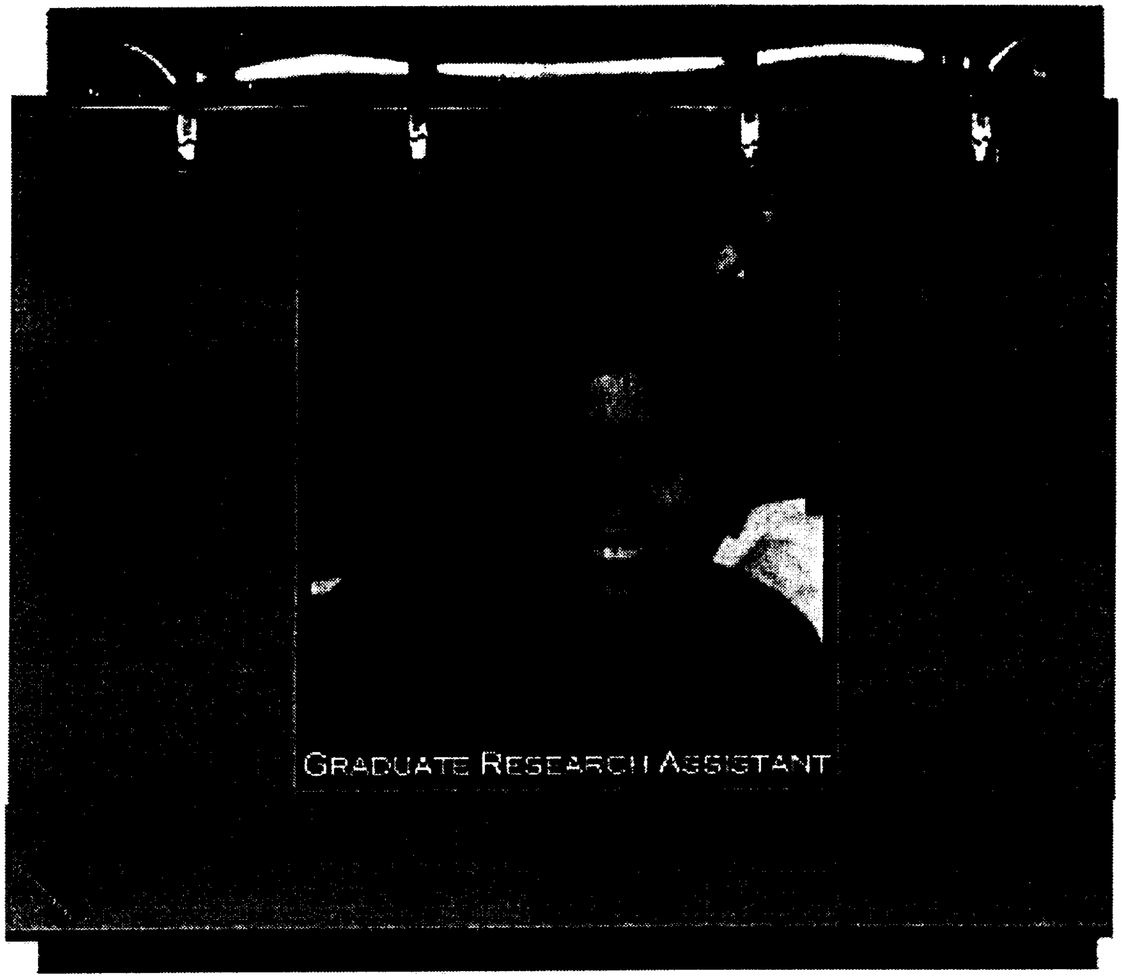


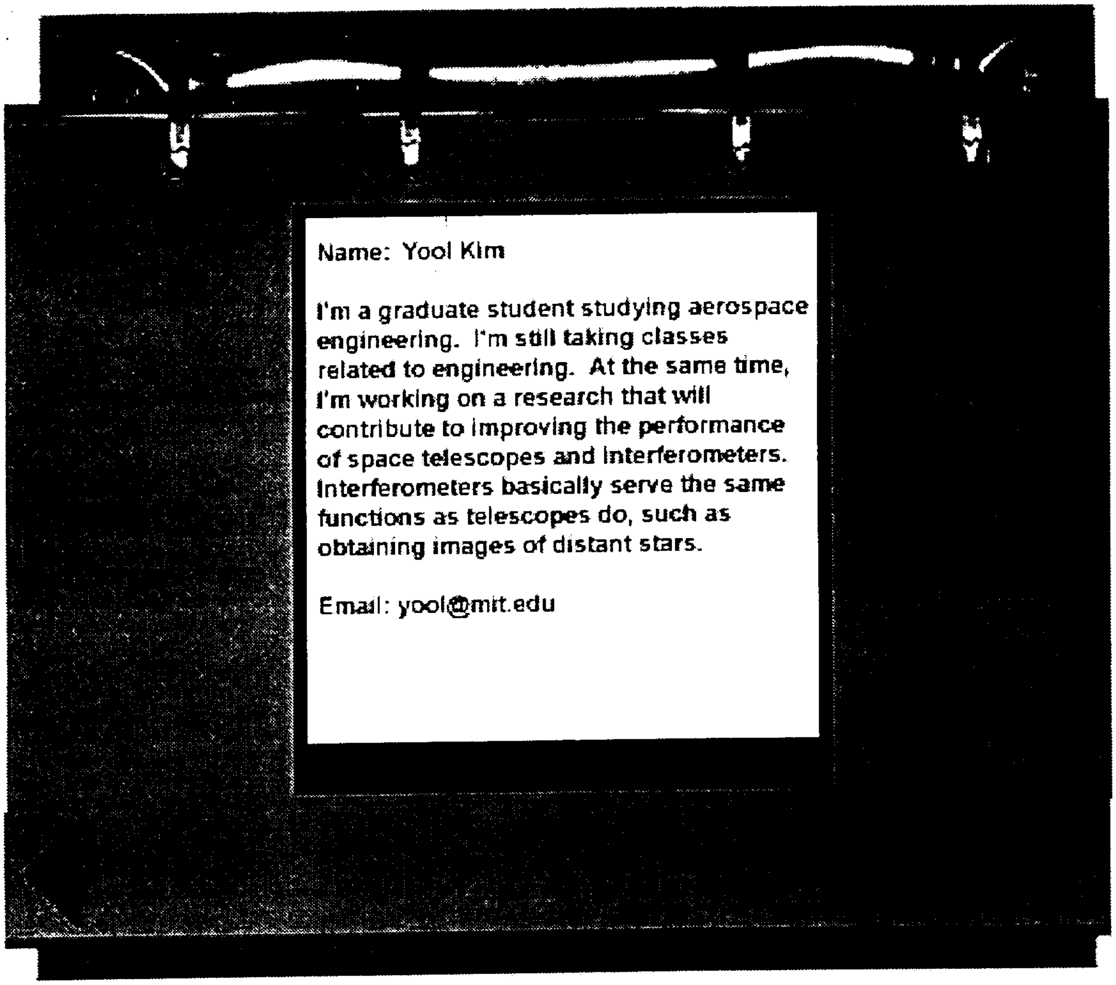
Name: Archie Stewart

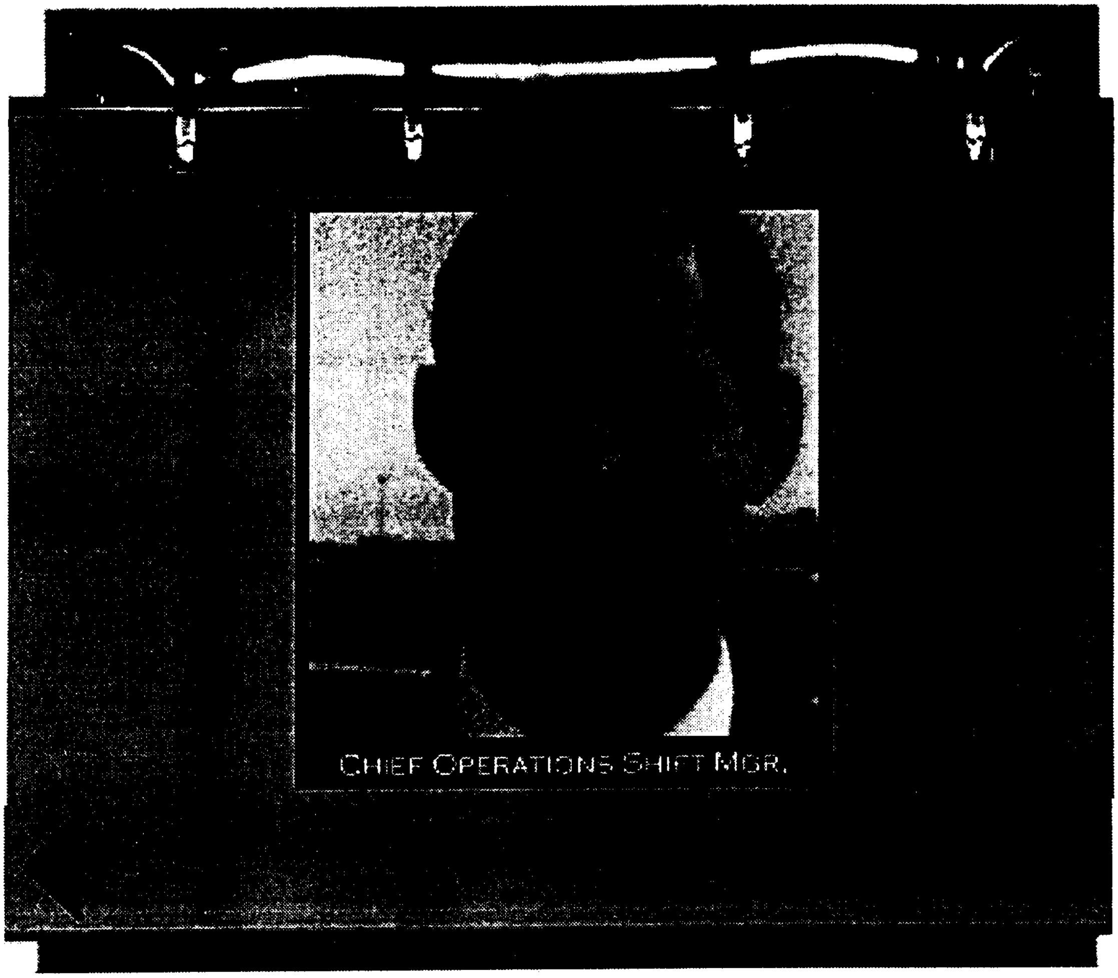
My background and fascination with aircraft and flight, together with my interest in kiting, has led me to spreading to kids of all ages the fun of learning how a simple object as a kite can nurture interest in a host of related subjects.

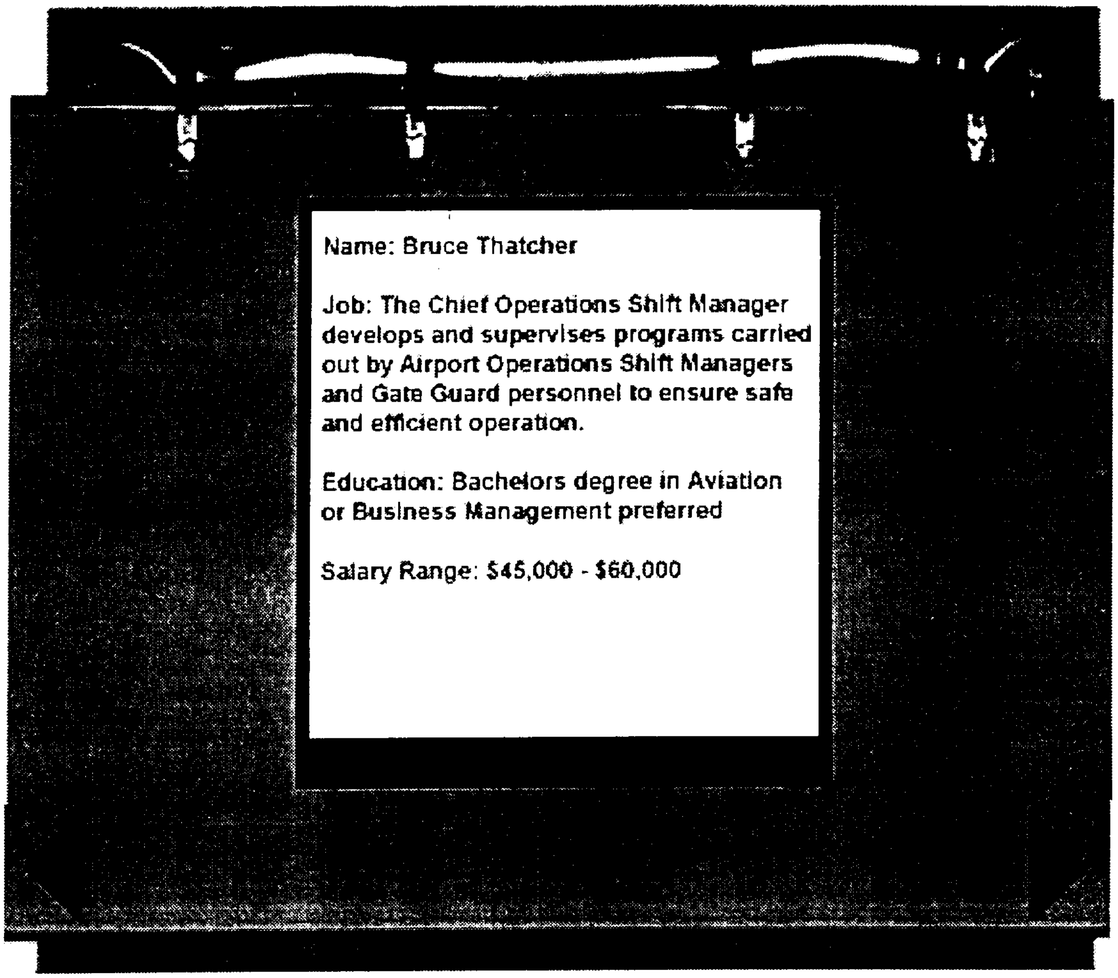
I conduct kite workshops at schools around the greater Boston area. I get a joy unlike anything else when at the end of a building session with kids, I see them all with their kites flying overhead with huge smiles on their faces.

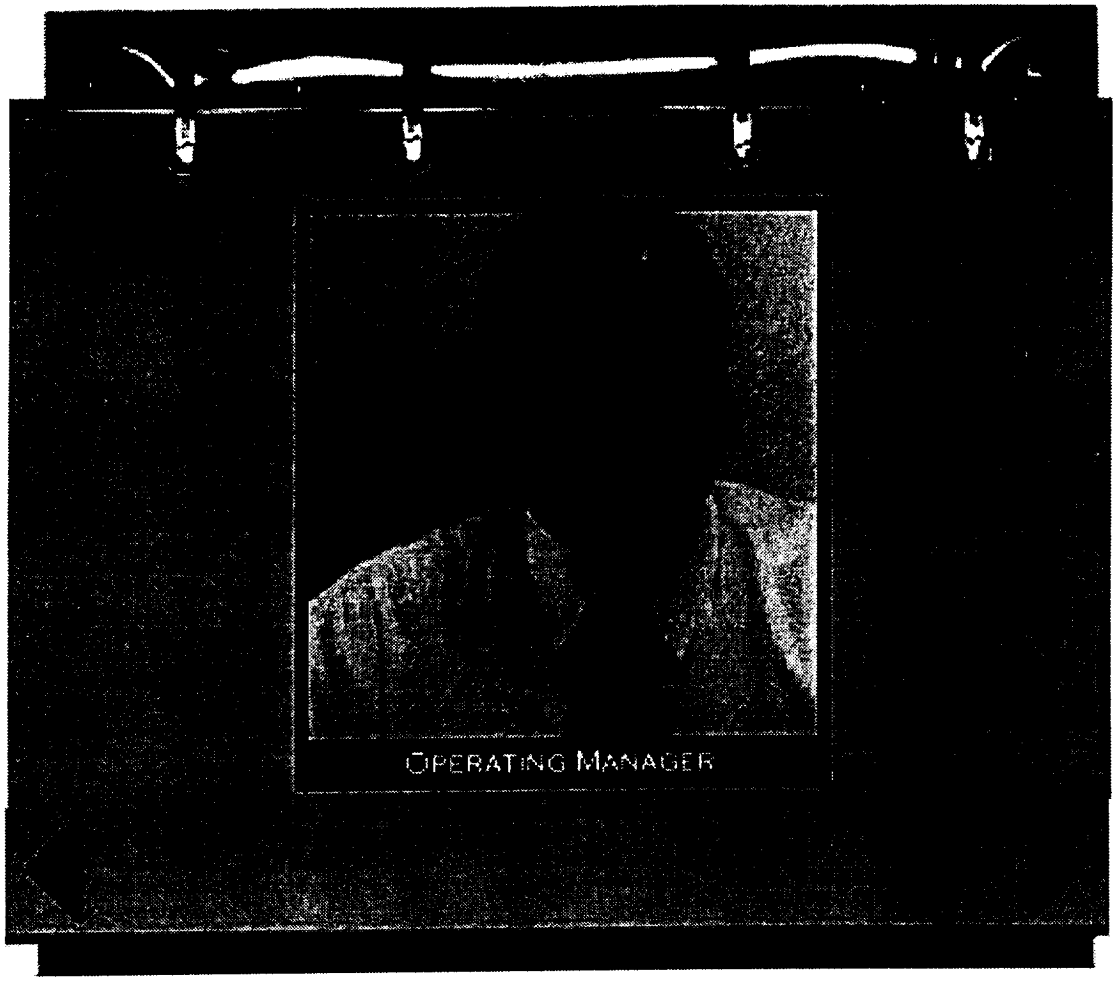
Email: IKITE2@aol.com

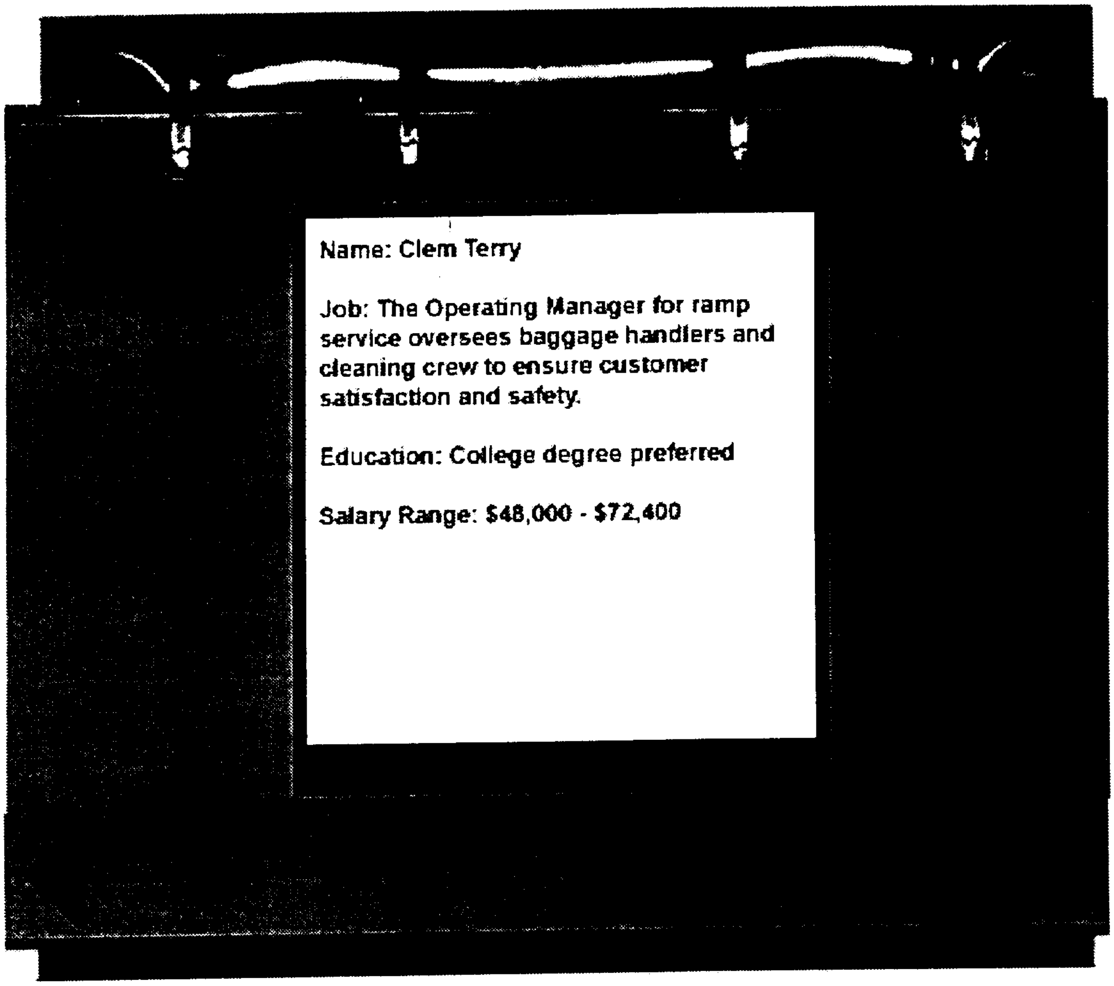

GRADUATE RESEARCH ASSISTANT

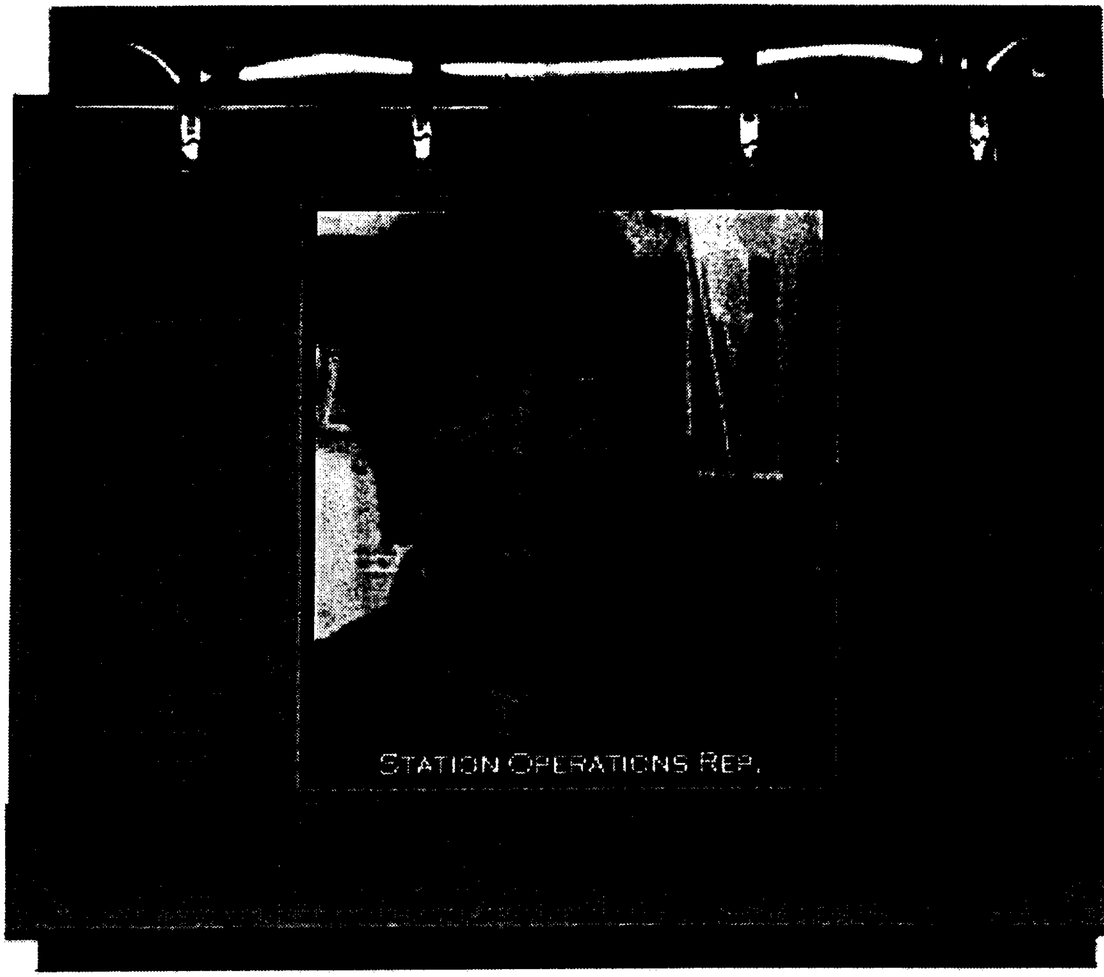

Name: Yool Kim
I'm a graduate student studying aerospace engineering. I'm still taking classes related to engineering. At the same time, I'm working on a research that will contribute to improving the performance of space telescopes and interferometers. Interferometers basically serve the same functions as telescopes do, such as obtaining images of distant stars.
Email: yool@mit.edu

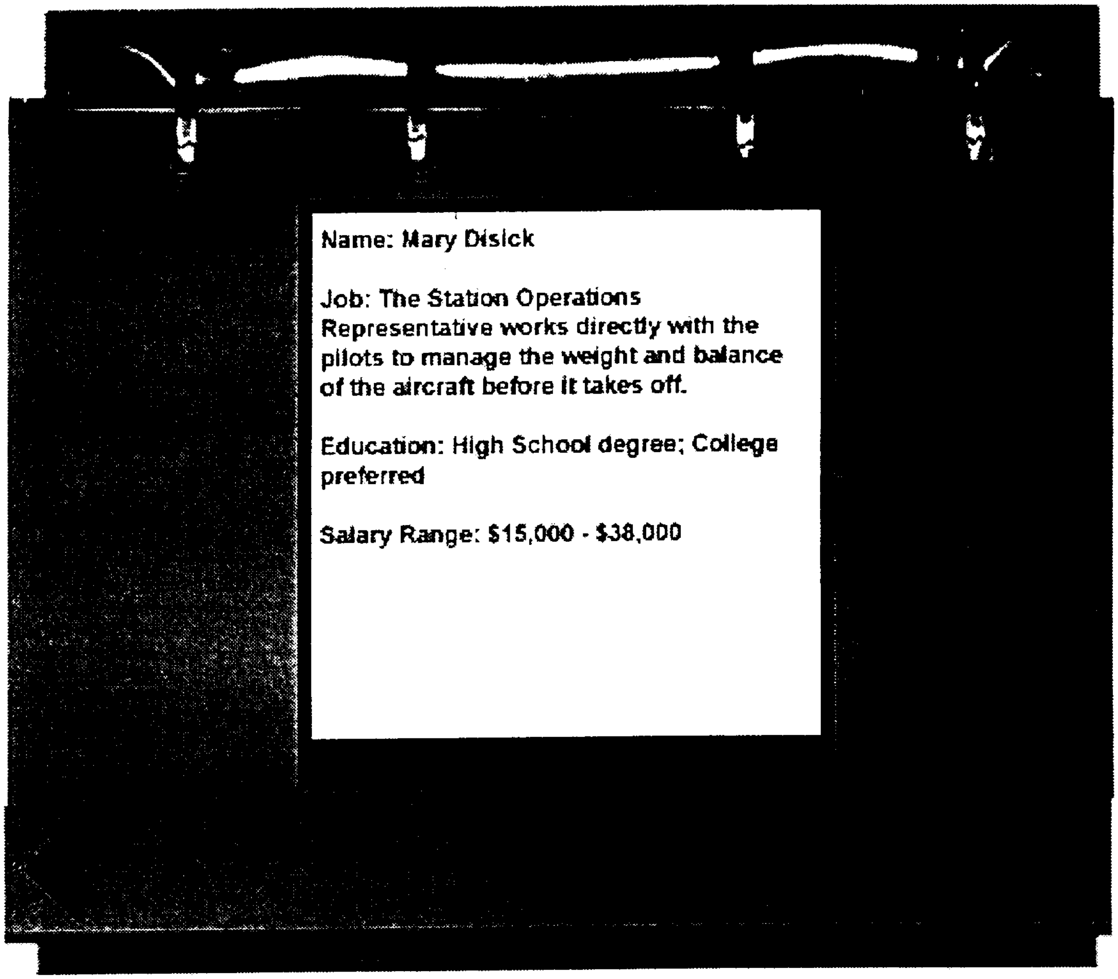

CHIEF OPERATIONS SHIFT MGR.


Name: Bruce Thatcher
Job: The Chief Operations Shift Manager develops and supervises programs carried out by Airport Operations Shift Managers and Gate Guard personnel to ensure safe and efficient operation.
Education: Bachelors degree in Aviation or Business Management preferred
Salary Range: $45,000 - $60,000


OPERATING MANAGER


Name: Clem Terry
Job: The Operating Manager for ramp service oversees baggage handlers and cleaning crew to ensure customer satisfaction and safety.
Education: College degree preferred
Salary Range: $48,000 - $72,400


STATION OPERATIONS REP.


Name: Mary Disick
Job: The Station Operations Representative works directly with the pilots to manage the weight and balance of the aircraft before it takes off.
Education: High School degree; College preferred
Salary Range: $15,000 - $38,000

Handouts

Activities

History

Glossary

Teachers' Lounge

Career Guide

Forum

Cool Links

MCET

NASA

LTP

greetings

Posted by Tony Turley on February 25, 1998 at 10:43:47:

Hello all,

I just discovered this site, and it contains a lot of very useful information. I've been interested in model airplanes and rockets for about as long as I can remember, and I've had the opportunity to use those interests a couple of times to work with elementary school children, showing them how important - and even fun - math and science are in everyday life.

I recently joined the FAA's aviation education program as a volunteer Aviation Education Counselor (in my day job, I work in Air Traffic). I'm looking forward to putting to use the resouces on this and other aviation education sites.

I would be happy to swap aviation education tales with others visiting this site.

TT

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: greetings

Comments:

: Hello all,

: I just discovered this site, and it contains a lot
and science are in everyday life.

: I recently joined the FAA's aviation education pro

: I would be happy to swap aviation education tales

: TT

Optional Link URL:

Link Title:

Optional Image URL:

[Follow Ups] [Post Followup] [Take Off! Forum] [FAQ]

Runway design

Posted by Kelly McDonald on January 12, 1998 at 09:42:38:

I am in the planning stages of building a private runway. Where do I find information regarding FAA requirements, length and wide requirements, lighting specifications, etc...

Follow Ups:

- Re: Runway design **Francesca Casella** *13:00:34 1/14/98* (0)

Post a Followup

Name:

E-Mail:

Subject: Re: Runway design

Comments:

: I am in the planning stages of building a private

Optional Link URL:

Link Title:

Optional Image URL:

Re: Runway design

Posted by Francesca Casella on January 14, 1998 at 13:00:34:

In Reply to: Runway design posted by Kelly McDonald on January 12, 1998 at 09:42:38:

: I am in the planning stages of
building a private runway.
Where do I find information regarding FAA
requirements, length and wide requirements,
lighting specifications, etc...

I suggest to contact the FAA directly. On the
FAA web site, http://www.faa.gov
follow the link to the
Directorate of Airport Planning and Programming
(AAP). The following pages provide names and
contact numbers of key personnel within the
division.

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: Runway design

Comments:

: : I am in the planning stages of
: building a private runway.
: Where do I find information regarding FAA
: requirements, length and wide requirements,
: lighting specifications, etc...

:
: I suggest to contact the FAA directly. On the
: FAA web site, http://www.faa.gov
: follow the link to the

Optional Link URL:

Link Title:

Optional Image URL:

[Follow Ups] [Post Followup] [Take Off! Forum] [FAQ]

Drag Coefficient of aCar

[Follow Ups] [Post Followup] [Take Off! Forum] [FAQ]

Posted by Karlene on November 28, 1997 at 15:51:36:

How can I find the drag coefficient of my car?? How can I find the horsepower of my car at various speeds??? Please e-mail me back.

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: Drag Coefficient of aCar

Comments:

: How can I find the drag coefficient of my car?? Ho

Optional Link URL:

Link Title:

Optional Image URL:

[Follow Ups] [Post Followup] [Take Off! Forum] [FAQ]

Space careers

[Follow Ups] [Post Followup] [Take Off! Forum] [FAQ]

Posted by Cathy Connor on November 12, 1997 at 10:46:00:

Where can I find children-focused information about both typical and unusual, behind-the-scenes careers at NASA/other organizations, from astronaut to wind tunnel test operator to the person at Mission Control who counts down a lift-off? The aviation career info was great; for space opportunities, I'm interested in titles and brief descriptions, not educational requirements, salary ranges, or specific job-holders. The more curious the better! Thanks for any help you can provide.

Follow Ups:

- Re: Space careers **Francesca Casella** *16:38:52 11/17/97* (0)

Post a Followup

Name:

E-Mail:

Subject: Re: Space careers

Comments:

: Where can I find children-focused information abou
brief descriptions, not educational requirements, sa

Optional Link URL:

Link Title:

Optional Image URL:

avaition

Posted by AirWolfe1 on October 01, 1997 at 15:02:43:

This site is soooo cool.
I need to find more sites like this.

Follow Ups:

Post a Followup

Name:
E-Mail:

Subject: Re: avaition

Comments:

: This site is soooo cool.
: I need to find more sites like this.

Optional Link URL:
Link Title:
Optional Image URL:

diagrams

Posted by Allen Lung on August 26, 1997 at 23:51:22:

I'm looking for diagrams of model airplanes. Are there any web sites
etc. that provide diagrams to get me started. Any information
you can provide me with will be helpfull.

TIA

Aaron Wynn

Follow Ups:

- Re: diagrams **francesca** *16:00:29 9/15/97* (0)

Post a Followup

Name:

E-Mail:

Subject: Re: diagrams

Comments:

: I'm looking for diagrams of model airplanes. Are
: etc. that provide diagrams to get me started. Any
: you can provide me with will be helpfull.

: TIA

: Aaron Wynn

Optional Link URL:

Link Title:

Optional Image URL:

Re: diagrams

Posted by francesca on September 15, 1997 at 16:00:29:

In Reply to: diagrams posted by Allen Lung on August 26, 1997 at 23:51:22:

: I'm looking for diagrams of model airplanes. Are there any web sites
: etc. that provide diagrams to get me started. Any information
: you can provide me with will be helpfull.

: TIA

: Aaron Wynn

Hi Aaron. Here is a list of web sites and publications that can help you with your models. I assume that you are looking for templates of paper planes downloadable from the web. I am including also some titles of books as they might be useful. You can usually find the templates at the Science stores anywhere.

Models of paper airplanes downloadable from the Internet:

http://www.dsw.com/airplane.htm -
2 models with templates

http://quest.arc.nasa.gov/pioneer10/education/paper/index.html.
This is not an airplane but a spacecraft.
It can be a challenging an fun activity anyway

http://pchelp.inc.net/paper_ac.htm
Slow connection but the site has an extensive collection of templates for airplane models

Books

http://www.just-for-kids.com/FUNCR.HTM
Books to buy from the "Just for Kids" site
The Just for Kids site has a few titles
on paper airplanes:
ISDN Title Author Grade
0806909048 Best Ever Paper Airplanes Sterling, Publis 9-12
1895569427 Best Ever Paper Airplanes Schmidt, Norman 9-12
0746022867 Big Book of Papercraft Smith, Alistair 9-12
0312067313 Big Wing Paper Gliders Johnson, Michael 9-12
The books can be ordered on-line

Another title obtainalbel from a bookstore (or a library)
Instant Paper Airplanes by E. Richard Churchill, Sterling Publish Co. Inc., New York, 1988

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: diagrams

Comments:

```
: : I'm looking for diagrams of model airplanes.  A
: : etc. that provide diagrams to get me started.  A
: : you can provide me with will be helpfull.

: : TIA

: : Aaron Wynn

: Hi Aaron. Here is a list of web sites and
: publications that can help you with your models.
```

Optional Link URL:

Link Title:

Optional Image URL:

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tutoring information

Posted by niki myers on July 01, 1997 at 12:18:10:

I am tutoring a sixth-grader in math this summer, and would like to incorporate some simple aviation experiments with my lesson plans. He needs help mostly with multiplication and fractions, does anyone know of any experiments I can do that will require some use of these skills to do the experiment? Just email me if you can, thanks!

Follow Ups:

- Re: tutoring information **Francesca Casella** *11:20:46 7/07/97* (0)

Post a Followup

Name:
E-Mail:

Subject: Re: tutoring information

Comments:

: I am tutoring a sixth-grader in math this summer,
thanks!

Optional Link URL:
Link Title:
Optional Image URL:

Re: tutoring information

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Posted by Francesca Casella on July 07, 1997 at 11:20:46:

In Reply to: tutoring information posted by niki myers on July 01, 1997 at 12:18:10:

: I am tutoring a sixth-grader in math this summer, and would like to incorporate some simple aviation experiments with my lesson plans. He needs help mostly with multiplication and fractions, does anyone know of any experiments I can do that will require some use of these skills to do the experiment? Just email me if you can, thanks!

A great site exploring math through activities
related to aviation can be found at
http://www.planemath.com/activities/
pmactivities.html

Using the ideas developed on this site, you can later expand
and add variations, for instance using the
relationship between speed, time and distance
and translating into different measurement units
(as the factors between the english and metric sys
.ems are not multiples of 10, that should give you
some interesting fractions to calculate).
The distance between the Earth and Mars, the speed of the
Pathfinder, and the dimensions of the planets
should also give you some ideas about interesting ways
to do mathematics with a sixth grader!
For on-line information (and photographs) of the
Mars Pathfinder Mission you can access
http://mars.catlin.edu/default1.html

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: tutoring information

Comments:

```
: : I am tutoring a sixth-grader in math this summe
can, thanks!

: A great site exploring math through activities
: related to aviation can be found at
: http://www.planemath.com/activities/
: pmactivities.html

: Using the ideas developed on this site, you can l
: and add variations, for instance using the
```

Optional Link URL:

Link Title:

Optional Image URL:

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Great Site!

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Posted by Sue Sorde on June 14, 1997 at 16:00:17:

Thanks so much for the great
aviation site. I especially enjoy
the career cards. I hope you'll
be expanding this section soon!

Follow Ups:

- Re: Great Site! **Francesca Casella** *10:06:15 6/27/97* (0)

Why have to hit a button for a ff that could easily be fit on the Page

Post a Followup

Name:

E-Mail:

Subject: Re: Great Site!

Comments:

```
: Thanks so much for the great
: aviation site.  I especially enjoy
: the career cards.  I hope you'll
: be expanding this section soon!
```

Optional Link URL:

Link Title:

Optional Image URL:

Re: Great Site!

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Posted by Francesca Casella on June 27, 1997 at 10:06:15:

In Reply to: Great Site! posted by Sue Sorde on June 14, 1997 at 16:00:17:

: Thanks so much for the great
: aviation site. I especially enjoy
: the career cards. I hope you'll
: be expanding this section soon!

I have good news for you, Sue. Yes we will
not only expand the career cards soon,
but renovate completely the look of the site
and add some interesting pages as well.
I hope you will visit us again in the near
future.

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: Great Site!

Comments:

```
: : Thanks so much for the great
: : aviation site.  I especially enjoy
: : the career cards.  I hope you'll
: : be expanding this section soon!

:
: I have good news for you, Sue. Yes we will
: not only expand the career cards soon,
: but renovate completely the look of the site
: and add some interesting pages as well.
```

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Link Title:

Optional Image URL:

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Cool Link & great instructional aid

Posted by Darrel Kelly on February 25, 1997 at 00:25:30:

Hi,

I saw the lessonon kites.
I thought that some may be interested in a two person kite.
It stays at ground level as it flys back and forth between the players.
It gives an oportunity to see how a kite works up close.
It is bright and colorful and will excite the kids.

You can see it at www.windblade.com

Sincerely,
Darrel Kelly

Follow Ups:

Post a Followup

Name:
E-Mail:

Subject: Re: Cool Link & great instructional aid

Comments:

: Hi,

: I saw the lessonon kites.
: I thought that some may be interested in a two pe
: It stays at ground level as it flys back and fort
: It gives an oportunity to see how a kite works up
: It is bright and colorful and will excite the kid

: You can see it at www.windblade.com

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Link Title:

Optional Image URL:

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Geometry

Posted by Nicole Leiter on December 05, 1996 at 19:26:24:

I am a freshman attending Curtis Middle School in Allen, TX, USA. I am doing a rpoet in Geometry about the uses of Geometry in careers. I need some information fast. Can you give me any ideas, sites, or some information directly??? If so please e-mail me. I need it tonight. Some topics I have already thought of are stained glass, cartography, architecture, textile assembly, astronomy, nanotechnology, metrology, fixuring, video game programming, computer programming, computer graphing, and virtual reality. I appreciate any input. Thanks!

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: Geometry

Comments:

: I am a freshman attending Curtis Middle School in
: Allen, TX, USA. I am doing a rpoet in Geometry ab
: the uses of Geometry in careers. I need some
: information fast. Can you give me any ideas, site
: or some information directly??? If so please e-ma
: me. I need it tonight. Some topics I have alread
: thought of are stained glass, cartography,
: architecture, textile assembly, astronomy,
: nanotechnology, metrology, fixuring, video game
: programming, computer programming, computer graph

Optional Link URL:

Link Title:

Optional Image URL:

Re: integrated units on flight

Posted by Ben Erwin on August 07, 1996 at 03:10:50:

In Reply to: integrated units on flight posted by kathleen cushman on June 28, 1996 at 16:53:17:

: We1re looking for good integrated math-sci-tech units on flight for grades 7-11. Suggestions?

If you build (or buy) a simple wind tunnel, a lot of neat experiments can be done. In the LDAPS project at Tufts we have built rather crude and inexpensive wind tunnels with a fan, paper, and wood.

for example, one exercise that we did with elementary school teachers at a conference last month was to tie pieces of string to the trailing edge of foam airplane wings. when they held them in front of the tunnel they could see that the strings had a preference to "wind-up" in a certain direction. This example was particularly interesting because it spurred a whole discussion of why birds fly in V-formation. Aerodynamics is not just for airplanes!

Another activity I liked a lot (and which is cheaper to do) is flow visualization of a different type: in water. With silky shampoo, water, and a drop of food coloring, moving various shapes through water and seeing the resulting patterns of flow emerge is beautiful. I like showing people that a symmetric wing moving through the water with no angle of attack doesn't produce anything major (although it is still pretty), but when you move it through the water with a slight angle of attack -- boom! you see a huge start-up vortex behind the wing -- and when you pull the wing out of the water you see a vortex of the opposite direction that was attached to the wing. This is amazing because one cannot pull the wing of an airplane out of the sky and see the circulation around it -- and so it is very hard to conceive of how the air is moving faster around the top of the wing than the bottom. With this example the answer is clear: circulation.

Ben Erwin

- Ben's home page

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: integrated units on flight

Comments:

```
: : Welre looking for good integrated math-sci-tech

: If you build (or buy) a simple wind tunnel, a lot
: of neat experiments can be done.  In the LDAPS
: project at Tufts we have built rather crude and
: inexpensive wind tunnels with a fan, paper, and wo

: for example, one exercise that we did with element
: school teachers at a conference last month was to
: pieces of string to the trailing edge of foam airp
```

Optional Link URL:

Link Title:

Optional Image URL:

Re: Space careers

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Posted by Francesca Casella on November 17, 1997 at 16:38:52:

In Reply to: Space careers posted by Cathy Connor on November 12, 1997 at 10:46:00:

: Where can I find children-focused
information about both typical and unusual,
behind-the-scenes careers at NASA/other
organizations, from astronaut to wind tunnel
test operator to the person at Mission Control
who counts down a lift-off? The aviation career
info was great; for space opportunities,
I'm interested in titles and brief descriptions,
not educational requirements, salary ranges,
or specific job-holders. The more curious the
better! Thanks for any help you can provide.

Hello Cathy.
Information about different careers at NASA,
with a focus on the personal aspects,
is available through Women of NASA program
(http://quest.arc.nasa.gov/women/intro.html)
The site provides profiles, background information,
but also depicts a typical day in the lives of
the participants; a chat line for communication
is also available so people can ask questions
directly.
The SHUTTLE TEAM ONLINE program also provides
profiles of many scientists involved in the
Shuttle missions; there are chats scheduled to interact with
some of them, and an email address is provided to
ask questions off-line
http://quest.arc.nasa.gov/shuttle/team/index.html

We will be upgrading the web site in the next couple of
weeks. One of the major innovations is the new
"Career Cards": some of the people profiled can be accessed
directly through e-mail, and they will be glad to
answer your questions

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: Space careers

Comments:

```
: : Where can I find children-focused
: information about both typical and unusual,
: behind-the-scenes careers at NASA/other
: organizations, from astronaut to wind tunnel
: test operator to the person at Mission Control
: who counts down a lift-off? The aviation career
: info was great; for space opportunities,
: I'm interested in titles and brief descriptions,
: not educational requirements, salary ranges,
: or specific job-holders. The more curious the
```

Optional Link URL:

Link Title:

Optional Image URL:

project 26

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Posted by Marco Testi on April 16, 1997 at 15:00:59:

Hi!

Thanks to exist!!

I'm 26 years old and live in Italy. I have a U.S. PPL (62.5 hrs tt) I got in Texas in 1991. Now I fly hang-gliders whenever I can, but I'd like to:

1- Go into competition aerobatics with powered A/C (plenty of money needed, which I don't have, but plenty of enthusiasm to sell)
2- Enter ANY kind of activity connected with A/C projecting, building, flight-testing, etc... I have some aeronautical engineering studies at University, and I worked 2 years as a technician in robot prototyping... I know how to do a deal of things, and I learn quickly. I have plenty of ideas.
I'm not interested in a job by now, only in a WAY to live with airplanes (if I find a roof and a meal, that's OK!!!).

To fulfill points 1 & 2 I can go wherever around the world, and let's say I can leave.... mmmmh, within the next 72hrs.

Do you have any ideas? Any general ideas on how to put down a career plan in aeronautics, but not the usual one: I'm interested in doing things like the above.

(If you like more details about me, I can send whatever you like: I was short just not to bore you)

Marco Testi
Pisa, Italy

EAA #527163
IAC #23808

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: project 26

Comments:

```
: Hi!

: Thanks to exist!!

: I'm 26 years old and live in Italy. I have a U.S.
: got in Texas in 1991. Now I fly hang-gliders whene
: like to:

: 1- Go into competition aerobatics with powered A/C
: needed, which I don't have, but plenty of enthusia
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Optional Link URL:

Link Title:

Optional Image URL:

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Aviation Links

Posted by Cheryl Taniguchi on January 27, 1997 at 14:18:24:

Hi all,

There is a nice link for Chinese kites at the following
address:

http://www.bbsi.net/kite/chinese/index.htm

Enjoy!

Cheryl

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: Aviation Links

Comments:

```
: Hi all,

: There is a nice link for Chinese kites at the foll
: address:

: http://www.bbsi.net/kite/chinese/index.htm

: Enjoy!

: Cheryl
```

Optional Link URL:

Link Title:

Optional Image URL:

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

ALLSTAR NASA Project

Posted by Yair Levy on August 13, 1996 at 14:26:39:

ALLSTAR NASA Project

Posted by Yair Levy on August 13, 1996 at 14:26:39:

integrated units on flight

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Posted by kathleen cushman on June 28, 1996 at 16:53:17:

We1re looking for good integrated math-sci-tech units on flight for grades 7-11. Suggestions?

Follow Ups:

- Re: integrated units on flight **Seeds Software** *16:46:09 5/13/97* (0)
- Re: integrated units on flight **Ben Erwin** *03:10:50 8/07/96* (0)

Post a Followup

Name:

E-Mail:

Subject: Re: integrated units on flight

Comments:

: We1re looking for good integrated math-sci-tech u

Optional Link URL:

Link Title:

Optional Image URL:

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Re: integrated units on flight

[Follow Ups] [Post Followup] [WWWBoard Version 2.0 Test] [FAQ]

Posted by Seeds Software on May 13, 1997 at 16:46:09:

In Reply to: integrated units on flight posted by kathleen cushman on June 28, 1996 at 16:53:17:

: We1re looking for good integrated math-sci-tech units on flight for grades 7-11. Suggestions?

We have developed Software that is an intgrated unit of math-sci-tech. There is a lot of interactive learning with simulations and illustrations on the computer. And there are a lot of "hands on actvy/labs" to do along with the software. The students can use math and science wto do computer aided design and build gliders.

- Introduction to Airplane Design

Follow Ups:

Post a Followup

Name:

E-Mail:

Subject: Re: integrated units on flight

Comments:

: : We1re looking for good integrated math-sci-tech

: We have developed Software that is an intgrated u

Optional Link URL:

Link Title:

Optional Image URL:

Appendix 2

External web sites with links within MCET's *Take Off!* web site

William "Billy" Mitchell

The ALLSTAR Network's **Heroes, People, and Organizations** section has two entries for this ndividual:

William "Billy" Mitchell (from Civil Air Patrol)

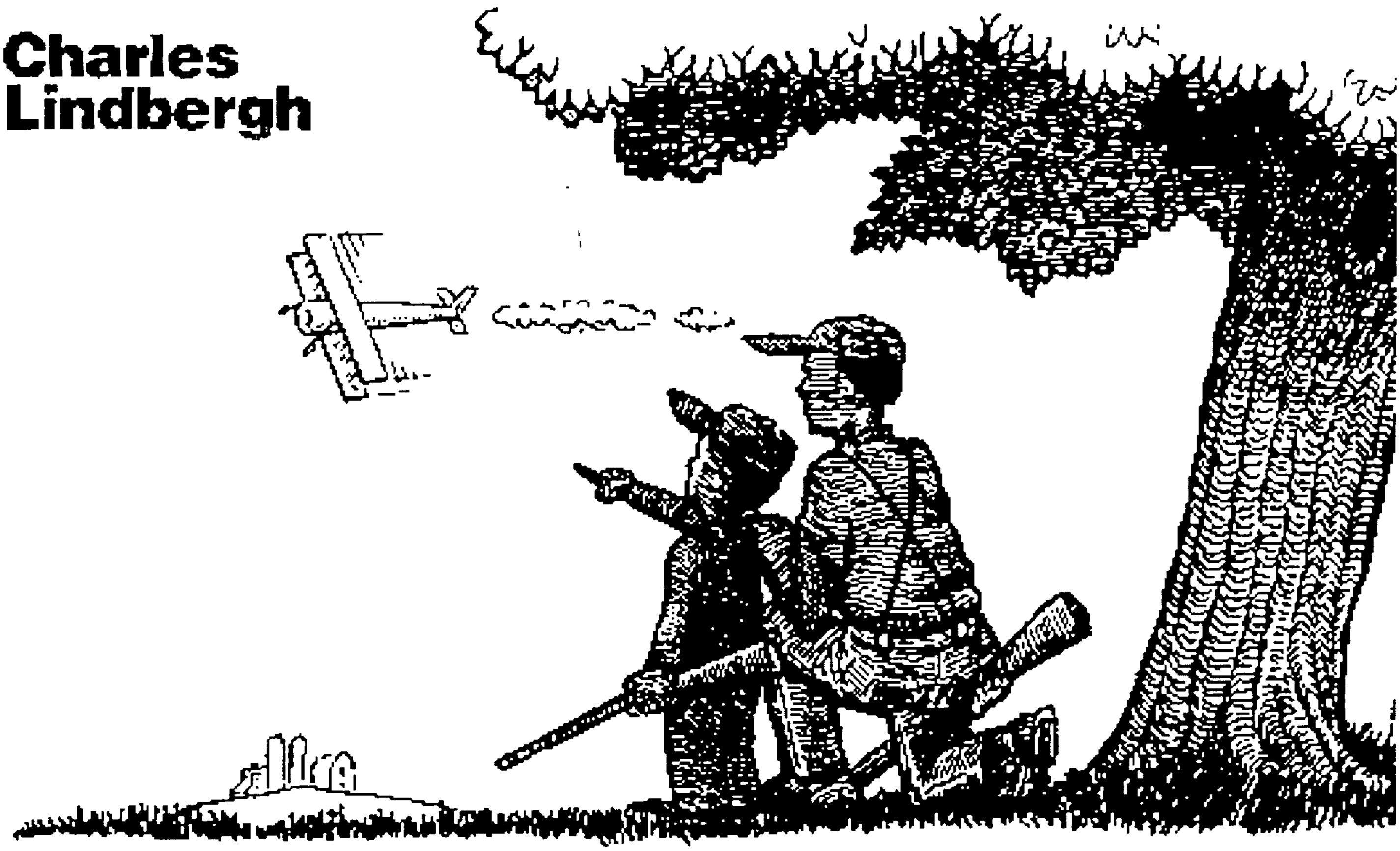
William Mitchell (from the San Diego Aerospace Museum's International Aerospace Hall of Fame)

Send all comments to aeromaster@eng.fiu.edu

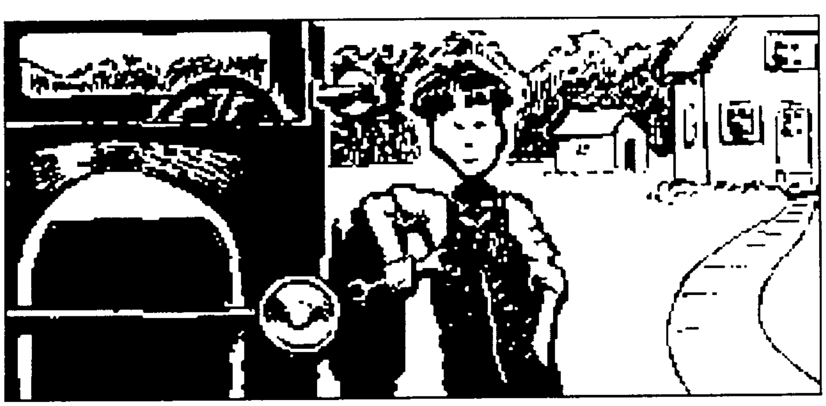
Funded in part by

Updated: 07 January, 1998

Charles Lindbergh

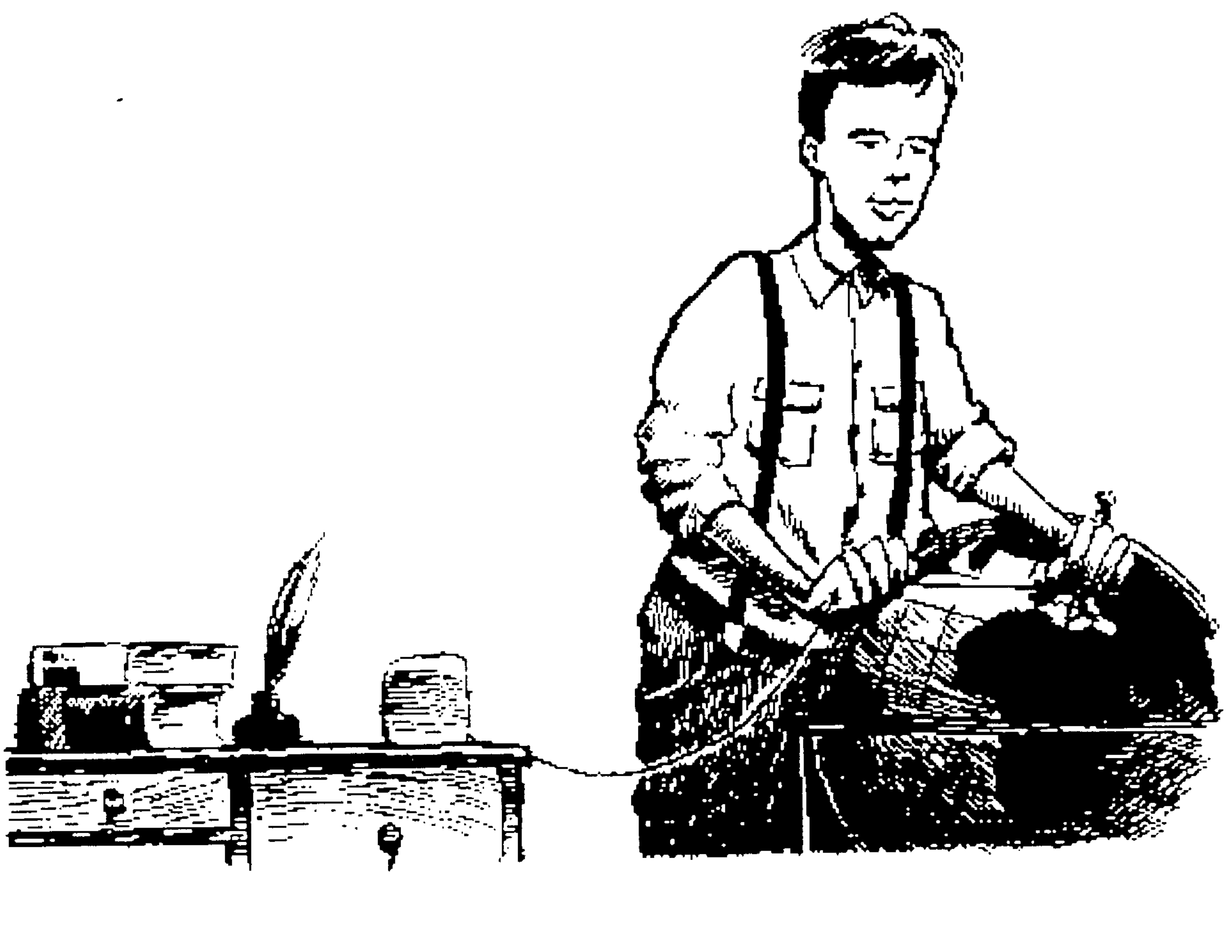


Charles Lindbergh was born in Detroit, Michigan on February 4, 1902. When he was very young, his family moved to a farm in central Minnesota near a town called Little Falls. His father was a United States congressman and his mother taught chemistry at the high school. Charles liked living the outdoor life in Minnesota. He helped with the farming and enjoyed swimming in the Mississippi river. Whenever his father was home from Washington D.C., he and Charles would go hunting. Young Charles was fascinated by the sight of airplanes. They were a new invention then and a thrill to see.

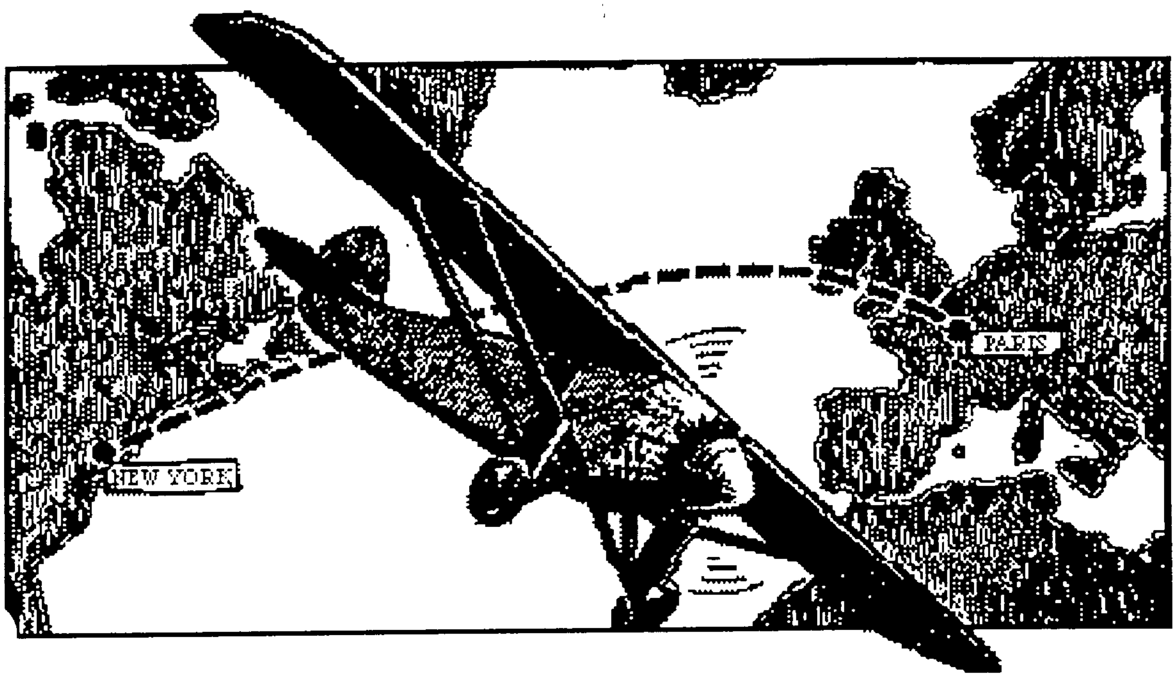


As a child, Charles was especially interested in mechanics. By age nine, he knew all about gasoline engines. At age eleven, his parents put him in charge of driving and fixing their car. Charles was already an excellent mechanic. In high school he helped with the farm and even built a tractor from a mail order kit. When Charles vas in college, he heard about a school in Nebraska that taught people how to fly and repair airplanes. With .is parents permission, he packed up his motorcycle and went to learn how to fly. Flying had everything he liked: being outdoors, adventure, and mechanics. After school in Nebraska he enrolled in the U.S. Army flight school to become a professional pilot.

He learned that becoming a professional pilot meant more than flying an airplane well. It also meant studying and getting good grades. At first his grades weren't so good. Afraid that he might fail, he began studying during every spare moment. He even studied in th bathroom at night when he was supposed to be in bed. His hard work paid off. He graduated with the highest grades in his class. Charles was now a professional pilot.



His first job as a professional pilot was flying a route between St.Louis and Chicago delivering mail to the owns along the way. This was not an easy job. He flew through terrible weather and landed at towns that didn't have an airport or a runway. While he was working at this job, he heard about a contest to see who could be the first pilot to fly across the Atlantic ocean between New York and Paris. This was a big challenge to pilots and airplane makers. There had been meany attempts so far, but no successes. In fact, six pilots had already died trying. Charles began thinking, how far was it from New York to Paris?



Charles decided to enter the contest. First he had to find a company that would build a plane for him. He believed the best plane for a trip like this would be a one person, single engine airplane. The airplane companies disagreed with him. It was too dangerous. How could anyone fly that far with only one engine? Charles kept searching. Finally, he found a company named Ryan that would build a plane for him. When the plane was ready, Charles was ready too. He packed a canteen of water, sandwiches, maps, and charts.

Not Found

The requested object does not exist on this server. The link you followed is either outdated, inaccurate, or the server has been instructed not to let you have it.

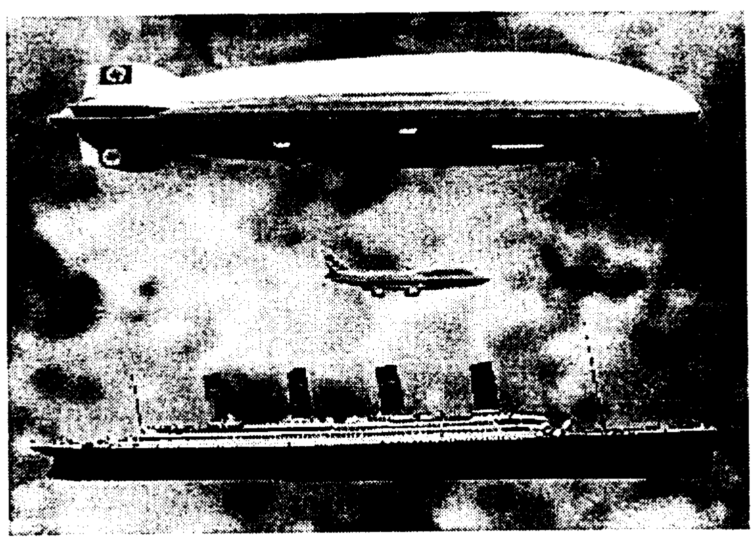
You may search our server to try to find what you are looking for.

Boeing Home

LZ-129, Hindenburg

The Hindenburg was a huge gamble in a long line of gambles for the Zeppelin Company. She still holds the record as the largest aircraft ever to fly but, as majestic and awe-inspiring as she was, the Hindenburg was meant to be only the first of a fleet. History dictated that she was to be the first of only two.

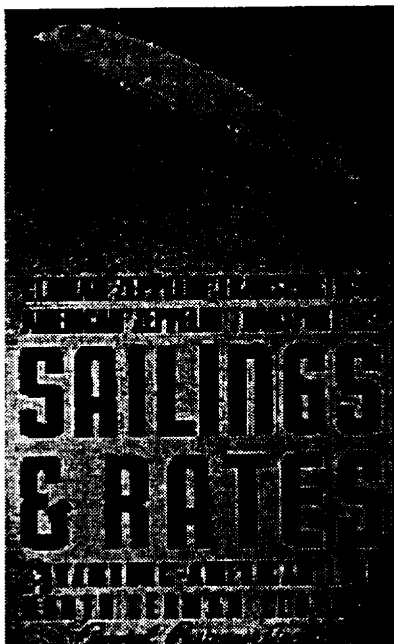
The Hindenburg was a marvel of zeppelin design. Her sheer size was truly an engineering masterpiece. For years builders of dirigibles, including the Zeppelin Company, had simply stretched the hulls of their airships to accommodate more lifting gas. The British built R101 was actually cut in half and had a whole extra section added to accommodate an additional gas bag to increase its poor lift and the famous Graf Zeppelin was in fact, little more than a stretched version of the LZ126, the Los Angeles. The Zeppelin Company decided that with this new zeppelin, they would increase gas volume by not only making her the longest they could, but also by radically increasing her girth. Where the Graf Zeppelin was an impressive 100 feet in diameter, the Hindenburg would measured in at 135 feet and 1 inch. Even though an increase of a little over 35 feet doesn't sound like so much, remember that these monstrous ships needed hangers to protect them from the elements and when the Hindenburg was being built in her new construction shed, she was wedged in as tight as possible! With her massive diameter and her impressive length, the Hindenburg would carry a gas volume of 7,062,000 cubic feet. This volume, when filled with hydrogen, would produce an astounding 242.2 tons of gross lift. The useful lift (the lift left after you subtract the weight of the structure from the gross lift) was still 112.1 tons. An astounding weight even by today's standards but mind-blowing in the 1930's. At this point in world aviation, airplanes could fly only short distances with constant refueling and as little weight as possible.

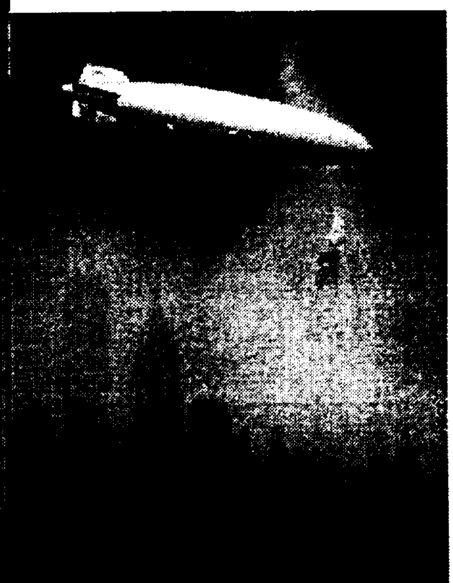


A size comparison of the Hindenburg with a 747 and the Titanic. The Titanic is only 78 feet longer than the Hindenburg at 882 feet long.

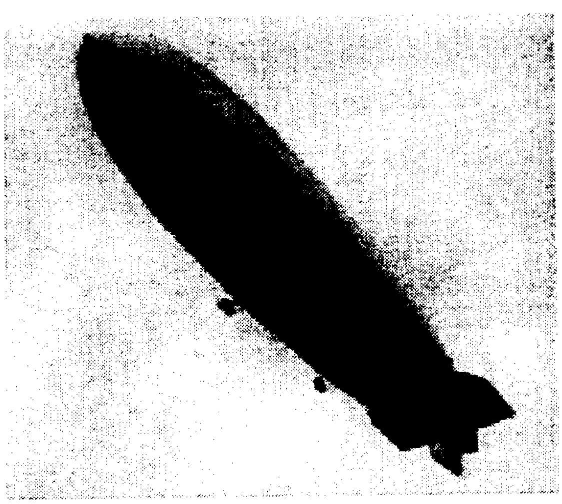
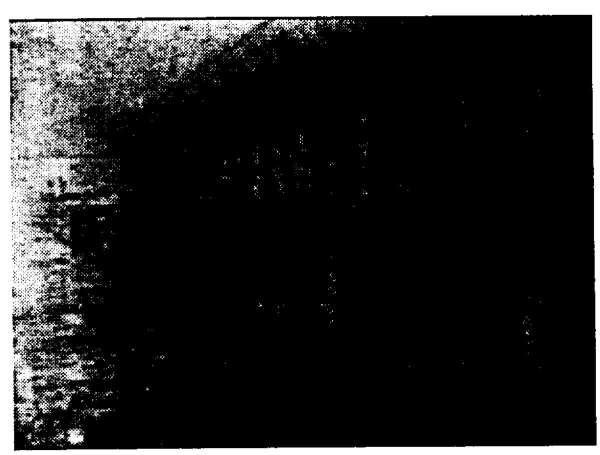
Although the Hindenburg is most famous for her fiery death, she was not initially meant to be filled with hydrogen at all. Dr. Hugo Eckner, then still the chairman of Zeppelin, had decided that it would be the wisest course to inflate his new ship with the nonflammable gas helium. The flaw in this plan started to unravel the idea at once. In order to keep the Zeppelin Company afloat during the hard times of the depression, large sums of money had been accepted by the now powerful National Socialist Party, better known as the Nazis. The majestic airships Hindenburg and Graf Zeppelin were emblazoned with the swastika on their vertical fins and had already been flown on many propaganda flights over Germany dropping pamphlets and generally showing of the power of the Nazi movement. The United States, having the only natural deposits of helium in the

world, was getting more and more suspicious of Hitler and his new Third Reich. Government officials wondered if the Zeppelin could be used for military purposes such as they were in World War One and favor in giving Dr. Eckner the helium was waning. This was supremely frustrating to Dr. Eckner who was openly critical of the Nazi government. He had been forced to seek help form a government that he did not like at all (his own) and because of this, a government who he got along with well was denying him what he needed for his new zeppelin. Even after a meeting with President Roosevelt, the decision was made in the U.S. Congress. The Helium Control Act would make it impossible for the Zeppelin Company to obtain helium for their new ship. With this turn of events, the Hindenburg was inflated with the volatile gas, hydrogen.
+Page Unfinished- More Information To Come+ -matt





A couple of travel posters for the Deutsche Zeppelin-Reederei. The second reads "In 2 Days to North America!, Deutsche Zeppelin Reederei.

Left: The LZ-129 passes slowly over head.

Right: A good view of the internal keel of the Hindenburg before the gas cells were installed. The keel would be the main walk way for the crew to move fore and aft in the great ship.

LZ-129 Hindenburg Statistics

Length	804 feet / 245.06 meters
Diameter	135 feet / 41.15 meters
Gas Volume	7,063,000 cu. feet / 211,890 cu. meters
Engines	Four 1200 hp Mercedes Benz engines
Maximum Speed	84.4 mph / 135 km/h
Lifting Gas Type	Hydrogen

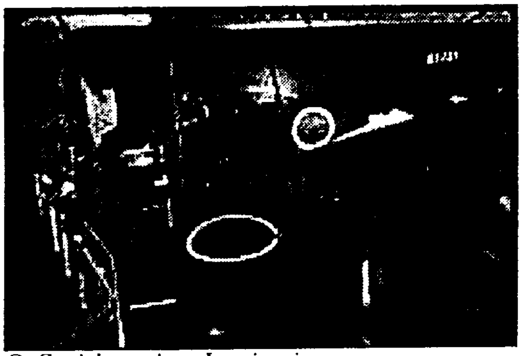
Back to The Great Zeppelins Page or Back to The Zeppelin Library home page

- Supermarine Spitfire
- Mitsubishi A6M5 Zero Model 52
- North American P-51 "Mustang"
- Messerschmitt Bf 109
- Macchi C.202
- Martin B-26B Marauder "Flak Bait"

Roaring directly at the viewer is Thunder Bird , a U.S. Boeing B-17 G Flying Fortress on its way to Wiesbaden, Germany, on August 15, 1944. This tense moment, frozen in time on a gaint mural by noted artist Keith Ferris, sets the theme for the gallery: memorializing the men and air machines of World War II.

Spitfire Mark VII (94k GIF or 56k JPEG)

The combination of speed and firepower made the **Supermarine Spitfire** a deadly machine. The Spitfire's elliptical wing, which reduced drag and increased speed, is its most distinguished characteristic. When the war ended, the Spitfire was the only airplane that had been in continuous production throughout the war--20,351 had rolled off the assembly line. This specimen is a Spitfire Mark VII, a high-altitude version, of which only 140 were produced.



Mitsubishi A6M5 Zero Model 52 (111k GIF or 73k JPEG)

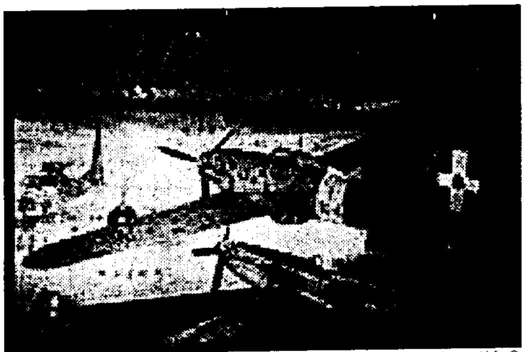
Also on exhibit is the **Mitsubishi A6M5 Zero Model 52**. Well designed, light and maneuverable, the Japanese Zero was a formidable opponent in the hands of a skilled pilot. Against later, more-powerful American fighters, however, the Zero lost ground and became an easy target by the end of the war.

North American P-51 Mustang (158 k GIF)

For those who flew it, the **North American P-51 Mustang** was a fighter pilot's airplane and one of the best fighters of World War II. Unlike other well known and widely used fighters of that time, the P-51 was first conceived during the war and built on the basis of combat experience. The markings on the Museum's P-51D (the yellow and black checkerboard design on the nose, and the letters "Willit Run?") are patterned after a P-51 flown in Britian by the 351st Fighter Squadron, 353rd Fighter Group, 8th Air Force.

Messerschmitt Bf 109 (132 k GIF)

of designs. Ours is the Bf 109G Gustav used later in World War II. This aircraft gained its fame as the major opponent of the Spitfire. It continued its intense rivalry with all Allied aircraft until the close of World War II.



Macchi C.202 (152k GIF or 94k JPEG)

© *Smithsonian Institution, SI photo #80-2089*

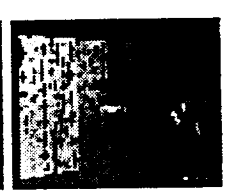
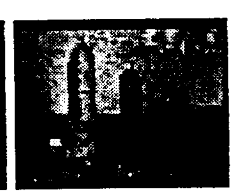
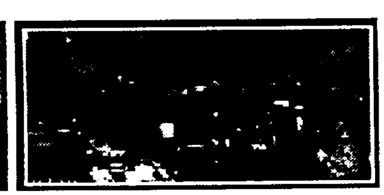
The **Macchi C.202** was one of Italy's most advanced World War II fighters. Outside Italy, however, it failed to achieve as much fame as contemporary fighters of other nations. Known as the Folgore, meaning "lightning," the pilots who flew it lauded its fingerlight handling and its superb agility. The Macchi C.202 is one of two remaining aircraft of this type anywhere in the world. Its early history is obscure, but it was one of many enemy World War II aircraft the Army brought to the United States for evaluation and testing after the war.

Martin B-26B Marauder "Flak Bait" (153k GIF or 74k JPEG)

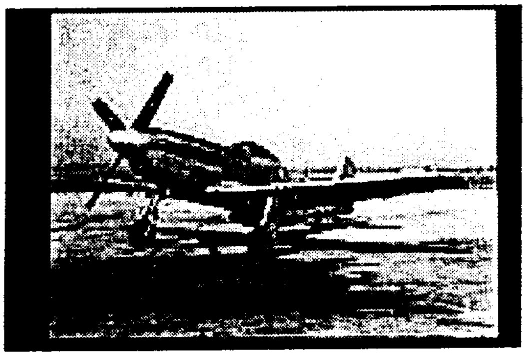
© *Smithsonian Institution*

The **Martin B-26B Marauder "Flak Bait"** (nose only here) flew more missions over Europe than any other American airplane of World War II. With 202 operational sorties to its credit, this medium bomber had the longest and most colorful combat history of any aircraft in the Museum. Despite their initial high rate of accidents in training, the Marauders soon vindicated themselves with the greatest bombing accuracy and lowest loss rate of any American aircraft. "Flak Bait" was given its name after "Flea Bait," a nickname for the dog belonging to the aircraft's pilot. The original paint is still bright, but more than a thousand patched flak holes bear witness to the fact that this most famous of Marauders was indeed appropriately named.

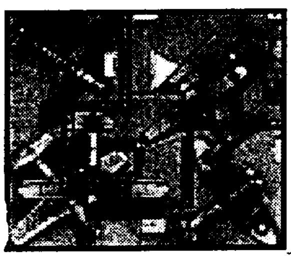
Other photos of gallery 205:

Experimental images using a QuickTake Digital Camera by M. Tuttle



Another Photo CD image of the P-51.



Gallery image.

December 11, 1995 (mjt)
web@www.nasm.edu

File Not found

The requested URL /louvre/paint/auth/picasso/guernica/ was not found on this server.

The Tuskegee Airmen

THE SKY WAS THE LIMIT

Written by Avonie Brown
Designed by Brian Klaas

World War II changed the face of America's armed forces as African-American men and women participated in liberating the world from the rise of tyranny and fascism. But the road to preserving world democracy was paved by the legacy of racism.

At the foundation of America's history is the institutionalized practice of racial segregation and discrimination that denied full citizenship to African Americans. Nonetheless, history is dotted with an infinite number of Black and White men and women who refused to allow prejudicial ignorance to limit their full participation in society.

From America's earliest military history, Blacks have been involved in all wars (declared and undeclared). Oftentimes they were not given full credit and recognition for services rendered; and in most cases, when they served in the country, they were isolated to all-Black units.

World War II was no exception, there was still a deeply entrenched policy of racial segregation of the armed forces. When the U.S. officially entered the war, Black leaders and the Black press increased their protest of the separate and significantly inferior access to training, facilities and participation that was available to Blacks.

Faced with the realities of war, the federal government reluctantly established The 66th Air Force Flying School at the Tuskegee Institute. Blacks considered this a flawed compromise but welcomed the opportunity to prove their ability and commitment to the war efforts.

On May 31, 1943, the 99th Squadron, the first

group of men trained at the Tuskegee Institute, arrived in North Africa. These combat pioneers began their journey towards redefining America's relationship with Black men in the Air Force.

In Sicily the squadron registered their first victory against an enemy aircraft and went on to more impressive strategic strikes against the German forces throughout Italy. Though often handicapped, when given a chance to fully participate, the record of the 99th in action is extremely impressive.

The Afro-American's correspondents documented the successes and frustrations of the Black military personnel. Their reports to the AFRO from 1941-1944 were complied by then publisher, Carl Murphy, in the book This is Our War. Their writing is treasured not only for its historical value, but also for the excellence of the writing. Along with an important historical record, these writers returned from Europe, Africa, the North and the Southwest Pacific with taut, engaging prose that still stands as a literary gem. Reports by Art Carter focused on the men of the 99th; he joined the group in Italy in December 1943, seven months after their initial arrival from Tuskegee.

However, the triumphs of the Tuskegee Airmen did not appease those who refused to accept their presence. Harsh criticisms were levied against them, adding to their frustrations. The men of the 99th had set high standards for themselves because they realized that every move was being scrutinized and that their success or failure would directly impact the future of Blacks in the military.

Their success was particularly evident when the 99th was paired with the 79th Fighter Group on October 9, 1943. The 79th was an all-White Squadron led by Col Earl Bates. For the first time they were integrated in the missions to eliminate their German opponents. They were no longer restricted to escort duties, but instead were assigned to bombing key German strongholds.

Operation Strangle, the last assignment of the team of the 79th and the 99th, marked the end of the 99th Squadron unit. On July 4, 1944, the 99th was joined into three other Squadrons: the 100th, 301st and the 302 to form the 332nd Fighter Group. All three groups were new to the combat zone, and like the 99th, had been trained at the Tuskegee institute. While their initial union was strained, the new group continued to demonstrate that they had the commitment, the drive and the technical ability to carry out successful military assignments.

Consequently, when the war ended, the War Department and the federal government were forced to reassess their segregated military policy. After several committee reports, President Truman was forced to issue two executive orders that effectively paved the way for the integration of the Air Force.

RETURN TO BLACK HISTORY MUSEUM INDEX

RETURN TO AFRO-AMERIC@ HOME PAGE

Women Airforce Service Pilots

During the summer of 1941, with the prospect of global warfare looming, the United States Army Air Force faced an alarming shortage of men to fill both combat and civilian pilot positions. Other Allied nations faced the same problem. Russia was even using women in ground combat supply missions. Could women pilots be utilized somehow to ease the shortage of male pilots available for combat duty? Because of the emergency situation, General Hap Arnold went to famed female aviatrix Jacqueline Cochran (left) for a solution.

By 1941, Jackie Cochran was already the holder of four international and 17 national aviation awards. The plan she devised involved accessing the medical and flying records of every woman listed in the Civil Aeronautics Administration's files. She would recruit these women for civilian flying work for the AAF but the military would need to provide additional training. Despite the approval of the Commanding Officer of Ferry Command, the Army Air Force decided not to utilize Ms. Cochran's plan. One preliminary step occurred, however, when the British Air commission asked Ms. Cochran to recruit and train a group of American women pilots for ferrying duty. In the spring of 1942, 25 American women went to England in a uniformed civilian capacity with the British Air Transport Auxiliary.

At home, an experimental women's squadron, headed by aviatrix Nancy Harkness Love (right), formed in September, 1942. This group of experienced pilots performed ferry duty for Air Transport Command with only four to six weeks of transitional training to acquaint them with military procedure. The success of this group-the Women's Auxiliary Ferrying Squadron (WAFS)-prompted Army Air Forces Command to revitalize Cochran's Women's Pilot Training Program.

Recruitment of women pilots began by mail as the government sent letters to potential candidates from CAA files. Teams of Cochran representatives visited every section of the country. Candidates were interviewed and scheduled for physical examination by a flight surgeon. Ms. Cochran, now Director of Women's Flying Training in A-3 of the Flying Training Command General Staff at Fort Worth, screened all candidates.

Minimum requirements for student pilots were: 21 through 25 years of age, high school education, commercial pilot license, not less than 200 hours of logged flight time, American citizenship and cross-country flying experience. As the pool of available women pilots drained, the 200 flying hours were reduced to 100 and then to the minimum of 35 hours.

The first recruits converged on the Municipal Airport at Houston, Texas. The first flying equipment they saw was motley, surplus or obsolete stock from various airfields. Despite this, the first class of Women Air Service Pilots-WASPs-(43-W-1)-graduated on April 28, 1943. Cramped training facilities, however caused the training base to be moved to Avenger Filed in Sweetwater, Texas, in early 1943.

Life at Avenger Field was no picnic. Training of women pilots covered three phases-military, ground school and flying phases-in 23 weeks. This originally allowed for 115 hours of flying and 180 hours of ground school. As women with less flying experience were accepted, the period was lengthened to 30 weeks with 210 hours of flight and 393 hours of ground school.

The possibility of militarization and actual commissioning caused living conditions to be set up much like those of aviation cadets. Pilots lived in military style barracks, wore military style uniforms (which did not always fit as the photo at left shows) and ate in mess halls. Training was hard, yet exhilarating.

Although the first birth pains were over for both the women pilots at Sweetwater and the WAFS in Delaware, tighter control was needed. On August 5, 1943, the two groups were merged into one group formally known as the WASPs.

Graduation from training at Avenger Field brought a whole new set of adventures and challenges. With the WASP program fully established, it was possible to devote attention to mission flying other than ferrying which had already proven successful. Towing of targets did not require combat-ready pilots so 25 women pilots were sent to Camp Davis, North Carolina, in July 1943 to take up the job. Later, WASP pilots undertook searchlight and tracking missions as well as simulated strafing, smoke laying, engineering test flying and administrative flying. Women pilots flew the B-17 Fortress, the B-26 Marauder and two WASPs flew the B-29 Super Fortress.

WASPs were assigned to numerous bases throughout the United States and served in such commands as the Air Transport Command (ferrying), the Third Air Force (towing targets, radio controlled target flying and personnel transport), Material Command (developing personnel equipment and flying experimental jets), the Weather Wing (personnel transport), and the Flying Training Command (bombardier pilot and navigational training.)

With the Allied Forces winning the war in Europe, male pilots began returning home. Their availability signaled the end of the WASP program. The order for deactivation was issued October 3, 1944, effective December 20, 1944. Although some women resigned early due to this order, most remained on duty until December 20. The last WASP training class actually graduated on December 7, 1944.

After disbanding, many WASPs simply went back to private life, some continued to fly. Others joined the Air Force Reserve through the provision of a 1948 United States Air Forces order allowing former WASPs to apply for appointment in the Air Force Reserve with WASP service counting as commissioned service. Peacetime desk work could not compete with the excitement of the WASPs, however, and few ex-WASPs made military service a lifetime job.

In the mid-1970's newspapers announced that the Air Force planned to train its "first women military pilots." To WASPs, the news was an insult. They began to campaign to be recognized as the veterans they knew themselves to be. In 1977 Congress recognized WASPs as veterans and were awarded veteran status from the United States Airforce. The Women Airforce Service Pilots are also proud that, in 1984, each was awarded the Victory medal. Those who served on duty for more than a year also received the American Theater medal.

It was a fitting ending for these women who served as pilots in World War II. What they achieved then paves the way for all American women who seek to serve the United States as military pilots.

FIFINELLA

Written by Ellen M. Reeher for the IWASM Quarterly

Want more online info about the WASP? Visit these sites:

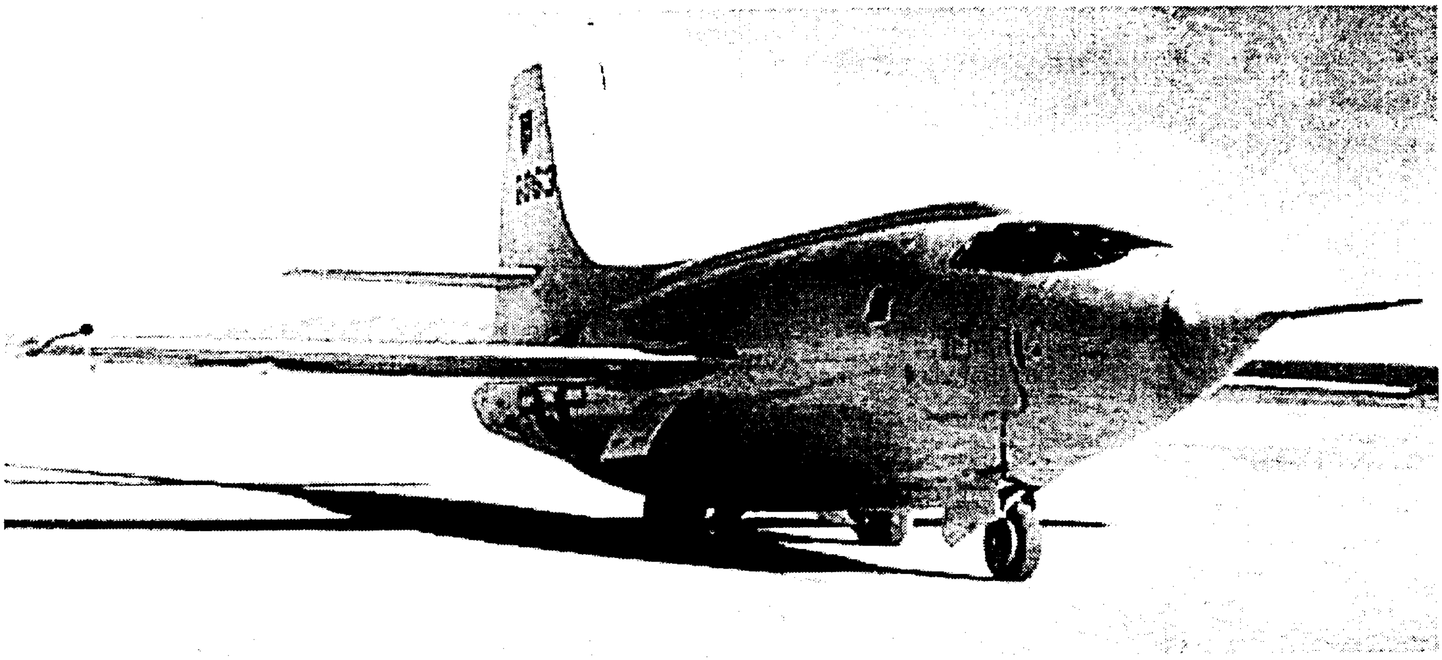
- The WASP Collection at Texas Women's University
- WASP fan David Reyes' page
- Lois Emma Brooks Hailey - a WASP during WWII
- Women Airforce Service Pilots FAQ
- Women with Wings: Female Flyers in Fact and Fiction
- Andy Hailey's Index of WASP's sorted by graduating class
- Go Home Little Fifinella a book by Winnie and Lidia LoPinto about the WASP experience

Fifinella, above right, is the WASP mascot designed by Walt Disney. Copyright owned by Disney.

Return to the International Women's Air & Space Museum home page

X-1 Research Aircraft

Movie Gallery



The X-1 was the first in a series of rocket-powered research aircraft built for the US Air Force and the National Advisory Committee on Aeronautics (NACA). Originally designated the XS-1 (Experimental Sonic-1) it was built by the Bell Aircraft Company in the hopes of breaking the alleged "sound barrier" and investigating the transonic speed range. The following movie runs about 25 seconds, and shows several air-to-air views of X-1 Number 2 and its modified B-50 mothership. It begins with different angles of the X-1 in-flight while mated to the B-50's bomb bay, and ends showing the air-launch. The X-1 drops below the B-50, then accelerates away as the rockets ignite.

X-1 Video Clips

Description	Date	320x240 Quicktime	160x120 Quicktime	320x240 MPEG
X-1 in flight	1949	3.1 MBytes	1.2 MBytes	3.0 MBytes
X-1 launch from B-29 mothership	1947	14.0 MBytes	2.9 MBytes	3.2 MBytes
X-1 in landing on lakebed	1947	14.3 MBytes	3.0 MBytes	2.6 MBytes

Information about the X-1 research project

The X-1 was the first in a series of rocket-powered research aircraft built for the US Air Force and the National

Advisory Committed on Aeronautics (NACA). Originally designated the XS-1 (Experimental Sonic-1) it was built by the Bell Aircraft Company in the hopes of breaking the alleged "sound barrier" and investigating the transonic speed range.

It was a truly pioneering effort. Transonic speeds were technological no-man's land when the program began in 1945. There were no research techniques or flight experience to duplicate it exactly.

The speed of sound was popularized as a danger zone that caused aircraft control reversal and shock waves that could tear a plane apart. Playing it safe, the fuselage of the XS-1 was based on the shape of a 50 caliber bullet (a known supersonic projectile), the aircraft was stressed to an amazing plus or minus 18 g's, and the control yoke was designed to give the pilot maximum leverage in case the supersonic speed bump was violent.

Three first generation X-1s were built under the original 1940s contract, and three modified versions (X-1A, X-1B, and X-1D) were built in the 1950s.

Setting a pattern that was to follow with many of the NACA and later NASA, research aircraft, it was taken aloft attached to a "mothership" in order to conserve fuel for the research flight. The X-1s were air-launched from modified B-29 and B-50 bombers.

X-1 Number 1 was glide-tested at Pinecastle Air Force Base, Florida, in early 1946. Subsequent powered flights began on December 9, 1946, at the NACA Muroc Flight Test Unit, now known as NASA Dryden Flight Research Center. Flying this plane on October 14, 1947, USAF Captain Charles "Chuck" Yeager became the first person to exceed Mach 1, passing through the dreaded barrier with barely a ripple. On March 10, 1948, NACA pilot Herb Hoover became the first civilian to fly supersonic, while at the controls of XS-1 Number 2.

Yeager's "Glamorous Glennis" XS-1 was painted orange, for visibility. So was the first NACA-Navy D-558-1research plane, as well as X-1 Number 2, but it soon became apparent that the dark color was in fact, difficult to see from the ground. When Number 2 was turned over to NACA after its Air Force flights, the agency painted it white, which became the standard color for its research aircraft.

The maximum speed attained in an X-1 was 957 mph, set by Yeager in Number 1, during 1948. Number 2 had a thicker wing than the other X-1s, with a thickness/chord ratio of 10% vs. their t/c of 8%. Mainly for this reason it was a slower airplane, with a maximum speed of 792 mph.

The X-1 was powered by a four-chamber, XLR11 rocket engine, fueled by a mixture of liquid oxygen and diluted ethyl alcohol. Although not throttleable, the chambers could be fired individually or in groups to produce a maximum thrust of 6000 lbs. at sea level. Fuel capacity limited full-power of the engine to about five minutes.

The cockpit was pressurized, but the windscreen on Numbers 1 and 2 required external strapping to prevent blow-out. Number 3 had a stronger windscreen that did not need the straps.

X-1 Number 3 was the most advanced of the X-1s. It had an increased fuel capacity, and an advanced, steam-drive turbopump to transfer propellants. But it was also the most ill-plagued. Delays in its development postponed delivery by about three years, and it made only one flight: a glide test on July 20, 1951. It was accidentally destroyed few months later, when it exploded on the ground while attached to a B-50 mothership.

Despite some features that now seem almost quaint, the X-1s were technologically advanced. They repeatedly broke world speed and altitude records during the 1940s, and made significant breakthroughs in the understanding of transonic flight.

The following movie runs about 25 seconds, and shows several air-to-air views of X-1 Number 2 and its modified B-50 mothership.

It begins with different angles of the X-1 in-flight while mated to the B-50's bomb bay, and ends showing the air-launch.The X-1 drops below the B-50, then accelerates away as the rockets ignite.

All but one of the X-1 flights began with an air-launch. In early 1949 Chuck Yeager made the one and only ground-launch of a rocket-powered X-plane. He tookoff from an Edwards runway, and rocketed to 23,000 ft. in only 90 seconds. Yeager then cut the power and made a normal, gliding return to the field, jettisoning the remaining fuel before landing.

For further information on-line, please consult the following sources:

- X-1 Photo Gallery
- B-29 Photo Gallery
- Research Aircraft Program Fact Sheet
- Bruce Peterson pilot biography
- Don Mallick pilot biography

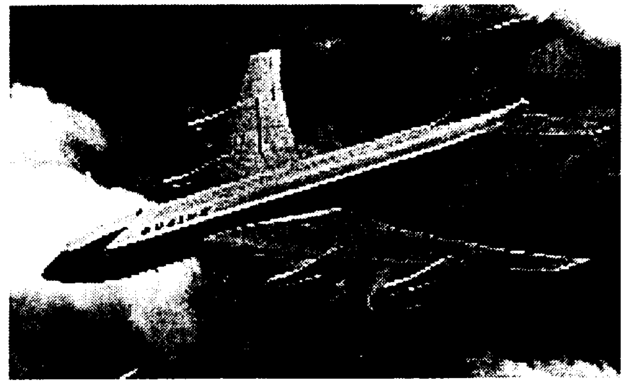
Fortieth Anniversary
Pioneering the Future

Responsible NASA Official: Marty Curry Marty.Curry@dfrc.nasa.gov

Page Curator: Robert Binkley Robert.Binkley@dfrc.nasa.gov

Modified: November 28, 1996

The 707



People thought we were crazy.

Juan Trippe, Pan American president, placing the first order for 707s, 1955

Boeing engineer Wellwood Beall had interesting news when he returned to Seattle in 1950, after delivering an order of Stratocruisers to British Overseas Airways Corporation. The British had developed a medium-range jet airliner, the de Havilland Comet. Though the plane never lived up to its potential, Beall and the other Boeing engineers knew that jet airliners were the planes of the future.

By then, propeller-driven transports were approaching their performance limits. Piston aircraft engines had as many as 28 cylinders, making them difficult and costly to maintain. Jet engines were simpler and more economical to service. The combination of high speed and cost efficiency of the jet made long-distance air travel more practical.

The time was right for Allen to take a chance on a revolutionary new airplane. Such a risk had paid off before when the B-17 catapulted Boeing into industry leadership. In August 1952, Boeing announced it would invest $16 million (two-thirds of the company's net profits from the postwar years) to build the prototype for a new long-range jet-powered aircraft. Intended as a military tanker, the new plane clearly had significant commercial possibilities.

The plane was developed by Boeing in secrecy to protect its market. The prototype was designated Model 367-80 to disguise it as merely an improved version of the Stratofreighter.

The Dash 80, the nickname ultimately given to the 707 prototype, was completed in 1954. Four turbojet engines delivered 10,000 pounds of thrust each, and the plane could fly 582 mph. William Boeing was present at the rollout ceremonies.

Like Egtvedt's B-17 decision 20 years before, Allen's gamble paid off. The 707 was ready before its primary competitor, the Douglas DC-8, giving Boeing the competitive advantage it has never lost.

The 707 truly revolutionized commercial aviation, cutting intercontinental travel time almost in half. The jetliners made the journey smoother and more comfortable by eliminating the vibrations from propellers and allowing high-altitude flight. The reliability and relatively low operating costs of the 707 brought airfares within the financial reach of more people. In the first two years of jetliner service, air travel almost doubled. The 707 helped create an entire industry in international air travel.

Until 1990, the 707 also served as Air Force One, the personal transport for the president of the United States. This duty is now being carried out by another Boeing aircraft, the 747. The military also used the 707 as the aircraft platform for the E-3 Airborne Warning and Control System (AWACS) and the E-6 submarine communication system.

Boeing delivered 855 Model 707s in all versions between 1957 and 1992, of these, 725, delivered between 1957 and 1978, were for commercial use.

707 home page

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Air Travelers

Science Background

Balloons and blimps fly because of the physical differences between different gases and how gases change with temperature. When the gas inside a balloon has a lower density than the surrounding gases, the balloon gains buoyancy. Some gases, like helium, have a lower molecular weight and rise up through the heavier air.

Gases are the most energetic of the three phases of matter. Gas molecules have little attraction to each other and are spread far apart. Increasing the temperature of a gas, increases the molecular energy, pushing the molecules farther apart. This decreases the density of the gas. Hot-air balloons hold hotter and therefore lighter air inside their envelopes and fly because of the buoyant force pushing the lighter hot air up.

The Ninety-Nines

WOMEN IN AVIATION

By Kelli Gant

Today, women pilots fly for the airlines, fly in the military and in space, fly air races, command helicopter mercy flights, haul freight, stock high mountain lakes with fish, seed clouds, patrol pipelines, teach students to fly, maintain jet engines, and transport corporate officers.

Women have made a significant contribution to aviation since the Wright Brothers' first 12 second flight in 1903. Blanche Scott was the first women pilot, in 1910, when the plane that she was allowed to taxi mysteriously became airborne. In 1911, Harriet Quimby became the first licensed woman pilot. And later in 1912, Harriet became the first women to fly across the English Channel.

In 1921, Bessie Coleman became the first African-American woman pilot. Because of the discrimination in the United States towards women as pilots and Bessie's race, Bessie moved to France and learned to fly at the most famous flight school in France--the Ecole d'Aviation de Freres Caudron. Bessie returned to the United States and pursed a barnstorming career until 1926.

On March 16, 1929, Louise Thaden make her bin for the women's endurance record from Oakland Municipal Airport, CA, in a Travel Air, and succeeded with a flight in 22 hours, 3 minutes. The record was broken a month later by Elinor Smith with 26 hours, 21 minutes over Roosevelt Field, New York.

Other firsts followed, Katherine Cheung, in 1931 in Los Angeles, CA was the first woman of Chinese ancestry to earn a license. Anne Morrow Lindbergh, wife of Charles Lindbergh, was the first U.S. woman glider pilot and first woman recipient of the National Geographic Society's Hubbad Award. And, Phoebe Fairgrave Omelie was the first woman transport pilot. Phoebe, considered to be one of America's top women pilots in the 1920's and 1930's, developed a program for training women flight instructors and was appointed as Special Assistant for Air Intelligence of the National Advisory committee for Aeronautics (the forerunner of the NASA), and was active in the National Air Marking and Mapping program to paint airport identification symbols on airports or nearby buildings.

Air racing was a way for women to demonstrate their abilities, and of course, the prize money was an incentive. All-women's air races were soon organized, the biggest being the National Women's Air Derby in 1929. The race was from Santa Monica, CA to Cleveland, OH and flown in eight days. The idea of letting women race airplanes was not accepted by many people. During the air race there were threats of sabotage and headlines that read "Race Should Be Stopped." However, the Derby drew twenty women from across the country and gave them the chance to meet face-to-face for the first time.

After the race, these women kept in contact with each other and talked about forming a women's pilot organization. Clara Trenchman, who worked in the Women's Department of the Curtiss Flying Service at Valley Stream, Long Island, convinced two Curtiss executives to invite licensed women to meet in Valley Stream to form such an organization. Responding to the invitation, 26 licensed women pilots met in a hanger at Curtiss Field on November 2, 1929 to formally create the Ninety-Nines Club. Later, after many rejected names, the organization choose its name "The Ninety-Nines" because 99 of the 117 licensed American women pilots in the United States at that time signed up as charter members.

Willa Brown was the first African-American commercial pilot and first African-American woman officer in the

Civil Air Patrol. In her hometown of Chicago, IL, she taught aviation courses in high schools and founded a flight school at Harlem Airport. In 1939, Willa helped form the National Airmen's Association of America who's purpose was to get African-Americans into the U.S. Armed Forces as aviation cadets. Willa also was the coordinator of war-training service for the Civil Aeronautics Authority (CAA), and more importantly, was the director of the Coffey School of Aeronautics. The school was selected by the Army and CAA to "conduct the experiments" that resulted in the admission of African-Americans into the Army Air Forces. Later, Coffey became a feeder school for the Army Air Forces' program for African-American aviators at Tuskegee Institute.

By 1930 there were 200 women pilots, by 1935, there were between 700 and 800 licensed women pilots. A major breakthrough in aviation was allowing women to air race against men. In 1936, Louise Thaden and Blanche Noyes won the prestigious Bendix Trophy Race. Women have competed against men ever since.

Most women who learned to fly during World War II, got instruction through the CAA's Civil Pilot Training Program. More than 935 women gained their license by in 1941 with 43 serving as CAA-qualified instructors. Mills College in Oakland, CA was one of the participating training colleges for women.

As World War II progressed, women were able to break into many aspects of the aviation world. They served as ferry and test pilots, mechanics, flight controllers, instructors, and aircraft production line workers. At the beginning of 1943, 31.3 percent of the aviation work force were women. World War II was very beneficial to the movement of women into aviation fields. The history of aviation during these years is immense.

The Women's Auxiliary Ferry Squadron (WAFS), founded by Nancy Harkness Love, and the Women's Flying Training Detachment (WFTD), founded by Jacqueline Cochran, were fused together by Roosevelt to become the Women's Airforce Service Pilots (WASP). The new organization was a vital part of the history of women in military aviation. Although these women were civilians and outnumbered by women in the regular military service of World War II, their experiences present a paradigm for the service of WWII military women. Unfortunately, the WASPs were not recognized as military personnel until the Senate passed a resolution in November 1977 and it was signed by President Carter into law.

The years since World War II have brought down many more barriers for women pilots and records continue to be broken. Jackie Cochran went on to be the first woman pilot to break the sound barrier, with Chuck Yager acting as her chase pilot, on May 20, 1953. And, Marion Hart flew the Atlantic in 1954 at the age of 62.

Women got their first step closer to space in 1959, when Geraldine Cobb, a talented young pilot, became the first woman to undergo the Mercury astronaut test. "Jerrie" was 28 years old, had 7,000 hours of flight time, and three world records. She was a pilot and manager for Aero Design and Engineering Company, which made the Aero Commander aircraft, and was one of the few women executives in aviation. Cobb successfully completed all three stages of the physical and psychological tests that were used to select the original seven Mercury astronauts. Although twelve women finished this first round of testing, NASA refused to authorize the completion of the tests for fear that such action might be taken as approval of female astronauts.

Not even the Soviet Union's launch of Valentina Tereshkova into space in 1963, nor the 1964 Civil Rights Act broke ground for women in space. It was not until June 17, 1983, that Dr. Sally Kristen Ride, NASA astronaut and a Ninety-Nines South Central Section member, made history as the first U.S. woman in space, serving as a specialist for STS-7 on the six-day flight of the orbiter, Challenger.

By the 1960s there were 12,400 licensed women pilots in the United States (3.6 percent of all pilots.) This number doubled by the end of the decade to nearly 30,000 women, but still only 4.3 percent of the total pilots. Today, women comprise about 6 percent of pilots in the United States.

Geraldine Mock became the first women to fly around the world in 1964 in a single-engine Cessna 180 called the Spirit of Columbus. That flight stirred up more interest in air races. The new All Women's International Air Race soon became known as the "Angel Derby" and the All-Woman Transcontinental Air Race is popularly called the "Powder Puff Derby." Other races that The Ninety-Nines have originated, developed and flown in are Formula 1, the Kachina Doll Air Race in Arizona, the Indiana Fairladies Air Races, the ever-popular Palms to Pines Air Race, and likely the largest and oldest proficiency race, the Michigan Small Race. Dozens of others, like the New England Air Race, have drawn competitors from many states and from Canada.

And the firsts continued... In 1974 Mary Barr became the first woman pilot with the Forest Service; Ensign Mary Crawford became the U.S. Navy's first woman Navel Flight Officer in June 1981; Charlotte Larson became the first woman smoke jumper aircraft captain in 1983 and Deanne Schulman was the first qualified woman smoke jumper; in 1984, Captain Beverly Burns was the first woman to captain a 747 cross-country and Captain Lynn Rippelmeyer was the first woman to captain a 747 on a transatlantic flight; and the first woman pilot in the U.S. Space Shuttle program was Lt. Col. Eileen Marie Collins.

People become pilots for the same reasons. First, they love flying, and they love using their talents and being respected for them. And mostly, they love the feeling of belonging to this strong family called aviation.

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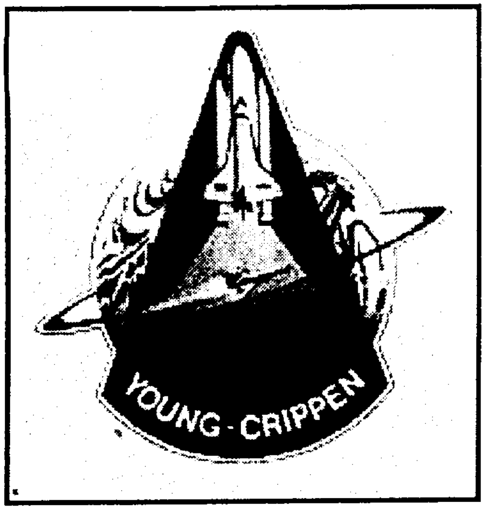

STS-1 (1)

COLUMBIA (1)
Pad 39-A (13)
1st Shuttle mission
1st Flight OV-102

Crew:

John W. Young (5), Commander
Robert L. Crippen (1), Pilot

Backup Crew:

Joseph H. Engle (0), Commander
Richard H. Truly (0), Pilot

Milestones:

03/24/79 - Arrival from Dryden
03/25/79 - Move to OPF-1 (610 days)
11/24/80 - Move to VAB-3 (35 days)
12/29/80 - Move to PAD-39A (105 days)
02/20/81 - Flight Readiness Firing (FRF)
04/12/81 - Launch
04/14/81 - Landing
04/28/81 - Return to KSC (14 days)

Payload:

DFI,ACIP

Mission Objectives:

Click here for Additional Info on STS-1

Demonstrate safe launch into orbit and safe return of the orbiter and crew. Verify the combined performance of the entire shuttle vehicle - orbiter, solid rocket boosters and external tank.

Payloads included the Developmental Flight Instrumentation (DFI) and the Aerodynamic Coefficient Identifications Package (ACIP) pallet containing equipment for recording temperatures, pressures and acceleration levels at various points on the vehicle.

Launch:

April 12, 1981, 7:00:03 a.m, EST. Launch April 10 postponed due to timing skew in orbiter's general purpose computer system. Backup flight software failed to synchronize with primary avionics software system. Countdown proceeded on schedule April 12. First 24 Shuttle liftoffs - STS-1 through 61-C - were from Pad 39-A. Launch Weight: 219,258 lbs.

Orbit:

Altitude: 166nm
Inclination: 40.3 degrees
Orbits: 37
Duration: 2 Days, 6 hours, 20 min, 53 seconds
Distance: 1,074,567 miles

Hardware:

SRB: BI-001
SRM: 001SW(SPM)
ET : 2/SWT-1
MLP : 1
SSME-1: SN-2007
SSME-2: SN-2006
SSME-3: SN-2005

Landing:

April 14, 1981, 10:20:57 a.m. PST, Runway 23, Edwards Air Force Base, Calif. Rollout distance: 8,993 feet. Rollout time: 60 seconds. Orbiter returned to KSC April 28, 1981. Landing Weight: 194,184 lbs.

Mission Highlights:

Primary mission objectives of the maiden flight were to check out the overall Shuttle system, accomplish a safe ascent into orbit and to return to Earth for a safe landing. All of these objectives were met successfully and the Shuttle's worthiness as a space vehicle was verified.

Major systems tested successfully on first flight of Space Trans- portation System. Orbiter sustained tile damage on launch and from overpressure wave created by solid rocket boosters. Sub sequent modifications to water sound suppression system eliminated problem. Sixteen tiles lost and 148 damaged.

The only payload carried on the mission was a Development Flight Instrumentation (DFI) package which contained sensors and measuring devices to record orbiter performance and the stresses that occurred during launch, ascent, orbital flight, descent and landing.

Post-flight inspection of the Columbia revealed that an overpressure wave which occurred when the SRB ignited resulted in the loss of 16 heat shield tiles and damage to 148 others. In all other respects, however, Columbia came through the flight with flying colors, and it was to fly the next four Shuttle missions.

Columbia was returned to Kennedy Space Center from California on April 28 atop its 747 carrier aircraft.

KSC Home Mission Index Next Mission STS-2

Last Updated Monday September 8 14:08:20 EDT 1997
Jim Dumoulin (dumoulin@titan.ksc.nasa.gov)

Launching to Earth, Moon, Mars and B

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Frequently Asked Questions
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latest across NASA, visit today@nasa.gov

STS-90/Neurolab Countdown Page is online. (STS-89 Landed 1/31/98)
Lunar Prospector launched 1/6/98 9:28pm EST (Video and Photos)
Cassini mission to Saturn launched 10/15/97 (Movies and Photos)
Live Camera views of the Space Station processing in the SSPF.

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Daedalus
Human Powered Aircraft

Photo Gallery

NASA Dryden Flight Research Center

The Michelob Light Eagle and Daedalus human powered aircraft were testbeds for flight research conducted at the NASA Dryden Flight Research Center, Edwards, California between January 1987 and March 1988.

Daedalus Images

Photo Description	Photo Date	DFRC Photo #	600x480 image	1280x1024 image	2000x1720 image
Image Contact Sheet	---	---	21 KBytes	21 KBytes	2 KBytes
Daedalus Project's Light Eagle - Human powered aircraft	1987	EC87-0014-8	75 KBytes	247 KBytes	
Daedalus - Last Dryden flight	7 Mar 1988	EC88-0059-002	77 KBytes	823 KBytes	10,200 KBytes

Additional Information

These unique aircraft were designed and constructed by a group of students, professors, and alumni of the Massachusetts Institute of Technology within the context of the Daedalus project. The construction of the Light Eagle and Daedalus aircraft was funded primarily by the Anheuser Busch and United Technologies Corporations, respectively, with additional support from the Smithsonian Air and Space Museum, MIT, and a number of other sponsors.

To celebrate the Greek myth of Daedalus, the man who constructed wings of wax and feathers to escape King Minos, the Daedalus project began with the goal of designing, building and testing a human-powered aircraft that could fly the mythical distance, 115 km. To achieve this goal, three aircraft were constructed. The Light Eagle was the prototype aircraft, weighing 92 pounds. On January 22, 1987, it set a closed course distance record of 59 km, which still stands. Also in January of 1987, the Light Eagle was powered by Lois McCallin to set the straight distance, the distance around a closed circuit, and the duration world records for the female division in human powered vehicles.

Following this success, two more aircraft were built, the Daedalus 87 and Daedalus 88. Each aircraft weighed approximately 69 pounds. The Daedalus 88 aircraft was the ship that flew the 199 km from the Iraklion Air Force Base on Crete in the Mediterranean Sea, to the island of Santorini in 3 hours, 54 minutes. In the process, the aircraft set new records in distance and endurance for a human powered aircraft.

The specific areas of flight research conducted at Dryden included characterizing the rigid body and flexible dynamics of the Light Eagle, investigating sensors for an autopilot that could be used on high altitude or human powered aircraft, and determining the power required to fly the Daedalus aircraft.

The research flights began in late December 1987 with a shake-down of the Light Eagle instrumentation and data transfer links. The first flight of the Daedalus 87 also occurred during this time. On February 7, 1988, the Daedalus 87 aircraft crashed on Rogers Dry Lakebed. The Daedalus 88, which later set the world record, was then shipped from MIT to replace the 87's research flights, and for general checkout procedures. Due to the accident, flight testing was extended four weeks and thus ended in mid-March 1988 after having achieved the major goals of the program; exploring the dynamics of low Reynolds number aircraft, and investigating the aeroelastic behavior of lightweight aircraft. The information obtained from this program had direct applications to the later design of many high-altitude, long endurance aircraft.

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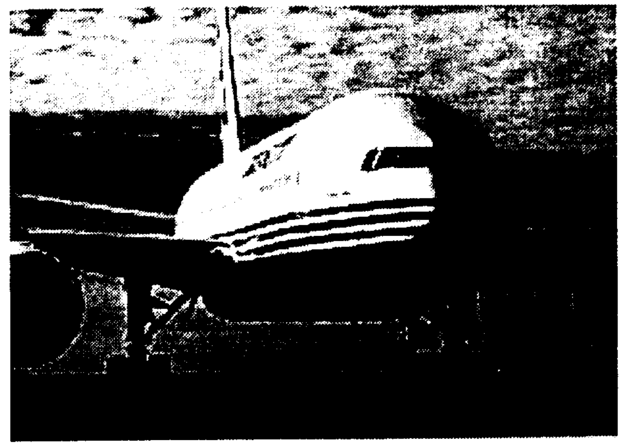
Modified: September 22, 1997

777

The Model 777, the first entirely new Boeing airplane in more than a decade, was delivered in May 1995. Market demand sized, shaped and launched the 777, created to be the most preferred airliner in the medium-sized aircraft category. As the world's largest twinjet, it carries 305 to 440 people and has a range of 4,560 miles. By mid-1996, 268 of the 777s had been ordered by 20 airlines. In June 1995, Boeing's board of directors authorized production of the 777-300, a stretched version of the 777. While maintaining passenger capacity and range capability, it burns one-third less fuel and has 40 percent lower maintenance costs than early model 747s. Delivery of the first 777-300 was set for spring 1998.



The 777 is the widest, most spacious airplane in its class, and includes improvements in airfoil technology, flight deck design, passenger comfort, and interior flexibility. Its greater payload and range capability result in lower operating costs to airlines and its standard equipment includes many features that are optional on other airliners.

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Chinese kites

風箏

Chinese Kite History

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By *Stéphan Leith* (kite@bbsi.net)

The Virtual Kite Zoo

Kites in the Classroom.

If you are a teacher, or a leader of any sort of childrens' or youth group, and if you work with children or young people of any age from pre-school upwards, you may like to consider a kite-building project.

- In a science class, kite building can demonstrate basic aerodynamic principles such as the aerofoil and the dihedral, and factors affecting stability of flight.
- In art classes, kites can be decorated with paints or crayons, or various other techniques such as marbling.
- In craft or sewing classes, kite-making can be used as an introduction to machine sewing and appliqué, and can be used to draw boys into a field traditionally dominated by girls.
- In childrens' groups, kite-making can be included as a useful creative activity with the reward at the end of a fun-thing to take home. It can be geared to almost any age and ability with greater or lesser amounts of preparation and supervision.

Quite regularly, someone posts a query to rec.kites saying something like "Where can I find plans to make kites with some kids?" There are numerous kite plans on the net ranging from extreemly sketchy and suitable only for experienced kite builders, to highly detailed and suitable for a range of ages and abilities. To save you a lot of time downloading different plans, here is a list suitable for children and youngsters, grouped according to suitability.

Paper Kites

All paper kite plans lend themselves to decoration, which may form a significant part of the aim of the activity. They are also useful in developing basic manual skills such as use of scissors and sticky tape etc.

- Uncle Jonathan's <u>20 Kids - 20 Kites - 20 Minutes</u> is a design especially aimed at classrooms and childrens' groups. The main requirements for each kite are a sheet of A4 paper and an 8" barbeque shishkabab stick. It is suitable for pre-school upwards, depending on the amount of assistance given.
- John Staplehurst's <u>Basic Sled Kite</u> also uses barbeque sticks, with an A3 sheet of paper. Children from about age 7 should have little trouble, and it could be used for younger children with a bit more assistance, for example, with tying the bridle and flying line.
- Another <u>Paper Kite</u> plan is given by Merlito Crespo. This doesn't even need the barbeque sticks, though he does suggest a toothpick for making the holes to attach the bridle (but a sharp pencil would do!)
- The <u>Peace Dove</u> and the <u>Sugar Glider Kite</u> are both very simple, using drinking straws for spars, but will both need greater care in cutting out than the previous kites.

Plastic Bag and Foil Gift-wrap Kites

Polythene sheeting makes a good kite sail, but can't be decorated as easily as paper except with permanent markers, which may not be suitable for younger children who may get them on their clothes. However, different colours are available in the form of supermarket bags. Mylar foil gift-wrap makes attractive kite material, and is available in many designs and colours, including holographic patterns. Its only disadvantage is its tendency for tears to propagate unchecked.

- Kel Krosschell's <u>2 cent Mini-Sled</u> is made out of a plastic bag and 2 drinking straws. Make sure you get the non-bendy type of straw. (It seems they instantly went out of fashion as soon as I started looking for them, but you'll find them out there somewhere!) Kel suggests heat-tacking the straws to the polythene, but an easier and safer method with children is to use several small slivers of double sided adhesive tape. That's the only part that might challenge the dexterity of 7 - 11 year olds.

- Again from Kel Krosschell, the One Square Inch Microkite takes some dexterity and so would prove tricky for children under 11, but can be built in only a few minutes. Basically a miniature Eddy kite (what's an Eddy??) it nicely demonstrates the principal of the dihedral.
- A traditional box kite can be made from these plans, with a very limited budget. A large kitchen garbage bag and around 18ft of dowelling are the main requirements. Age range is around 9 - 12.
- Glenda Woodburn's Tetrahedral Kite is an easily made version of Bell's tetrahedral kite (Bell's what??). Normally considered a fairly formidable proposition to build, this version uses drinking straws for spars and is aimed at 6th grade students, but could be used with older or younger children, adjusting the adult supervision accordingly.
- A Fighter kite (in French) (English translation) should be within the grasp of an 11 year old. Flying a fighter is quite different from flying normal single line kites - great fun for a beginner but with enormous scope for the development of skill. (More on fighters.)

Ripstop Nylon Kites

The final category is suitable for 13 - 16 year olds in developing basic skills with a sewing machine. Some of them can be decorated with appliqué.

- Buck Childer's Ram-Air Pocket sled is very easily made. I've made several as Christmas presents, each appliquéd with the recipient's initial. No woodwork is required since it has no spars.
- A rok is easily made (what's a rok?), consisting of a hexagonal sail and three (dowel or fibreglass) spars. Purely as a sewing project, it would hardly be taxing, but it has a large flat surface that can be used for appiqué in as sophisticated a pattern as you like. Charlie Charlton's 1.2m Rok plan is very comprehensive.
- Charlie's Jewel Kite plan is equally comprehensive. This consists of a patchwork of 22 panels sewn together to represent a gemstone, and looks great in the sky.

Ripstop nylon, fibreglass rod, and other kite-making materials are available from kiteshops everywhere, many of which are happy to deal mail-order. In the UK, consult the KSGB address list, or elsewhere, try the business links.

Other Resources

- Shortly before putting this page online, I heard of Buck Childer's Kid Kite Web, which has a very similar purpose to this page. Go and have a look!
- Also recently introduced is Dave Ellis' Kites, kids and education page.

Return to the Entrance Lobby - Continue the Guided Tour

IL PROTAGONISTA: MARCO POLO.

Il giro d'affari dei Polo spaziava dall'Europa continentale al Baltico, dal Mar Nero alla Palestina, dall'Egitto all'Asia occidentale. L'interesse di Marco non poteva tuttavia che essere rivolto alla Asia dei Mongoli, là dove il padre e lo zio si erano avventurati già da tempo, senza più dare notizie.

Marco Polo nacque a Venezia nel 1254 da una famiglia di mercanti, che apparteneva al ceto patrizio della città. Marco trascorse l'adolescenza sotto le cure della madre; il padre, Niccolò, si separò dal figlio quando questi era in tenera età per intraprendere il primo viaggio in Estremo Oriente che lo avrebbe tenuto lontano da Venezia fino al 1269. La collocazione sociale della famiglia destinava Marco a divenire egli stesso mercante, e molto probabilmente (ma non vi sono testimonianze certe) i suoi studi nelle scuole di grammatica e di abaco furono rivolti all'apprendimento delle tecniche commerciali. E' lecito credere che le competenze, di cui darà prova nel Milione, in materia di prezzi, di valore delle merci, di misurazione della portata delle navi, gli derivarono dai rudimenti teorici appresi a scuola e dalla pratica effettuata nell'azienda di famiglia. Fattosi ragazzo, Marco era pronto a compiere la sua esperienza in un paese straniero, secondo l'uso dei mercanti veneziani, per i quali era abituale già prima dei vent'anni procacciarsi ricchezze in paesi lontani. Il ventaglio delle possibilità era ampio tanto quanto il giro d'affari della Repubblica: spaziava dall'Europa continentale al Baltico, dal Mar Nero alla Palestina, dall'Egitto all'Asia occidentale. Ma l'interesse di Marco non poteva che essere rivolto alla Asia dei Mongoli, là dove il padre e lo zio si erano avventurati già da tempo, senza più dare notizie.

Marco Polo

Ibn Battutah
Jacopo da Sanseverino
L'archetipo del viaggio religioso, la "Navigatio Sancti Brandani"

Un grande viaggiatore: Marco Polo

Il protagonista : Marco Polo
Il viaggio di Matteo e Nicolò Polo: da Venezia alla Persia.
Il viaggio di Matteo e Nicolò Polo: Khubilai Khan e il ritorno.
L'incontro con papa Gregorio X a S.Giovanni d'Acri.
Il viaggio di Marco Polo.
Marco Polo in Cina.
Marco Polo funzionario imperiale.
La vita di Marco Polo a Venezia dopo il ritorno dall'Oriente.
La prigionia.

Uno dei viaggi più lunghi della storia

Gengis Khan
Kublilai Khan
Tartari di Levante e Tartari di Ponente
La Principessa Tartara Cacesi
Guglielmo da Tripoli e Nicolò da Vicenza
Il prete Gianni
Re Giorgio
Sulle tracce di Alessandro Magno
L'attezzatura di viaggio di Marco Polo
I luoghi del Milione
L'Oriente latino
S. Giovanni D'Acri
Laiazzo (Laias)
Piccola e Grande Erminia
L'Anatolia
Baudac
Bucara
Bolgara
Balac
L'Asia Centrale
Lop
Catai
Mangi
India
Toris
Mare Oceano
Sabba
Samarcanda
Tibet
Cipangu, il famoso Giappone
Seilla
L'Arabia e l'Africa nordorientale
Le figure antropomorfe
Le terre dell'Albro Solo
Malle e Femelle
Il Vecchio della montagna e gli Assassini
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Le reliquie di Adamo

Un capolavoro: il *Milione*

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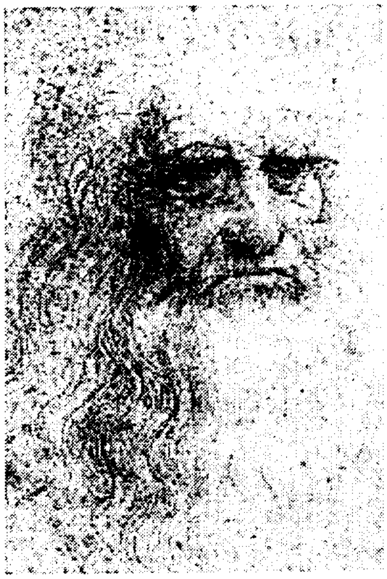

Leonardo Da Vinci

Scientist - Inventor - Artist

November 1st 1996 to Februar 2nd 1997

Historisches Museum Schottenstift

Wien 1, Entrance: Freyung 6, daily 9 am - 7 pm

Infoline Wien 536 37

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- I. Preparations for Art
- II. Leonardo's Anatomical Studies
- III. The Artist Leonardo da Vinci
- IV. Leonardo's Writings
- V. Water, Bridges and Canals
- VI. Mathematics, Geometry and Engineering
- VII. Leonardo da Vinci and Man's Dream of Flying
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FROM LEONARDO'S "TREATISE UPON THE FLIGHT OF BIRDS."

Those feathers which are farthest from their fastening will be the most flexible; then the tops of the feathers of the wings will be always higher than their origins, so that we may with reason say, that the bones of the wings will be lower in the lowering of the wings than any other part of the wings, and in the raising these bones of the wing will always be higher than any other part of such a wing. Because the heaviest part always makes itself the guide of the movement.

The kite and other birds which beat their wings little, go seeking the course of the wind, and when the wind prevails on high then they will be seen at a great height, and if it prevails low they will hold themselves low.

When the wind does not prevail in the air, then the kite beats its wings several times in its flight in such a way that it raises itself high and acquires a start, with which start, descending afterwards a little, it goes a long way without beating its wings, and when it is descended it does the same thing over again, and so it does successively, and this descent without flapping the wings serves it as a means of resting itself in the air after the aforesaid beating of the wings.

When a bird which is in equilibrium throws the centre of resistance of the wings behind the centre of gravity, then such a bird will descend with its head down.

This bird which finds itself in equilibrium shall have the centre of resistance of the wings more forward than the bird's centre of gravity, then such a bird will fall with its tail turned to the earth.

When the bird is in the position and wishes to rise it will raise its shoulders and the air will press between its sides and the point of the wings so that it will be condensed and will give the bird the movement toward the ascent and will produce a momentum in the air, which momentum of the air will by its condensation push the bird up.

Of four movements performed by birds reflected and incidental to different aspects of the wind.

The slanting descent of birds being made against the wind will be made under the wind, and its reflex movement will be made above the wind. But if such an incidental movement is made to the east, the wind blowing from the north, then the northern wing will remain under the wind; in the reflex movement will do the same, so that, at the end of this reflex the bird will find itself with its face to the north.

And if the bird descends to the south, the northern wind reigning, he will make such a descent above the wind and his reflex movement will be under the wind; but here comes in a long dispute which will be told in its place, because here it seems to happen that he cannot make the reflex movement.

When the bird makes his reflex movement above the wind then he will mount much more than belongs to his natural momentum, seeing that he adds to that the help of the wind which, entering under him, acts as a wedge. But when he has reached the end of the ascent he will have used up his momentum, and he will have remaining only the help of the wind, which would overturn him because he strikes it with his breast, were it not that he lowers the right or left wing, which makes him turn to the right or to the left descending in a semi-circle.

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Of four movements performed by birds reflected and incidental to different aspects of the wind.

The slanting descent of birds being made against the wind will be made under the wind, and its reflex movement will be made above the wind. But if such an incidental movement is made to the east, the wind blowing from the north, then the northern wing will remain under the wind; in the reflex movement will do the same, so that, at the end of this reflex the bird will find itself with its face to the north.

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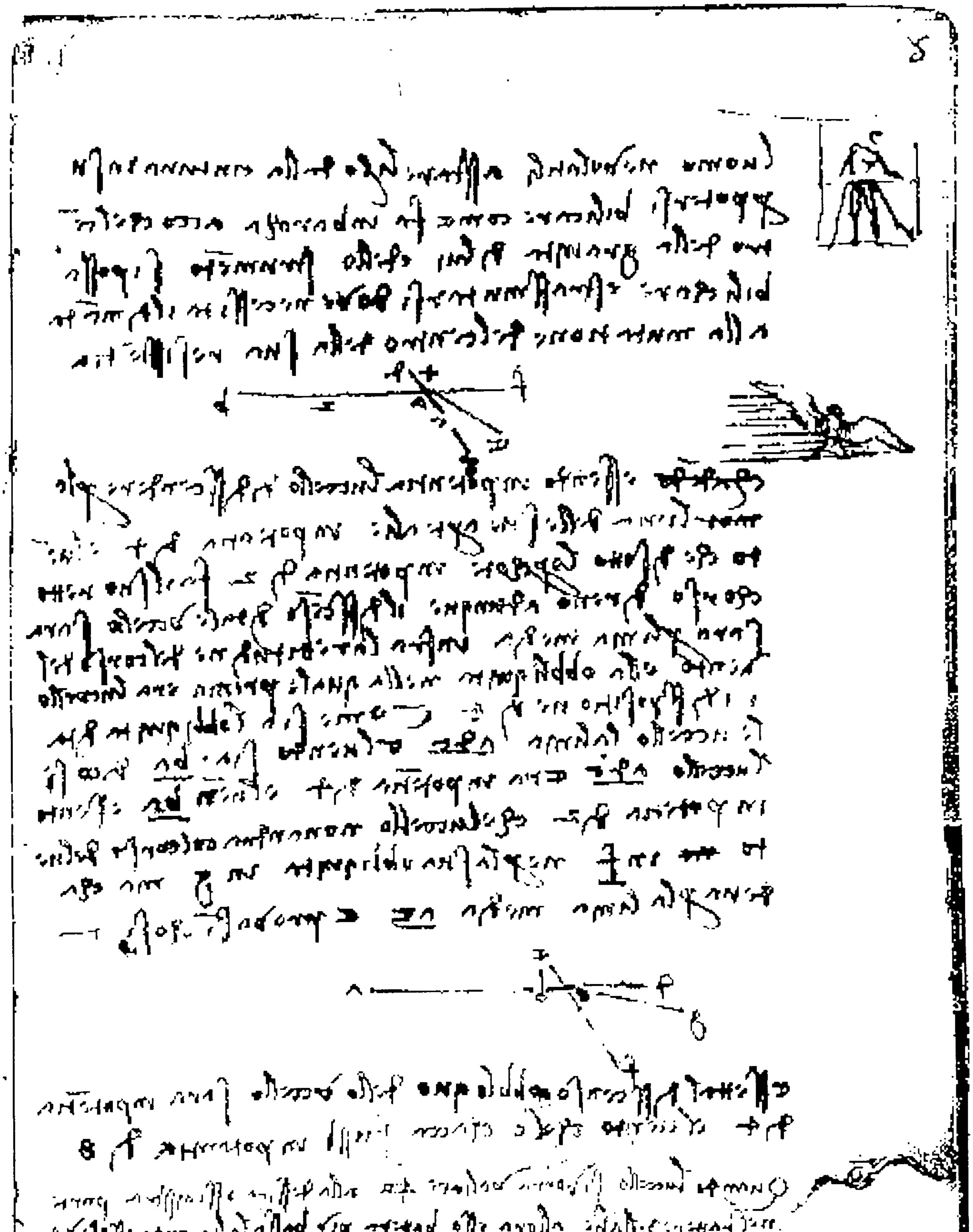
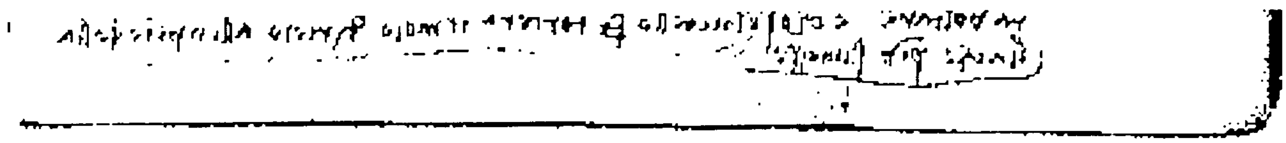
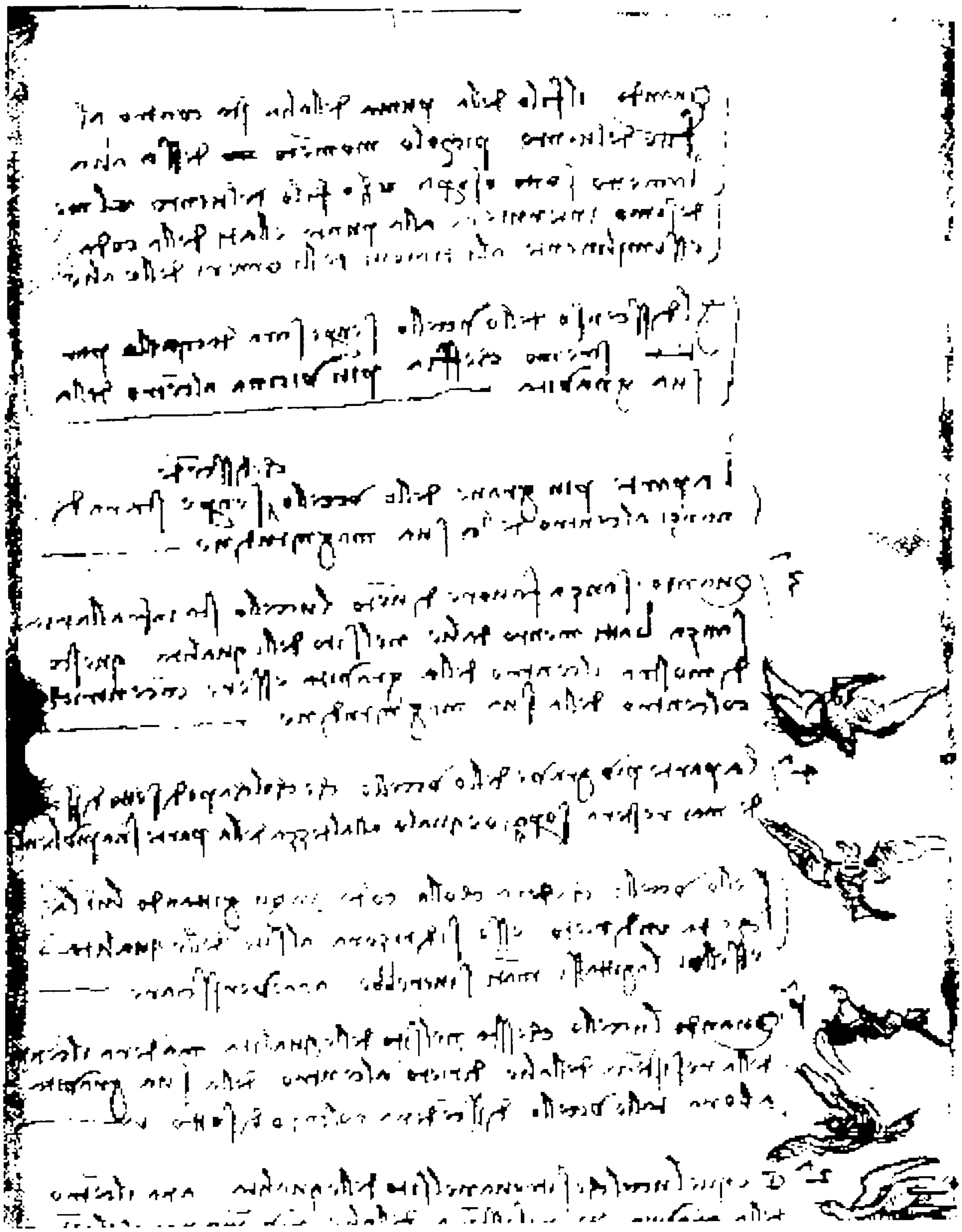
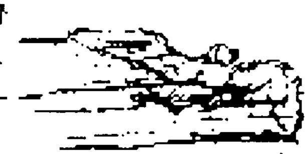
The descent of the bird will always be by that extremity which shall be the nearest to its centre of gravity. The heaviest part of the bird which descends will remain always in front of the centre of its mass.





FROM LEONARDO'S TREATISE ON THE FLIGHT OF BIRDS.
Paris, 1893.





FROM LEONARDO'S TREATISE ON THE FLIGHT OF BIRDS.
Paris, 1893.

When without help of the wind the bird remains in the air without flapping its wings, this shows that the centre of its gravity is concentric with the centre of its mass.

The man in the flying-machine to be free from the waist up that he may be able to keep himself in equilibrium as he does in a boat, so that the centre of his gravity and that of the instrument may set itself in equilibrium and change when necessity requires it to the changing of the centre of its resistance.

NOTE.–This paragraph refers to the figure of the man seen in Plate VIII. Of course a supporting surface above the man is presupposed. The interval between Leonardo's writing and Lilienthal's practical work is nearly four hundred years. The former has clearly shown that he understood the supporting power of aerocurves, and in this last paragraph he indicates a knowledge of the fact that the chief difficulty which a soaring man encounters is that of keeping his centre of gravity at all times in the right place. To appreciate Leonardo one must understand Lilienthal. See Mr. Chanute's "Progress in Flying-Machines," p. 285, line 30; and p. 286, line 1.–Ed.

Back to da Vinci page

cbbg

THE HISTORY OF LIGHTER-THAN-AIR

About 1650, a Jesuit Monk, Francesco de Lana suggested that a hollow sphere from which all air had been pumped should rise into the air. Unfortunately, such a proposition was impossible. Over a hundred years passed before anyone thought to reverse that idea. Instead of attempting de Lana's impossible suggestion, more practical men finally conceived the idea of filling a light weight container with some sort of gas that was inherently lighter than air.

Two brothers, Joseph Montgolfer (1740-1810) and Etienne Montgolfer (1745-1799) experimenting in Annonay near Lyons, France, in 1782, found that if they held a light paper bag over their kitchen fire, it would fill out into a "balloon" and would rise into the air. On June 5, 1783, they astonished the countryside (and possibly themselves) by sending up and unmanned hot-air balloon some thirty (30) feet in diameter and weighing all together some three hundred (300) pounds. Thereafter, the Montgolfers carried aloft a sheep, a rooster and a duck. The animals returned to earth unharmed and on October 15, 1783, Jean Francois Pilatre de Rozier (1756-1785) made the first human assent in history rising to a height of eighty-four feet and remaining aloft for four minutes and twenty-four seconds.

The first successful airship was constructed by Henri Giffard of France in 1852. That first airship was three hundred and fifty (350) pounds and had a three (3) horse power motor capable of traveling at a height of one hundred and forty-four (144) feet, at the rate of six (6) miles per hour.

The first airship capable of sustained, directed flight was that of two French army officers, Charles Renard and A.C. Krelo. Their dirigible, La France, was made of Hydrogen and traveled in its initial flight of five (5) miles at fourteen (14) miles per hour.

The most famous of all airships or Blimps was the Hindenburg, which was an eight hundred and four (804) foot (245 meter) long airship of conventional Zeppelin design that was first launched at Friedrichshafen, Germany in April, 1936. It had a maximum speed of eighty-four (84) miles per hour (135 km/h) and a cruising speed of seventy-eight (78) miles per hour (126 km/h). In 1936, the Hindenburg inaugurated commercial air service across the north Atlantic by carrying 1002 passengers on ten (10) scheduled round trips between Germany and the United States.

On May 6, 1937, while landing at Lakehurst, New Jersey, on the first of the scheduled 1937 transatlantic crossings, the hydrogen-inflated Hindenburg burst into flames and was completely destroyed; thirty-six (36) of the ninety-seven (97) persons on board were killed. The fire was generally attributed to discharge of atmospheric electricity in the vicinity of a hydrogen gas leak from the airship, though it has also been widely speculated that the dirigible was the victim of an anti-Nazi act of sabotage.

Today you can see the airship on TV almost at any major sports event. Modern non-rigid airships have become a powerful advertising tool. About 20 airships are currently in operation in the world with 14 of them flying in the US.

Produced by: Scott's Sites E-mail Webmaster@aeros-co.com

back to the Periodic Table

Hydrogen

For rocket fuel

Atomic Number:	1
Atomic Symbol:	H
Atomic Weight:	1.0079
Electron Configuration:	1

History

(Gr. hydro, water, and genes, forming) Hydrogen was prepared many years before it was recognized as a distinct substance by Cavendish in 1776.

Named by Lavoisier, hydrogen is the most abundant of all elements in the universe, and it is thought that the heavier elements were, and still are, being built from hydrogen and helium.

Sources

Hydrogen is estimated to make up more than 90% of all the atoms or three quarters of the mass of the universe. This element is found in the sun and most stars, and plays an important part in the proton-proton reaction and carbon-nitrogen cycle, which accounts for the energy of the sun and stars.

Hydrogen is thought to be a major component of Jupiter and that at some depth in the planet's interior the pressure is so great that solid molecular hydrogen is converted to solid metalic hydrogen.

In 1973, a group of Russian experimenters may have produced metallic hydrogen at a pressure of 2.8 Mbar. At the transition the density changed from 1.08 to 1.3 g/cm^3. Earlier, in 1972, a Livermore, California, a group also reported on a similar experiment in which they observed a pressure-volume point centered at 2 Mbar. Predictions say that metallic hydrogen may be metastable; others have predicted it would be a superconductor at room temperature.

Compounds

On earth, hydrogen occurs chiefly in combination with oxygen in water, but it is also present in organic matter such as living plants, petroleum, coal, etc. It is present as the free element in the atmosphere, but only to the extent of less than 1 ppm by volume. The lightest of all gases, hydrogen combines with other elements -- sometimes explosively -- to form compounds.

Uses

Great quantities are required commercially for the fixation of nitrogen from the air in the Haber ammonia process and for the hydrogenation of fats and oils. It is also used in large quantities in methanol production, in hydrodealkylation, hydrocracking, and hydrodesulfurization. Other uses include rocket fuel, welding, producing hydrochloric acid, reducing metallic ores, and filling baloons.

The lifting power of 1 ft^3 of hydrogen gas is about 0.07 lb at 0C, 760 mm pressure. Production of hydrogen in the U.S. alone now amounts to about 3 billion cubic feet per year. Hydrogen is prepared by

- steam on heated carbon,
- decomposition of certain hydrocarbons with heat,
- action of sodium or potassium hydroxide on aluminum
- electolysis of water, or
- displacement from acids by certain metals.

Liquid hydrogen is important in cryrogenics and in the study of superconductivity, as its melting point is only 20 degrees above absolute zero.

Tritium is readily produced in nuclear reactors and is used in the production of the hydrogen bomb. It is also used as a radioactive agent in making luminous paints, and as a tracer.

Consideration is being given to an entire economy based on solar- and nuclear-generated hydrogen. Public acceptance, high capital investment, and the high cost of hydrogen with respect to today's fuels are but a few of the problems facing such an economy.

Located in remote regions, power plants would electrolyze sea water; the hydrogen produced would travel to distant cities by pipelines. Pollution-free hydrogen could replace natural gas, gasoline, etc., and could serve as a reducing agent in metallurgy, chemical processing, refining, etc. It could also be used to convert trash into methane and ethylene.

Cost

The current price of tritium, to authorized personnel, is about $2/Ci; deuterium gas is readily available, without ›ermit, at about $1/l.

Heavy water, deuterium oxide (D2O), which is used as a moderator to slow down neutrons, is available without permit at a cost of 6c to $1/g, depending on quantity and purity.

Forms

Quite apart from isotopes, it has been shown that under ordinary conditions hydrogen gas is a mixture of two kinds of molecules, known as ortho- and para-hydrogen, which differ from one another by the spins of their electrons and nuclei.

Normal hydrogen at room temperature contains 25% of the para form and 75% of the ortho form. The ortho form cannot be prepared in the pure state. Since the two forms differ in energy, the physical properties also differ. The melting and boiling points of parahydrogen are about 0.1C lower than those of normal hydrogen.

Isotopes

The ordinary isotope of hydrogen, H, is known as Protium, the other two isotopes are Deuterium and Tritium. Hydrogen is the only element whose isotopes have been given different names. Deuterium and Tritium are both used as fuel for nuclear fusion reactors. One atom of Deuterium is found in about 6000 ordinary hydrogen atoms.

Deuterium is used as a moderator to slow down neutrons. Tritium atoms are also present but in much smaller proportions. Tritium is readily produced in nuclear reactors and is used in the production of the hydrogen fusion) bomb. It is also used as a radioactive agent in making luminous paints, and as a tracer.

Sources: CRC Handbook of Chemistry and Physics and the American Chemical Society.

Last Updated: 12/19/97, CST Web Team

Writings of Sir George Cayley

Arguably the most important paper in the invention of the airplane is a triple paper *On Aerial Navigation* by Sir George Cayley. The article appeared in three issues of Nicholson's Journal. In this paper, Cayley argues against the ornithopter model and outlines a fixed-wing aircraft that incorporates a a separate system for propulsion and a tail to assist in the control of the airplane. Both ideas were crucial breakthroughs necessary to break out of the ornithopter tradition.

We are not finished proofing the material, so please report any errors you find.

On Aerial Navigation, Part One.

On Aerial Navigation, Part Two.

On Aerial Navigation, Part Three.

Back to the Invention of the Airplane

Chemical Sciences

Chemical Thermodynamics

Heat and Enthalpy

Early Steam Engines

The first half of the eighteenth century marks the real beginning of both the technology and the science of heat. In these fifty years it became clear that heat could be employed to do useful work, replacing that of men, horses, wind, or falling water. Theoretical ideas, which were clearly formulated by the end of the century, began to develop before 1750. The two most important of these were the suggestion that heat might be conserved and the distinction between quantity of heat and quality of heat. Quality of heat, which we now call **temperature**, was taken up in earlier sections. Quantity of heat, or in modern terminology **enthalpy**, also taken up in earlier sections, was linked to work both theoretically and practically through the development of the steam engine.

Comparatively few power sources were available in 1800:

- Man (turning a crank), output 30 - 60 W
- Horse (turning a mill); output 300 - 450 W
- Waterwheel (6 metre, overshot); output 1.5 - 3.8 kW
- Windmills (large Dutch); output 1.5 - 10.5 kW
- Watt engine (500 in use by 1800); output 11 - 30 kW

Energy sources other than human muscles have a long history, dating back to beyond the dawn of history with the domestication of animals. The dog, probably the earliest animal to be domesticated, was used to assist in hunting and as a scavenger, but not as a source of power to replace human muscles. In the early Neolithic period, even as early as BC 6000, both goat and sheep may have been domesticated, but again were not used as power sources but for food and clothing.

Cattle, including oxen, and horses and donkeys were domesticated later, after settled agriculture had begun in Europe. Domestication occurred some time after BC 5000 and by BC 2000 these animals were in wide use for powering grain mills. Oxen were used for plowing and threshing, but the use of ox-harness on horses and donkeys reduced the power of a pulling animal from 15 times that of a man to 4 times. Since one horse eats about as much as 4 slaves, the economic advantages of replacement of slave labor with that of animals did not exist in the Roman Empire. In addition, effective horse-shoes did not penetrate Europe until after AD 900, while effective harness appears only from about the same time and is not prevalent in Europe until about AD 1300. In Roman times, the usual grain mill was operated either by two slaves or one donkey and had an energy output of perhaps 300 W.

During the Roman Empire, between BC 100 and AD 100, small horizontal water-wheels came into use to replace the slave-operated mills in areas where swiftly-flowing streams were available. These had about the same power output as the slaves they replaced, and spread slowly through even the early Middle Ages for domestic flour production. Water-mills using overshot and undershot wheels became known after AD 100; the known examples dating from AD 300 onwards have a power output of about 2 kW. In the Middle Ages the water-mills spread extensively and were used throughout Europe for grinding grain. Later water-mills were applied to irrigation, olive pressing, fulling cloth, making paper, and operating forging hammers, and could develop 70-100 kW.

Windmills do not appear to have been known in the ancient world; they seem to have been developed in Persia and penetrated Europe through Islamic areas after about AD 1000. They were used for corn-grinding by 1200. The use of windmills for drainage, as in Holland, dates from about 1400 and is extensive by 1500. The power of a large windmill is about 7.5 kW for an efficient Dutch design of about 1700, considerably less than that available from a large water-mill.

At the beginning of the eighteenth century the ideas of work and heat had not been placed, as they are now, under the embracing concept of energy. The idea of mechanical work was well established, however. A horse, properly harnessed, could clearly do more work than a man, and both windmills and watermills were well known throughout Europe.

It was in England, rather than in Continental Europe, that the need for work became acute. The forests of England had by then been considerably reduced. There was a considerable demand for coal for heating and, after 1709, for conversion into coke for the smelting of iron. Coal mines were then, and are still, subject to flooding and leakage of water from the surface into the mine. This water had to be removed, and in most mines this could only be done by lifting it up the mineshaft in buckets attached to a rope. Thus work came to be measured in terms of the foot-pound, which is the amount of work done lifting one pound of water (or any other mass) one foot against the force of gravity. In England, this may well have been due to a suggestion of Thomas Savery around 1700. We will use the English foot and pound in our discussion, but similar units were in use for the same purpose throughout the mining districts of Europe.

The Savery Engine

Figure is not available.

The Savery engine, shown in the above Figure, had a comparatively brief history. Invented in 1698 by Captain Thomas Savery, it began to be superseded by the Newcomen engine from 1712 and was out of use by 1730. The use of this engine was solely for the pumping of water out of mines, in which it replaced horses. It was an atmospheric engine, that is, one in which the power of the lift is provided by the pressure of the atmosphere. As a consequence it can lift water only about 32 feet, the height at which the pressure of a column of water equals that of the atmosphere. The operation of the Savery engine is shown in the Figure above. The maximum lift of water to the cylinder is 32 feet; the water can be forced higher into a reservoir by the pressure of the steam, but full steam pressure then appears in the boiler and as the lift increases the resulting boiler pressure increase is highly dangerous. The maximum additional pressure rise was probably about 2 atmospheres or another 60 feet; even this could produce boiler explosions. The method of operation is as follows. Valve V1 is opened to fill the cylinder with steam. Valve V1 is then closed and V2 is opened. The cylinder is cooled by the water, steam condenses, and water from the lower reservoir fills the cylinder. Valve V2 is closed and V1 again opened, and the steam expels the water into the upper reservoir through the one-way valves. The process is continued by closing V1 and opening V2, repeating the cycle. The engine has a tendency to become airlogged, because air dissolved in the water is driven out by heating in the boiler and air can not be condensed by cold water. This problem can be resolved by using some steam up the main pipe to the upper reservoir to blast out the accumulated air every so often even though Savery himself recommended against this "wasteful" practice.

The Newcomen Engine

The Newcomen engine had a longer useful life than the Savery engineand was altogether a much more successful device. It was developed by Thomas Newcomen in 1712 and began to be superseded, by Boulton-Watt engines, in the 1770's. It had become obsolete completely by about 1800. Like the Savery engine, it is an atmospheric engine obtaining its power from the pressure of the atmosphere, and its virtually exclusive use was in the pumping of flood waters out of mines. Unlike the Savery engine, the maximum distance of water lift by a Newcomen engine was not limited by the engine at all but only by the associated pumps.

Figure is not available.

The operation of the Newcomen engine is shown in the above Figure. The great beam is weighted at the pump so that the cylinder end is counterweighted upwards; the power stroke in the cylinder is down, the driving force being the pressure of the atmosphere. The plug frame, which is simply a board hanging from the great beam, uses tappets or plugs T1 and T2 to turn valve V2 between open and closed. A similar frame, not shown, operates valve V1 in a similar automatic fashion; this automatic valve gear was introduced in 1720. Operation of the engine is as follows: with V1 open and V2 closed, steam from the boiler fills the cylinder as the piston is moved upwards by the pump weight. The inrush of steam forces any air out through the snifting valve, preventing airlogging. When the piston reaches the top of its stroke the motion upwards of T2 opens V2 (and another tappet closes V1) so that cold water enters the cylinder. The steam thereby is condensed and the force of atmospheric pressure drives down the piston into the resulting vacuum, operating the pump. When the piston reaches the bottom of its stroke, the downward motion of T1 closes V2 (and another tappet opens V1) thus repeating the cycle. The condensed steam and warmed condensing water are returned to the boiler, thus effecting some saving in heat; this last is a minor later improvement.

The Newcomen engine used no high-pressure steam and thus was safe, reliable, and basically simple. It made no demands beyond the very limited technical resources of the early eighteenth century. It was also a powerful machine, economically at least equal and generally superior to any other available method of pumping water.

Following its invention and use in England, the Newcomen engine rapidly spread across Europe for use in the drainage of mines. In 1726 it was in Sweden, and 1725 in the mining areas of Slovakia. The engine was steadily improved by systematic empirical experimentation, especially that of J. Smeaton (1750 - 1775). This showed up as an increase in its efficiency, from 4.7 million foot-pounds/bushel of coal to about 9 million foot-pounds/bushel of coal.

[NEXT: James Watt and True Steam Power]

PRACTICAL EXPERIMENTS FOR THE DEVELOPMENT OF HUMAN FLIGHT.

BY OTTO LILIENTHAL.

(Written expressly for the Annual.)

WHOEVER has followed with attention the technical treatises on flying will have become convinced that human flight cannot be brought about by one single invention, but is proceeding towards its perfection by a gradual development; for only those trials have met with success which correspond with such a development.

Formerly men sought to construct flying machines in a complete form, at once capable of solving the problem, but gradually the conviction came that our physical and technical knowledge and our practical experiences were by far insufficient to overcome a mechanical task of such magnitude without more preliminaries.

Those proceeding on this basis therefore applied themselves, not to the problem of flying as a whole, but rather divided it into its elements, and sought first to bring a clear understanding into said elements which should form the basis of final success. For example, take the laws of atmospheric resistance, upon which all flying depends, and regarding which, until very recent years, the greatest uncertainty has existed; these have now been defined to such an extent that the different phases of flight can be treated mathematically. Besides which, the physical processes of the natural flight of the creatures have become the subject of minute investigation, and have in most cases been satisfactorily explained. The nature of the wind also, and its influence on flying bodies, have been carefully studied, thus enabling us to understand several peculiarities of the birds' flight hitherto unexplainable, so that one can apply the results thus obtained in perfecting human flight.

The theoretical apparatus needed for the technics of flying has been enriched so much by all these studies within the last few years that the elements of flying apparatus can now be calculated and constructed with sufficient accuracy. By means of this theoretical knowledge one is enabled to form and construct wing- and sailing-surfaces according as the intended effect renders it desirable.

But with all this, we are not yet capable of constructing and using complete flying machines which answer all requirements. Being desirous of furthering with all speed the solution of the problem of flight, men have repeatedly formed projects in these last few years which represent complete air ships moved by dynamos; but the constructors are not aware of the difficulties which await us as soon as we approach the realizing of any ideas in flying.

All those, who have occupied themselves to any extent with actual flying experiments, have found that, even if they mastered theoretically the problem of flying, the practical solving of the same can only be brought about by a gradual and wearisome series of experiments based one upon the other.

Also the practical tasks of the technics of flying should be simplified and divided as much as possible instead of steering straight to the final goal.

As these principles have been seldom carried out, the practical results in human flight have remained very scanty up to the present day.

One can get a proper insight into the practice of flying only by actual flying experiments. The journey in the air without the use of the balloon is absolutely necessary in order to gain a judgment as to the actual requirements for an independent flight. It is in the air itself that we have to develop our knowledge of the stability of flight so that a safe and sure passage through the air may be obtained, and that one can finally land without destroying the apparatus. One must gain the knowledge and the capacity needed for these things before he can occupy himself successfully with practical flying experiments.

As a rule the projectors and constructors of flying machines have not gathered this absolutely necessary practical experience, and have therefore wasted their efforts upon complicated and costly projects.

In free flight through the air a great many peculiar phenomena take place which the constructor never meets with elsewhere; in particular, those of the wind must be taken into consideration in the construction and in the employment of flying apparatus. The manner in which we have to meet the irregularities of the wind when soaring in the air can only be learnt by being in the air itself. At the same time it must be considered that one single blast of wind can destroy the apparatus and even the life of the person flying. This danger can only be avoided by becoming acquainted with the wind by constant and regular practice and by perfecting the apparatus so that we may achieve safe flight.

The only way which leads us to a quick development in human flight is a systematic and energetic practice in actual flying experiments. These experiments and exercises in flying must not only be carried out by scientists, but should also be practised by those wishing for an exciting amusement in the open air, so that the apparatus and the way of using it may by means of common use be quickly brought to the highest possible degree of perfection.

The question is therefore to find a method by which experiments in flying may be made without danger, and may at the same time be indulged in as an interesting amusement by sport-loving men.

Another condition is, that simple, easily constructed, and cheap apparatus should be used for such flying exercises, in order to conduce to a still more general participation in this sport.

All these conditions are easily fulfilled. One can fly long distances with quite simple apparatus without taxing one's strength at all, and this kind of free and safe motion through the air affords greater pleasure than any other kind of sport.

From a raised starting point, particularly from the top of a flat hill, one can, after some practice, soar through the air, reaching the earth only after having gone a great distance.

For this purpose I have hitherto employed a sailing apparatus very like the outspread pinions of a soaring bird. The drawings opposite page 22 represent such apparatus. It consists of a wooden frame covered with shirting (cotton-twill). The frame is taken hold of by the hands, the arms resting between cushions, thus supporting the body. The legs remain free for running and jumping. The steering in the air is brought about by changing the centre of gravity. This apparatus I had constructed with supporting surfaces of ten to twenty square metres. The larger sailing surfaces move in an incline of one to eight, so that one is enabled to fly eight times as far as the starting hill is high. The steering is facilitated by the rudder, which is firmly fastened behind in a horizontal and vertical position.

The machines weigh, according to their size, from 15 to 25 kilograms (33 to 55 lbs.).

In order to practise flying with these sailing surfaces one first takes short jumps on a somewhat inclined surface till he has accustomed himself to be borne by the air. Finally, he is able to sail over inclined surfaces as far as he wishes.

The supporting capacity of the air is felt, particularly if there is a breeze. A sudden increase in the wind causes a longer, stoppage in the air, or one is raised to a still higher point.

The charm of such flight is indescribable, and there could not be a healthier motion or more exciting sport in the open air.

The rivalry in these exercises cannot but lead to a constant perfecting of the apparatus, the same as, for instance, is the case with bicycles. I speak from experience, for, although the system of my sailing apparatus remains the same, it has gone through numberless changes from year to year.[1]

The apparatus which I now employ for my flying exercises contains a great many improvements as compared with the first sailing surfaces with which I commenced this kind of experiment five years ago. The first attempts in windy weather taught me that suitable steering surfaces would be needed to enable me to keep my course better against the wind. Repeated changes in the construction led to a kind of apparatus with which one can throw himself without danger from any height, reaching the earth safely after a long distance. The construction of the machine is such that it resembles in all its parts a strut frame, the joints of which are calculated to stand pull and pressure, in order to combine the greatest strength with the least weight.

An important improvement was to arrange the apparatus for folding which can be seen the most clearly in the figure opposite page 22. All of my recent machines are so arranged that they can be taken through a door 2 metres high. The unfolding and putting together of the flying implements takes about two minutes.

A single grip of the hands is sufficient to attach the apparatus safely to the body, and one gets out of the apparatus just as quickly on landing. In case of a storm the flying sail is folded up in half a minute and can be laid by anywhere. If one should not care to fold the apparatus, he may await the end of the storm under cover of the wings, which are capable of protecting twenty persons. Even the heaviest rain will not damage the apparatus. The flying apparatus, even if completely drenched, is soon dried by a few sailing flights after the rain stops, as the air passes through the same with great speed.

The latest improvements of the flying apparatus which I use for practical experiments refer to gaining of greater stability in windy weather.

My experiments tend particularly in two directions. On the one side I endeavor to carry my experiments in sailing through the air with immovable wings to this extent; I practise the overcoming of the wind in order to penetrate, if possible, into the secret of continued soaring flight. On the other hand I try to attain the dynamic flight by means of flapping the wings, which are introduced as a simple addition to my sailing flights. The mechanical contrivances necessary for the latter, which can reach a certain perfection only by gradual development, do not allow yet of my making known any definite results. But I may state that since my sailing flights of last summer, I am on much more intimate terms with the wind.

What has prevented me till now from using winds of any strength for my sailing experiments, has been the danger of a violent fall through the air, if I should not succeed in retaining the apparatus in those positions by which one insures a gentle landing. The wildly rushing wind tries to dash about the free floating body, and if the apparatus take up a position, if only for a short time, in which the wind strikes the flying surfaces from above, the flying body shoots downward like an arrow, and can be smashed to pieces before one succeeds in attaining a more favorable position in which the wind exercises a supporting effect. The stronger the wind blows, the easier this danger occurs, as the gusts of wind are so much the more irregular and violent.

As long as the commotion of the air is but slight, one does not require much practice to go quite long distances without danger. But the practice with strong winds is interesting and instructive, because one is at times supported quite by the wind alone. The size of the apparatus, however, unhappily limits us. We may not span the sailing-surfaces beyond a certain measure, if we do not wish to make it impossible to manage them in gusty weather. If the surfaces of 14 square metres do not measure more than 7 metres[2] from point to point, we can eventually overcome moderate winds of about 7 metres[3] velocity, provided one is well practised. With an apparatus of this size it has happened to me that a sudden increase in the wind has taken me way up out of the usual course of flying, and has sometimes kept me for several seconds at one point of the air. It has happened in such a case, that I have been lifted vertically by a gust of wind from the top of the hill (shown in Fig. 3), floating for a time above the same at a height of about 5 metres whence I then continued my flight, against the wind.

Although, while making these experiments I was thrown about by the wind quite violently and was made to execute quite a dance in the air in order to keep my balance, I yet was always,, enabled to effect a safe landing, but still I came to the conviction, that an increase in the size of the wings or the utilizing of still stronger winds which would lengthen the journey in the air, would necessitate something being done, to perfect the steering and to facilitate the management of the apparatus. This appeared to me to be all the more important as it is very necessary for the development of human flight that all, who take up such experiments, should quickly learn how to use the apparatus safely and understand how to use the same even if the air is disturbed. It is in the wind that this practice becomes so exciting and bears the character of a sport, for all the flights differ from each other and the adroitness of the sailing-man has the largest field for showing itself. Courage also and decision can be here shown in a high degree.

If such exercises are gone through with in a regular and approved method, they are not more dangerous than if one engages in riding, or sailing on the water.

Just as it is in sports on the water, so it is in sports in the air, that the greatest aim will be to reach the most startling results. The machines themselves, as well as the adroitness of their operators, will vie with each other.

He who succeeds in flying the farthest from a certain starting-point, will come forth from the contest as conqueror. This fact will necessarily lead to the production of more and more improved flying apparatus. In a short time we shall have improvements of which to-day we have not the faintest idea.

The foundation for such a development exists already; it only needs a more thorough carrying out to gain perfection. The greater the number is of such persons who have the furthering of flying and the perfecting of the flying apparatus at heart the quicker we shall succeed in reaching a perfect flight. It is therefore of paramount importance that as many physically and technically well trained men as possible take interest in these affairs, and that an apparatus be constructed which is as convenient and as cheap as possible.

The means by which I sought to facilitate the management of the machines and to increase their use in wind, consisted in the first place in different arrangements for changing the shape of the wings at will. I will, however, pass over the results here obtained as another principle gave surprisingly favorable results.

My experiments in sailing flight have accustomed me to bring about the steering by simply changing the centre of gravity.

The smaller the surface extension of the apparatus is, the better control I have over it, and yet if I employ smaller bearing surfaces in stronger winds, the results are not more favorable. The idea therefore occurred to me to apply two smaller surfaces, one above the other, which both have a lifting effect when sailing through the air. Thus the same result must follow which would be gained by a single surface of twice the bearing capacity, but on account of its small dimensions this apparatus obeys much better the changes of the centre of gravity.

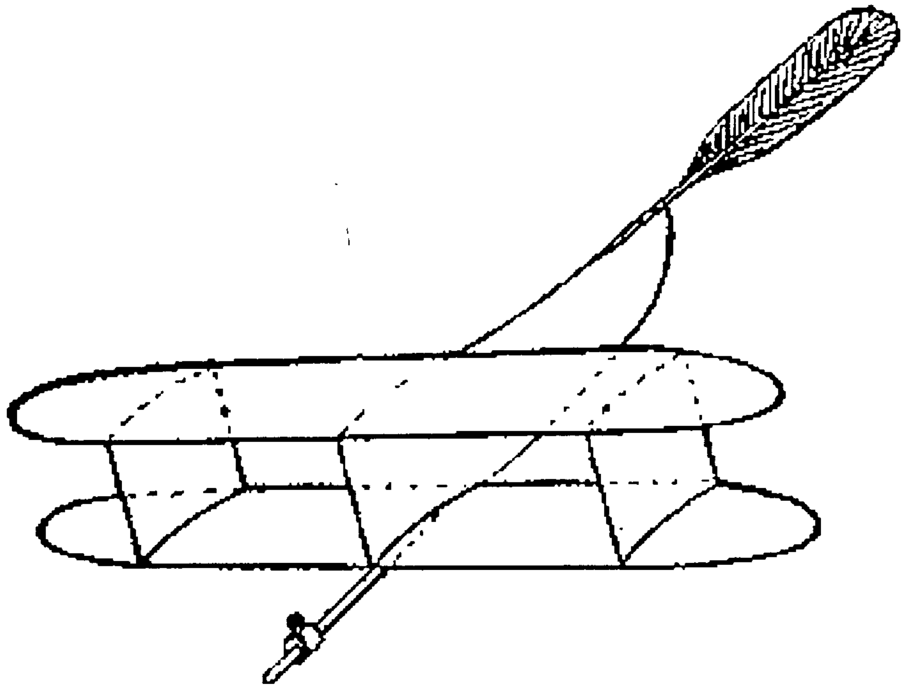
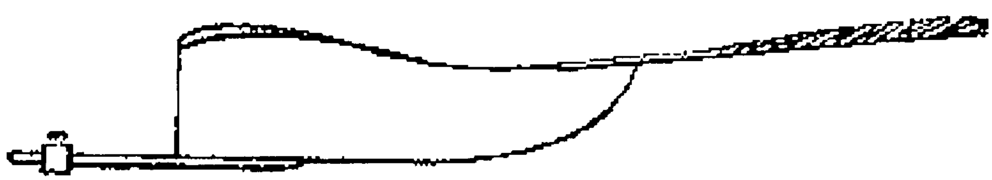


Fig. 1.

Before I proceeded to construct these double-sailing machines, I made small models in paper after that system, in order to study the free movements in the air of such flying bodies and then to construct my apparatus on a large scale, depending on the results thus obtained. The very first experiments with these small models, the form of which may be seen in Figs. 1 and 2, surprised me greatly on account of the stability of their flight. It appears as if the arrangement of having one surface over the other had materially increased the safety and uniformity of the flight. As a rule it is rather difficult to produce models resembling birds, which, left to themselves, glide through the air from a higher point in uniformly inclined lines. I need only recall the extensive and expensive experiments made by Messrs. Riedinger, von Sigsfeld, and von Parsefal, of Augsburg, which showed the difficulty of constructing models that would automatically take up a course of stable flight. I myself doubted formerly very much that an inanimate body sailing quickly forward, could be well balanced in the air, and was all the better pleased in succeeding in this with my little double surfaces.



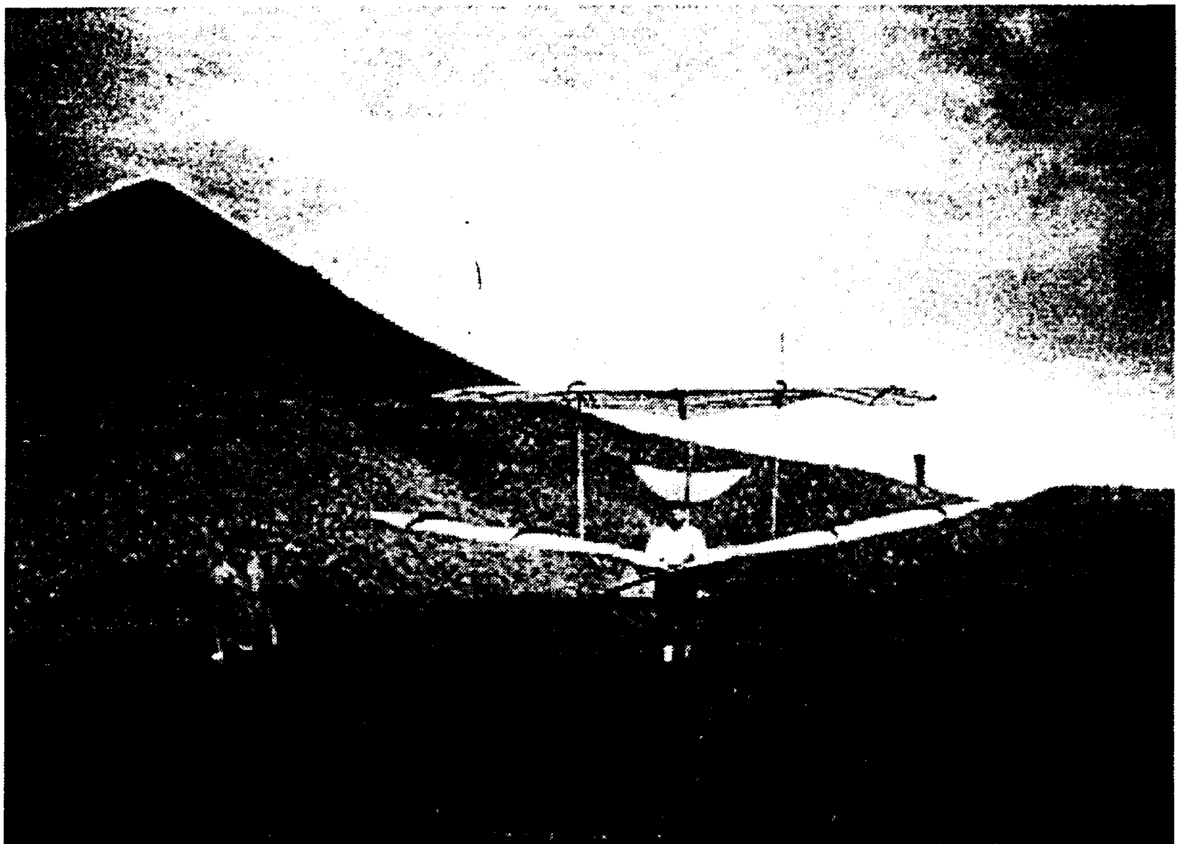


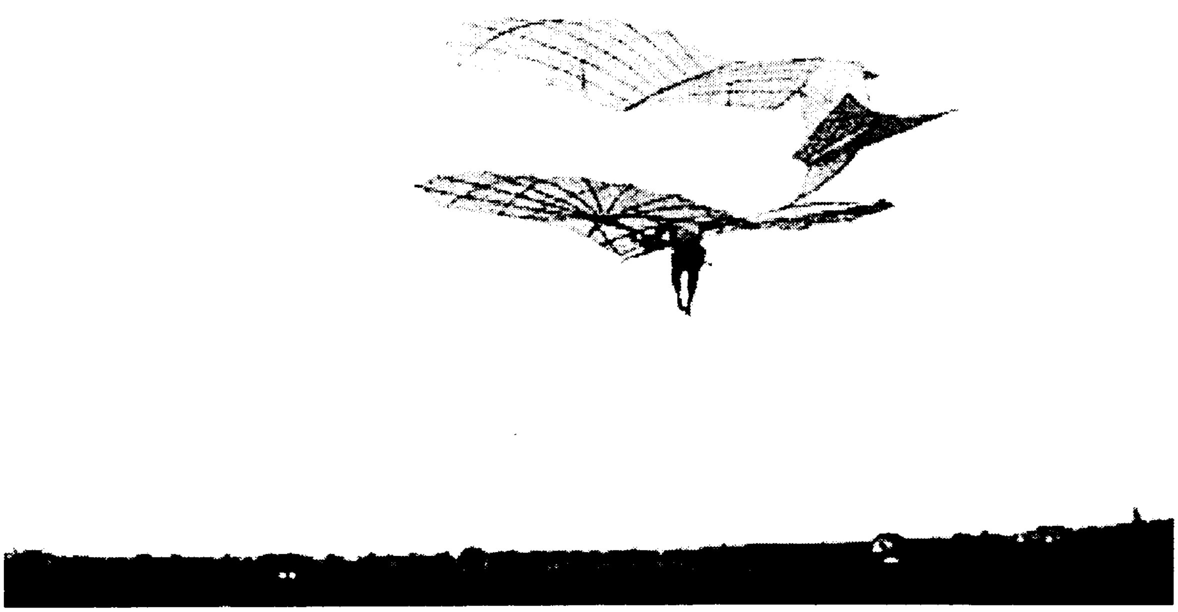
Fig. 3.

The upper surface is separated from the lower by a distance equal to three quarters of the breadth of the lower surface, and it has no disturbing influence whatever, but creates only a vertically acting lifting force. One must consider that with such an apparatus one always cuts the air quickly, so that both surfaces are met by the air-current, and therefore both act as lifters.

The whole management of such an apparatus is just the same as that of a single sailing surface. I could, therefore, use at once the skill I had already obtained.

Fig. 4 shows how I have to change the centre of gravity, and particularly the position of the legs, to the left. in order to press down the left wing, which is a little raised. In Fig. 5 the opposite movement to the right is shown. I retain the middle position, as shown in the frontispiece, whenever the apparatus floats horizontally.

Fig. 4.



The flights undertaken with such double sailing surfaces are distinguished by their great height, as is shown in Fig. 6, which gives a side-view of the apparatus.

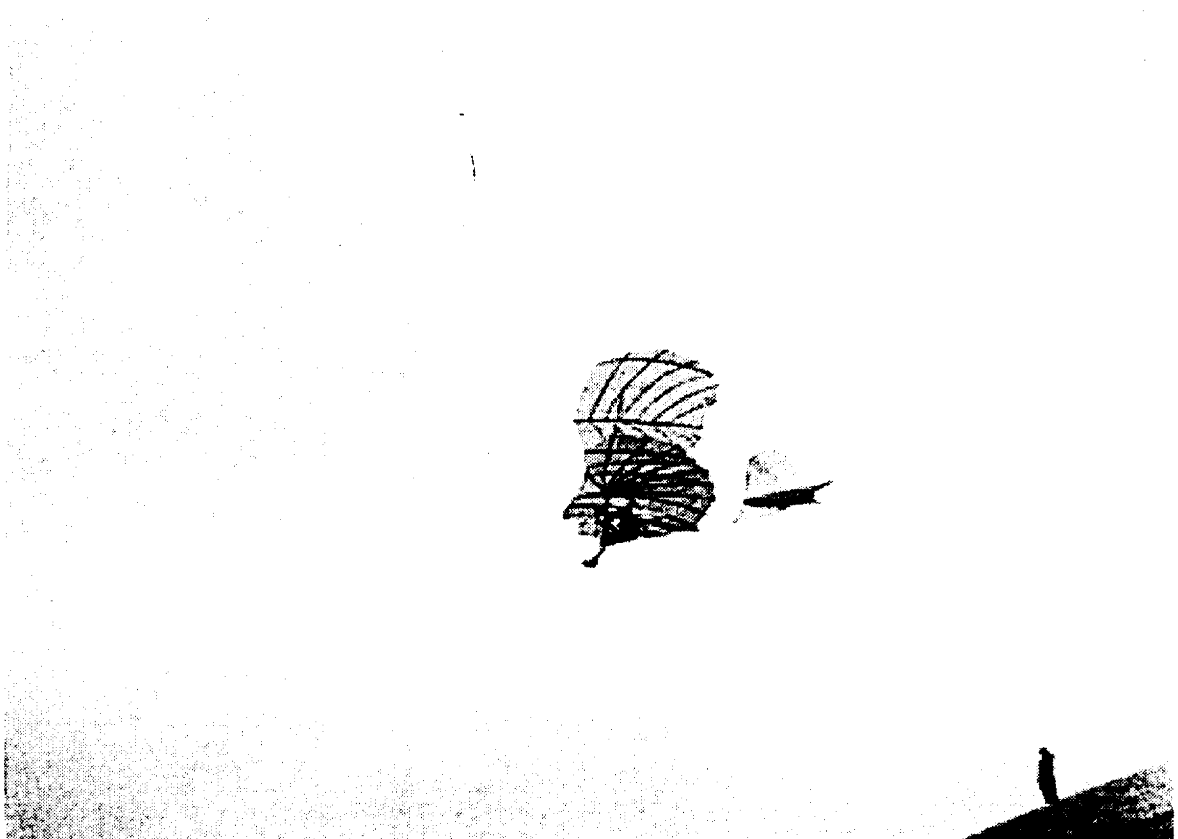


Fig. 6.

The landing with this apparatus is brought about in the same way as with the single sailing surfaces by raising the apparatus in front somewhat and by lessening the speed, as shown in Fig. 7.

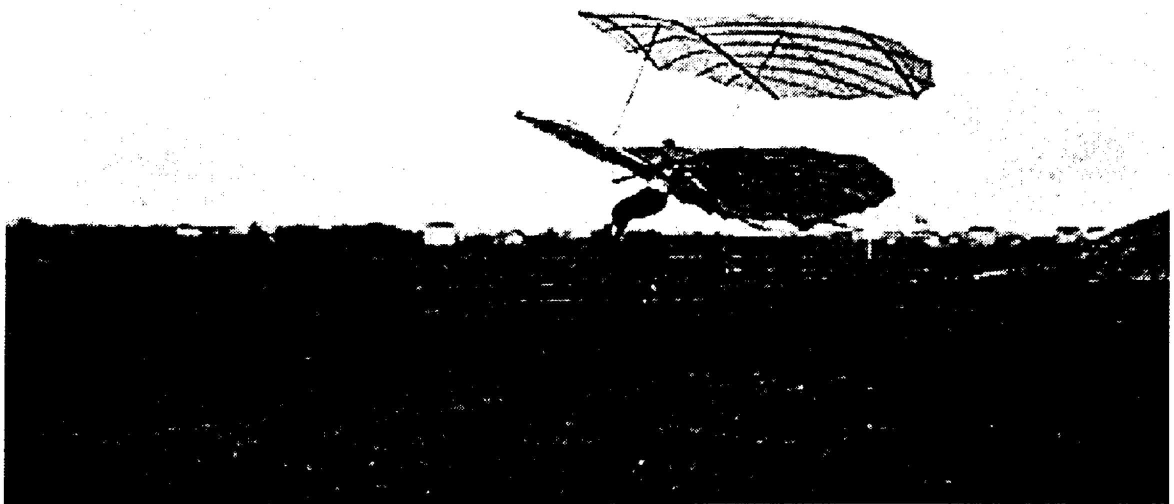


Fig. 7.

Fig. 8 shows an exact picture of the construction of the, apparatus, as well as of the management of the same.

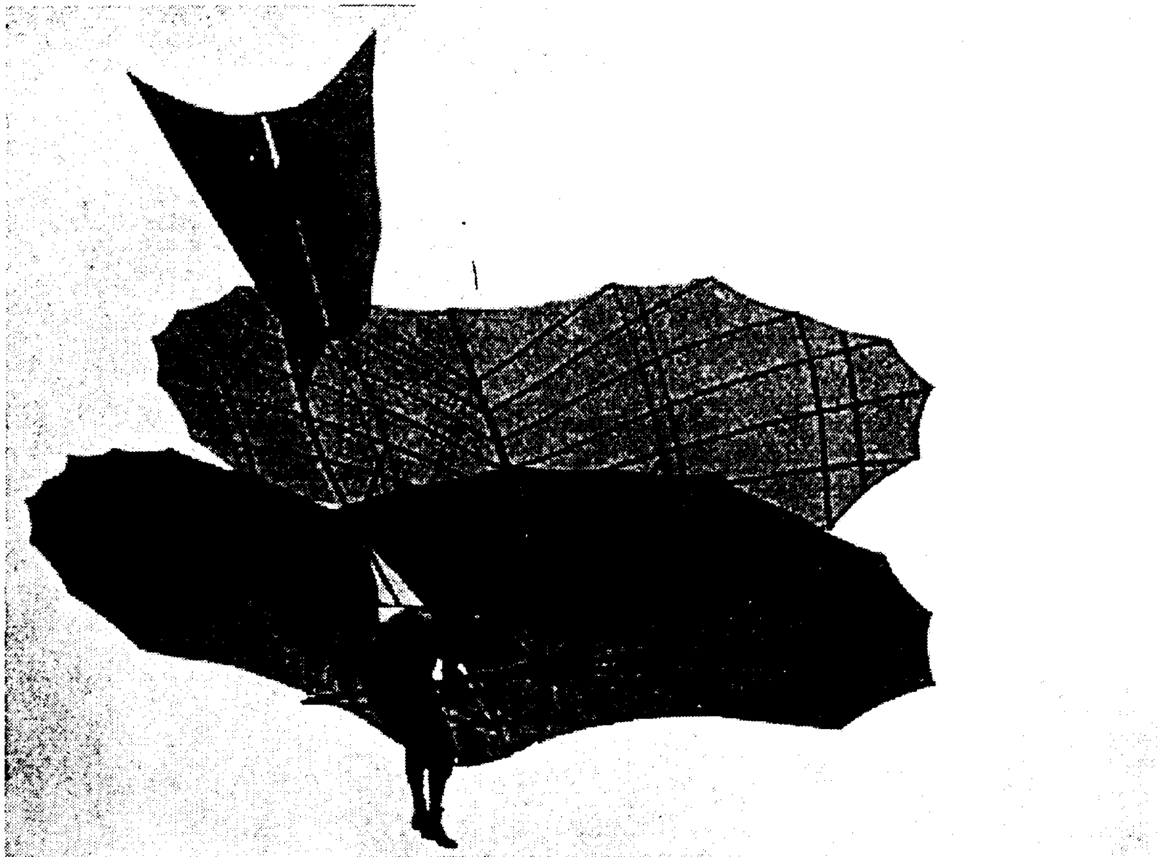


Fig. 8.

The energetic effect of the change of the centre of gravity and the safe starting of the apparatus obtained by it gave me courage to trust myself to a wind which at times exceeded a velocity of 10 metres (about 24 miles per hour).

Wind." It is no easy step from the theoretical conviction to the practical execution. The dexterity required to allow one's self to be borne by the wind alone, by describing well directed circles, is only understood by those who are well acquainted with the difficulties one encounters with the wind. And yet all that may be acquired by practice. When the time comes that athletic associations emulate each other, such results will not be long in following.

Moreover, experimenters will proceed from simple floating and sailing, which in any case form the foundation for practical flight, by degrees to flying with movable implements. As one is enabled to balance himself for some time in the air, the foundations for more extended dynamic effects are easily and safely attained. The different projects may be easily tried by adding the motor work to the simple sailing flight taken as a basis. In this manner one will soon find out the best methods; for practical experience in the air is far better than figuring on paper.

The only thing which may cause difficulties is the procuring of a suitable place for practising.

Just as the starting from the earth is rather difficult for larger birds, the human body, being still heavier, meets with peculiar difficulties at the first flight upward. The larger birds take a running start against the wind or throw themselves into the air from elevated points, in order to obtain free use of their pinions. As soon, however, as they float in the air, their flight, which was begun under special difficulties, is easily continued. The case is similar in human flight. The principal difficulty is the launching into the air, and that will always necessitate special preparations. A man will also have to take a running start against the wind with his flying apparatus, but on a horizontal surface even that will not be sufficient to free himself from the earth. But, on taking a running start from a correspondingly inclined surface, it is easy to begin one's flight even if there is no wind.

According to the example of birds, man will have to start against the wind; but as an inclined surface is necessary for this he needs a hill having the shape of a flat cone, from the top of which he may take starts against the wind in any direction .

Such a place is absolutely necessary, if one wishes to make flying experiments in a convenient way without being dependent on the direction of the wind.

For this purpose I have had an artificial hill, 15 metres high, erected near my house in Gross Lichterfelde, near Berlin, and so have been enabled to make numerous experiments. The drawings show this hill, or part of the same, from the outside. Fig. 9 represents a section of it, showing the cavity in the top intended for keeping the apparatus. At the same time the line of flight taken in calm weather is shown by dotted lines.

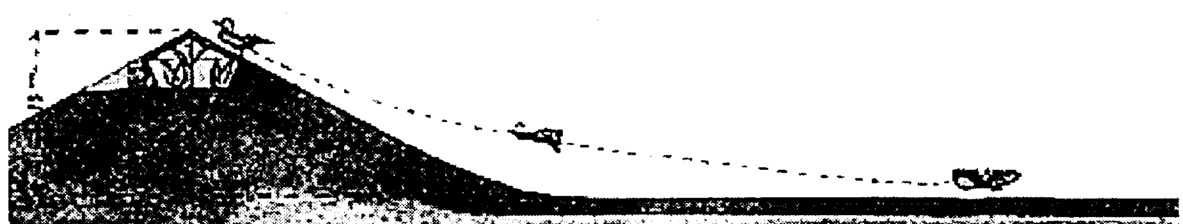


Fig. 9.

If a place for this sport is procured where young persons wishing to indulge in flight can disport themselves in the air, they will then have a chance to make instructive and interesting sailing flights, and I should advise having the hill twice as high, and to form it according to Fig. 10, so that one can commence the flights from a height of 30 metres. The cavity inside should be large enough to hold several complete machines.

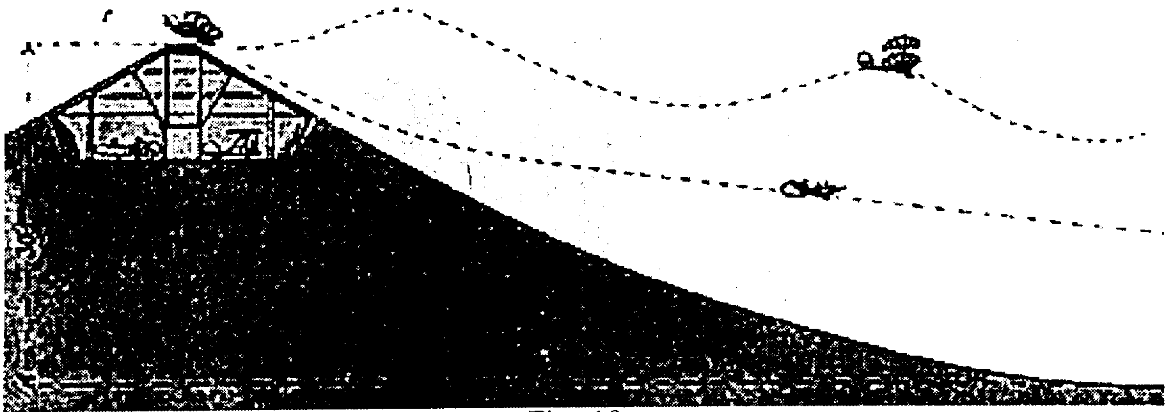


Fig. 10.

From such a hill one can take flight of 200 metres distance, and the floating through the air on such long distances affords indescribable pleasure. Added to which this highly exciting exercise is not dangerous, as one can effect a safe landing at any time.

Such a place in which young men can practise sailing flights and can at times make motor experiments with the wings would prove to be of great interest, both to those participating and to the public in general.

And when, from time to time, competitive flights were arranged, we should soon have a national amusement in this as in other sports which we have already. One can see even now that the pleasure and interest of the public in such races, when the gymnasts skilled in flights, shoot through the air, would be greater and more intense than, for instance, in horse or boat racing. The air is the freest element; it admits of the most unfettered movement, and the motion through it affords the greatest delight not only to the person flying, but also to those looking on. It is with astonishment and admiration that we follow the air gymnast swinging himself from trapeze to trapeze; but what are these tiny springs as compared to the powerful bound which the sailer in the air is able to take from the top of the hill, and which carries him over the ground for hundreds of yards ?

If the atmosphere is undisturbed, the experimenter sails with uniform speed; as soon, however, as even a slight breeze springs up, the course of the flight becomes irregular, as indicated in Fig. 10. The apparatus inclines now to the right, now to the left.

The person flying ascends from the usual line of flight, and, borne by the wind, suddenly remains floating at a point high up in the air; the on lookers hold their breath; all at once cheers are heard, the sailer proceeds and glides amid the joyful exclamations of the multitude in a graceful curve back again to the earth.

Can any sport be more exciting than flying? Strength and adroitness, courage and decision, can nowhere gain such triumphs as in these gigantic bounds into the air, when the gymnast safely steers his soaring machine house-high over the heads of the spectators.

That the danger here is easily avoided when one practises in a reasonable way, I have sufficiently proved, as I myself have made thousands of experiments within the last five years, and have had no accidents whatever, a few scratches excepted.

But all this is only a means to the end; our aim remains--the developing of human flight to as high a standard as possible. If we can succeed in enticing to the hill the young men who to day make use of the bicycle and the

Footnotes

[1] See article entitled "Wheeling and Flying."

[2] About 23 feet.

[3] About 22 miles

[4] About 97 sq. feet.

[5] About 18 feet.

[6] The photographs were made by Drs. Neuhaus and Fullerborn, who used a camera constructed by Dr. Neuhaus on the Stegemann principle.

Webmaster's note: This article appeared in the 1896 edition of James Means' *The Aeronautical Annual*, pp. 7-20. Scan by Cory Kotowsky; HTML and photos by Gary Bradshaw.

Samuel Pierpont Langley

Samuel Pierpont Langley (1834 - 1906) is often used as a contrast to the Wrights. Unlike the two brothers, Langley was highly-educated and had more than ample funding in support of his efforts to develop an airplane. His stature at Secretary of the Smithsonian Institution lent great credibility to his efforts to build an airplane, as did his success with the unmanned aerodromes. In particular, his Aerodrome No. 6 flew 4,200 feet at about 30 mph on November 28, 1896. This unmanned tandem-wing craft employed a lightweight steam engine for propulsion. The wings were set at a distinct dihedral angle so that the craft was dynamically stable, capable of righting itself when disturbed by a sideways breeze. There was no method of steering this craft, nor would it have been easy to add any means to control the direction the craft flew.

From the success of No. 6, Langley was able to convince the War Department (a.k.a. Department of Defense) to contribute $50,000 toward the development of a person-carrying machine. The Smithsonian contributed a like sum towards Langley's efforts. Charles Manley developed an extraordinary radial-cylinder internal combustion engine that developed 52 horsepower for the man-carrying Great Aerodrome. Langley felt it would be safest to fly over water, so he spent almost half of his funds constructing a houseboat with a catapult that would be capable of launching his new craft.

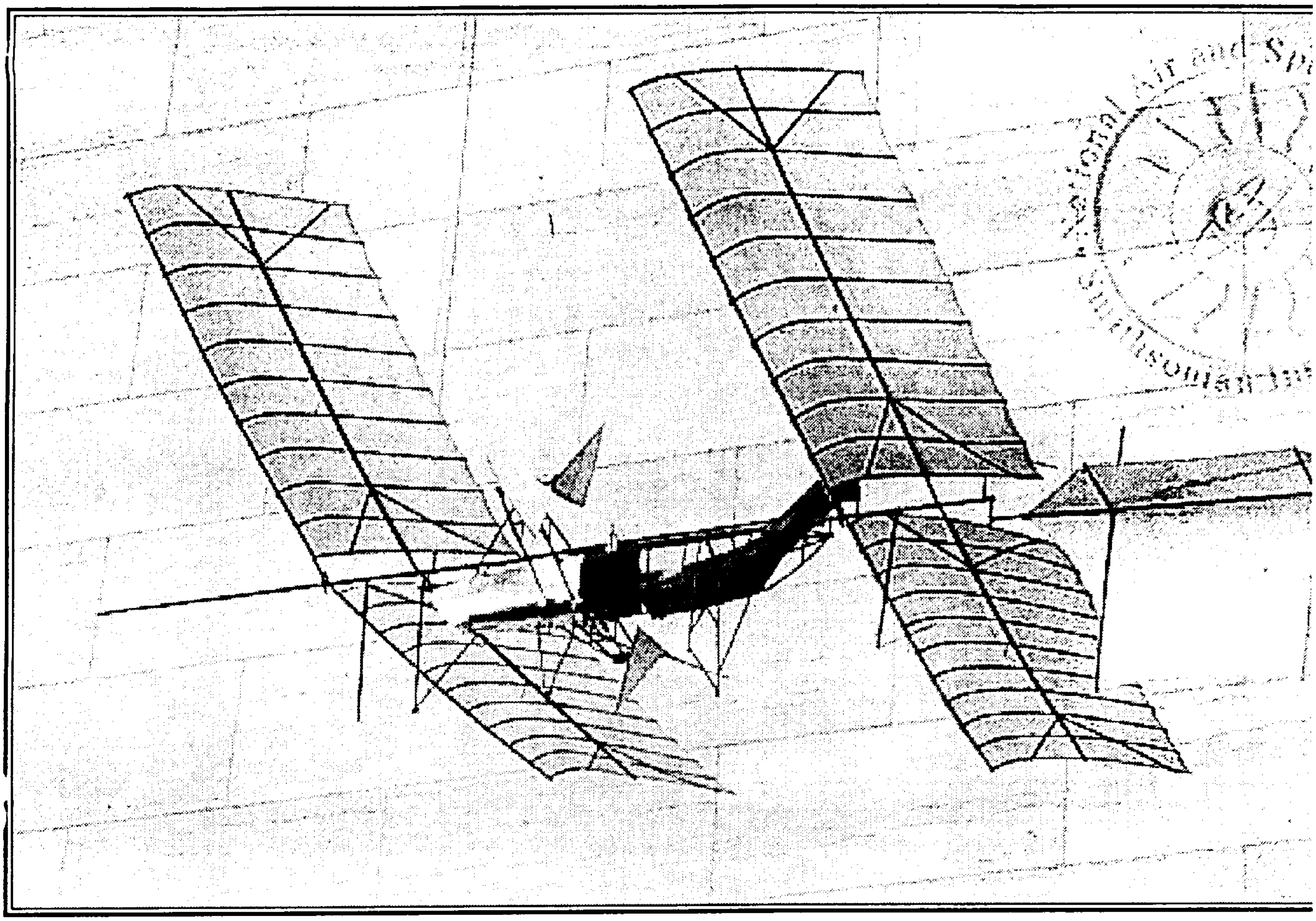
The Great Aerodrome *might* have flown if Langley had chosen a more traditional means of launching the craft from the ground. The pilot still would have lacked any means of steering the plane, and so faced dangers aplenty. But it might have at least gotten into the air. Unfortunately, Langley chose to stick with his 'tried-and-true' approach of catapult launches. The plane had to go from a dead stop to the 60 m.p.h. flying speed in only 70 feet. The stress of the catapult launch was far greater than the flimsy wood-and-fabric airplane could stand. The front wing was badly damaged in the first launch of October 7, 1903. A reporter who witnessed the event claimed it flew "... like a handful of mortar." Things went even worse during the second launch of December 9, 1903, where the rear wing and tail completely collapsed during launch. Charles Manley nearly drowned before he could be rescued from the wreckage and the ice-covered Potomac river.

Needless to say, the Washington critics had a field day. The *Brooklyn Eagle* quoted Representative Hitchcock as saying, "You tell Langley for me ... that the only thing he ever made fly was Government money." Representative Robinson characterized Langley as "a professor ... wandering in his dreams of flight ... who was given to building ... castles in the air."

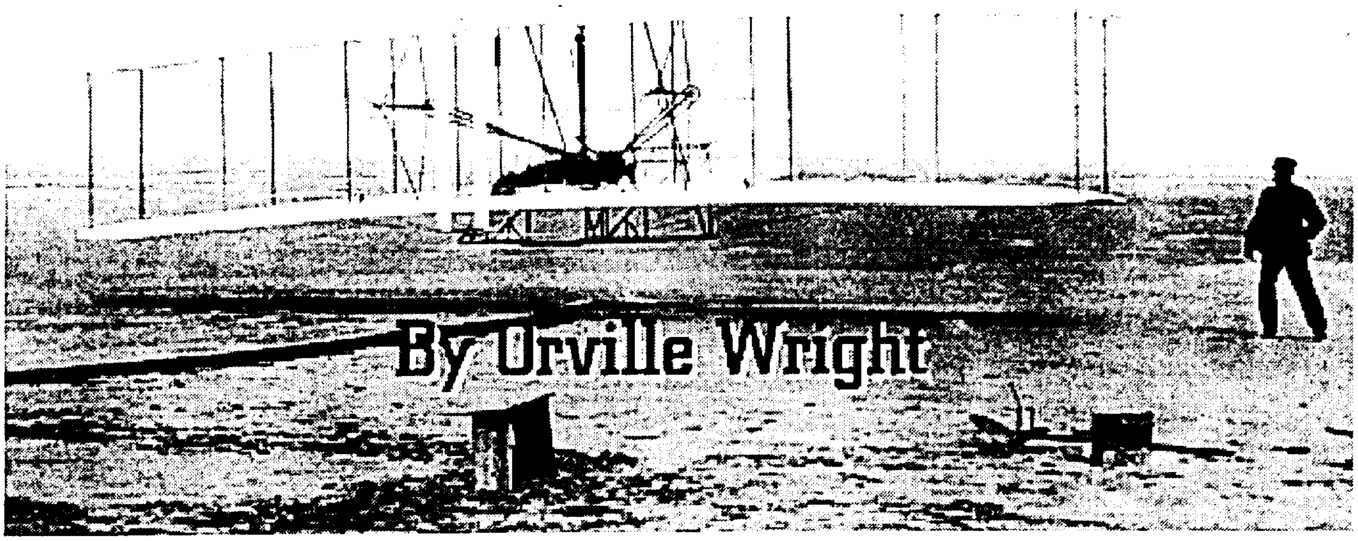
The War Department, in its final report on the Langley project, concluded "we are still far from the ultimate goal, and it would seem as if years of constant work and study by experts, together with the expenditure of thousands of dollars, would still be necessary before we can hope to produce an apparatus of practical utility on these lines." Eight days after Langley's spectacular failure, a sturdy, well-designed craft, costing about $1000, struggled into the air in Kitty Hawk, defining for all time the moment when humankind mastered the skies.

In spite of 18 years of well-funded and concerted effort by Langley to achieve immortality, his singular contribution to the invention of the airplane was the pair of 30-lb aerodromes that flew in 1986. He died in 1906 after a series of strokes, a broken and disappointed man.

Back to the Inventor's Gallery



How We Made The First Flight



How We Made The First Flight - by Orville Wright (With Frames for Netscape 2.0 users)
How We Made The First Flight - by Orville Wright (Without Frames)

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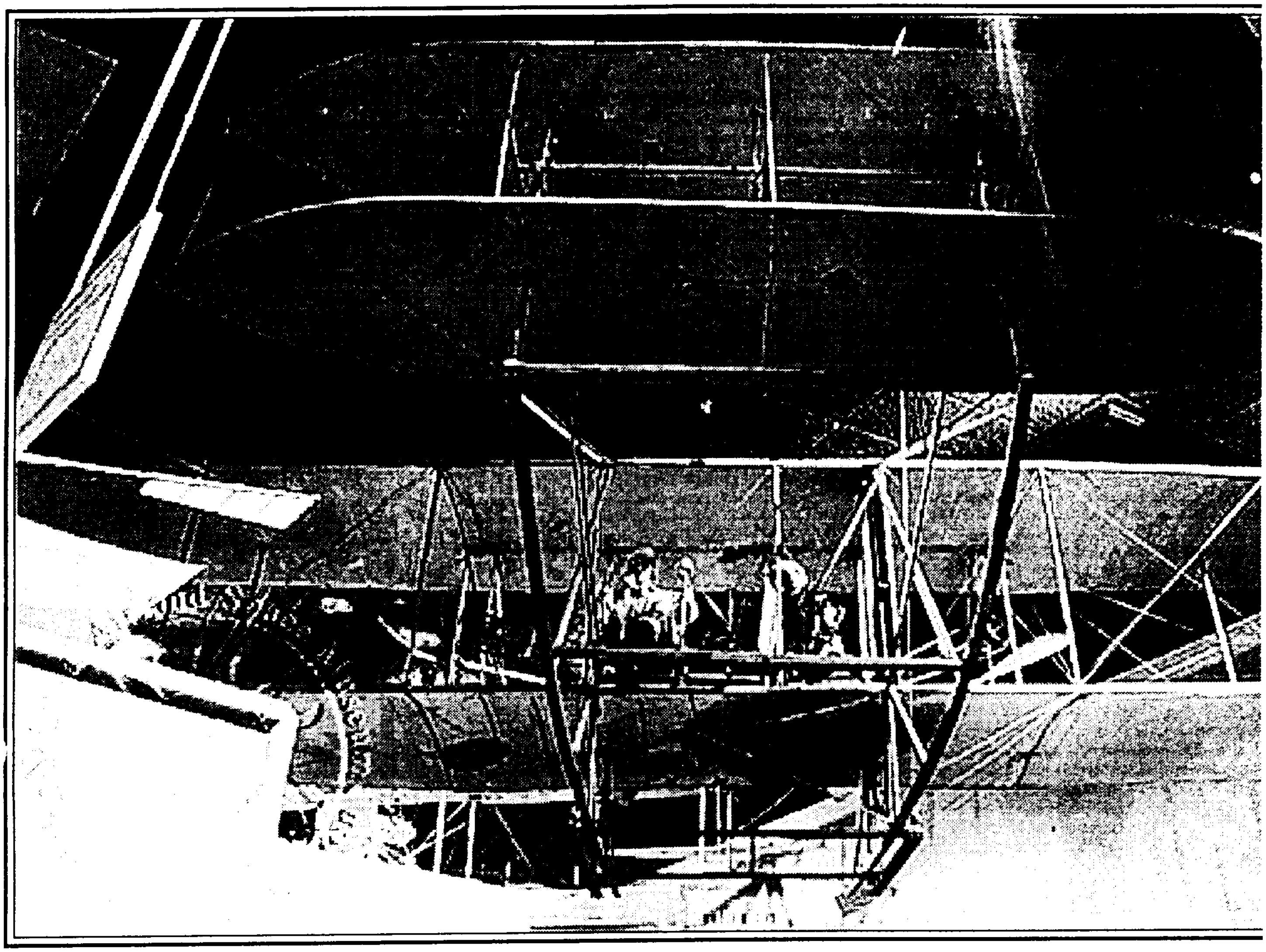
Comments/suggestions to air-info@brooklyn.cuny.edu



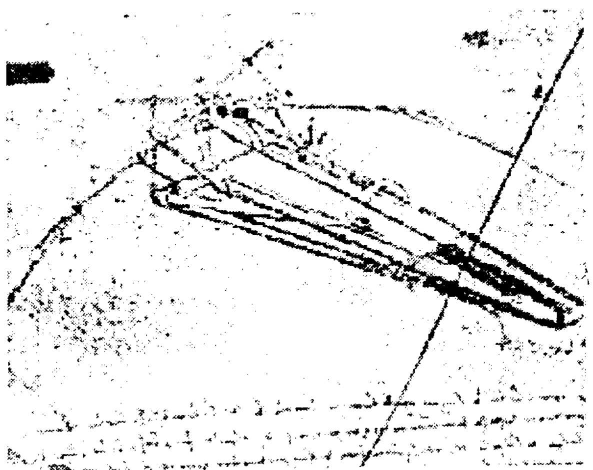
HISTORY OF THE BRAZILIAN AIR FORCE

ALBERTO SANTOS-DUMONT

Father of Aviation

The history of Alberto Santos-Dumont confounds itself with the conquest of the skies by Mankind.

Fly through the skies was always a Man´s dream. Many are the Ancient mythological characters who have the ability to fly; the Greeks had Daedalus and Icarus, the Romans the god Mercury, and the Nordics, the god Thor. To be able to fly represented Power - as the skies remained unconquered but for the birds, long after Man had mastered the lands and the seas.



The ornithopterus of Leonardo da Vinci.

Many were those that tried to fly over the years; there were those who tried to mimic the birds, attaching a pair of wings to their bodies, and throwing themselves from towers and walls, found their death. Those trials, without a scientific basis, did very little to fulfil that dream. By the middle of the XVth century, Leonardo da Vinci studied the wings of the birds, and designed many machines, like the *ornithopterus* (with flapping wings moved by human power), *helicopters* (with propellers driven by springs) and a *parachute* . He wrote more than 5,000 pages of notes about flight, and many problems were studied and solved, including how to compute the area needed to achieve flight; however his works were lost for almost three centuries.

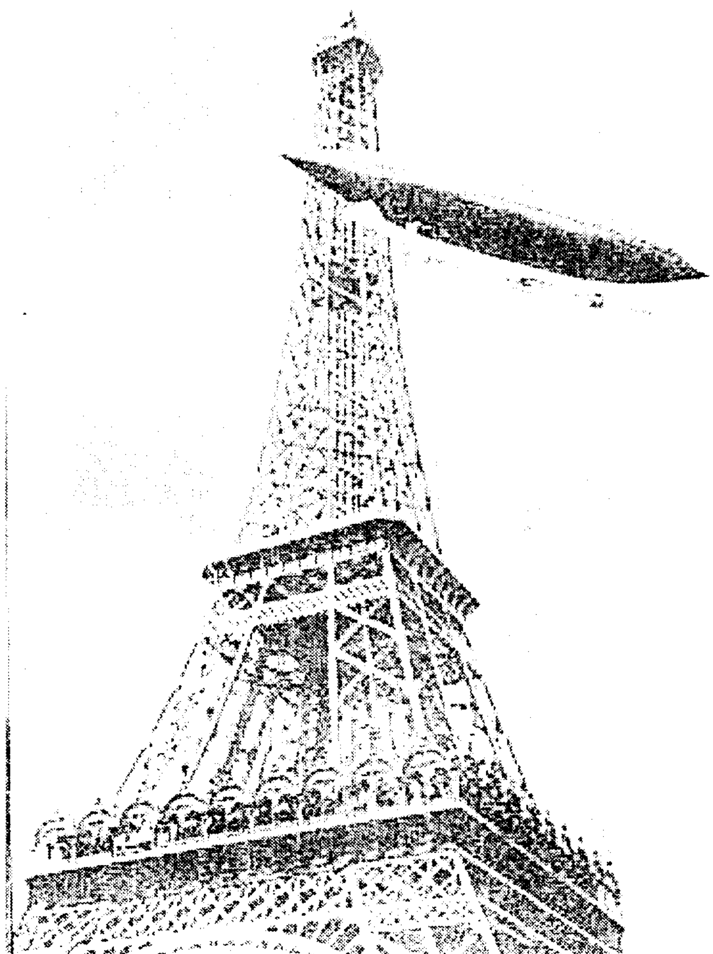
Others continued with their experiences, trying to fly. In 1709, the Brazilian priest Bartolomeu de Gusmão, born in 1685 in the village of Santos, showed to D. João V, King of Portugal, that a "lighter-than-the-air" artifact, or *balloon* , could take itself to the skies. On the 5th of August of 1709, a small paper balloon, having had warmed the air in its inside by a flame, took-off for 20 spans of a hand, inside a palace; some days later, the experience was repeated outside, and the balloon was elevated into the skies.

In 1783, the Montgolfier brothers built a balloon using the same hot air principle, which flew 2,000 metres high, on the 4th of June of the same year. With the discovery of the hydrogen gas, Jacques Charles filled a ballon with it and flew on 23 August 1783. Although dangerous, it had the advantage of allowing a longer flight to be performed.

However, those aircraft did only partially fulfil the dream of flight, since they did not allow for a controlled flight -- Man was still at the mercy of the winds. Some pioneers of the aviation tried to adapt vapour engines (Giffard, 1855) and electric engines with batteries (Renard e Krebs, 1884) to solve the controllability problem. Such experiences did not succeed, since the sheer weight of the engines made them impractical to be installed on a balloon. Only with the development of internal combustion engines by the end of the XIXth century would it be possible to solve this problem definitely.

Among these pioneers, we find two Brazilians: Júlio César Ribeiro de Souza, who in 1880 cubic metres, which was duly baptized as "Brazil". Soon he became one of the best flyers in Paris, although not without incidents, having become involved in a number of crashes.

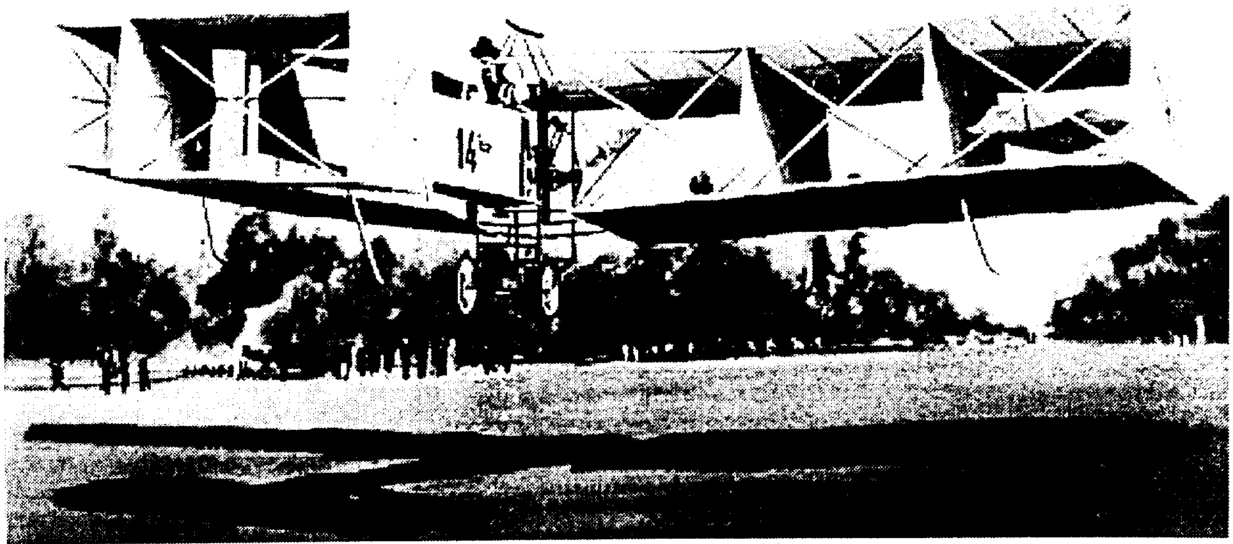
Santos-Dumont payed for his aeronautical activities with his own money (it cost him almost US$ 500,00 to fill a 620 cubic metres balloon in 1901). Several dirigible balloons were built by Santos-Dumont; he showed that it was possible to use petrol engines on hydrogen balloons, contrary to many people's ideas. His balloon *no. 2*, with a length of 25 metres, had a 1.5 CV power engine, weighing 30 Kg, driving a propeller at 1,200 r.p.m. The balloon *no. 2* flew slowly but steadily at his master's wishes!


Santos-Dumont going round the Eiffel tower with the dirigible no. 6.

Until July 1901, Santos-Dumont was known only to the aeronautical circles in Paris. On the 12th and 13th of that month, he flew around the Eiffel tower, watched by a crowd, piloting his dirigible balloon *no. 5*. From then onwards, Santos-Dumont became known to the international press. On 19 October 1901, he won the coveted 50,000 francs Deustch Prize. That prize had been instituted by the petroleum magnate Henri Deutsch de La Meurthe, to be given to first man who, between 1st May 1900 and 1st October 1903, would fly around the Eiffel tower, taking-off and landing from the field of Saint-Cloud. This had to be done by the aircraft own means and without landing during the flight, all to be completed in 30 minutes at most. At 2:42 PM, Santos-Dumont took-off with his dirigible *no. 6*, with 33 metres of length and 622 cubic metres; after 29 minutes and 30 seconds the *no. 6* was back at the starting point. With this flight, Santos-Dumont proved that Man could control his moving across the skies. It is worth of note that the flyer donated half of the prize (25,000 francs) to the poor people of Paris.

Santos-Dumont continued developing other dirigible balloons, but the challenge of building an aircraft "heavier-than-the-air" was also conquered by this pioneer. On 17 december 1903, the Wright brothers, in the USA, made use of a rudimentary catapult (with an inclined plan) to throw into the air their *Flyer* biplane, having flown close to the ground for a short hop of 40 metres (in subsequent flights they managed to fly for 200 metres). Santos-Dumont, however, would be the first to build and fly an aircraft "heavier-than-the-air" *by its own means of propulsion*.

In 1906, Santos-Dur took the nacelle of his dirigible balloon *no. 14* and added to it a fuselage and biplane wings, whose cellular structure resemble


Santos-Dumont and the 14-bis.

the kites still found nowadays in Japan. An Antoinette V8 engine of 24 CV power was installed ahead of the wings, driving a propulsion propeller; the airplane flew rear-first and was denominated *14-bis* (since it was descendent of the dirigible balloon *no. 14*). It had a wingspan of 12 metres and 10 metre-long fuselage, and had a tricycle fixed landing gear. Santos-Dumont developed what has to be called the first *flight simulator*, using winches and gears to let the *14-bis* roll down a plan, while he learned how to control the plane.

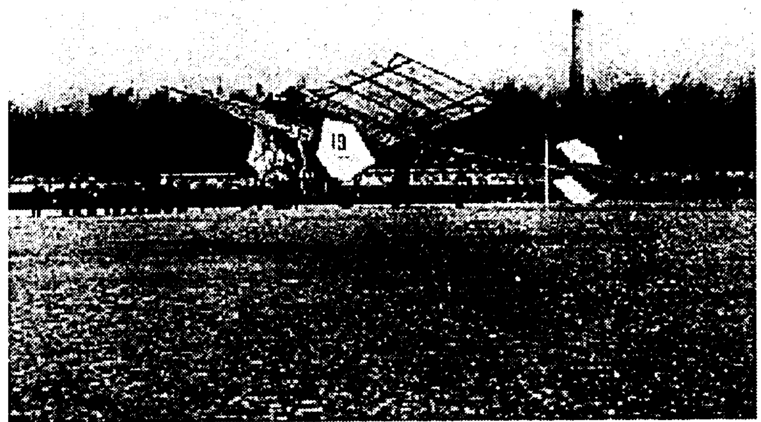
On 21 August 1906, Santos-Dumont made the first attempt to fly; it did not succeed, since the *14-bis* was underpowered. On 13th September, with a re-engined *14-bis* (now with a 40CV or 50 CV power engine which he obtained through Louis Bréguet), Santos-Dumont made the first flight, of 7 or 13 metres (according to different accounts), which ended with a violent landing, damaging the propeller and landing gear.

The historic flight of Santos-Dumont on the 14-bis at Bagatelle.

On the 23rd of October, Santos-Dumont flew from the field of Bagatelle, watched by a crowd and representatives of the Aero Club of France. By his own means of propulsion, the ***14-bis*** rolled for 100 metres and took off, flying for 60 metres in 7 seconds, in a level flight a few metres above ground. Santos-Dumont won the 3,000 francs Prize Archdeacon, instituted in July 1906 by the American Ernest Archdeacon, to honour the first flyer to achieve a level flight of at least 25 metres.

On 12 November 1906, Santos-Dumont improved even more the performance of the 14-bis and his flying ability, making several flights always increasing the distance flown, finally flying for 21.5 seconds at 5 or 6 metres above ground, covering 220 metres at a speed of 41 Km/h. Indeed, that primordial dream of Man - to fly free as a bird - was made reality on that

The flyer continued with his experiments, building other dirigible balloons, as well as the aircraft *no. 19* , initially called "Libellule" (later changed to "Demoiselle"). It was a small monoplane high wing, with only 5.10 metres wingspan, 8 metres long and weighing little more than 110 Kg with Santos-Dumont at the controls. With optimum performance, easily covering 200 metres of ground during the initial flights and flying at speeds of more than 100 Km/h, the "Demoiselle" was the last aircraft built by Santos-Dumont; he retired from his aeronautical activities in 1910.

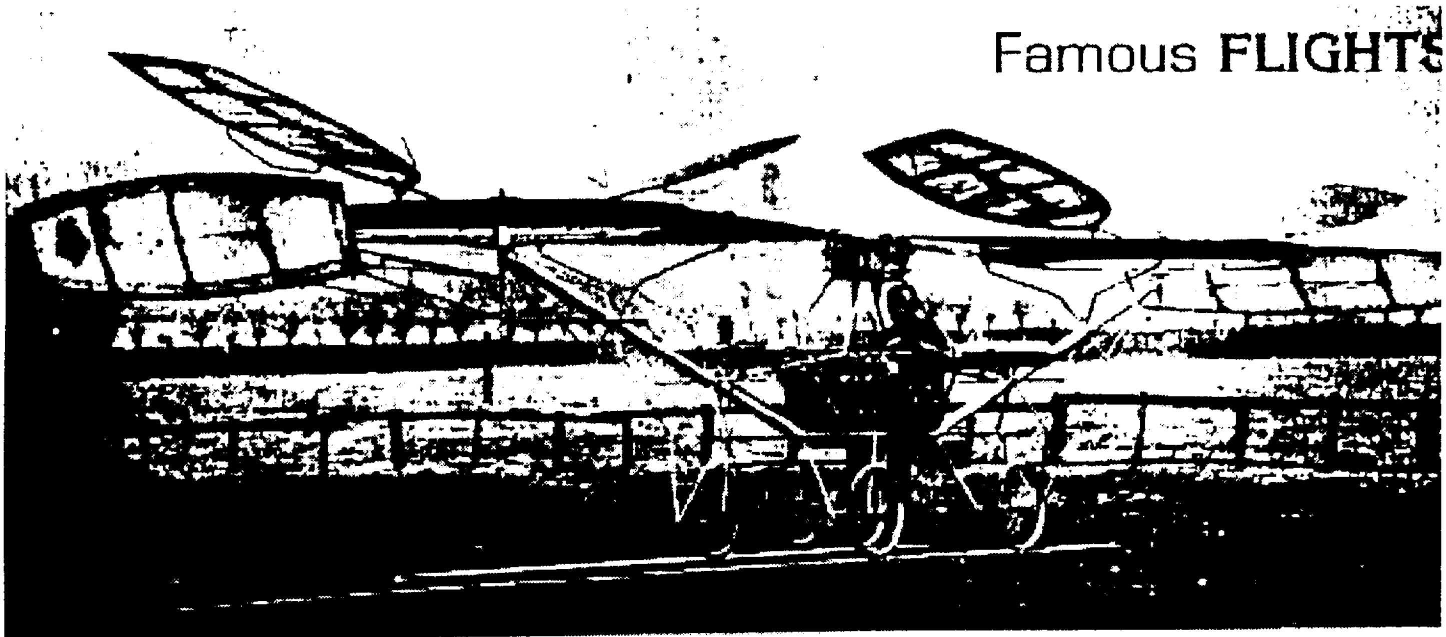

Santos-Dumont's no. 19, the 'Demoiselle'.

Santos-Dumont never accepted that his invention could be used for war purposes, which was so very well proved during the Great War of 1914-1918. He believed that an airplane was to be used to foster the well-being of people, as a means of transportation, and for leisure as well, as he had shown when travelling on his aircraft in Paris to go to the Ópera or visit friends. He went back to Brazil and died on 23 July 1932, at the town of Guarujá, State of São Paulo.

Brazil is proud of Santos-Dumont´s achievements and has payed him great homages, and on 22 September 1959 he was posthumously commissioned as Air-Marshall of the Brazilian Air Force; and on the seventieth anniversary of his memorable flight around the Eiffel tower on 19 October 1901, Santos-Dumont was declared "Patron of the Brazilian Air Force". More recently, on 23 October 1991, the title of "Father of Aviation" was posthumously bestowed upon Santos-Dumont by the Brazilian Government; the title of "Patron of the Brazilian Air Force" was transferred to a pioneer of the FAB, *Mar.-do-Ar Eduardo Gomes* .

Many and great are the aeronautical achievements of Mankind in this century; little less than 68 years after Santos-Dumont flew around the Eiffel tower, the north-american astronaut

Picture of the Week: November 8, 1996



Paul Cornu: One Piece of the Vertical Flight Puzzle

Development of the helicopter can be likened to a jigsaw puzzle with the correct placement of each piece solving such problems as lack of power, stability, control, and torque. From its earliest mention as a fourth century Chinese toy, the idea of vertical flight has intrigued succeeding generations with each contributing another piece to the puzzle, but progress was slow. In fact, it was not until the 1860's that vertical flight aircraft were even given a name. Viscount Gustave de Ponton d'Amecourt combined the words "heliko" (meaning spiral) and "pteron" (meaning wing) coining the word "helicopteres." It was only in the beginning of the 20th century that technology could even begin to make practical experimentation of full-size models possible.

After the Wright brothers proved that powered, manned flight was possible, the Deutsch-Archdeacon prize was offered to encourage the further growth of aviation. Named after its wealthy sponsors, the prize was offered to the first pilot to fly around a specified one kilometer (0.62 mile) course.

The race was on with the contestants experimenting with a variety of designs from fixed-wing aircraft to primitive helicopters. Of all the aircraft builders, only the Wrights had more than met the prize requirements with flights of more than 24 miles lasting over 30 minutes. However, for some reason they chose not to compete, leaving the field wide open to all the others, who had barely flown a quarter of the required distance. It is not surprising that nearly every hopeful aircraft inventor was scrambling for the 50,000 franc ($10,000) prize. One of these contestants was a French engineer, Paul Cornu from Lisieux, a firm believer in vertical flight.

In 1906 Cornu had flown successfully a model helicopter that weighed 28 pounds. Feeling he had a good chance to win the Deutsch-Archdeacon prize, he built a full-scale model that had been financed by 125 friends. They must have believed his sales pitch because each chipped in the then astronomical sum of 100 francs ($20). By August of 1907 he was ready to test fly the full-scale machine, but not confident enough yet to fly it himself. The "pilot" would be a 110-pound bag of sand. After a series of adjustments based on the results of the test flights, he was ready to act as test pilot.

Cornu's helicopter was a compact two-rotor machine measuring 40 feet 4 inches in length and weighing a total of 573 pounds. The framework consisted of 20-foot steel tubing bent to form a long wide U with the rotors mounted in tandem on either end. The paddle-shaped rotor blades were 5 feet 11 inches in length and linked by a leather drive belt running over pulleys above the pilot's head. It had two tilted wind vanes mounted under the main rotors that were supposed to propel the machine forward by deflecting the slipstream from the rotors backwards and downwards. However, it never functioned successfully as the driving force of the wind vanes was weak. The cockpit area was compact to say the least. The 24 horsepower Antoinette engine was practically in the pilot's lap and the pilot's seat was directly over the battery and the landing gear, which was composed of four bicycle tires.

On November 13,1907, Cornu took off in this ungainly looking ancestor of the helicopter and ascended to the staggering altitude of one foot and hovered there for about 20 seconds. This earned him a place in aviation history for making the first successful manned free flight in a helicopter. On later flights, he managed a height of five feet and was timed at six miles per hour in forward flight. He also gained, by accident, a record for two-person flight when his brother grabbed the craft's frame to keep it from tipping and ended up in the air instead. The brother apparently was not terribly impressed with his record-making flight, because the helicopter was tethered for all future test flights.

Over the next few months Cornu would lift off about 15 times and achieve forward and backward movement in more than 300 flight attempts. Then the unthinkable happened on January 13. Henry Farman's fixed-wing aircraft flew around the one kilometer course and won the Deutsch-Archdeacon prize.

Paul Cornu gave up his helicopter experiments in 1909. He could not seem to conquer problems involving the aircraft's severe lack of control and stability in flight. More importantly, he lacked the money to continue his experiments, so he faded from vertical flight history. Although his helicopter was not as successful as he had anticipated, Cornu had added one more piece to the vertical flight puzzle -- the first true "free flight" of a manned helicopter.

The emergence of the total picture would have to wait 30 years for Igor Sikorsky to successfully develop the first practical helicopter. By the mid-1940's another tandem helicopter was developed -- this time successful -- by Frank Piasecki. No doubt its nickname, the "Flying Banana," would have brought a smile of irony and pride to a certain French engineer.

FAA Aviation News /July - August 1991, contributed by P. Felton.

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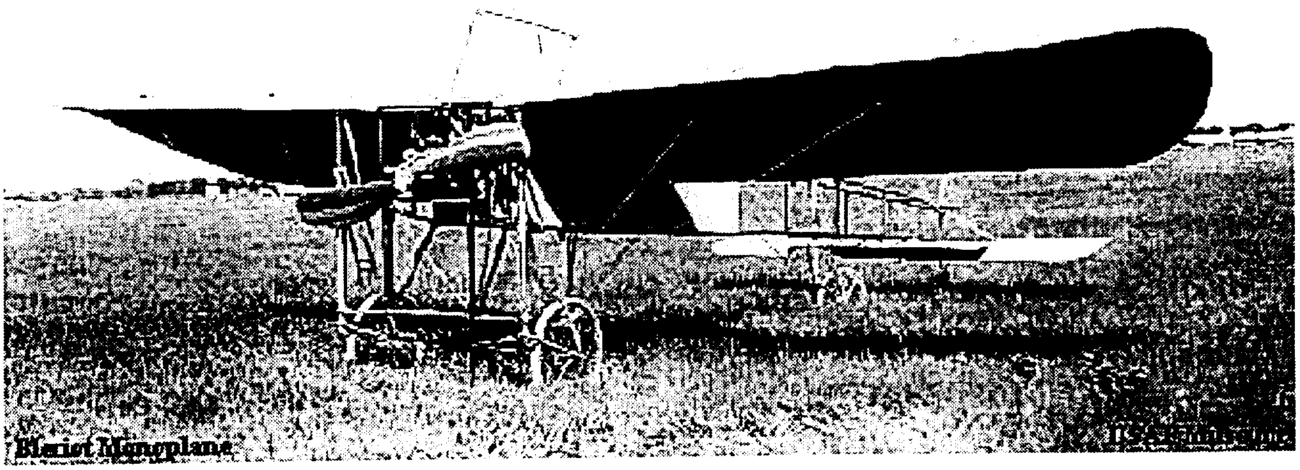
BLERIOT MONOPLANE



The Bleriot monoplane is one of the most significant of pre-WW I aircraft. It first achieved fame in 1909 when its designer, Louis Bleriot of France, flew one to Dover, England on the first flight across the English Channel.

During the early days of WW I, both the British and French used two-seat Bleriots for reconnaissance behind German lines. By 1915, Bleriots were outclassed by more advanced airplanes and they were relegated to training Allied aviators including many Americans who joined the British and French flying services prior to U.S. Air Service entry into the war. By 1917, Bleriots were being used only as ground trainers. Many members of the U.S. Air Service sent to France for flight training received their first instructions in Bleriots with "clipped" wings which prevented them from taking off. At full throttle, the fledgling pilots bounced across the airfield, learning to control the rudder with their feet; once they could keep the Bleriot on a fairly straight course, they advanced to an airplane which could leave the ground.

The Bleriot on display was built by Mr. Ernest C. Hall (Ohio Director of Aeronautics prior to WW II) of Warren, Ohio in 1911 from factory drawings. In it, he taught himself to fly. Mr. Hall donated the aircraft to the Museum in 1969.

More Bleriot images...

- As displayed

SPECIFICATIONS
Span: 28 ft. 6 in.
Length: 25 ft. 3 in.
Height: 8 ft. 4 in.
Weight: 700 lbs. loaded
Engine: Anzani three-cylinder of 20 hp.

PERFORMANCE
Maximum speed: 45 mph.

Go to the next Display

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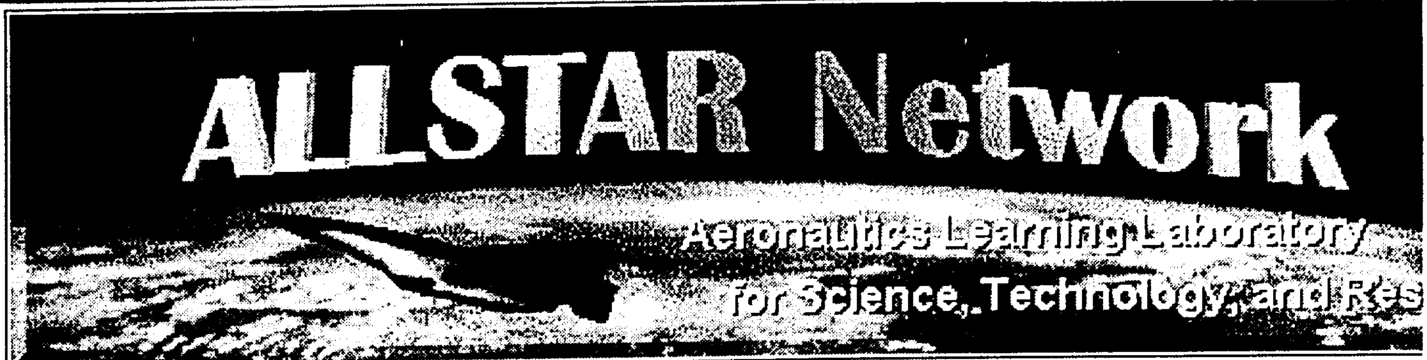


Harriet Quimby

In her purple wool knickers and satin monks hood, Harriet Quimby cut quite a figure in early aviation. Described as "beautiful and willowy" by her contemporaries, she dared to fly when women were barely allowed to drive automobiles.

Harriet was born in Ovid Township, just south of Coldwater, MI on May 11, 1875. She was the youngest of two daughters of Irish immigrants. Her father, William Quimby, served as a cook in the Union Army and her mother, Ursula Cook, of Niagara New York, was determined to make a better life for herself and her family. William took up farming, but never made a success of it. In 1884, the family moved to Arroyo Grande, a small community in the San Luis Obispo area between Los Angeles and San Francisco. When that farm failed, William took a job on a neighboring dairy farm. During the 1890's, William opened a general store that also failed. Ursula convinced William to move to San Francisco to start a cottage industry in herbal cures while Ursula sewed prune sacks to make extra money to send her daughters to better schools.

Ursula was a strong believer in women's emancipation. Her own health had been ruined by farm work and she wanted a better life for her daughters. When Harriet's sister Kitty chose to marry, Ursula was deeply disappointed and focused all her energies on Harriet. She created a new identity for Harriet, telling everyone that her daughter was born in 1884 (instead of 1875) in Boston and had attended school in Switzerland. Sometimes Ursula said that William was a member of the Consulate service, and other times, a wealthy collector. She shrewdly knew that this new, younger, wealthier identity would give Harriet entree into more elite social circles. Journalism was a field that was opening for women, so Ursula pushed her daughter toward this career.

Around 1900, Harriet was working at the Dramatic Review in San Francisco and later at the Call-Bulletin & Chronicle where she wrote Sunday features. Her writing style was vivid - with a real talent for taking her readers and letting them see, smell, hear and touch the same things she did. She dreamed of one day writing a novel - when she had the time and money. While she never support the emancipation movement (she thought them too extreme), she often forwarded women's causes. Whenever possible, Harriet's articles were filled with tips on how women could find safe and inexpensive lodging, jobs and improve them selves.

By 1903, Harriet's fame had spread and she moved to New York. She quickly found work as a part time freelancer at Leslie's Illustrated Weekly. Her first article appeared on Jan 22, 1903. By 1904, she was promoted to a full time position at Leslie's. In 1906 she was their resident drama critic, noted for her fair and comprehensive coverage, and editor of the Women's Page. She often traveled unescorted and visited Cuba, Egypt, South America, and Africa as Leslie's first travel correspondent. Also in 1906, she attended a motor car race and convinced a driver to take her for a spin around the track. The 60 mph adventure fueled her taste for speed. She quickly obtained her own car and drivers license - and championed women drivers.

In late October 1910, at the invitation of her best friend Matilde Moisant, Harriet went to the Belmont Park Air Show. Matilde's brother, John, was a featured flier and wrecked three planes during the course of the show - walking away unharmed each time. He called himself the 'king of aviation,' and beat the best pilots Europe had to offer in the Statue of Liberty race, a daring 36 air mile, 34 minute flight. Flying looked easy and glamorous to Harriet and she convinced Matilde to arrange a dinner with her brother John and balloon pilot A. Leo Stevens. John agreed to teach Harriet and Matilde in the spring as he was off to air shows in the south for the winter. But John was killed in an airplane crash in New Orleans on December 31, 1910. Alfred Moisant, John and Matilde's brother took over the air school and on May 10, 1911, Harriet and Matilde enrolled at Moisant's aviation school on Nassau Boulevard on Long Island.

To draw less attention, Harriet's lessons were at dawn, but word soon leaked out. When the newspapers found out, they called her the 'Dresden China aviatrix.' Harriet thrived on the publicity and by May 25, even Leslie's Weekly capitalized on their reporter's lessons with a series of articles and opinions from Harriet. On July 31, 1911, after five weeks of lessons, involving progressively more control of the plane, she took her pilot's exam. The test, consisting of figure-8's and landing, was supervised by officials from the Aero Club of America who did not want to allow her to take the test, believing that a woman was incapable of flying. She passed the flight part of the exam, but failed the landing test when she touched down more than the proscribed 100 feet from the takeoff point. A second test was grudgingly arranged for the next day and on August 1, 1911 Harriet set a landing accuracy record of 7'9" from the mark and was awarded her license - the very first one granted to a woman in the United States.

On September 4, 1911, Harriet set her first official record at the Richmond County Fair. She took off at night across the narrows of New York harbor and climbed to about 2000 feet and then swooped low over the crowds and judges. The applause was so loud and wild that she did it again. Through 1911, she had little trouble finding ways to make money in aviation. She routinely won contests and gave paid demonstration flights. In October, 1911, Harriet joined Matilde and the Moisant International Aviators Exhibition team on a trip through Mexico.

During the winter of 1911-1912, Harriet began planning her most daring flight: the flight across the English Channel. On March 7, 1912, Harriet sailed to Calais to meet Louis Bleriot and see his new 70 HP airplane. Disappointed that the plane would not be ready for many weeks, she agreed to borrow one of his 50 HP planes to make the crossing. She packed the plane up and headed for England. Fighting terrible weather, she waited and waited, fretting that someone else would beat her to the record. On Tuesday, April 16, 1912, the weather cleared slightly and she decided to make a go of it. After a short lesson in how to use a compass, she took off in the fog at 5:30 am. The 22 mile flight took 59 minutes - almost all of it spent in thick fog. She landed on a beach in France and was greeted as a conquering hero.

Harriet dreamed of the adulation that she would receive - but her daring feat hardly earned a mention in the papers. The sinking of the Titanic sunk Harriet's story as well.

Harriet was determined to earn some financial security after her Channel crossing. A. Leo Stevens, her long time friend and business manager, knew that she was a fabulous drawing card for the 1912 Boston Aero-Meet and negotiated a $100,000 fee for her 7-day appearance in Quincy, Massachusetts.

When Harriet arrived on July 1, 1912, William Willard, the event organizer, and his son tossed a coin to see who would win the privilege of a flight with Harriet. Willard senior won the toss and climbed into the passenger seat. After a routine flight out to Boston Light, Harriet circled the plane and returned to Quincy. A crowd of 5000 watched as the plane approached the air field from Boston Harbor.

As the spectators watched, the plane suddenly pitched forward and Willard was thrown from his seat. Harriet fought to regain control of the plane, but was thrown out seconds later. Harriet and Willard both fell more than 200 feet and died on impact on the tidal mud flats of Quincy. Just why the plane pitched forward has been debated in aviation circles. General agreement is that the Bleriot was notoriously difficult to handle and keep balanced. If Willard (who weighed well over 200 lbs.) suddenly leaned forward to speak with Harriet, that could have thrown off the balance, and once Willard was thrown from the plane, she would not have been able to regain balance (she had to fly with sandbags in the passenger seat when alone.) The Boston Globe attributed the cause of death to lack of seatbelts. The strangest twist of this story is that the plane righted itself and landed without a scratch.

She had been a strong advocate of aviation. Believing the United States was falling behind other nations in the field of aviation, she had urged the country to give more attention to commercial aviation and aeronautical development.

On July 4, 1912, Harriet was buried at Woodlawn Cemetery on Staten Island. A year later, her remains her moved to Kenisco Cemetery in Valhalla, New York at her mothers request.

References:

Aerospace: The Challenge - by H. Bacon, M. Schrier, P. McGill, and G. Hellinga, Civil Air Patrol, Maxwell Air Force Base, Alabama, Third Edition 1989.

Her Mentor was an Albatross - by Henry M. Holden, Black Hawk Publishing, Mt. Freedom , NJ, 1993. Excellent, readable account of Harriet's life. Pulls together facts from many sources.

For a Brief Moment, the World Seemed Wild About Harriet - by Terry Gwynn Jones, Smithsonian, January 1984. Quincy Historical Society, 8 Adams Street, Quincy, MA.

A Past Carved From Stone: Quincy Massachusetts, by Patricia Harrigan Browne, Arcadia Publishing, *Images of America* Series, Dover, NH, 1996. A chapter on the 1910 Boston Aero-Meet (the second in the United States) is included along with 18 photos of the air meet and participants. Contact Patricia Brown to order if you can't find it locally. $16.99 + $4.00 shipping.

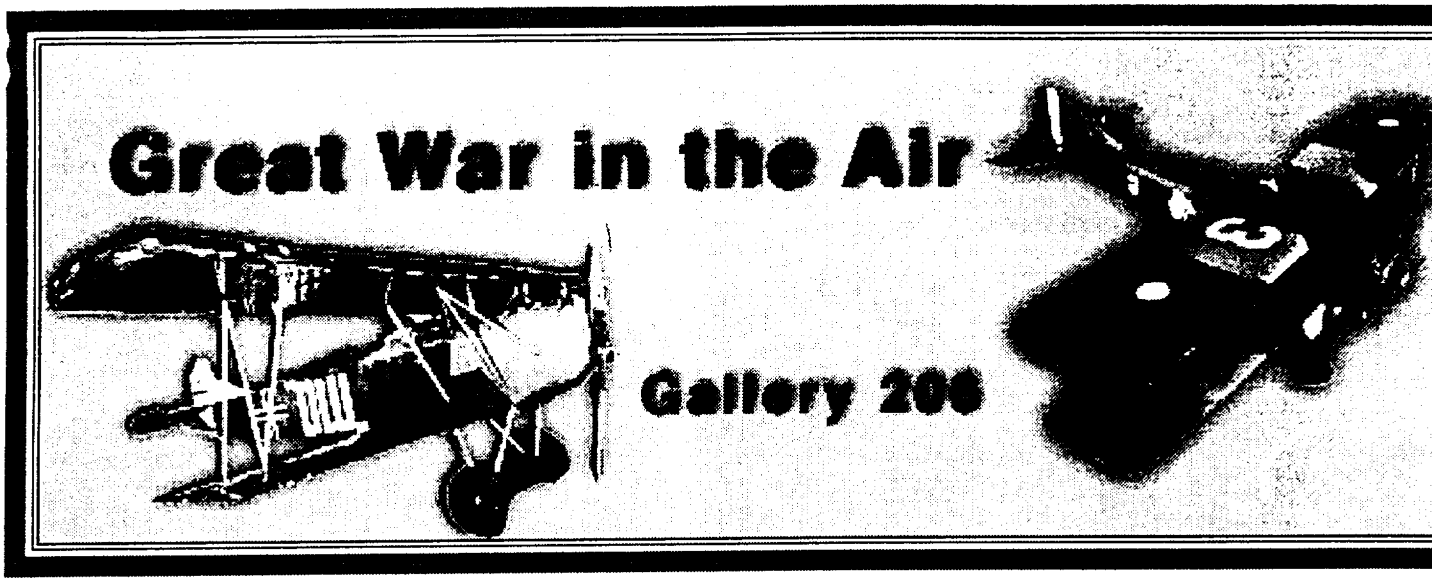
Credits:

The Harriet Quimby biography was prepared by Patricia Brown with a minor addition made by the ALLSTAR Network staff from *Aerospace: The Challenge.*

Send all comments to aeromaster@eng.fiu.edu

Funded in part by

Updated: 28 October, 1997

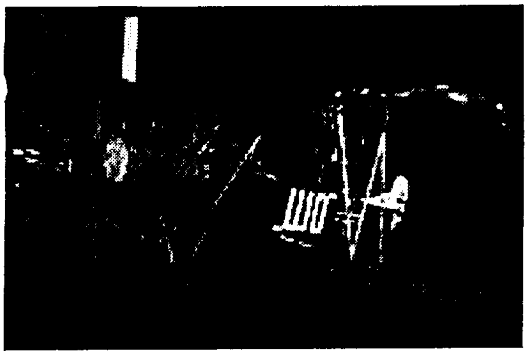


This exhibit places aircraft and air power in proper perspective and examines the contradictions between the myths and realities of World War I combat. The aircraft exhibited here took to the skies during the Great War in the air--World War I.

- Fokker D.VII
- SPAD XIII
- Sopwith Snipe
- Voisin VIII
- Albatros D.Va
- Pfalz D.VII

 **FokkerD.VII** (90 k jpeg)

The **Fokker D.VII** is considered by most historians to be Germany's best fighter in that war, rightfully feared by its opponents. It reached front-line squadrons early in May 1918, too late to turn the tide of battle. This Fokker D.VII landed by mistake on a forward aerodrome behind the front lines on November 9, 1918, two days before the Armistice. The "U-10" markings represent the pilot's former affiliation with the 10th Uhlan cavalry regiment.



Fokker D.VII (182 k gif)

NOTE: This photo was taken in the old WWI gallery -- © Smithsonian Institution, photo by D. Penland

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SPAD XIII (99 k jpeg)

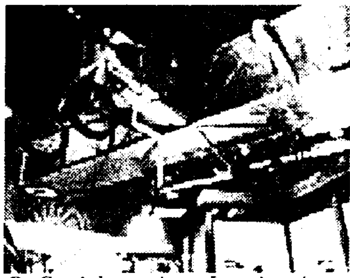
© Smithsonian Institution

Rugged and fast, the French SPAD airplanes fought well in the hands of experienced pilots. On exhibit is a **SPAD XIII**, one the three examples left in existence (8,472 were originally built). This aircraft was a refinement of the SPAD VII, with twin machine guns and a more powerful engine. This SPAD XIII is the most thoroughly documented and complete U.S. World War I fighter in any collection.

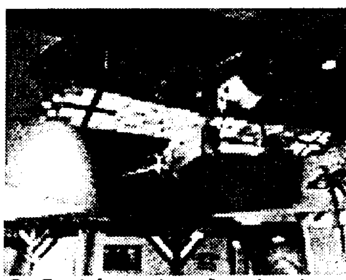
Sopwith Snipe (102 k jpeg)

© Smithsonian Institution

Also on exhibit in this gallery is a **Sopwith Snipe**, a development of the Famous Sopwith Camel. Historians remember the Snipe as the first standard postwar Royal Air Force fighter; its wartime career was limited to service with only three squadrons. Major W.G. Barker made the Snipe famous by single-handedly battling 15 enemy fighters. Barker later received the Victoria Cross from King George V for his bravery.


Voisin 8 (89 k jpeg)

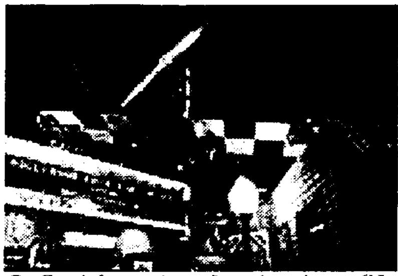
The **Voisin 8** bomber was a strong and serviceable type based on pre-war design. It was built beginning in 1916, in an attempt to equip the French Air Service with a faster and more powerful aircraft capable of carrying a substantial bomb load deep into Germany's industrial region. The poor handling qualities and the disappointing performance of the 200 h.p. Peugeot engine, however, forced the French to use it on night missions to avoid fighter opposition. This Voisin was transferred to the Smithsonian Institution in 1918.


Albatros D.Va (71 k jpeg)

The Germans and the other Central Powers used the Albatros more than any other aircraft during World War I. The aircraft exhibited in this gallery, standing resplendent with "circus" tail markings of *Jagdstaffel 46* , is an **Albatros D.Va** type. It was in this type, not the Fokker DR.I Triplane, that Baron Manfred von Richtofen (the "Red Baron") scored 59 of his 80 victories. The origin of the word "Stropp" is unknown, but is typical of individualized markings created by the German pilots. This Albatros fought on the Western Front, was damaged in battle, and was captured. It is one of the two remaining examples in existence.

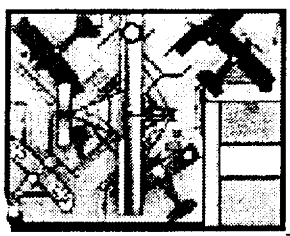
(142 k gif)

NOTE: This photo is from the old WWI gallery -- © Smithsonian Institution, SI photo #80-2086

 Pfalz D.XII (91 k jpeg)

© Smithsonian Institution, SI Photo # 91-16388-8 by C. Russo

The wartime history of this German Pfalz D.XII fighter is obscure. After the war it was one of two Pfalz D.XII brought to this country as part of Allied war reparations. In 1928, it was purchased as war surplus and brought to Hollywood for use in the 1930 version of *The Dawn Patrol*. Howard Hughes later purchased it for his film *Hell's Angels*. The aircraft was stored on a back lot until 1938, when it was purchased by Louis C. Kennell, Paramount Pictures' property manager, who restored it for the 1938 film *Men with Wings*. The Smithsonian Institution later acquired the aircraft and refurbished it for use in this exhibition.

 Gallery map.

January 25, 1996 (mjt)
web@www.nasm.edu

How To Use This Site

This brief history of The Boeing Company is divided into three interconnected areas: a chronology, a narrative history, and biographies of chief company officers.

Chronologies:
The eras in the left column are links to descriptive chronologies. The title of each era's chronology is a link to the top narrative page for that era. Links within the chronology connect to products and events in the narrative and to biographies.

Narratives:
The navigation at the bottom of each narrative page allows you to go forward and backward in that era or back to the chronology. Most of the small photos in the narrative pages are clickable and linked to larger versions of the same picture.

Biographies:
Each biography page has a link back to the biographies index.

Outside links:
Narratives for contemporary products also have links outside the History site to the current home pages.

Forward to the Introduction

Current Events in NASA History

What's New Page

Publications

Historical Subjects

"hot topics"

Other Resources

Search NASA History

Not Found

The requested object does not exist on this server. The link you followed is either outdated, inaccurate, or the server has been instructed not to let you have it.

You may search our server to try to find what you are looking for.

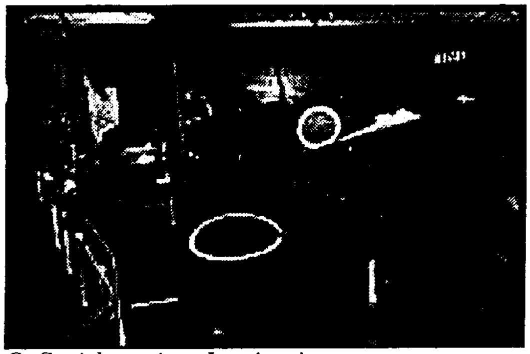
Boeing Home

- Supermarine Spitfire
- Mitsubishi A6M5 Zero Model 52
- North American P-51 "Mustang"
- Messerschmitt Bf 109
- Macchi C.202
- Martin B-26B Marauder "Flak Bait"

Roaring directly at the viewer is Thunder Bird , a U.S. Boeing B-17 G Flying Fortress on its way to Viesbaden, Germany, on August 15, 1944. This tense moment, frozen in time on a gaint mural by noted artist Keith Ferris, sets the theme for the gallery: memorializing the men and air machines of World War II.

Spitfire Mark VII (94k GIF or 56k JPEG)

The combination of speed and firepower made the **Supermarine Spitfire** a deadly machine. The Spitfire's elliptical wing, which reduced drag and increased speed, is its most distinguished characteristic. When the war ended, the Spitfire was the only airplane that had been in continuous production throughout the war--20,351 had rolled off the assembly line. This specimen is a Spitfire Mark VII, a high-altitude version, of which only 140 were produced.



Mitsubishi A6M5 Zero Model 52 (111k GIF or 73k JPEG)

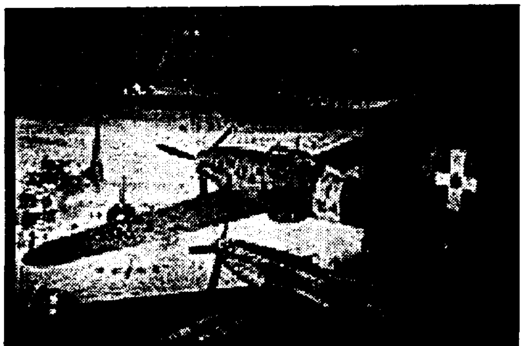
Also on exhibit is the **Mitsubishi A6M5 Zero Model 52**. Well designed, light and maneuverable, the Japanese Zero was a formidable opponent in the hands of a skilled pilot. Against later, more-powerful American fighters, however, the Zero lost ground and became an easy target by the end of the war.

North American P-51 Mustang (158 k GIF)

For those who flew it, the **North American P-51 Mustang** was a fighter pilot's airplane and one of the best fighters of World War II. Unlike other well known and widely used fighters of that time, the P-51 was first conceived during the war and built on the basis of combat experience. The markings on the Museum's P-51D (the yellow and black checkerboard design on the nose, and the letters "Willit Run?") are patterned after a P-51 flown in Britian by the 351st Fighter Squadron, 353rd Fighter Group, 8th Air Force.

Messerschmitt Bf 109 (132 k GIF)

of designs. Ours is the Bf 109G Gustav used later in World War II. This aircraft gained its fame as the major opponent of the Spitfire. It continued its intense rivalry with all Allied aircraft until the close of World War II.



Macchi C.202 (152k GIF or 94k JPEG)

© *Smithsonian Institution, SI photo #80-2089*

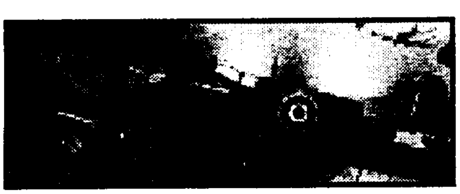
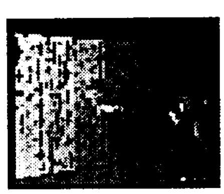
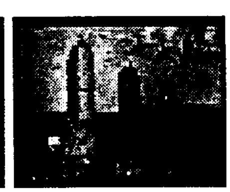
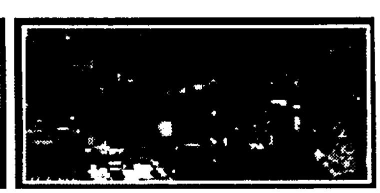
The **Macchi C.202** was one of Italy's most advanced World War II fighters. Outside Italy, however, it failed to achieve as much fame as contemporary fighters of other nations. Known as the Folgore, meaning "lightning," the pilots who flew it lauded its fingerlight handling and its superb agility. The Macchi C.202 is one of two remaining aircraft of this type anywhere in the world. Its early history is obscure, but it was one of many enemy World War II aircraft the Army brought to the United States for evaluation and testing after the war.

Martin B-26B Marauder "Flak Bait" (153k GIF or 74k JPEG)

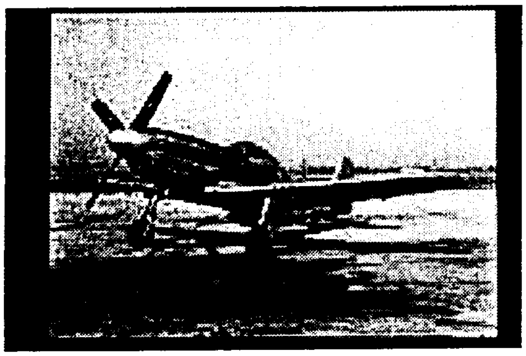
© *Smithsonian Institution*

The **Martin B-26B Marauder "Flak Bait"** (nose only here) flew more missions over Europe than any other American airplane of World War II. With 202 operational sorties to its credit, this medium bomber had the longest and most colorful combat history of any aircraft in the Museum. Despite their initial high rate of accidents in training, the Marauders soon vindicated themselves with the greatest bombing accuracy and lowest loss rate of any American aircraft. "Flak Bait" was given its name after "Flea Bait," a nickname for the dog belonging to the aircraft's pilot. The original paint is still bright, but more than a thousand patched flak holes bear witness to the fact that this most famous of Marauders was indeed appropriately named.

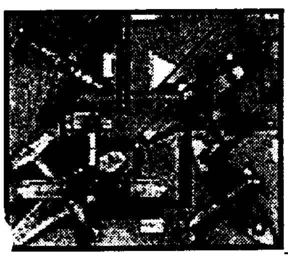
Other photos of gallery 205:

Experimental images using a QuickTake Digital Camera by M. Tuttle



Another Photo CD image of the P-51.

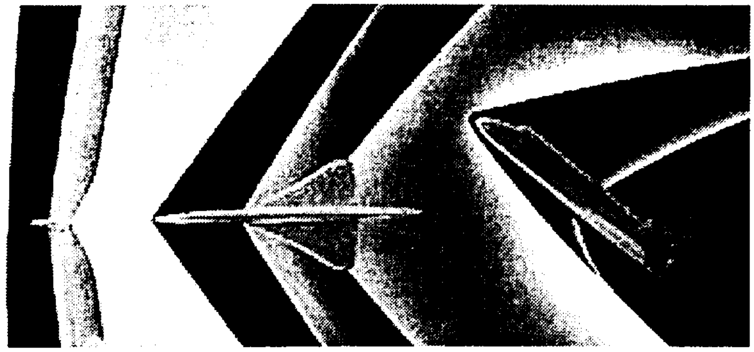


Gallery image.

HOME | MUSEUM MAP | EXHIBITS | AIRCRAFT | SPACE ARTIFACTS

December 11, 1995 (mjt)
web@www.nasm.edu

Faster Than Sound



As an airplane approaches the speed of sound, conditions around it begin to change. The air ahead of it starts to compress. Shock waves form on its wings. Drag increases dramatically. Supersonic flight--flying faster than sound--is a whole new game with a different set of rules.

(Rev. 09/17/96, mjt)

Jacqueline Cochra[n]

America's Fastest Woma[n]

Jackie Cochran never owned a pair of shoes until she was eight years old.

Jackie Cochran was born in Florida into a life of poverty, somewhere between 1905 and 1908. She had almost no formal education and since she was orphaned at birth, she had only foster parents to depend on. Taking the opportunity to improve her situation early on, she got a job in a Georgia cotton mill at the age of eight and was making six cents an hour. She learned to read by reading the writing on the sides of boxcars that rolled by her home. Jackie eventually left the factories to become a hairdresser, operating the newly invented permanent wave machine. She became such a success that she opened her own shop in Pensacola, and soon after moved to New York.

At the age of 22 she was working at a prestigious salon and was at the top of her profession. With the money she saved she developed a line of cosmetics, which would later become her empire, Jacqueline Cochran Cosmetics. Her husband to be, millionaire businessman Floyd Odlum, suggested she learn to fly in order to use her travel and sales time more efficiently. In two days she soloed and 18 days later had her pilots license.

Despite her lack of education, she mastered flying in mere weeks. Jackie soon owned her first airplane, a Travelair, and later a Northrop Gamma. She was the first woman to enter the Bendix Race in 1935 and allthough she did not win it that year (the first woman to win it was Louise Thaden with Blanche Noyes in 1936) she placed first in the women's division and third overall in 1937. By this time, Jackie had married Floyd and they had four houses: a grand apartment in New York City, a Connecticut estate, a sheep farm in Arizona and a California ranch. The American dream had come true.

Jackie was hooked on flying and her taste for record setting was strong. She set three speed records, won the Clifford Burke Harmon trophy three times and set a world altitude record of 33,000 feet ~ all before 1940.

With World War II on the horizon, Jackie talked Eleanor Roosevelt (who, like Jackie, had been friendly with Amelia Earhart) into the necessity of women pilots in the coming war effort. It was probably no small coincedence that Jackie was soon recruiting women pilots to ferry planes for the British Ferry Command, and became the first female trans-Atlantic bomber pilot. In 1942 Jackie recruited over one thousand Women Airforce Service Pilots and supervised their training and service until they were disbanded in 1944. She didn't stop there - she went on to be a press correspondent and was present at the surrender of Japanese General Yamashita, was the first US woman to set foot in Japan after the war, and went on to China, Russia, Germany and even the Nuremburg trials.

Flying was still her passion, and with the onset of the jet age, there were new planes to fly and records to break! And she did both. Access to jet aircraft was mainly restricted to military personnel, but Jackie had enough connections to get he where she wanted to be. With the assistance of her friend General Chuck Yeager, Jackie became the first woman to break the sound barrier in an F-86 Sabre Jet, and went on to set a world speed record of 1,429 mph in 1964.

Jacqueline Cochran broke the sound barrier when she was well over 50 years old. After heart problems and a pacemaker stopped her fast-flying activities at the age of 70, Jackie took up soaring. At the time of her death in 1980 she held literally hundreds of speed and altitude records ~ more than anyone else in the world, male or female.

Some of her achievements include:
- First Woman to enter the Bendix Race, 1935
- Won 14 Harmon Trophies in her lifetime
- Mitchell Award, 1938
- Set Altitude record of 33,000 feet, 1939
- First female trans-Atlantic bomber pilot, 1941
- Supervised the WASP, 1942-44
- Flew future president Lyndon Johnson to the Mayo clinic for emergency kidney surgery, saving his life, 1948
- Awarded French Legion of Honor, 1949
- Awarded air medals from Belgium, Spain, Thailand, Turkey and Rumania
- Served as an advisor to the US Air Force, FAA and NASA during the 1950's and 60's
- Company pilot for Canadair, Lockheed and Northrop
- First woman to break the sound barrier and set *world* speed record of 1,429 mph, 1964
- Chairman, National Aeronautic Association, 1962
- First woman to be awarded the Federation Aeronautique Internationale Gold Medal
- First woman to be elected president of the Federation Aeronautique Internationale, 1969
- Awarded the USAF Distinguished Flying Cross, 1969
- Honorary Fellow, Society of Experimental Test Pilots, 1971
- Aviation Hall of Fame, 1971

View the Jackie Cochran postage stamp and press release
Fred Wohosky's "Airfield of Dreams" has a model of Jackie's Northrop Gamma

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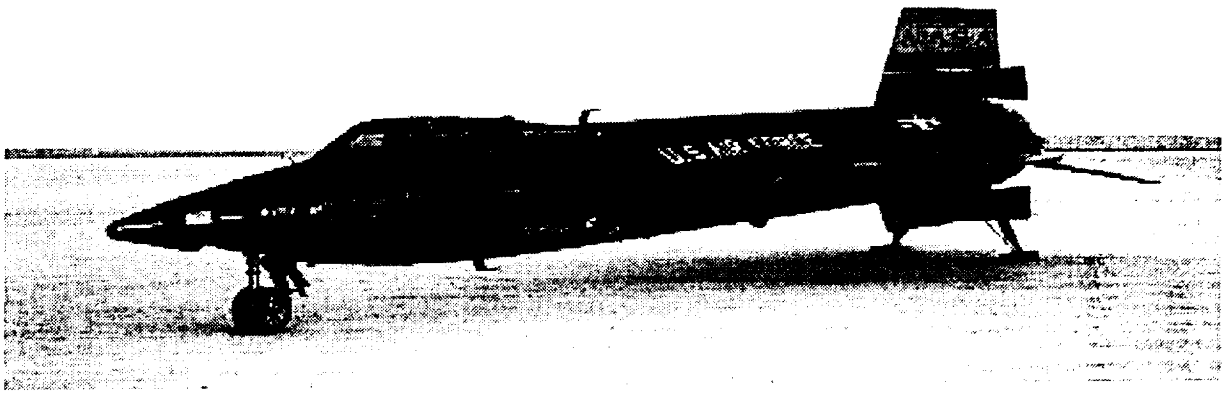
Return to the International Women's Air & Space Museum home page
text by Jenna Kimberlin

X-15 Aircraft

Movie Gallery



Three X-15s made 199 flights during a research program which lasted from 1960 through 1968. It was a daring, yet highly successful program that resulted in hundreds of technical reports. Although it made some contributions to the NASA space program of the 1960s, it had more impact on the design of the Space Shuttle many years later.

X-15 Video Clips

Description	Date	320x240 Quicktime	160x120 Quicktime	320x240 MPEG
X-15 air launch from B-52 mothership	1960s	8.1 MBytes	2.1 MBytes	2.8 MBytes
X-15 drop launch, view from B-52 mothership	1960s	8.1 MBytes	1.4 MBytes	2.8 MBytes
X-15 air drop launch and flight	1960s	4.2 MBytes	3.8 MBytes	3.2 MBytes
X-15 landing on lakebed	1960s	6.7 MBytes	2.6 MBytes	2.0 MBytes
X-15 landing	1960s	5.9 MBytes	5.4 MBytes	5.9 MBytes
X-15 pilots	1960s	8.6 MBytes	2.3 MBytes	4.5 MBytes

Information about the X-15 project

An unofficial motto of flight research of the 1940s and 1950s was "higher and faster." By the late 1950s the last frontier of that goal was hypersonic flight (Mach 5+) to the edge of space. It would require a huge leap in aeronautical technology, life support systems and flight planning. The North American X-15 rocket plane was built to meet that challenge. It was designed to fly at speeds up to Mach 6, and altitudes up to 250,000 ft. The aircraft went on to reach a maximum speed of Mach 6.7 and a maximum altitude of 354,200 ft. Looking at it another way, Mach 6 is about one mile per second, and flight above 265,000 ft. qualifies an Air Force pilot for astronaut wings.

The plane was air launched by NASA's converted B-52 at 45,000 feet and a speed of 500 mph. Generally there were two types of flight profiles: high-speed, or high-altitude. High-speed flights were usually done below an altitude of 100,000 feet and flown as a conventional airplane using aerodynamic controls. High-altitude flights began with a steep, full-power climb to leave the atmosphere, followed by up to two minutes of "coasting up" to the peak altitude after the engine was shut down. "Weightless" flight would last for 2 - 5 minutes as it made a ballistic arc before reentering the atmosphere. A reaction control system was used to maintain attitude above the atmosphere. The reaction controls employed hydrogen peroxide thrusters located on the nose and wings.

A typical research flight lasted about 10 or 11 minutes while covering nearly 400 miles along a course that stretched from Smith Ranch, Nevada to Edwards Air Force Base.

The X-15 program made many accomplishments, here is list of some of its contributions to space flight:

- First use of a full-pressure suit for spaceflight.
- First use of reaction controls for maneuvering in space.
- First use of a flight control system that automatically blended aerodynamic and reaction controls.
- Development of thermal protection for hypersonic reentry.
- Development of the first large, restartable, and throttleable rocket engine.
- Development of an inertial guidance system.
- Demonstration of a pilot's ability to operate in "micro-gravity".
- Demonstration of the first piloted reentry-to-landing from space.
- Acquisition of hypersonic acoustic measurements, which influenced structural design criteria for Mercury capsule.
- Verification of the validity of hypersonic wind tunnel data, which were later used in the design of the Space Shuttle.

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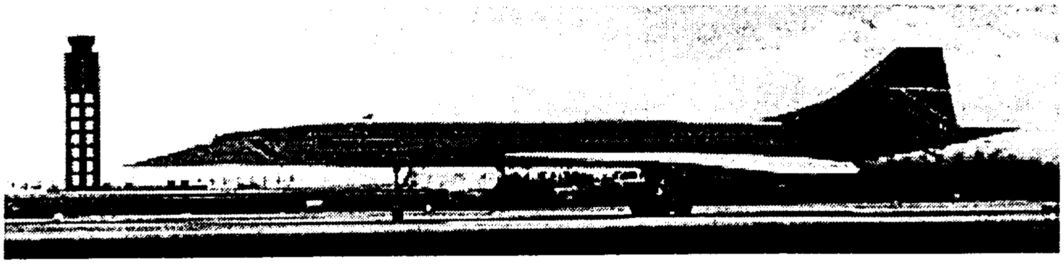
Fortieth Anniversary
Pioneering the Future

Responsible NASA Official: Marty Curry Marty.Curry@dfrc.nasa.gov

Page Curator: Robert Binkley Robert.Binkley@dfrc.nasa.gov

Modified: June 30, 1997

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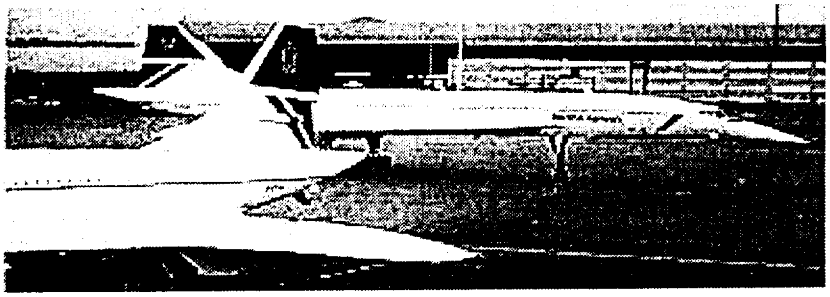

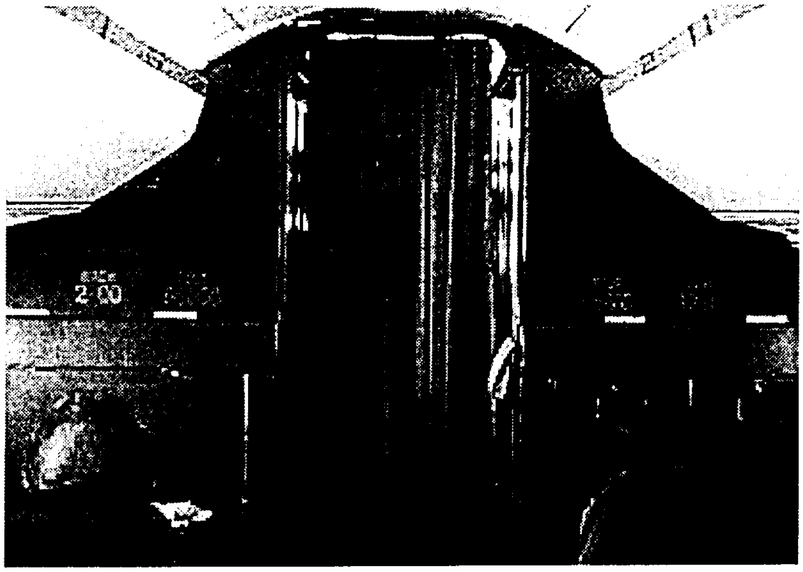
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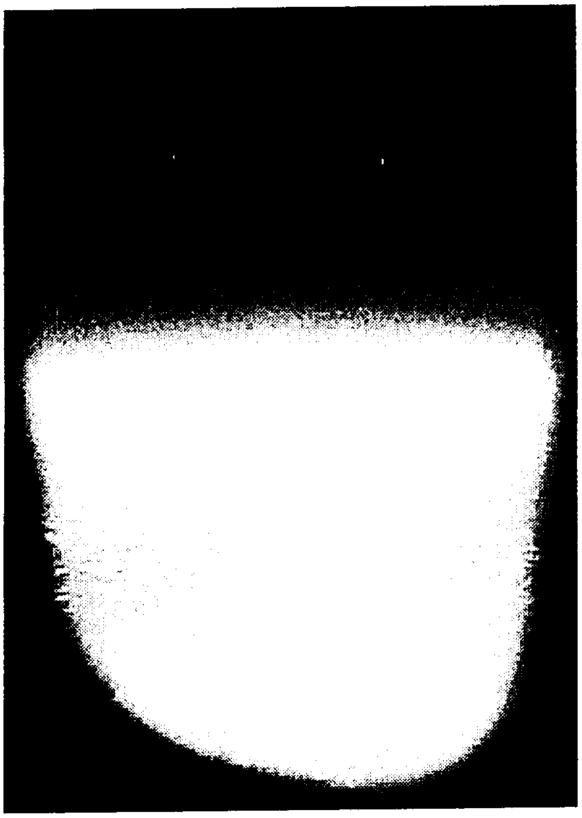

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B. Web Logs

Table 1

Number of web sites located by each of five search engines in response to five search term(s). MCET's *Take Off!* was not in the first 100 sites located by any of the five search engines.

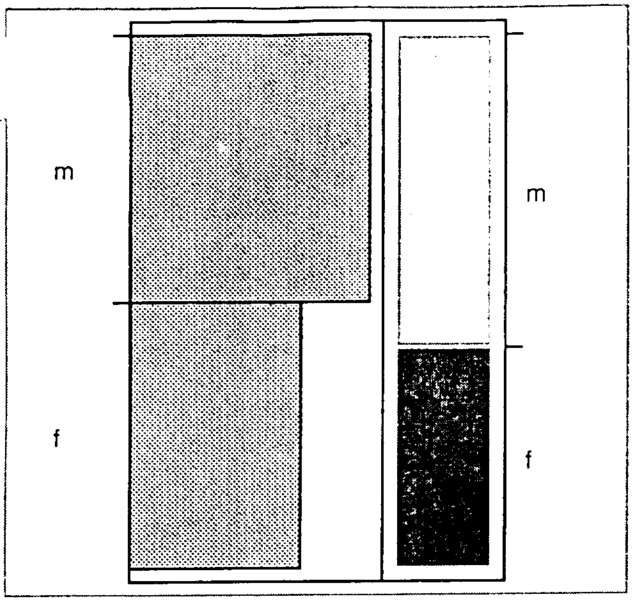
Search Term(s)	Infoseek	Lycos	Yahoo	Excite	Alta Vista
Aviation	203 966	>100	No Sites Located	138 968	2 201
Aeronautics	31 029	>100	No Sites Located	32 734	109
Aviation + Aeronautics	305 842	>100	No Sites Located	170 066	145
Aviation + Aeronautics + Careers	2 278 335	>100	No Sites Located	373 167	12
Aviation + Aeronautics + Education	5 523 470	>100	No Sites Located	2 064 820	767 510

Table 2

Percent relevance of search terms which included "MCET".

Search Term(s)	Infoseek
Aviation + MCET	70 %
Aeronautics + MCET	71 %
Aviation + Aeronautics+ MCET	68 %
Aviation + Aeronautics + Careers + MCET	68 %

Gender



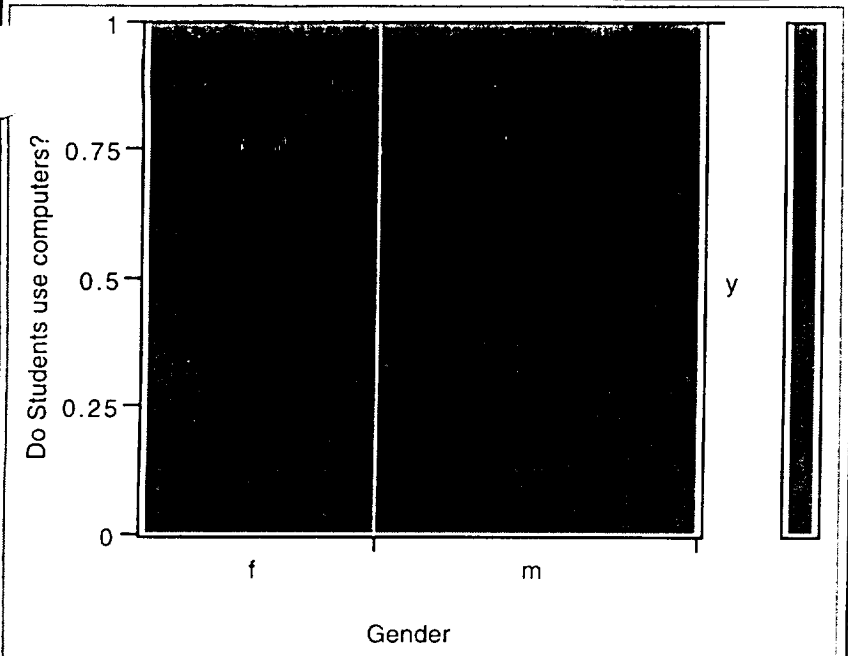
Frequencies

Level	Count	Probability	Cum Prob
f	31	0.41892	0.41892
m	43	0.58108	1.00000
Total	74		
	2 Levels		

Test Probabilities

Malden
Core Site

Do Students use computers? By Gender



Crosstabs

Gender

Do Students use computers?

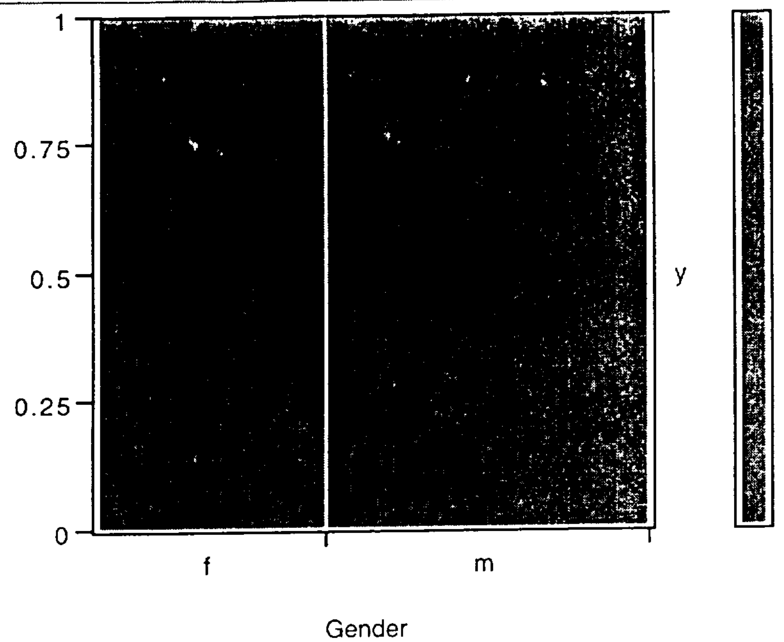
Count Total % Row % Col %	f	m	
y	31 41.89 41.89 100.00	43 58.11 58.11 100.00	74 100.00
	31 41.89	43 58.11	74

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	0	-0	.
Error	74	0	
C Total	74	-0	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	-0.000	0.0000
Pearson	0.000	0.0000

After: students use computers? By Gender



Crosstabs

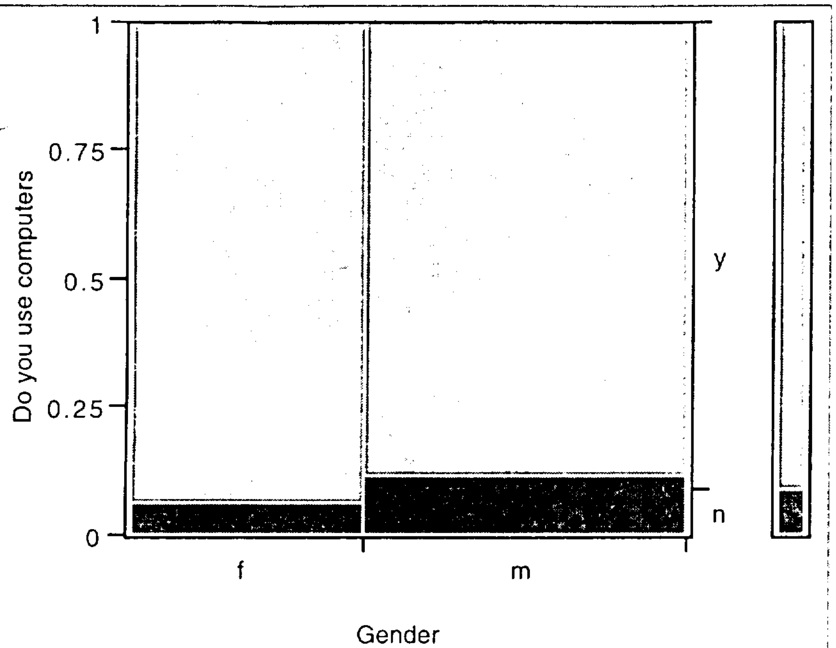
Count / Total % / Row % / Col %	Gender: f	m	
y	30 41.10 41.10 100.00	43 58.90 58.90 100.00	73 100.00
	30 41.10	43 58.90	73

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	0	-0	.
Error	73	0	
C Total	73	-0	
Total Count	73		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	-0.000	0.0000
Pearson	0.000	0.0000

Do you use computers By Gender



Crosstabs

Gender

Do you use computers: Count / Total % / Row % / Col %	f	m	
n	2 2.70 28.57 6.45	5 6.76 71.43 11.63	7 9.46
y	29 39.19 43.28 93.55	38 51.35 56.72 88.37	67 90.54
	31 41.89	43 58.11	74

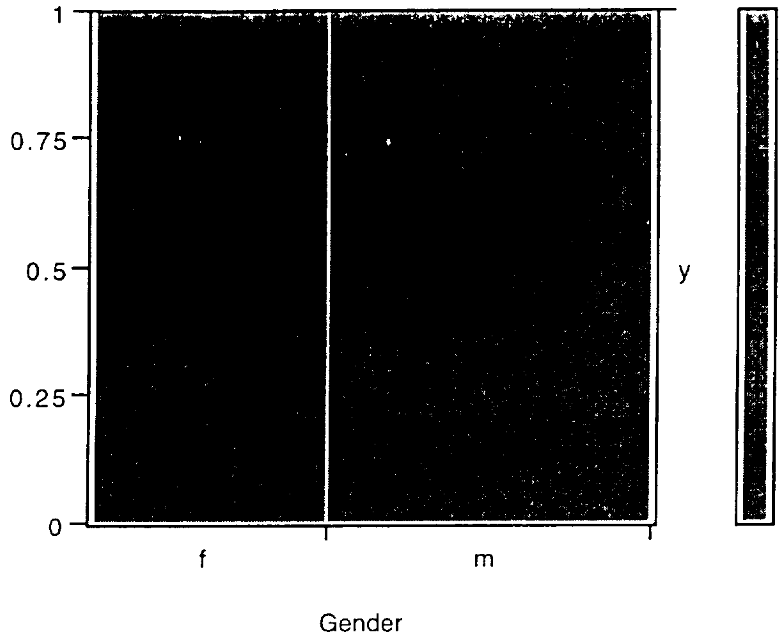
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.293169	0.0127
Error	72	22.871871	
C Total	73	23.165040	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.586	0.4438
Pearson	0.564	0.4528

Fisher's Exact Test	Prob
Left	0.3717
Right	0.8771
2-Tail	0.6917

After: Do you use computers By Gender



Crosstabs

Gender

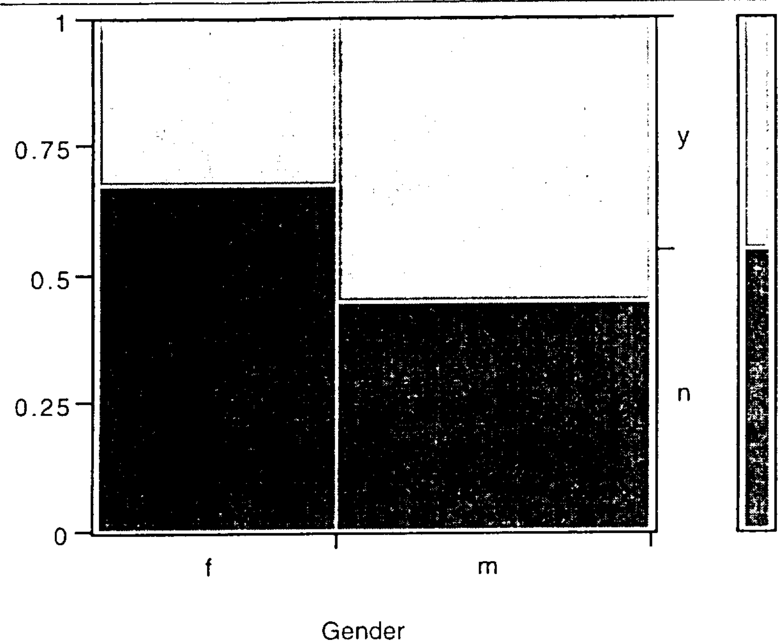
Count Total % Row % Col %	f	m	
y	31 41.89 41.89 100.00	43 58.11 58.11 100.00	74 100.00
	31 41.89	43 58.11	74

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	0	-0	•
Error	74	0	
C Total	74	-0	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	-0.000	0.0000
Pearson	0.000	0.0000

Easy internet access By Gender



Crosstabs

Count / Total % / Row % / Col %	Gender: f	m	
n	21 29.58 53.85 67.74	18 25.35 46.15 45.00	39 54.93
y	10 14.08 31.25 32.26	22 30.99 68.75 55.00	32 45.07
	31 43.66	40 56.34	71

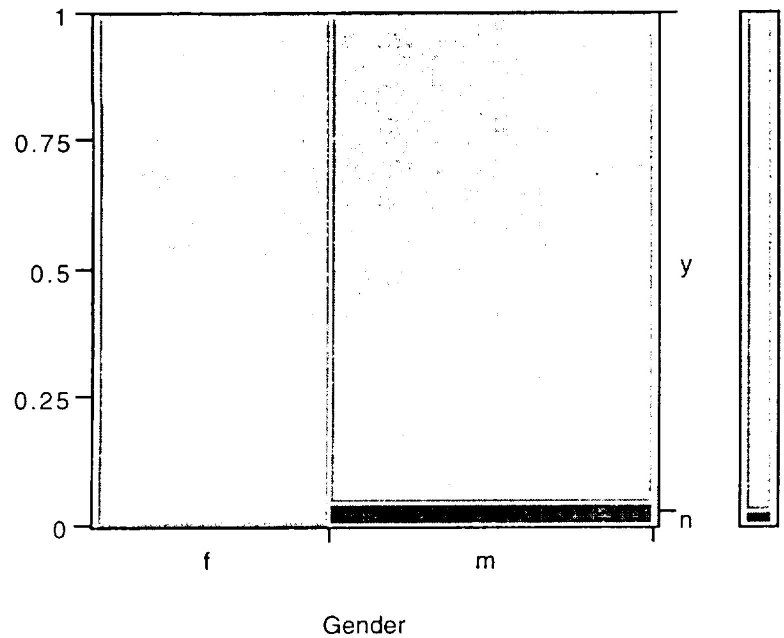
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	1.849484	0.0378
Error	69	47.018334	
C Total	70	48.867818	
Total Count	71		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	3.699	0.0544
Pearson	3.649	0.0561

Fisher's Exact Test	Prob
Left	0.9848
Right	0.0469
2-Tail	0.0916

After: easy internet access? By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	0 0.00 0.00 0.00	2 2.70 100.00 4.65	2 2.70
y	31 41.89 43.06 100.00	41 55.41 56.94 95.35	72 97.30
	31 41.89	43 58.11	74

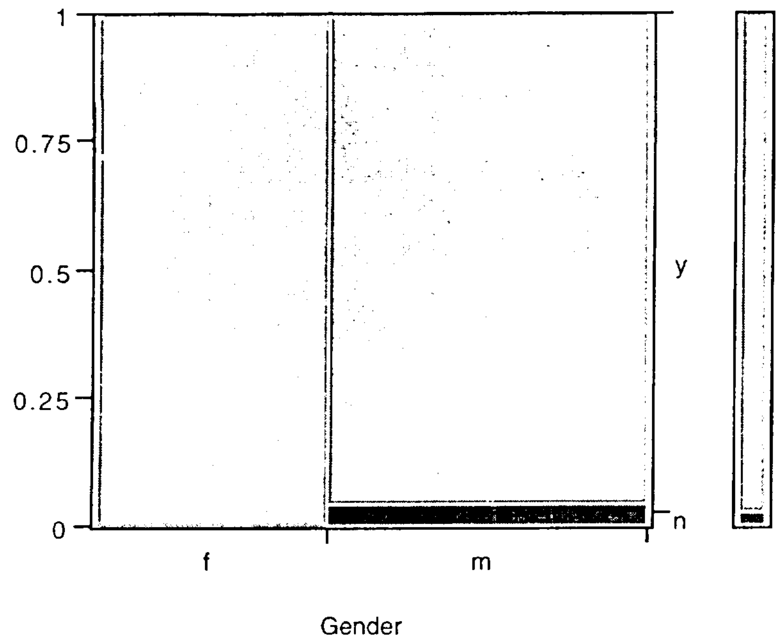
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	1.1057061	0.1203
Error	72	8.0888559	
C Total	73	9.1945620	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	2.211	0.1370
Pearson	1.482	0.2235

Fisher's Exact Test	Prob
Left	0.3343
Right	1.0000
2-Tail	0.5065

Computer use teaching By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	0 0.00 0.00 0.00	2 2.70 100.00 4.65	2 2.70
y	31 41.89 43.06 100.00	41 55.41 56.94 95.35	72 97.30
	31 41.89	43 58.11	74

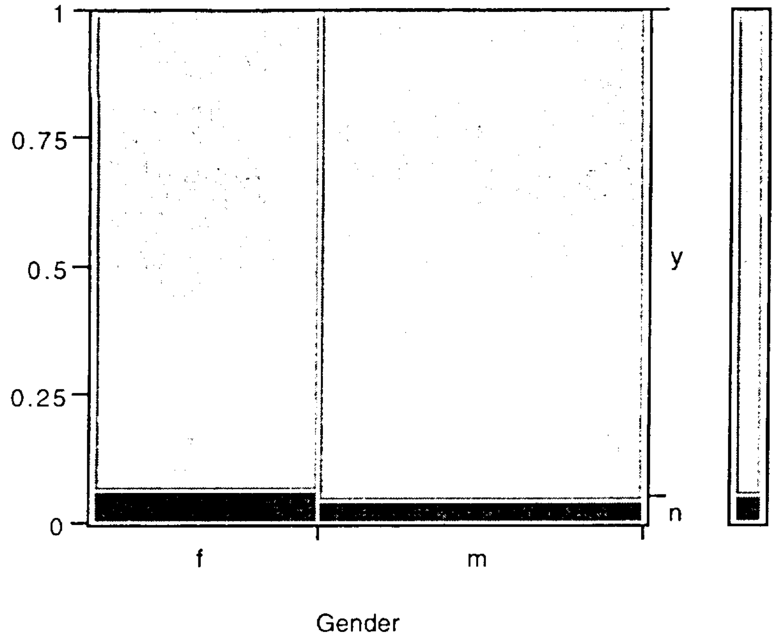
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	1.1057061	0.1203
Error	72	8.0888559	
C Total	73	9.1945620	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	2.211	0.1370
Pearson	1.482	0.2235

Fisher's Exact Test	Prob
Left	0.3343
Right	1.0000
2-Tail	0.5065

After: computer use teaching By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	2 2.74 50.00 6.67	2 2.74 50.00 4.65	4 5.48
y	28 38.36 40.58 93.33	41 56.16 59.42 95.35	69 94.52
	30 41.10	43 58.90	73

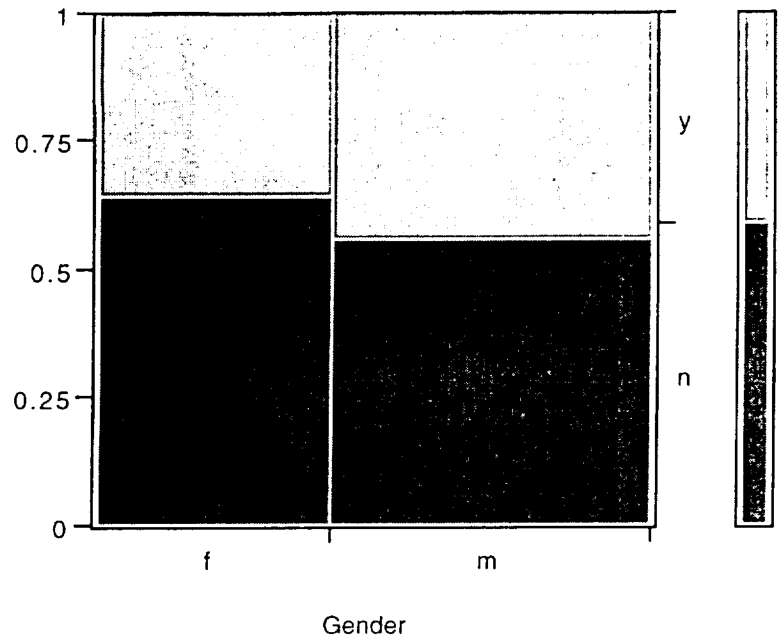
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.068256	0.0044
Error	71	15.436757	
C Total	72	15.505013	
Total Count	73		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.137	0.7118
Pearson	0.139	0.7097

Fisher's Exact Test	Prob
Left	0.8144
Right	0.5465
2-Tail	1.0000

Your use of e-mail By Gender



Crosstabs

Gender

Count Total % Row % Col %	f	m	
n	20 27.03 45.45 64.52	24 32.43 54.55 55.81	44 59.46
y	11 14.86 36.67 35.48	19 25.68 63.33 44.19	30 40.54
	31 41.89	43 58.11	74

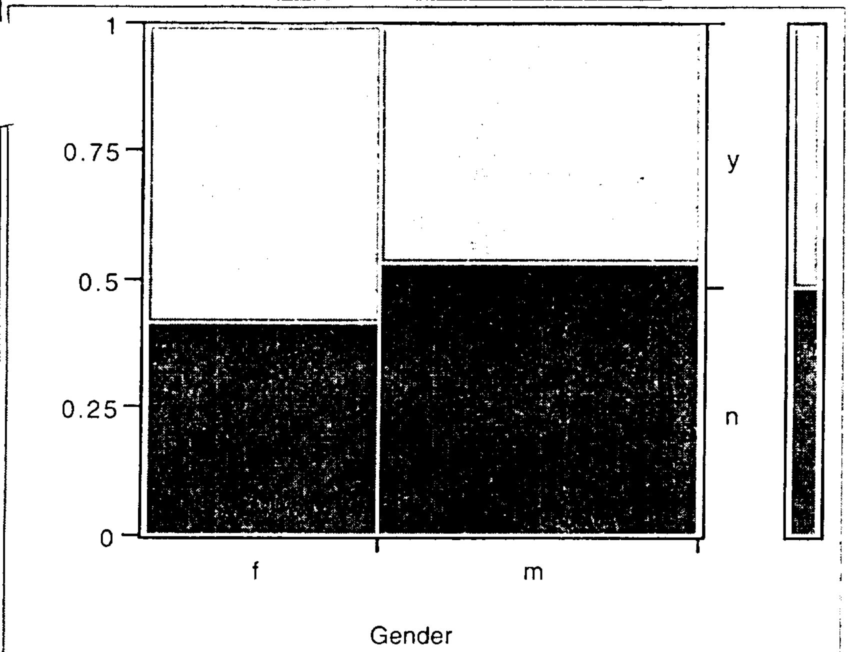
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.284469	0.0057
Error	72	49.676082	
C Total	73	49.960552	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.569	0.4507
Pearson	0.566	0.4519

Fisher's Exact Test	Prob
Left	0.8394
Right	0.3051
2-Tail	0.4819

After: your use e-mail By Gender



Crosstabs

Gender

Count Total % Row % Col %	f	m	
n	13 17.57 36.11 41.94	23 31.08 63.89 53.49	36 48.65
y	18 24.32 47.37 58.06	20 27.03 52.63 46.51	38 51.35
	31 41.89	43 58.11	74

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.482698	0.0094
Error	72	50.783163	
C Total	73	51.265861	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.965	0.3258
Pearson	0.962	0.3266

Fisher's Exact Test	Prob
Left	0.2282
Right	0.8883
2-Tail	0.3553

Response: Gender

Iteration History

Iter	LogLikelihood	Step	Delta-Criterion	Obj-Criterion
1	-51.29289136	Initial	0.23104693	•
2	-49.52145523	Newton	0.00968812	0.03576386
3	-49.51914191	Newton	0.00003898	0.00004671

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.796467	2	1.592933	0.4509
Full	49.519142			
Reduced	50.315609			

RSquare (U)	0.0158
Observations (or Sum Wgts)	74

Lack of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack of Fit	1	1.376665	2.753331
Pure Error	70	48.142477	**Prob>ChiSq**
Total Error	71	49.519142	0.0971

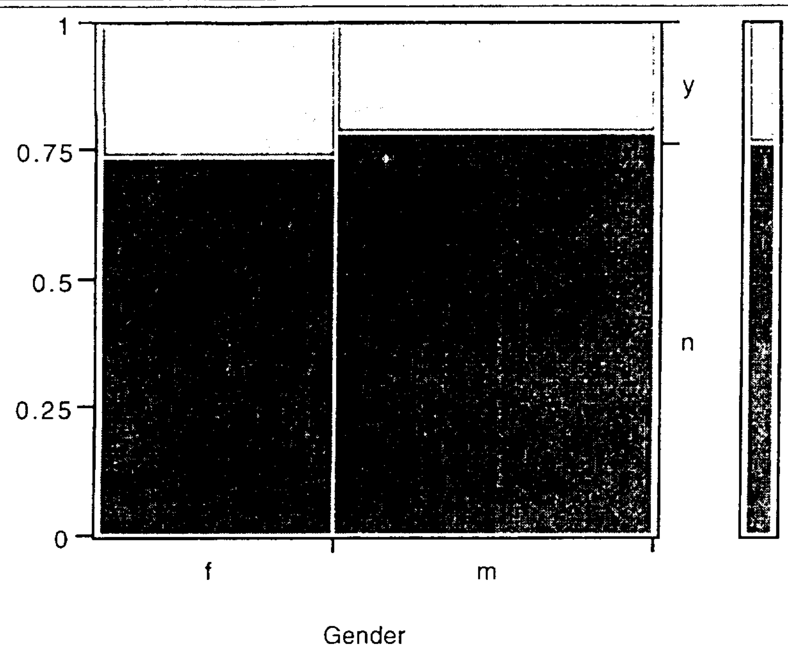
Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
tercept	-0.3776538	0.2448481	2.38	0.1230
′our use[n-y]	0.1926936	0.2445063	0.62	0.4306
.fter: y[n-y]	-0.240735	0.2390236	1.01	0.3139

Effect Test

Source	Nparm	DF	Wald ChiSquare	Prob>ChiSq
Your use of e-mail	1	1	0.6210900	0.4306
After: your use e-mail	1	1	1.0143717	0.3139

Computers for career learning By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	23 31.51 41.07 74.19	33 45.21 58.93 78.57	56 76.71
y	8 10.96 47.06 25.81	9 12.33 52.94 21.43	17 23.29
	31 42.47	42 57.53	73

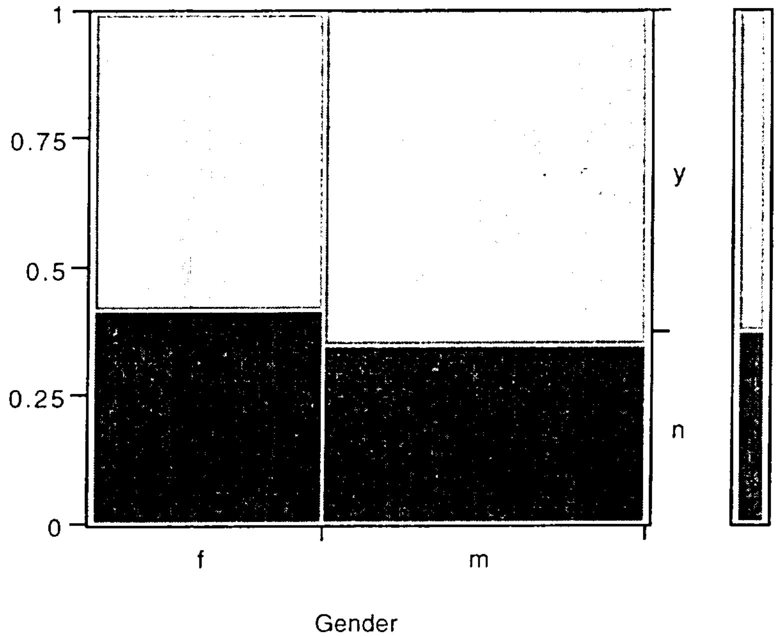
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.095160	0.0024
Error	71	39.524057	
C Total	72	39.619218	
Total Count	73		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.190	0.6626
Pearson	0.191	0.6618

Fisher's Exact Test	Prob
Left	0.4347
Right	0.7643
2-Tail	0.7811

After: computer career learning By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	13 17.57 46.43 41.94	15 20.27 53.57 34.88	28 37.84
y	18 24.32 39.13 58.06	28 37.84 60.87 65.12	46 62.16
	31 41.89	43 58.11	74

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.189891	0.0039
Error	72	48.891696	
C Total	73	49.081586	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.380	0.5377
Pearson	0.381	0.5372

Fisher's Exact Test	Prob
Left	0.8052
Right	0.3533
2-Tail	0.6293

Response: Gender

Iteration History

Iter	LogLikelihood	Step	Delta-Criterion	Obj-Criterion
1	-50.59974418	Initial	0.13234219	•
2	-49.51832623	Newton	0.00309766	0.02183433
3	-49.51805558	Newton	0.00000268	0.00000546

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.249756	2	0.499513	0.7790
Full	49.518056			
Reduced	49.767812			

RSquare (U)	0.0050
Observations (or Sum Wgts)	73

Lack of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack of Fit	1	0.004923	0.009845
Pure Error	69	49.513133	**Prob>ChiSq**
Total Error	70	49.518056	0.9210

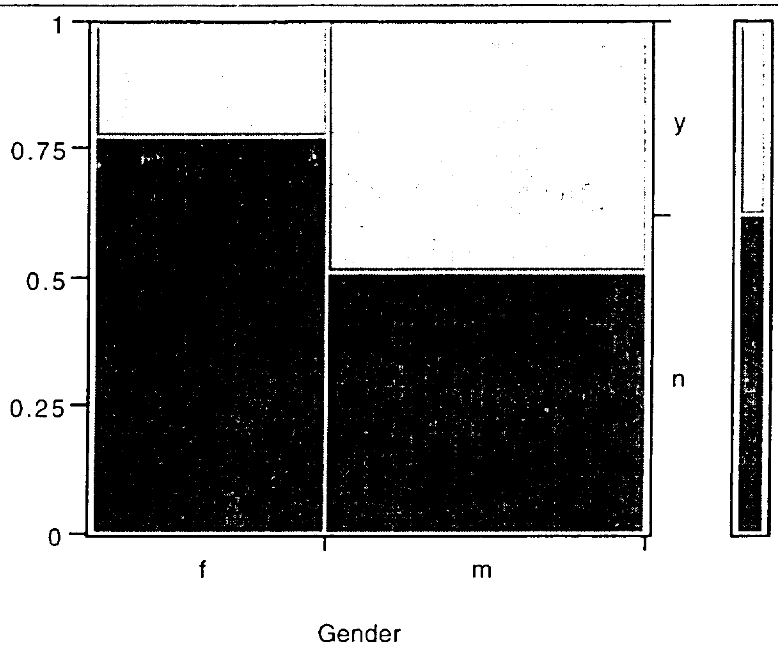
Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
ntercept	-0.2059021	0.2850386	0.52	0.4701
;omputer[n-y]	-0.1275716	0.279173	0.21	0.6477
fter: c[n-y]	0.13543985	0.2435519	0.31	0.5781

Effect Test

Source	Nparm	DF	Wald ChiSquare	Prob>ChiSq
Computers for career learning	1	1	0.20881470	0.6477
After: computer career learning	1	1	0.30925024	0.5781

You use WWW? By Gender



Crosstabs

Count / Total % / Row % / Col %	Gender: f	m	
n	24 32.43 52.17 77.42	22 29.73 47.83 51.16	46 62.16
y	7 9.46 25.00 22.58	21 28.38 75.00 48.84	28 37.84
	31 41.89	43 58.11	74

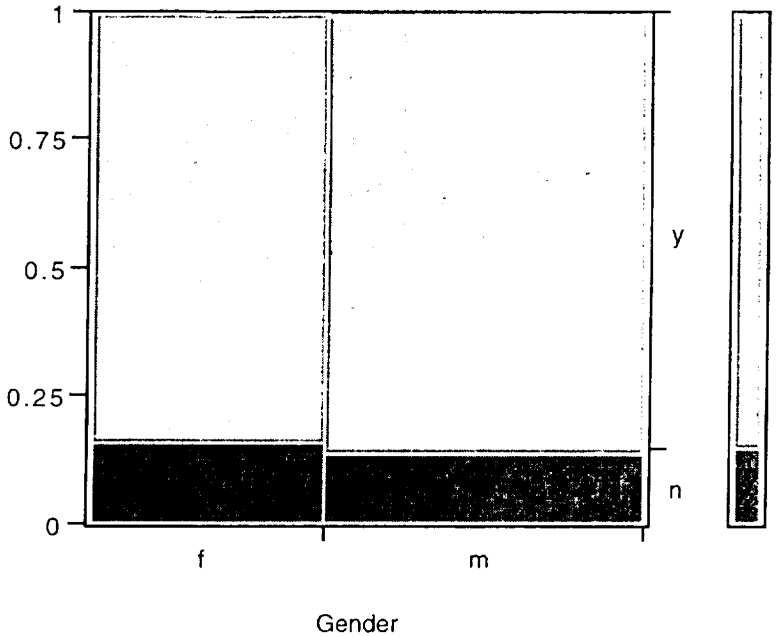
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	2.728946	0.0556
Error	72	46.352640	
C Total	73	49.081586	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	5.458	0.0195
Pearson	5.280	0.0216

Fisher's Exact Test	Prob
Left	0.9951
Right	0.0189
2-Tail	0.0291

after: you use WWW? By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	5 6.76 45.45 16.13	6 8.11 54.55 13.95	11 14.86
y	26 35.14 41.27 83.87	37 50.00 58.73 86.05	63 85.14
	31 41.89	43 58.11	74

Tests

Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	1	0.033492	0.0011
Error	72	31.072989	
C Total	73	31.106481	
Total Count	74		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	0.067	0.7958
Pearson	0.067	0.7952

Fisher's Exact Test	**Prob**
Left	0.7247
Right	0.5231
2-Tail	1.0000

Response: Gender

Iteration History

Iter	LogLikelihood	Step	Delta-Criterion	Obj-Criterion
1	-51.29289136	Initial	0.04301809	•
2	-47.60379793	Newton	0.00246563	0.0774795
3	-47.57777847	Newton	0.00114342	0.00054677
4	-47.57776482	Newton	0.00000065	0.00000029

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	2.737844	2	5.475688	0.0647
Full	47.577765			
Reduced	50.315609			

RSquare (U)	0.0544
Observations (or Sum Wgts)	74

Lack of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack of Fit	1	0.438818	0.877636
Pure Error	70	47.138947	**Prob>ChiSq**
Total Error	71	47.577765	0.3488

Parameter Estimates

erm	Estimate	Std Error	ChiSquare	Prob>ChiSq
ntercept	-0.5392178	0.3640337	2.19	0.1385
ou use [n-y]	0.59854572	0.2670453	5.02	0.0250
after: y[n-y]	-0.0455167	0.34154	0.02	0.8940

Effect Test

Source	Nparm	DF	Wald ChiSquare	Prob>ChiSq
You use WWW?	1	1	5.0237134	0.0250
after: you use WWW?	1	1	0.0177606	0.8940

WWW activity By Gender

Crosstabs

Gender

Count	f	m	
Astronomy	1	0	1
Get info	0	3	3
Many things	1	0	1
Profiles	1	0	1
Projects	0	6	6
Research	1	2	3
Search	0	3	3
	4	14	18

Tests

Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	6	7.625169	0.2429
Error	6	23.763455	
C Total	12	31.388624	
Total Count	18		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	15.250	0.0184
Pearson	14.143	0.0281

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Varning: average cell count less than 5, LR Chi-square suspect

After: WWW activity By Gender

Crosstabs

Count	Gender f	m	
Aviation stuff	1	0	1
Education	0	1	1
Info	3	4	7
Info & software	0	1	1
Many things	0	1	1
NASA	0	1	1
Projects	12	18	30
Research	5	3	8
Research & e-mail	1	0	1
Search	0	1	1
Social studies	0	1	1
The Simpsons	1	0	1
WW 1 info	0	1	1
computer class	0	1	1
fun	0	3	3
projects	1	0	1
yahoo.com	1	0	1
	25	36	61

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	16	11.02152	0.0957
Error	29	104.15313	
C Total	45	115.17464	
Total Count	61		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	22.043	0.1418
Pearson	16.392	0.4259

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 5, LR Chi-square suspect

Career 1 Before By Gender

Crosstabs

Gender

Count	f	m	
airforce	0	2	2
airports	0	1	1
army	0	1	1
astronaut	9	7	16
astronauts	1	0	1
astronomy	0	1	1
biologist	1	0	1
chemist	1	0	1
flying	0	1	1
marine biologist	0	1	1
military	0	1	1
pilot	10	22	32
plane	0	2	2
scientist	4	1	5
vet	2	2	4
	28	42	70

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	14	10.99642	0.0874
Error	42	114.76832	
C Total	56	125.76474	
Total Count	70		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	21.993	0.0788
Pearson	17.448	0.2331

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 5, LR Chi-square suspect

After: Career 1 By Gender

Crosstabs

Gender

Count	f	m	
army	0	1	1
astronaut	10	10	20
electrical engineer	0	1	1
flight attendant	0	1	1
football	0	1	1
lawyer	1	0	1
mechanic	0	2	2
pilot	17	25	42
scientist	2	1	3
	30	42	72

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	8	4.783828	0.0554
Error	56	81.557232	
C Total	64	86.341060	
Total Count	72		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	9.568	0.2967
Pearson	7.053	0.5309

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 5, LR Chi-square suspect

Career 2 Before By Gender

Crosstabs

Count	Gender: f	m	
air traffic controller	0	1	1
air traffic controllerA	0	1	1
airforce	1	0	1
airline	1	0	1
airliner	0	1	1
airport	0	1	1
astronaut	7	15	22
astronomer	1	0	1
aviation engineer	0	1	1
biologist	1	0	1
bird watching	0	1	1
chemist	2	1	3
electronic	0	1	1
engineer	0	2	2
helicopter	1	0	1
military	0	1	1
pilot	10	9	19
scientist	3	3	6
steward	1	0	1
	28	38	66

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	18	12.01451	0.0876
Error	30	125.12274	
C Total	48	137.13725	
Total Count	66		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	24.029	0.1541
Pearson	18.198	0.4427

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 5, LR Chi-square suspect

After: Career 2 By Gender

Crosstabs

Count	Gender: f	m	
air traffic controller	0	2	2
airforce	0	2	2
astronaut	12	16	28
astronomer	1	0	1
basketball	0	2	2
co-pilot	0	1	1
flight attendant	4	1	5
jet flying	0	1	1
marine	0	1	1
mechanic	0	2	2
pilot	10	10	20
scientist	2	2	4
stewardess	1	1	2
	30	41	71

Tests

Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	12	8.71263	0.0676
Error	47	120.19743	
C Total	59	128.91006	
Total Count	71		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	17.425	0.1343
Pearson	12.979	0.3706

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 5, LR Chi-square suspect

Career 3 Before By Gender

Crosstabs

Count	Gender: f	m	
IIT	0	1	1
aeronautist	1	0	1
air traffic controller	0	1	1
airforce	2	0	2
army	2	1	3
army marine	0	1	1
astronaut	3	7	10
astronomer	1	3	4
chemist	1	1	2
engineer	1	1	2
flight attendant	3	2	5
jet pilot	1	0	1
jet plane	0	1	1
marine biologist	2	0	2
mechanic	1	1	2
military	0	1	1
oceanologist	0	1	1
pilot	4	1	5
pilot instructor	0	1	1
public airlines	0	1	1
science teacher	0	1	1
scientist	0	1	1
sky diver	2	2	4
space explor	0	1	1
stewardess	1	3	4
	25	33	58

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	24	14.33364	0.0846
Error	10	155.18898	
C Total	34	169.52262	
Total Count	58		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	28.667	0.2329
Pearson	22.253	0.5642

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 5, LR Chi-square suspect

After: Career 3 By Gender

Crosstabs

Count	Gender: f	m	
aeronautical engineer	0	1	1
air traffic controller	1	1	2
airforce	0	1	1
airplane	0	1	1
architect	0	1	1
army	1	0	1
astronaut	5	6	11
astronomer	1	1	2
aviator	0	1	1
co-pilot	0	1	1
electrical engineer	0	1	1
engine parts	0	1	1
engineer	4	6	10
flight attendant	4	7	11
flight control	0	1	1
pilot	2	3	5
scientist	5	5	10
stewardess	2	1	3
traffic controller	2	0	2
	27	39	66

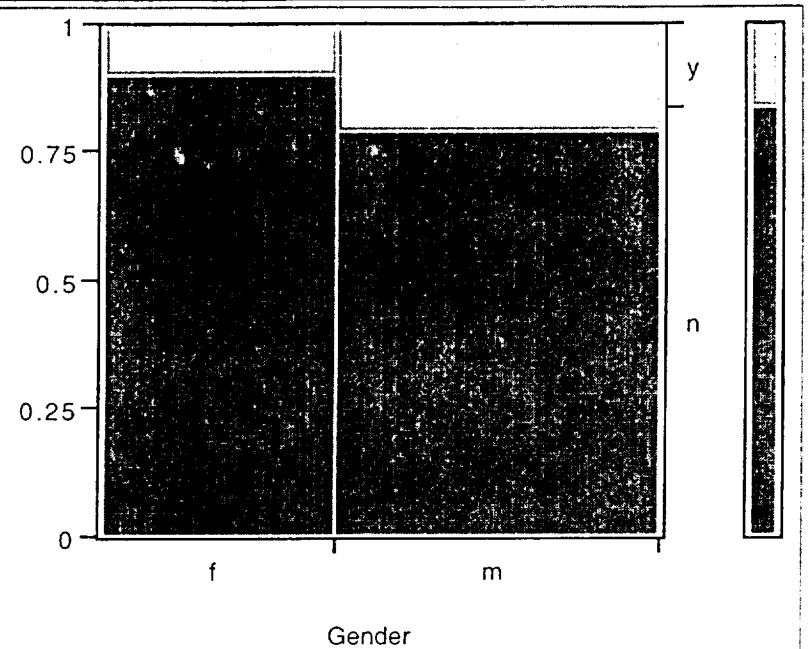
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	18	8.15253	0.0503
Error	30	154.05737	
C Total	48	162.20991	
Total Count	66		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	16.305	0.5713
Pearson	12.059	0.8442

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 5, LR Chi-square suspect

Aviation career thoughts? By Gender



Crosstabs

Count / Total % / Row % / Col %	Gender: f	Gender: m	
n	28 37.84 45.16 90.32	34 45.95 54.84 79.07	62 83.78
y	3 4.05 25.00 9.68	9 12.16 75.00 20.93	12 16.22
	31 41.89	43 58.11	74

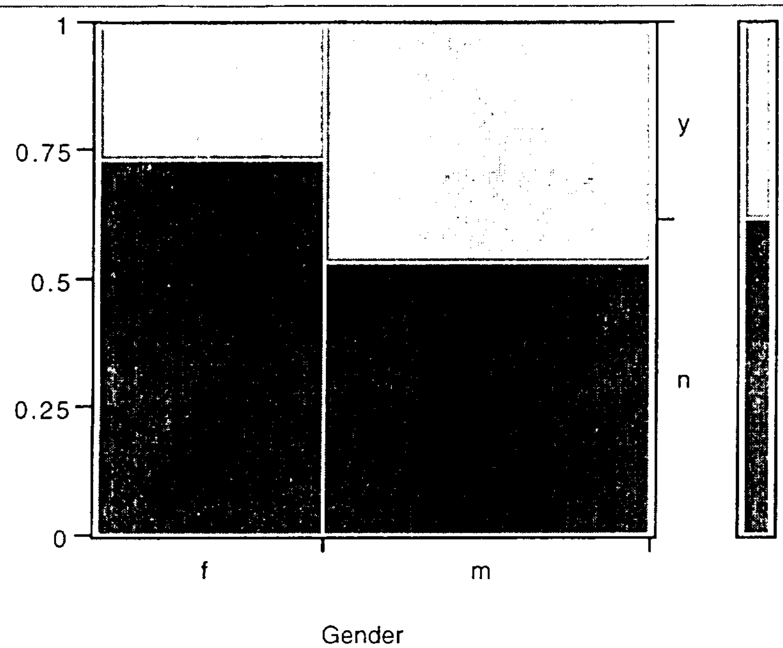
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.883239	0.0269
Error	72	31.916366	
C Total	73	32.799605	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1.766	0.1838
Pearson	1.679	0.1951

Fisher's Exact Test	Prob
Left	0.9505
Right	0.1650
2-Tail	0.3380

After: Aviation career thoughts By Gender



Crosstabs

Count / Total % / Row % / Col %	Gender: f	m	
n	22 30.14 48.89 73.33	23 31.51 51.11 53.49	45 61.64
y	8 10.96 28.57 26.67	20 27.40 71.43 46.51	28 38.36
	30 41.10	43 58.90	73

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	1.503953	0.0309
Error	71	47.098048	
C Total	72	48.602001	
Total Count	73		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	3.008	0.0829
Pearson	2.943	0.0862

Fisher's Exact Test	Prob
Left	0.9761
Right	0.0698
2-Tail	0.0952

Response: Gender

Iteration History

Iter	LogLikelihood	Step	Delta-Criterion	Obj-Criterion
1	-50.59974418	Initial	0.3541384	•
2	-47.57297518	Newton	0.02735168	0.06361034
3	-47.54896565	Newton	0.00183694	0.00050484
4	-47.54894484	Newton	0.00000207	0.00000044

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	1.887068	2	3.774136	0.1515
Full	47.548945			
Reduced	49.436013			

RSquare (U)	0.0382
Observations (or Sum Wgts)	73

Lack of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack of Fit	1	0.406424	0.812848
Pure Error	69	47.142521	Prob>ChiSq
Total Error	70	47.548945	0.3673

Parameter Estimates

erm	Estimate	Std Error	ChiSquare	Prob>ChiSq
ntercept	-0.6875252	0.3636039	3.58	0.0586
viation[n-y]	0.31540594	0.370113	0.73	0.3941
After: A[n-y]	0.38203996	0.2640195	2.09	0.1479

Effect Test

Source	Nparm	DF	Wald ChiSquare	Prob>ChiSq
Aviation career thoughts?	1	1	0.7262246	0.3941
After: Aviation career thoughts	1	1	2.0938502	0.1479

What Aviation career By Gender

Crosstabs

Count	Gender: f	m	
F15 pilot	0	1	1
airforce	0	1	1
astronaut	0	5	5
flight attendant	1	0	1
pediatrician	1	0	1
pilot	0	2	2
sky diver & vet	1	0	1
	3	9	12

Tests

Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	6	6.748022	0.3310
Error	0	13.637374	
C Total	6	20.385396	
Total Count	12		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	13.496	0.0358
Pearson	12.000	0.0620

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Varning: average cell count less than 1, Pearson Chi-square suspect
Varning: average cell count less than 5, LR Chi-square suspect

After: what aviation career By Gender

Crosstabs

Count	Gender: f	m	
air traffic controller	0	1	1
astronaut	3	5	8
co-pilot	0	1	1
designer	0	1	1
electrical engineer	0	1	1
flight attendant	2	0	2
pilot	1	9	10
pilot airforce	0	1	1
science teacher	0	1	1
soil scientist	1	0	1
veterinarian science	1	0	1
	8	20	28

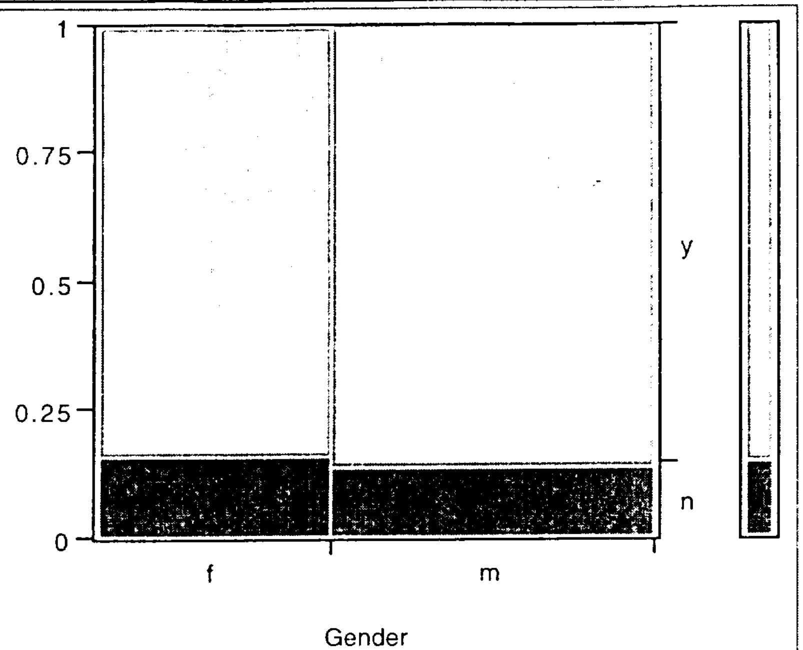
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	10	8.208213	0.1571
Error	8	44.045836	
C Total	18	52.254049	
Total Count	28		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	16.416	0.0883
Pearson	14.402	0.1554

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 5, LR Chi-square suspect

Career Oppertunities for women? By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	5 6.76 45.45 16.13	6 8.11 54.55 13.95	11 14.86
y	26 35.14 41.27 83.87	37 50.00 58.73 86.05	63 85.14
	31 41.89	43 58.11	74

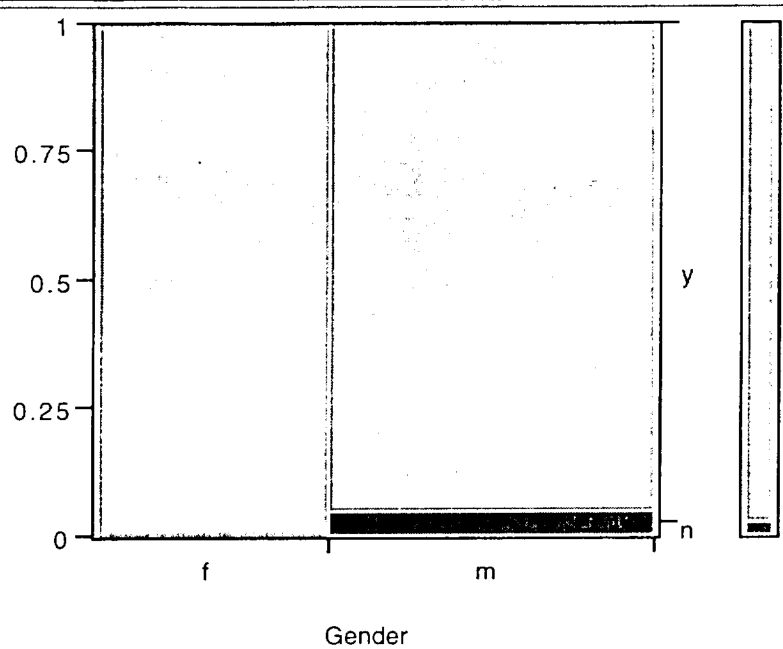
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.033492	0.0011
Error	72	31.072989	
C Total	73	31.106481	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.067	0.7958
Pearson	0.067	0.7952

Fisher's Exact Test	Prob
Left	0.7247
Right	0.5231
2-Tail	1.0000

After: careers for women? By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	0 0.00 0.00 0.00	2 2.78 100.00 4.76	2 2.78
y	30 41.67 42.86 100.00	40 55.56 57.14 95.24	70 97.22
	30 41.67	42 58.33	72

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	1.0983478	0.1202
Error	70	8.0406514	
C Total	71	9.1389993	
Total Count	72		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	2.197	0.1383
Pearson	1.469	0.2254

Fisher's Exact Test	Prob
Left	0.3369
Right	1.0000
2-Tail	0.5070

Response: Gender

Iteration History

Iter	LogLikelihood	Step	Delta-Criterion	Obj-Criterion
1	-49.906597	Initial	0.84745763	•
2	-48.03955522	Newton	0.56646788	0.03885659
3	-47.87078983	Newton	0.52174259	0.0035247
4	-47.81605825	Newton	0.50765828	0.00114439
5	-47.79672468	Newton	0.5027745	0.00040441
6	-47.78971338	Newton	0.50101503	0.00014668
7	-47.78714741	Newton	0.50037265	0.00005368
8	-47.78620524	Newton	0.50013699	0.00001971
9	-47.78585887	Newton	0.50005038	0.00000725

Converged by Objective

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	1.116056	2	2.232113	0.3276
Full	47.785859			
Reduced	48.901915			

RSquare (U)	0.0228
Observations (or Sum Wgts)	72

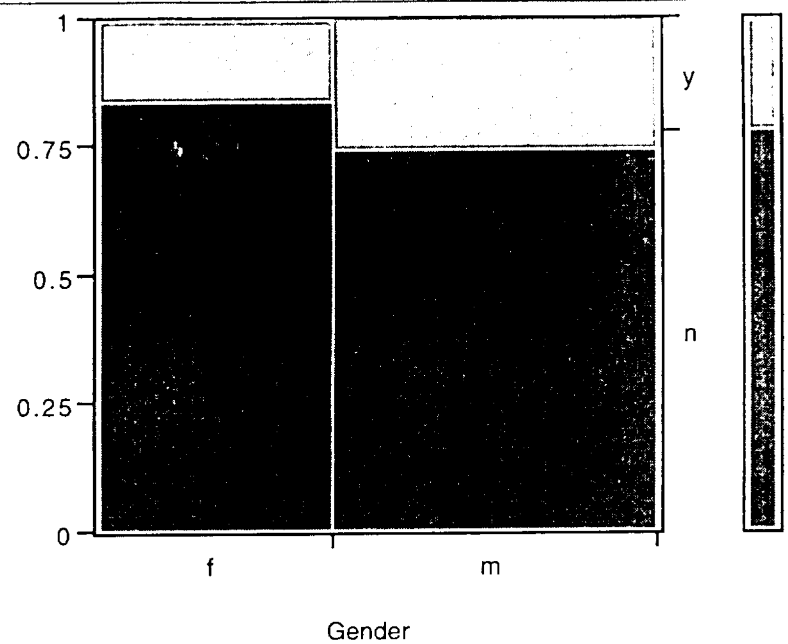
Parameter Estimates

Term		Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	Unstable	-4.6925285	35.226006	0.02	0.8940
areer O[n-y]		0.06258157	0.3301812	0.04	0.8497
'ter: c[n-y]	Unstable	-4.4476253	35.224951	0.02	0.8995

Effect Test

Source	Nparm	DF	Wald ChiSquare	Prob>ChiSq
Career Oppertunities for women?	1	1	0.03592430	0.8497
After: careers for women?	1	1	0.01594247	0.8995

Do you know an aviator By Gender



Crosstabs

Gender Count Total % Row % Col %	f	m	
n	26 35.14 44.83 83.87	32 43.24 55.17 74.42	58 78.38
y	5 6.76 31.25 16.13	11 14.86 68.75 25.58	16 21.62
	31 41.89	43 58.11	74

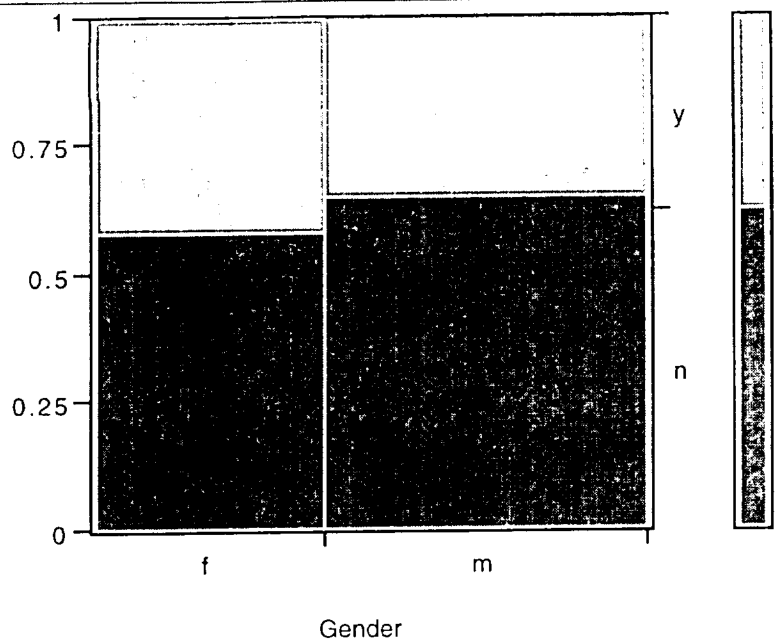
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.486591	0.0126
Error	72	38.147112	
C Total	73	38.633703	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.973	0.3239
Pearson	0.950	0.3298

Fisher's Exact Test	Prob
Left	0.8976
Right	0.2477
2-Tail	0.3996

After: Do you know an aviator By Gender



Crosstabs

Gender

Count Total % Row % Col %	f	m	
n	18 24.32 39.13 58.06	28 37.84 60.87 65.12	46 62.16
y	13 17.57 46.43 41.94	15 20.27 53.57 34.88	28 37.84
	31 41.89	43 58.11	74

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.189891	0.0039
Error	72	48.891696	
C Total	73	49.081586	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.380	0.5377
Pearson	0.381	0.5372

Fisher's Exact Test	Prob
Left	0.3533
Right	0.8052
2-Tail	0.6293

Response: Gender

Iteration History

Iter	LogLikelihood	Step	Delta-Criterion	Obj-Criterion
1	-51.29289136	Initial	0.32649817	•
2	-49.08184257	Newton	0.01646742	0.04503903
3	-49.075499	Newton	0.00012119	0.00012924
4	-49.07549838	Newton	0.00000004	0.00000001

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	1.240110	2	2.48022	0.2894
Full	49.075498			
Reduced	50.315609			

RSquare (U)	0.0246
Observations (or Sum Wgts)	74

Lack of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack of Fit	1	0.190170	0.380339
Pure Error	70	48.885329	**Prob>ChiSq**
Total Error	71	49.075498	0.5374

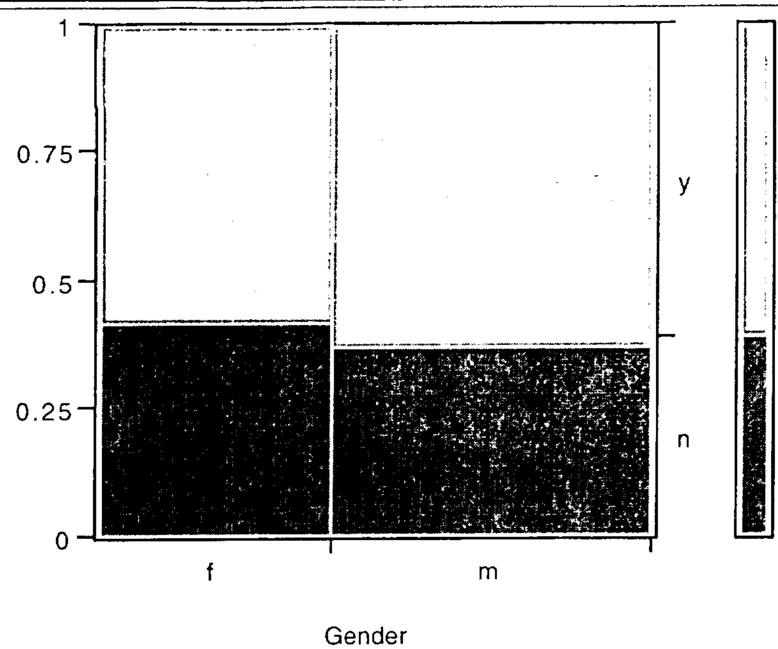
Parameter Estimates

erm	Estimate	Std Error	ChiSquare	Prob>ChiSq
tercept	-0.5308758	0.3042934	3.04	0.0811
ɔ you k[n-y]	0.48664074	0.3461016	1.98	0.1597
After: D[n-y]	-0.3430868	0.2828058	1.47	0.2251

Effect Test

Source	Nparm	DF	Wald ChiSquare	Prob>ChiSq
Do you know an aviator	1	1	1.9770140	0.1597
After: Do you know an aviator	1	1	1.4717412	0.2251

Career opp. for most people? By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	13 17.57 44.83 41.94	16 21.62 55.17 37.21	29 39.19
y	18 24.32 40.00 58.06	27 36.49 60.00 62.79	45 60.81
	31 41.89	43 58.11	74

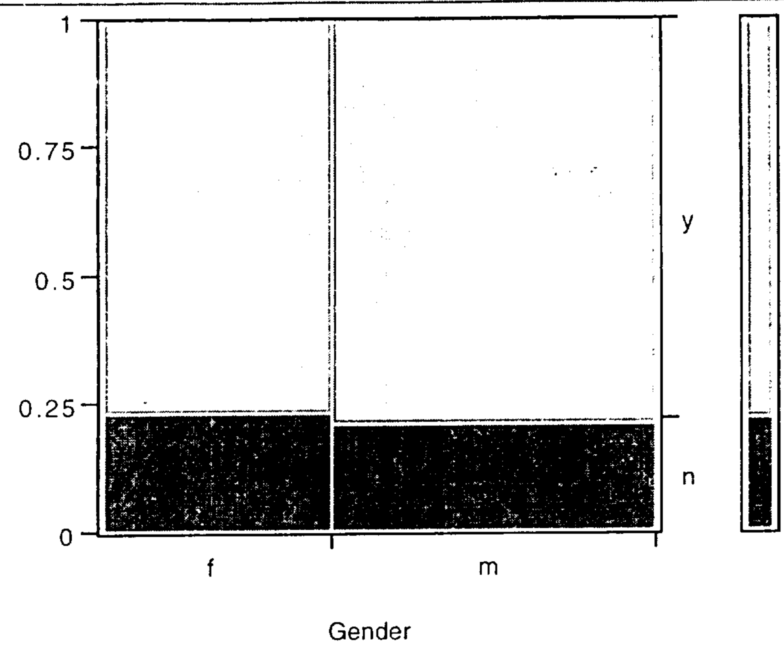
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.084266	0.0017
Error	72	49.465160	
C Total	73	49.549426	
Total Count	74		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.169	0.6814
Pearson	0.169	0.6811

Fisher's Exact Test	Prob
Left	0.7432
Right	0.4317
2-Tail	0.8100

After: careers for most people? By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	7 9.72 43.75 23.33	9 12.50 56.25 21.43	16 22.22
y	23 31.94 41.07 76.67	33 45.83 58.93 78.57	56 77.78
	30 41.67	42 58.33	72

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.018310	0.0005
Error	70	38.120537	
C Total	71	38.138846	
Total Count	72		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.037	0.8482
Pearson	0.037	0.8480

Fisher's Exact Test	Prob
Left	0.6861
Right	0.5344
2-Tail	1.0000

Response: Gender

Iteration History

Iter	LogLikelihood	Step	Delta-Criterion	Obj-Criterion
1	-49.906597	Initial	0.00737064	•
2	-48.80219492	Newton	0.00016161	0.02262554
3	-48.80198998	Newton	0.0000001	0.0000042

Converged by Gradient

Whole-Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	0.099925	2	0.19985	0.9049
Full	48.801990			
Reduced	48.901915			

RSquare (U)	0.0020
Observations (or Sum Wgts)	72

Lack of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack of Fit	1	2.903105	5.806211
Pure Error	68	45.898885	Prob>ChiSq
Total Error	69	48.801990	0.0160

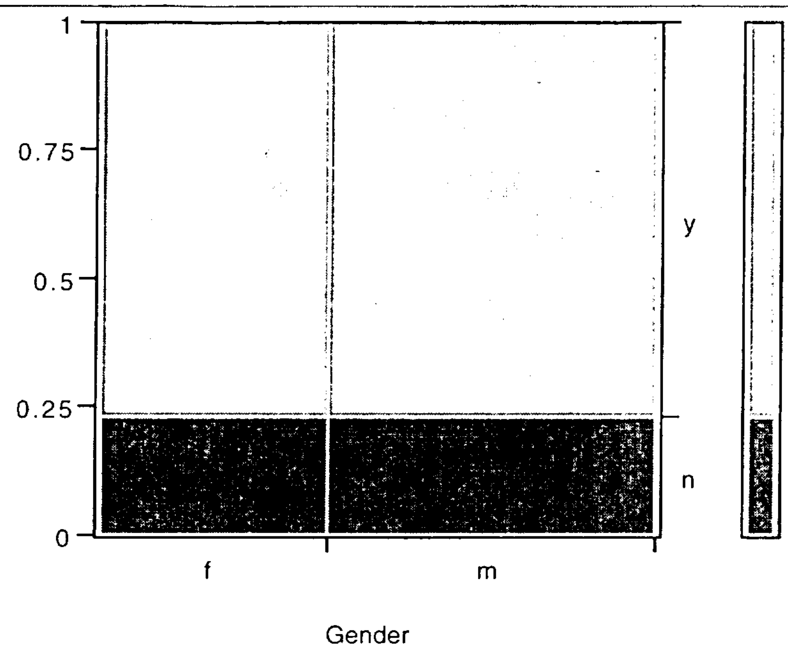
Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
tercept	-0.3125469	0.2870855	1.19	0.2763
·areer o[n-y]	0.10620334	0.2627574	0.16	0.6861
:er: c[n-y]	0.00753225	0.3095113	0.00	0.9806

Effect Test

Source	Nparm	DF	Wald ChiSquare	Prob>ChiSq
Career opp. for most people?	1	1	0.16336781	0.6861
After: careers for most people?	1	1	0.00059224	0.9806

After: 4 videos seen? By Gender



Crosstabs

Count / Total % / Row % / Col %	Gender: f	m	
n	7 9.59 41.18 23.33	10 13.70 58.82 23.26	17 23.29
y	23 31.51 41.07 76.67	33 45.21 58.93 76.74	56 76.71
	30 41.10	43 58.90	73

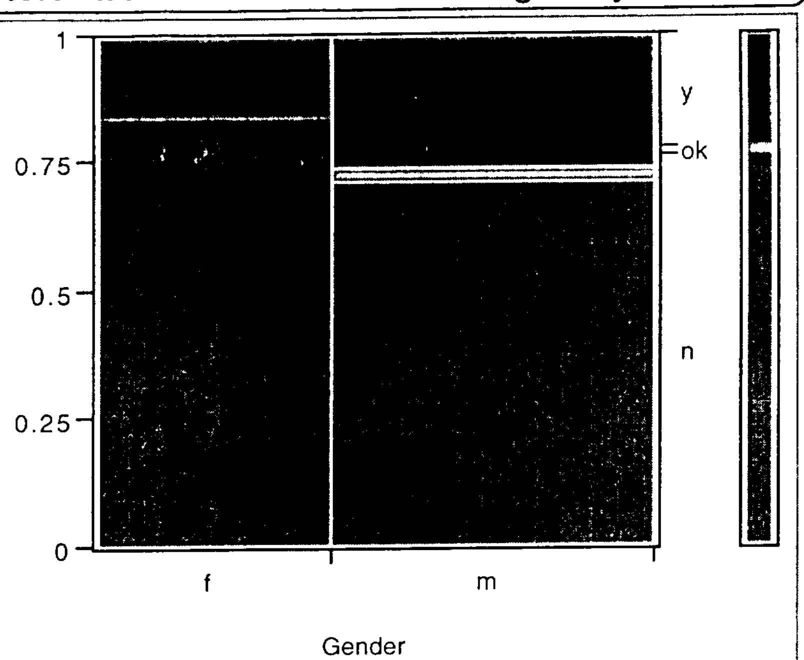
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.000030	0.0000
Error	71	39.619188	
C Total	72	39.619218	
Total Count	73		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.000	0.9938
Pearson	0.000	0.9938

Fisher's Exact Test	Prob
Left	0.6166
Right	0.6042
2-Tail	1.0000

After: were videos interesting? By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	26 35.62 46.43 83.87	30 41.10 53.57 71.43	56 76.71
ok	0 0.00 0.00 0.00	1 1.37 100.00 2.38	1 1.37
y	5 6.85 31.25 16.13	11 15.07 68.75 26.19	16 21.92
	31 42.47	42 57.53	73

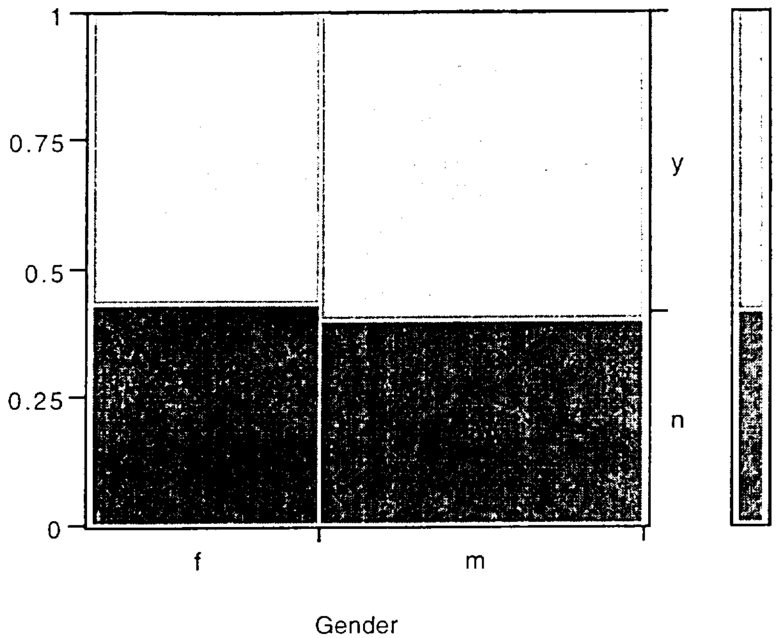
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	2	1.157167	0.0266
Error	69	42.265258	
C Total	71	43.422425	
Total Count	73		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	2.314	0.3144
Pearson	1.922	0.3825

Warning: 20% of cells have expected count less than 5, Chi-squares suspect

After: learn about careers? By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	13 18.06 43.33 43.33	17 23.61 56.67 40.48	30 41.67
y	17 23.61 40.48 56.67	25 34.72 59.52 59.52	42 58.33
	30 41.67	42 58.33	72

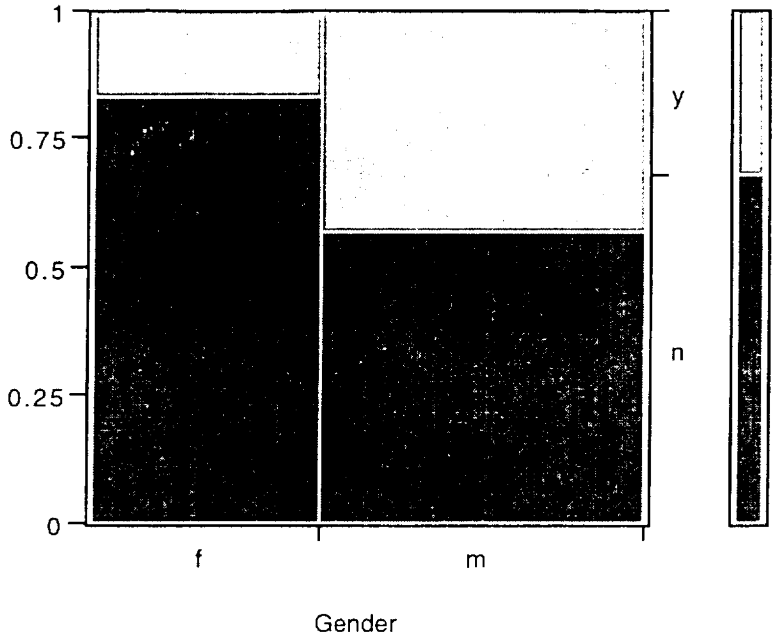
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.029361	0.0006
Error	70	48.872554	
C Total	71	48.901915	
Total Count	72		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.059	0.8085
Pearson	0.059	0.8084

Fisher's Exact Test	Prob
Left	0.6865
Right	0.4991
2-Tail	0.8138

After: recommend program? By Gender



Crosstabs

Gender

Count Total % Row % Col %	f	m	
n	25 34.72 51.02 83.33	24 33.33 48.98 57.14	49 68.06
y	5 6.94 21.74 16.67	18 25.00 78.26 42.86	23 31.94
	30 41.67	42 58.33	72

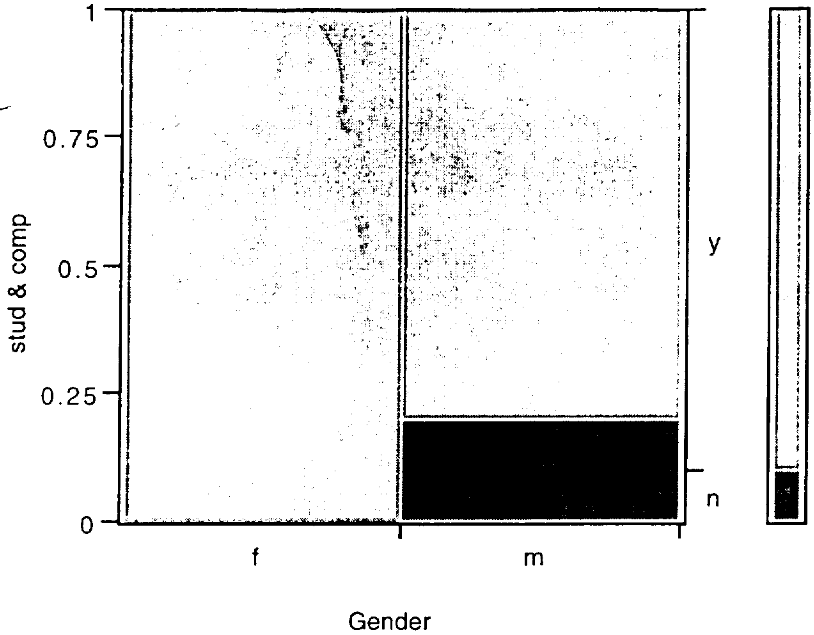
Tests

Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	1	2.905422	0.0644
Error	70	42.198977	
C Total	71	45.104399	
Total Count	72		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	5.811	0.0159
Pearson	5.522	0.0188

Fisher's Exact Test	**Prob**
Left	0.9963
Right	0.0167
2-Tail	0.0226

stud & comp By Gender



East Boston

Core Site

Crosstabs

stud & comp	Count / Total % / Row % / Col %	Gender: f	m	
	n	0 0.00 0.00 0.00	1 10.00 100.00 20.00	1 10.00
	y	5 50.00 55.56 100.00	4 40.00 44.44 80.00	9 90.00
		5 50.00	5 50.00	10

Tests

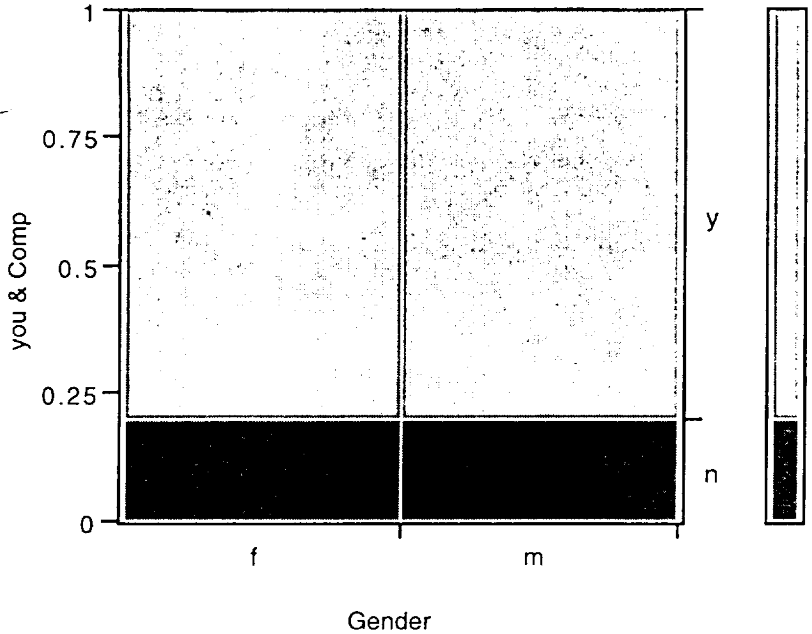
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.7488176	0.2303
Error	8	2.5020121	
C Total	9	3.2508297	
Total Count	10		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1.498	0.2210
Pearson	1.111	0.2918

Warning: average cell count less than 5, LR Chi-square suspect

isher's Exact Test	Prob
eft	0.5000
Right	1.0000
2-Tail	1.0000

you & Comp By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
you & Comp: n	1 10.00 50.00 20.00	1 10.00 50.00 20.00	2 20.00
y	4 40.00 50.00 80.00	4 40.00 50.00 80.00	8 80.00
	5 50.00	5 50.00	10

Tests

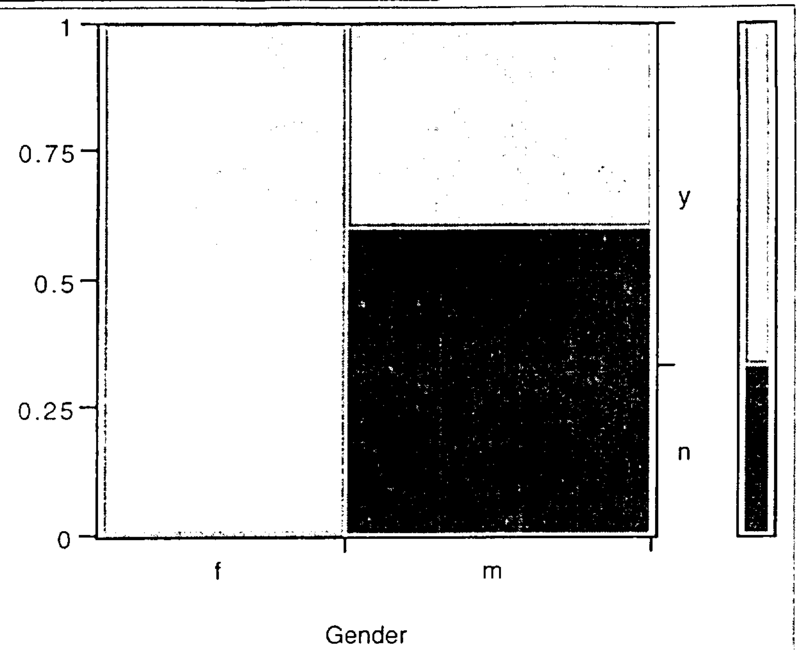
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.0000000	0.0000
Error	8	5.0040242	
C Total	9	5.0040242	
Total Count	10		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.000	1.0000
Pearson	0.000	1.0000

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	Prob
Left	0.7778
Right	0.7778
2-Tail	1.0000

Easy Internet By Gender



Crosstabs

Gender

Count Total % Row % Col %	f	m	
n	0 0.00 0.00 0.00	3 33.33 100.00 60.00	3 33.33
y	4 44.44 66.67 100.00	2 22.22 33.33 40.00	6 66.67
	4 44.44	5 55.56	9

Tests

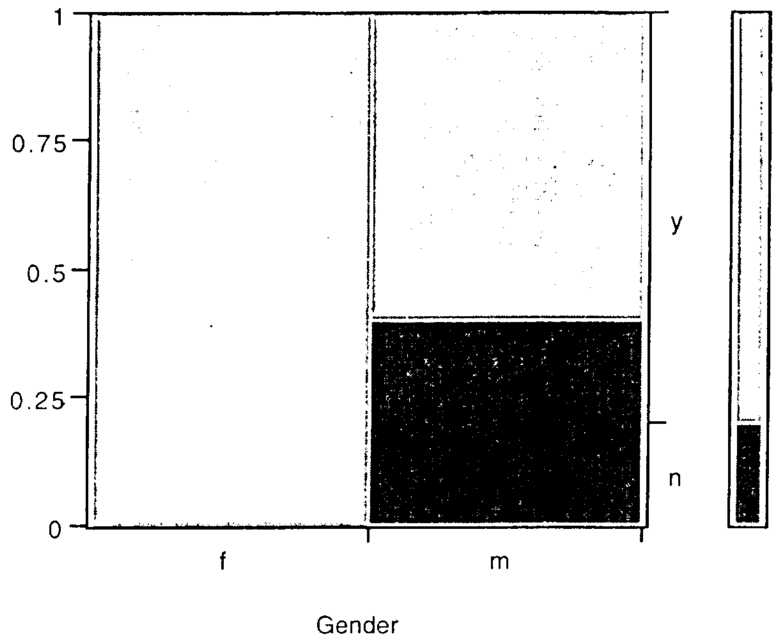
Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	1	2.3635692	0.4126
Error	7	3.3650583	
C Total	8	5.7286275	
Total Count	9		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	4.727	0.0297
Pearson	3.600	0.0578

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	**Prob**
Left	0.1190
Right	1.0000
2-Tail	0.1667

Teach comp By Gender



Crosstabs

Gender

Count Total % Row % Col %	f	m	
n	0 0.00 0.00 0.00	2 20.00 100.00 40.00	2 20.00
y	5 50.00 62.50 100.00	3 30.00 37.50 60.00	8 80.00
	5 50.00	5 50.00	10

Tests

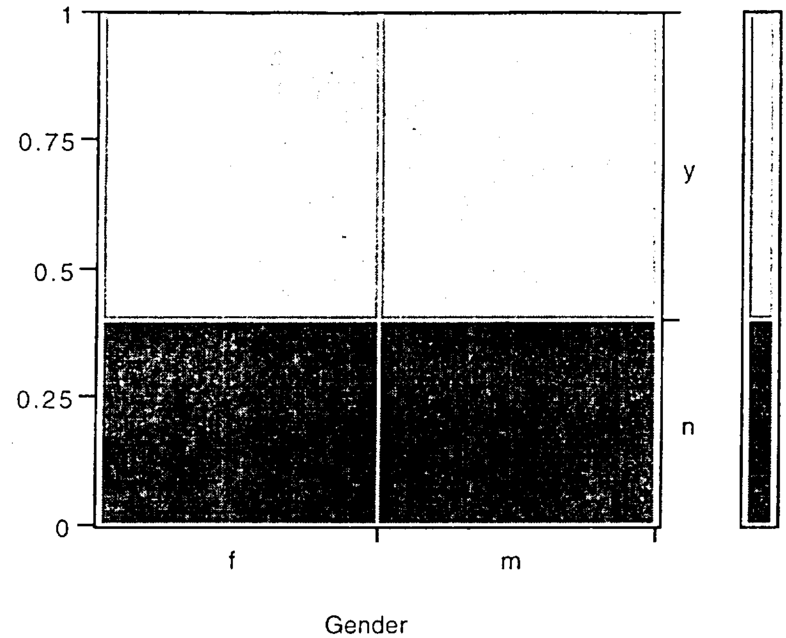
Source	DF	-LogLikelihood	RSquare (U)
Model	1	1.6389659	0.3275
Error	8	3.3650583	
C Total	9	5.0040242	
Total Count	10		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	3.278	0.0702
Pearson	2.500	0.1138

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	Prob
Left	0.2222
Right	1.0000
2-Tail	0.4444

e-mail By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	2 20.00 50.00 40.00	2 20.00 50.00 40.00	4 40.00
y	3 30.00 50.00 60.00	3 30.00 50.00 60.00	6 60.00
	5 50.00	5 50.00	10

Tests

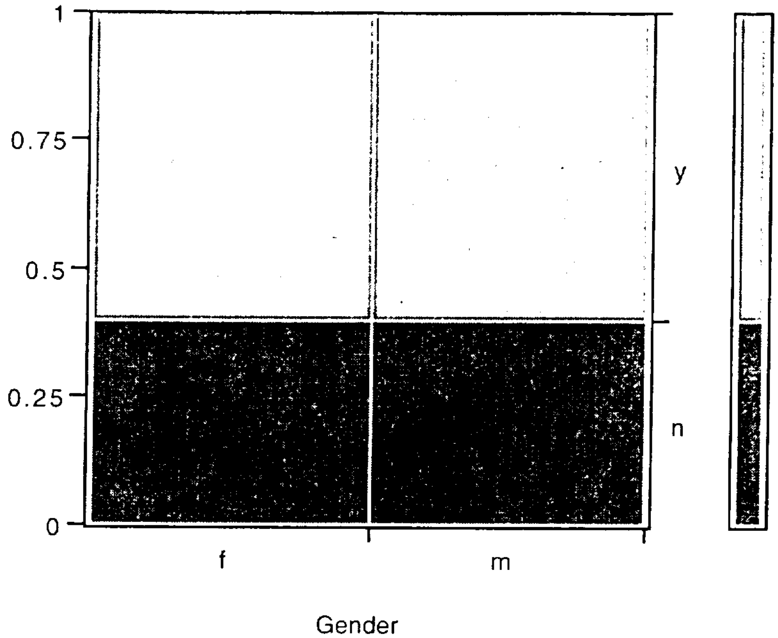
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.0000000	0.0000
Error	8	6.7301167	
C Total	9	6.7301167	
Total Count	10		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.000	1.0000
Pearson	0.000	1.0000

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	Prob
Left	0.7381
Right	0.7381
2-Tail	1.0000

careers & Comp By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	2 20.00 50.00 40.00	2 20.00 50.00 40.00	4 40.00
y	3 30.00 50.00 60.00	3 30.00 50.00 60.00	6 60.00
	5 50.00	5 50.00	10

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.0000000	0.0000
Error	8	6.7301167	
C Total	9	6.7301167	
Total Count	10		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.000	1.0000
Pearson	0.000	1.0000

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	Prob
Left	0.7381
Right	0.7381
2-Tail	1.0000

WWW used By Gender

Crosstabs

Gender

Count	f	m	
jobs	0	1	1
n	3	0	3
y	2	4	6
	5	5	10

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	2	3.1123868	0.3466
Error	6	5.8670705	
C Total	8	8.9794572	
Total Count	10		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	6.225	0.0445
Pearson	4.667	0.0970

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 5, LR Chi-square suspect

WWW activity By Gender

rosstabs

Gender

Count	f	m	
chat room	1	0	1
everything	0	1	1
games	0	1	1
pilot	0	1	1
projects	1	1	2
sports	0	1	1
	2	5	7

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	5	2.801593	0.2290
Error	-3	9.433484	
C Total	2	12.235077	
Total Count	7		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	5.603	0.3468
Pearson	4.550	0.4732

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
'Varning: average cell count less than 1, Pearson Chi-square suspect
ırning: average cell count less than 5, LR Chi-square suspect

Career 1 By Gender

Crosstabs

Gender

Count	f	m	
mechanic	0	1	1
pilot	3	2	5
science	1	0	1
scientist	1	0	1
	5	3	8

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	3	1.9274476	0.2244
Error	2	6.6608952	
C Total	5	8.5883428	
Total Count	8		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	3.855	0.2776
'earson	2.880	0.4105

'ning: 20% of cells have expected count less than 5, Chi-squares suspect
varning: average cell count less than 5, LR Chi-square suspect

Career 2 By Gender

Crosstabs

Gender

Count	f	m	
accountant	1	0	1
astronaut	1	3	4
computer	1	0	1
science teacher	1	0	1
	4	3	7

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	3	2.5310162	0.3134
Error	1	5.5451774	
C Total	4	8.0761936	
Total Count	7		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	5.062	0.1673
Pearson	3.938	0.2683

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 1, Pearson Chi-square suspect
Warning: average cell count less than 5, LR Chi-square suspect

Career 3 By Gender

Crosstabs

Gender

Count	f	m	
engineer	0	1	1
mecanic	1	0	1
scientist	1	0	1
	2	1	3

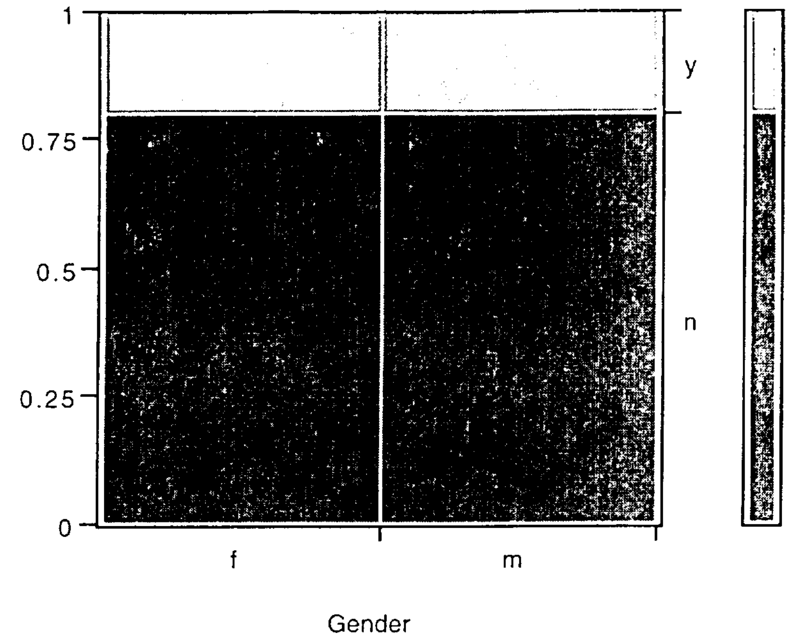
Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	2	1.9095425	0.5794
Error	-1	1.3862944	
C Total	1	3.2958369	
Total Count	3		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	3.819	0.1481
Pearson	3.000	0.2231

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 1, Pearson Chi-square suspect
Warning: average cell count less than 5, LR Chi-square suspect

Career thoughts By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	4 40.00 50.00 80.00	4 40.00 50.00 80.00	8 80.00
y	1 10.00 50.00 20.00	1 10.00 50.00 20.00	2 20.00
	5 50.00	5 50.00	10

Tests

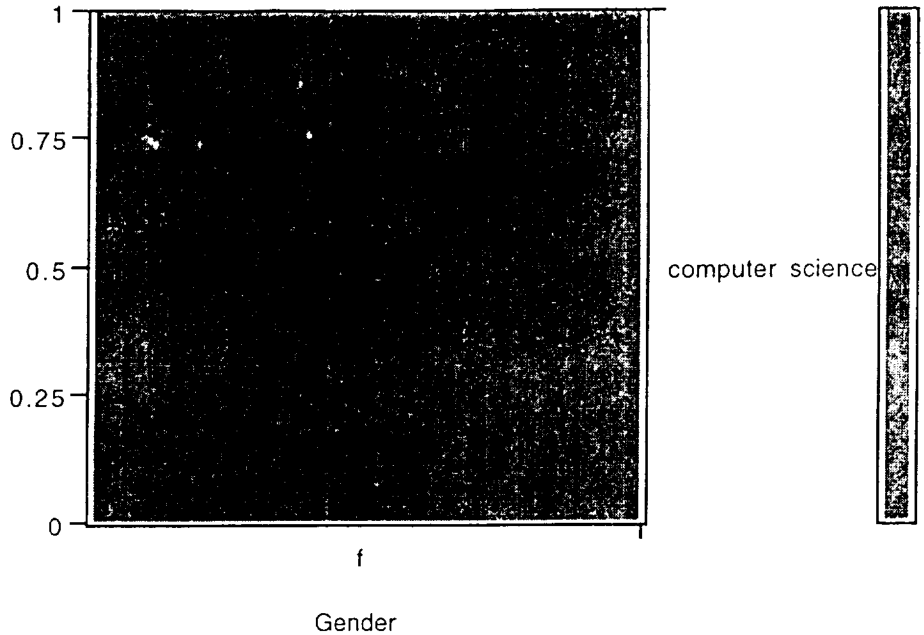
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.0000000	0.0000
Error	8	5.0040242	
C Total	9	5.0040242	
Total Count	10		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.000	1.0000
Pearson	0.000	1.0000

''arning: average cell count less than 5, LR Chi-square suspect

isher's Exact Test	Prob
eft	0.7778
Right	0.7778
2-Tail	1.0000

Av. career By Gender



Crosstabs

Gender

Count	f	m	
computer science	1	0	1
	1	0	1

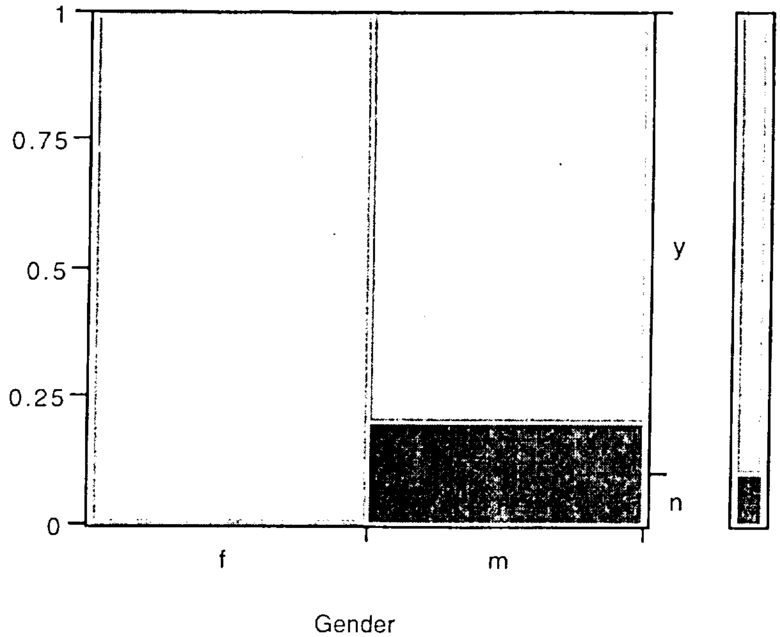
Tests

Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	0	-0	.
Error	1	0	
C Total	1	-0	
Total Count	1		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	-0.000	0.0000
Pearson	0.000	0.0000

Warning: average cell count less than 1, Pearson Chi-square suspect
Warning: average cell count less than 5, LR Chi-square suspect

Women & Av By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	0 0.00 0.00 0.00	1 10.00 100.00 20.00	1 10.00
y	5 50.00 55.56 100.00	4 40.00 44.44 80.00	9 90.00
	5 50.00	5 50.00	10

Tests

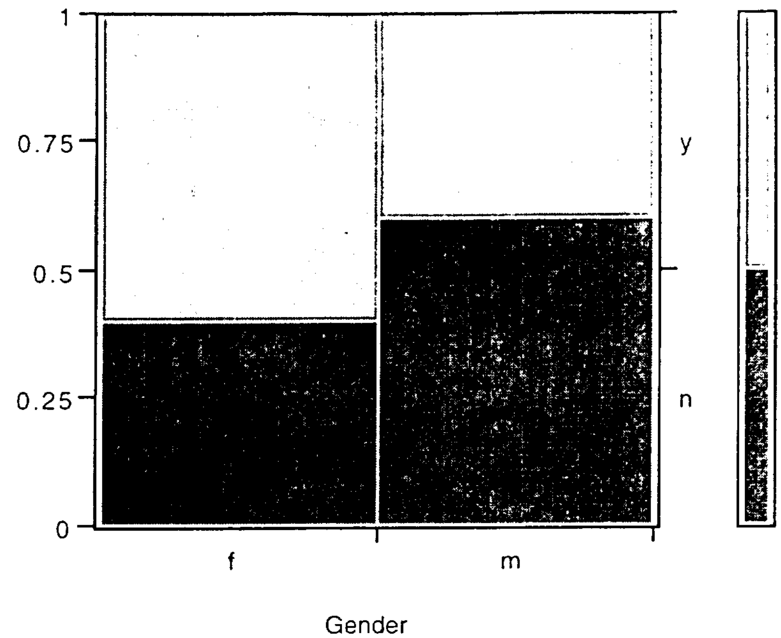
Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	1	0.7488176	0.2303
Error	8	2.5020121	
C Total	9	3.2508297	
Total Count	10		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	1.498	0.2210
Pearson	1.111	0.2918

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	**Prob**
Left	0.5000
Right	1.0000
2-Tail	1.0000

Know aviator By Gender



Crosstabs

Gender	f	m	
Count Total % Row % Col %			
n	2 20.00 40.00 40.00	3 30.00 60.00 60.00	5 50.00
y	3 30.00 60.00 60.00	2 20.00 40.00 40.00	5 50.00
	5 50.00	5 50.00	10

Tests

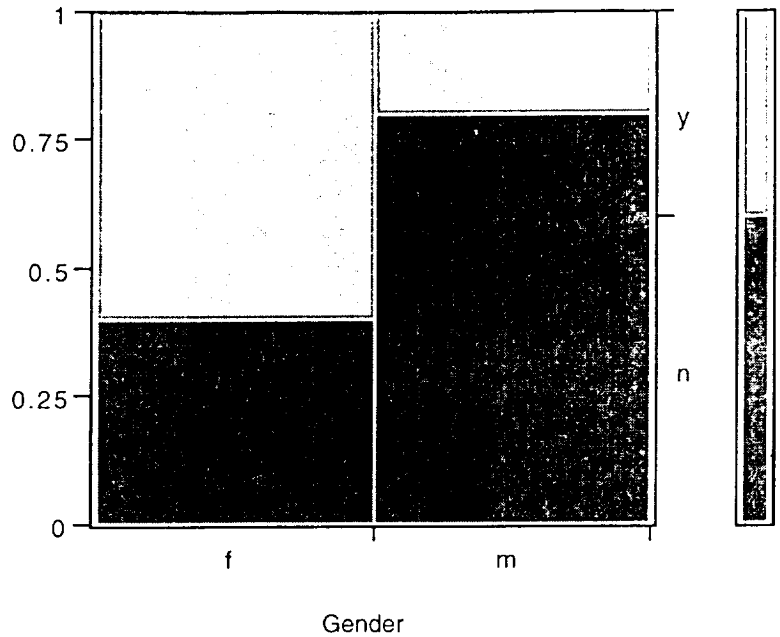
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.2013551	0.0290
Error	8	6.7301167	
C Total	9	6.9314718	
Total Count	10		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.403	0.5257
Pearson	0.400	0.5271

'rning: average cell count less than 5, LR Chi-square suspect

'isher's Exact Test	Prob
.eft	0.5000
Right	0.8968
2-Tail	1.0000

most people By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	2 20.00 33.33 40.00	4 40.00 66.67 80.00	6 60.00
y	3 30.00 75.00 60.00	1 10.00 25.00 20.00	4 40.00
	5 50.00	5 50.00	10

Tests

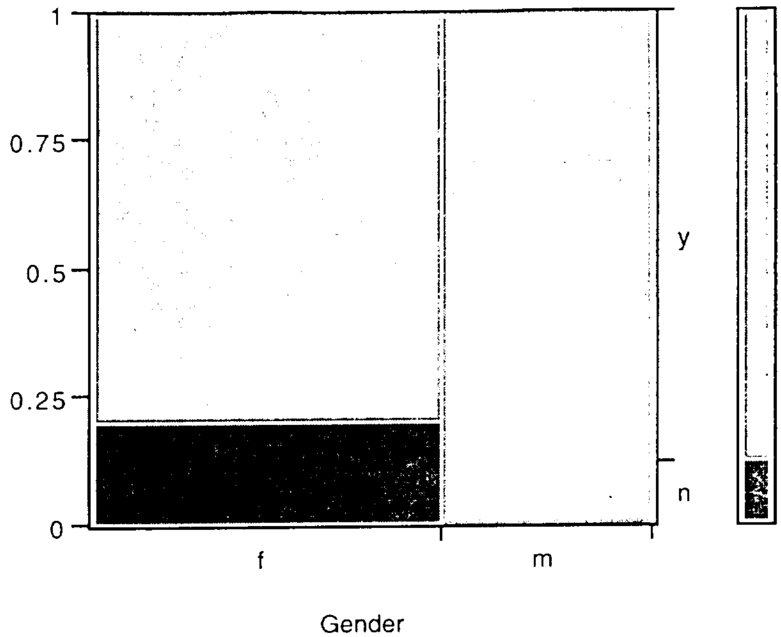
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.8630462	0.1282
Error	8	5.8670705	
C Total	9	6.7301167	
Total Count	10		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1.726	0.1889
Pearson	1.667	0.1967

·rning: average cell count less than 5, LR Chi-square suspect

·isher's Exact Test	Prob
·eft	0.2619
Right	0.9762
2-Tail	0.5238

2 Stud & comp By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	1 12.50 100.00 20.00	0 0.00 0.00 0.00	1 12.50
y	4 50.00 57.14 80.00	3 37.50 42.86 100.00	7 87.50
	5 62.50	3 37.50	8

Tests

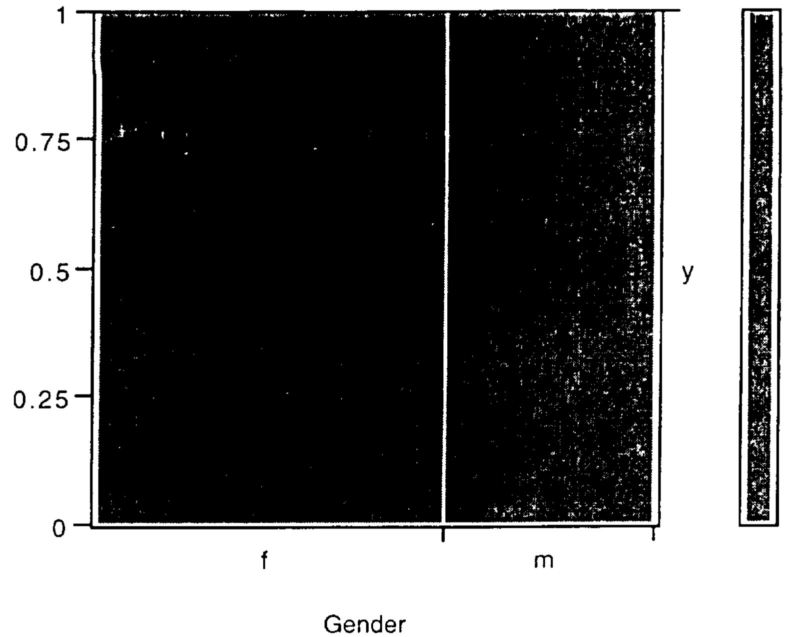
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.5121492	0.1699
Error	6	2.5020121	
C Total	7	3.0141613	
Total Count	8		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1.024	0.3115
Pearson	0.686	0.4076

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	Prob
Left	1.0000
Right	0.6250
2-Tail	1.0000

2 you & Comp By Gender



Crosstabs

Gender

Count Total % Row % Col %	f	m	
y	5 62.50 62.50 100.00	3 37.50 37.50 100.00	8 100.00
	5 62.50	3 37.50	8

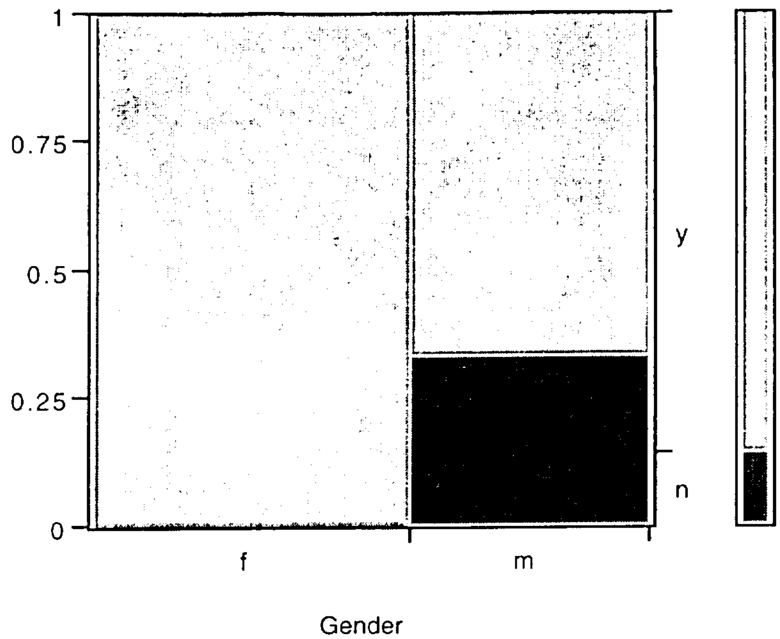
Tests

Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	0	-0	.
Error	8	0	
C Total	8	-0	
Total Count	8		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	-0.000	0.0000
Pearson	0.000	0.0000

Warning: average cell count less than 5, LR Chi-square suspect

2 Easy Internet By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	0 0.00 0.00 0.00	1 14.29 100.00 33.33	1 14.29
y	4 57.14 66.67 100.00	2 28.57 33.33 66.67	6 85.71
	4 57.14	3 42.86	7

Tests

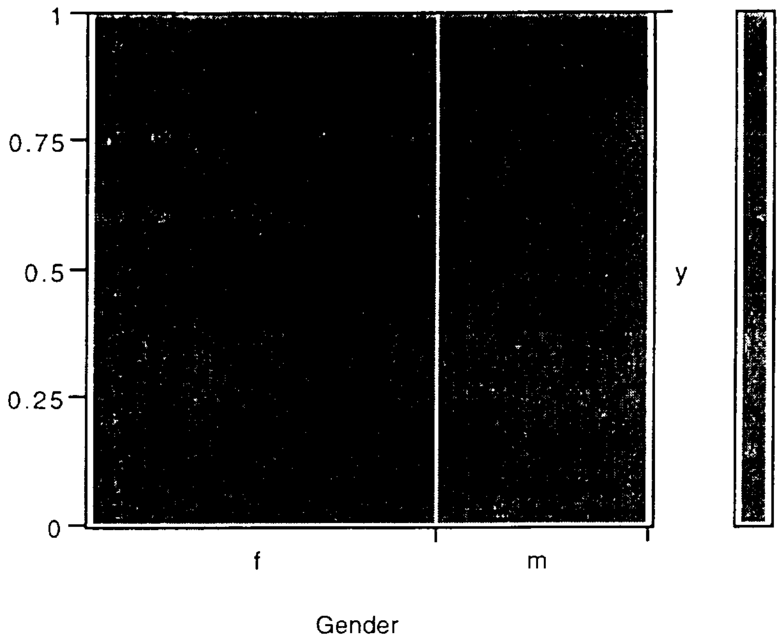
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.9612717	0.3348
Error	5	1.9095425	
C Total	6	2.8708142	
Total Count	7		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1.923	0.1656
Pearson	1.556	0.2123

'''arning: average cell count less than 5, LR Chi-square suspect

·isher's Exact Test	Prob
ɜft	0.4286
Right	1.0000
2-Tail	0.4286

2 2 Teach Comp By Gender



Crosstabs

Gender

Count Total % Row % Col %	f	m	
y	5 62.50 62.50 100.00	3 37.50 37.50 100.00	8 100.00
	5 62.50	3 37.50	8

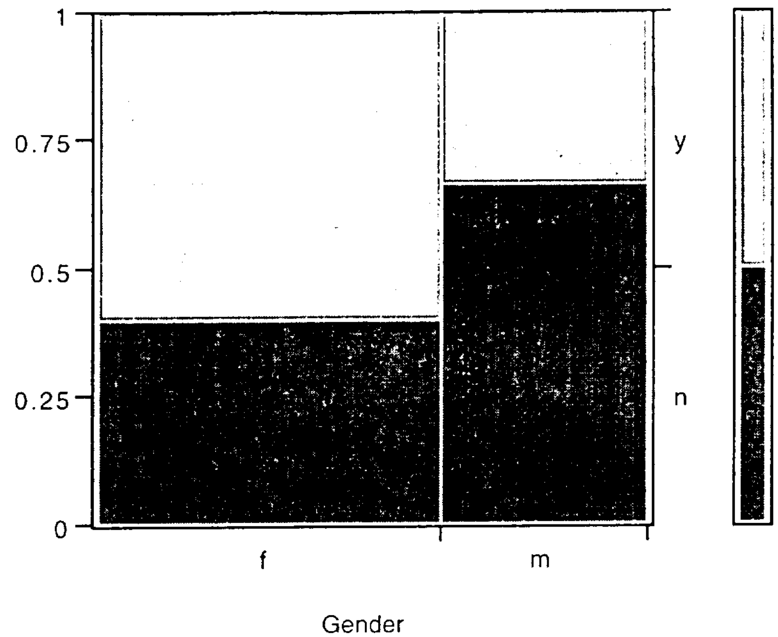
Tests

Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	0	-0	•
Error	8	0	
C Total	8	-0	
Total Count	8		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	-0.000	0.0000
Pearson	0.000	0.0000

Warning: average cell count less than 5, LR Chi-square suspect

2 e-mail By Gender



Crosstabs

Gender

Count Total % Row % Col %	f	m	
n	2 25.00 50.00 40.00	2 25.00 50.00 66.67	4 50.00
y	3 37.50 75.00 60.00	1 12.50 25.00 33.33	4 50.00
	5 62.50	3 37.50	8

Tests

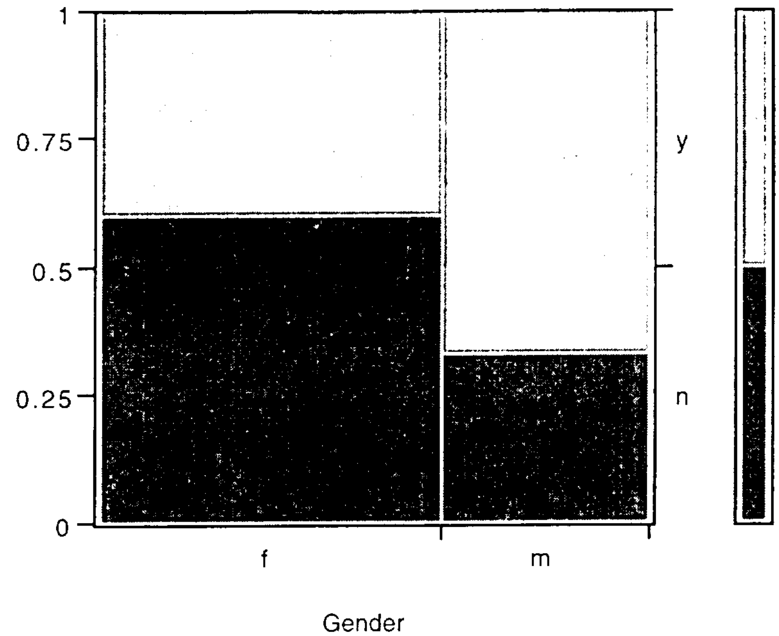
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.2705766	0.0488
Error	6	5.2746008	
C Total	7	5.5451774	
Total Count	8		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.541	0.4620
Pearson	0.533	0.4652

arning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	Prob
Left	0.5000
Right	0.9286
2-Tail	1.0000

2 Career & Comp By Gender



Crosstabs

Count / Total % / Row % / Col %	Gender f	Gender m	
n	3 37.50 75.00 60.00	1 12.50 25.00 33.33	4 50.00
y	2 25.00 50.00 40.00	2 25.00 50.00 66.67	4 50.00
	5 62.50	3 37.50	8

Tests

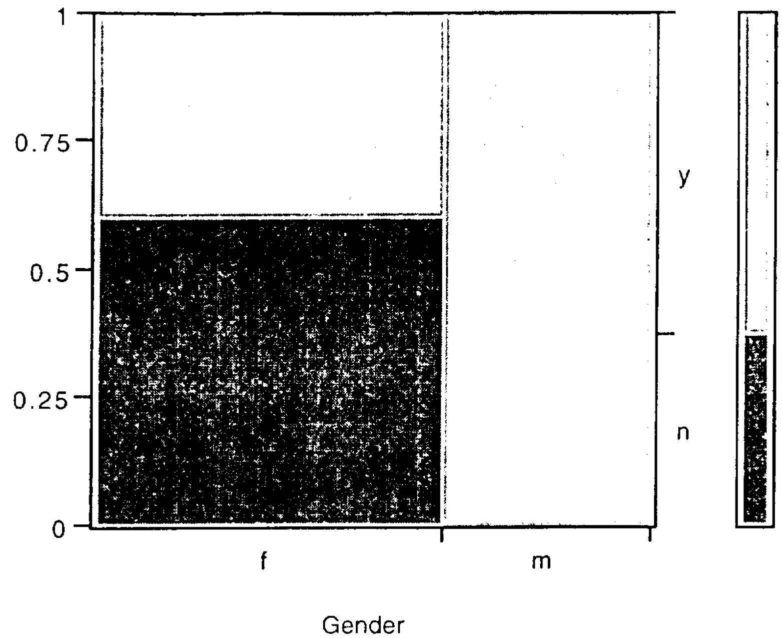
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.2705766	0.0488
Error	6	5.2746008	
C Total	7	5.5451774	
Total Count	8		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.541	0.4620
Pearson	0.533	0.4652

rning: average cell count less than 5, LR Chi-square suspect

isher's Exact Test	Prob
eft	0.9286
Right	0.5000
2-Tail	1.0000

2 WWW Used By Gender



Crosstabs

Gender			
Count Total % Row % Col %	f	m	
n	3 37.50 100.00 60.00	0 0.00 0.00 0.00	3 37.50
y	2 25.00 40.00 40.00	3 37.50 60.00 100.00	5 62.50
	5 62.50	3 37.50	8

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	1.9274476	0.3642
Error	6	3.3650583	
C Total	7	5.2925059	
Total Count	8		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	3.855	0.0496
Pearson	2.880	0.0897

'arning: average cell count less than 5, LR Chi-square suspect

'isher's Exact Test	Prob
Left	1.0000
Right	0.1786
2-Tail	0.1964

2 WWW purpose By Gender

Crosstabs

Gender

Count	f	m	
e-mail & home work	1	0	1
everything	0	1	1
projects	1	0	1
sports	0	1	1
	2	2	4

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	3	2.7725887	0.5000
Error	-2	2.7725887	
C Total	1	5.5451774	
Total Count	4		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	5.545	0.1360
Pearson	4.000	0.2615

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 1, Pearson Chi-square suspect
Warning: average cell count less than 5, LR Chi-square suspect

Career 1 By Gender

Crosstabs

Gender

Count Total % Row % Col %	f	m	
pilot	3 75.00 75.00 100.00	1 25.00 25.00 100.00	4 100.00
	3 75.00	1 25.00	4

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	0	-0	•
Error	4	0	
C Total	4	-0	
Total Count	4		

›st	ChiSquare	Prob>ChiSq
·kelihood Ratio	-0.000	0.0000
›arson	0.000	0.0000

Warning: average cell count less than 5, LR Chi-square suspect

2 Career 2 By Gender

Crosstabs

Gender

Count Total % Row % Col %	f	m	
astronaut	1 33.33 50.00 50.00	1 33.33 50.00 100.00	2 66.67
science teacher	1 33.33 100.00 50.00	0 0.00 0.00 0.00	1 33.33
	2 66.67	1 33.33	3

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.5232481	0.2740
Error	1	1.3862944	
C Total	2	1.9095425	
Total Count	3		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1.046	0.3063
Pearson	0.750	0.3865

Warning: average cell count less than 1, Pearson Chi-square suspect
Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	Prob
Left	0.6667
Right	1.0000
2-Tail	1.0000

2 Career 3 By Gender

Crosstabs

Gender			
Count Total % Row % Col %	f	m	
mechanic	1 50.00 100.00 50.00	0 0.00 0.00 •	1 50.00
scientist	1 50.00 100.00 50.00	0 0.00 0.00 •	1 50.00
	2 100.00	0 0.00	2

Tests

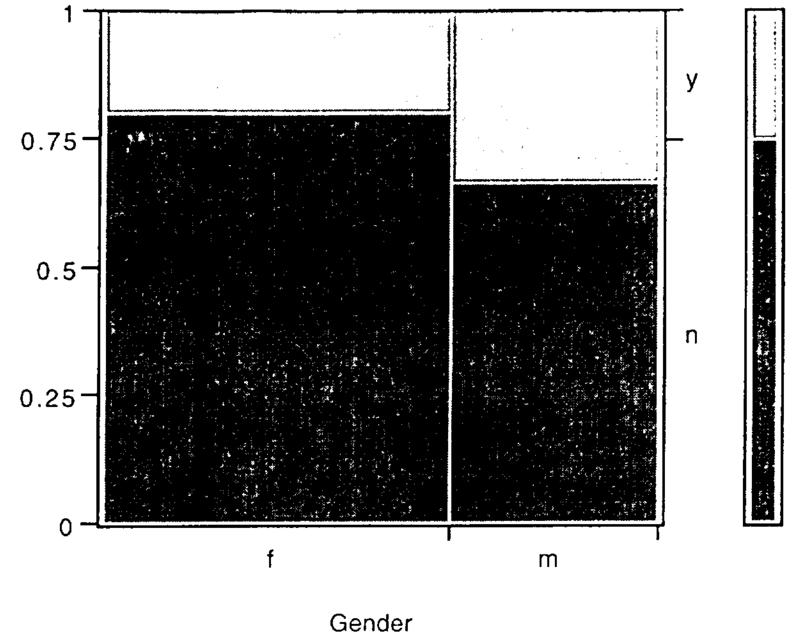
Source	DF	-LogLikelihood	RSquare (U)
Model	0	0.0000000	0.0000
Error	1	1.3862944	
C Total	1	1.3862944	
Total Count	2		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.000	0.0000
Pearson	0.000	0.0000

Warning: average cell count less than 1, Pearson Chi-square suspect
Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	Prob
Left	1.0000
Right	1.0000
2-Tail	1.0000

2 AV thoughts By Gender



Crosstabs

Count / Total % / Row % / Col %	Gender: f	m	
n	4 50.00 66.67 80.00	2 25.00 33.33 66.67	6 75.00
y	1 12.50 50.00 20.00	1 12.50 50.00 33.33	2 25.00
	5 62.50	3 37.50	8

Tests

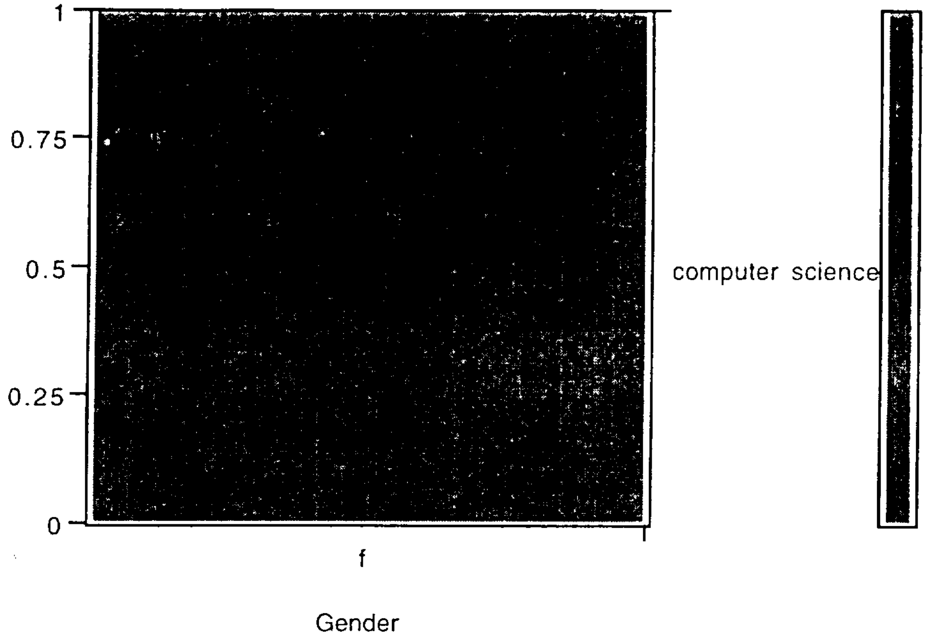
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.0871265	0.0194
Error	6	4.4115546	
C Total	7	4.4986812	
Total Count	8		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.174	0.6764
Pearson	0.178	0.6733

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	Prob
Left	0.8929
Right	0.6429
2-Tail	1.0000

2 Av Career By Gender



Crosstabs

Gender

Count Total % Row % Col %	f	m	
computer science	1 100.00 100.00 100.00	0 0.00 0.00 •	1 100.00
	1 100.00	0 0.00	1

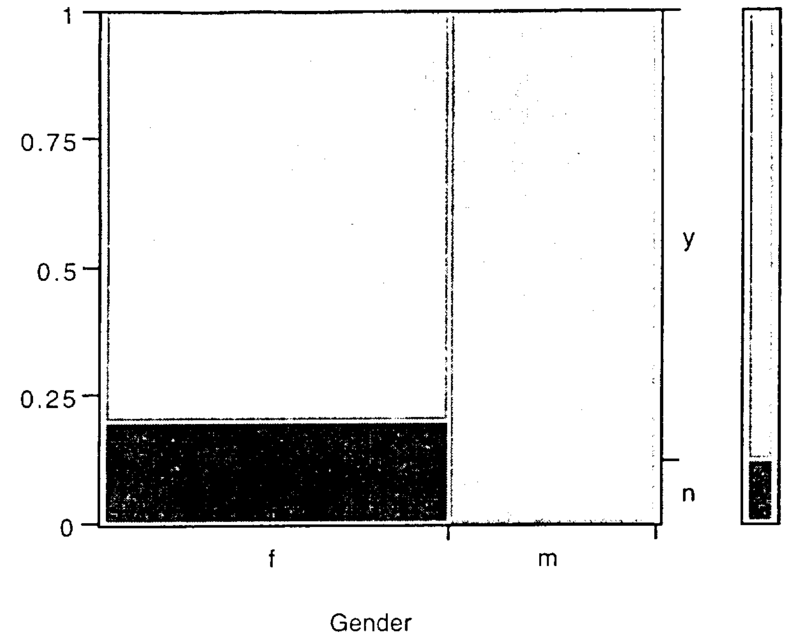
Tests

Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	0	-0	•
Error	1	0	
C Total	1	-0	
Total Count	1		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	-0.000	0.0000
Pearson	0.000	0.0000

Warning: average cell count less than 1, Pearson Chi-square suspect
Warning: average cell count less than 5, LR Chi-square suspect

2 Women & Av By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	1 12.50 100.00 20.00	0 0.00 0.00 0.00	1 12.50
y	4 50.00 57.14 80.00	3 37.50 42.86 100.00	7 87.50
	5 62.50	3 37.50	8

Tests

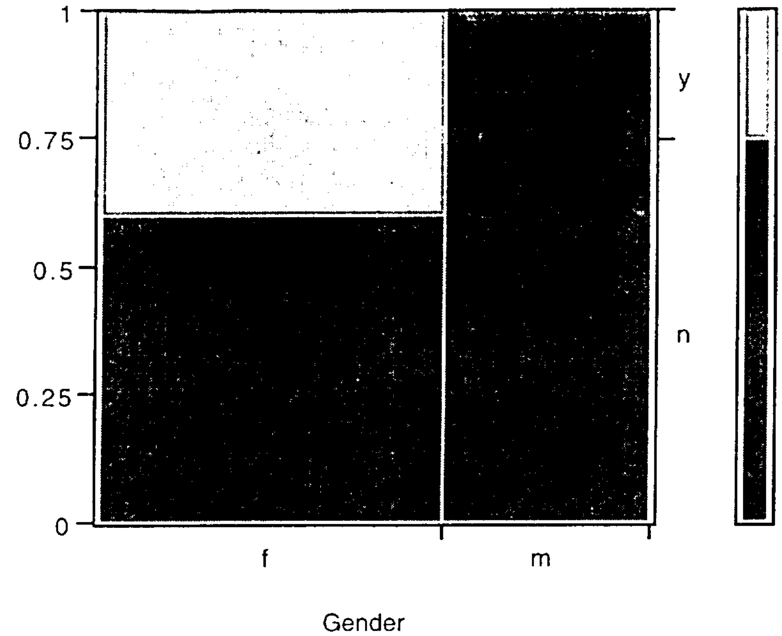
Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.5121492	0.1699
Error	6	2.5020121	
C Total	7	3.0141613	
Total Count	8		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1.024	0.3115
Pearson	0.686	0.4076

…rning: average cell count less than 5, LR Chi-square suspect

…isher's Exact Test	Prob
…eft	1.0000
Right	0.6250
2-Tail	1.0000

2 know Aviator By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	3 37.50 50.00 60.00	3 37.50 50.00 100.00	6 75.00
y	2 25.00 100.00 40.00	0 0.00 0.00 0.00	2 25.00
	5 62.50	3 37.50	8

Tests

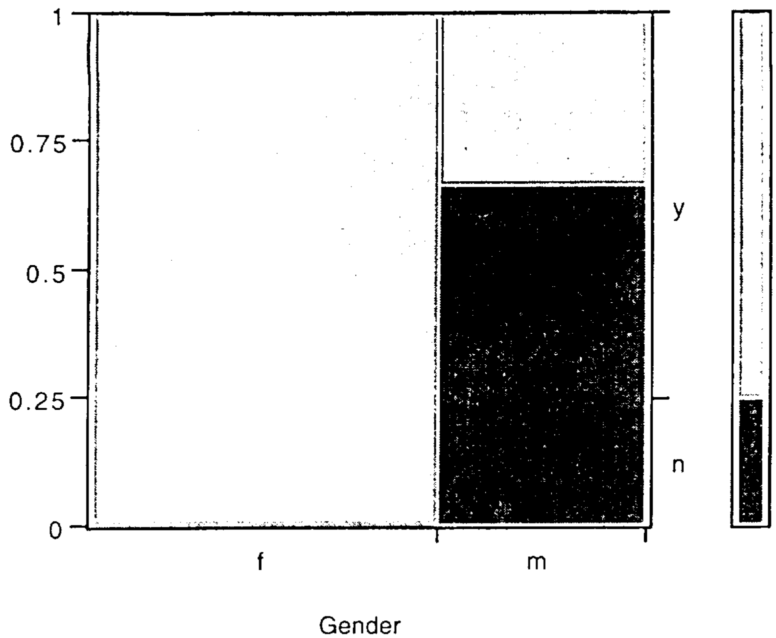
Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	1	1.1336228	0.2520
Error	6	3.3650583	
C Total	7	4.4986812	
Total Count	8		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	2.267	0.1321
Pearson	1.600	0.2059

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	**Prob**
Left	0.3571
Right	1.0000
2-Tail	0.4643

2 most people By Gender



Crosstabs

Gender

Count / Total % / Row % / Col %	f	m	
n	0 0.00 0.00 0.00	2 25.00 100.00 66.67	2 25.00
y	5 62.50 83.33 100.00	1 12.50 16.67 33.33	6 75.00
	5 62.50	3 37.50	8

Tests

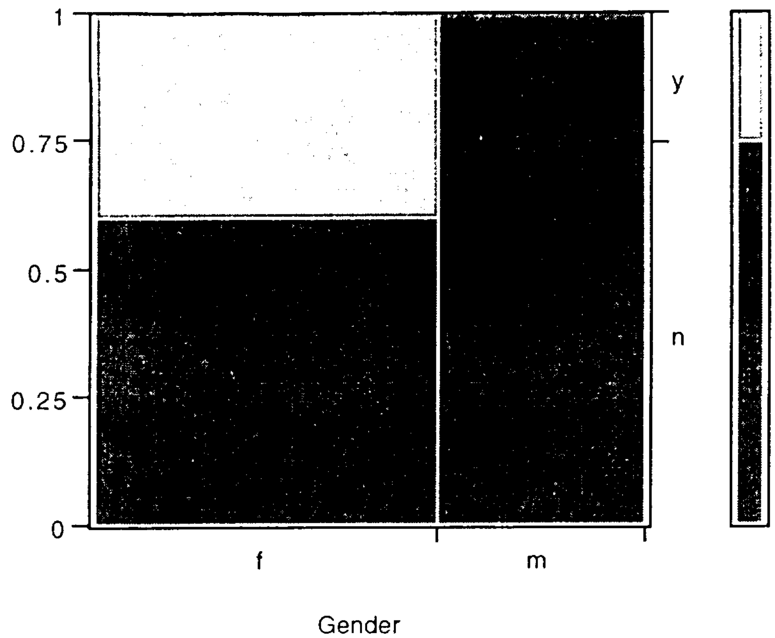
Source	DF	-LogLikelihood	RSquare (U)
Model	1	2.5891387	0.5755
Error	6	1.9095425	
C Total	7	4.4986812	
Total Count	8		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	5.178	0.0229
Pearson	4.444	0.0350

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	Prob
Left	0.1071
Right	1.0000
2-Tail	0.1071

2 four broadcasts By Gender



Crosstabs

Gender			
Count Total % Row % Col %	f	m	
n	3 37.50 50.00 60.00	3 37.50 50.00 100.00	6 75.00
y	2 25.00 100.00 40.00	0 0.00 0.00 0.00	2 25.00
	5 62.50	3 37.50	8

Tests

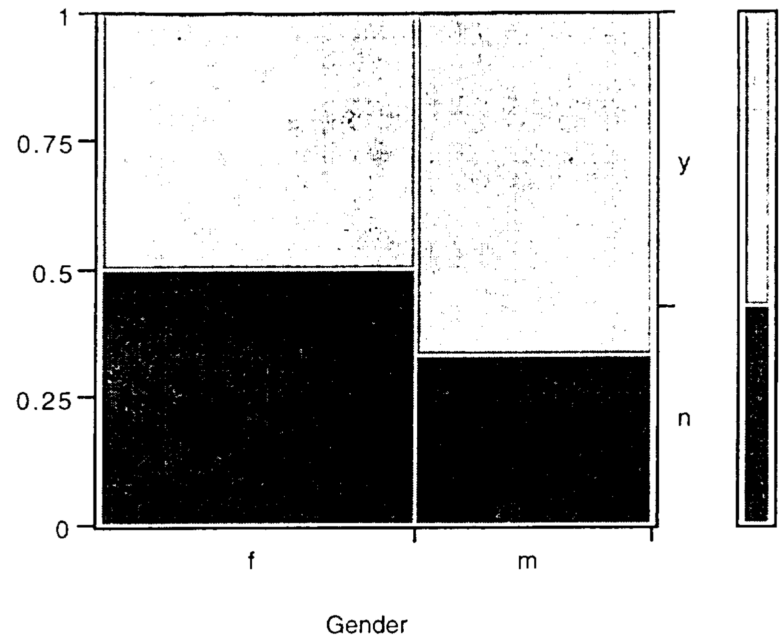
Source	DF	-LogLikelihood	RSquare (U)
Model	1	1.1336228	0.2520
Error	6	3.3650583	
C Total	7	4.4986812	
Total Count	8		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	2.267	0.1321
Pearson	1.600	0.2059

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	Prob
Left	0.3571
Right	1.0000
2-Tail	0.4643

2 Interesting By Gender



Crosstabs

Count / Total % / Row % / Col %	f	m	
n	2 28.57 66.67 50.00	1 14.29 33.33 33.33	3 42.86
y	2 28.57 50.00 50.00	2 28.57 50.00 66.67	4 57.14
	4 57.14	3 42.86	7

Tests

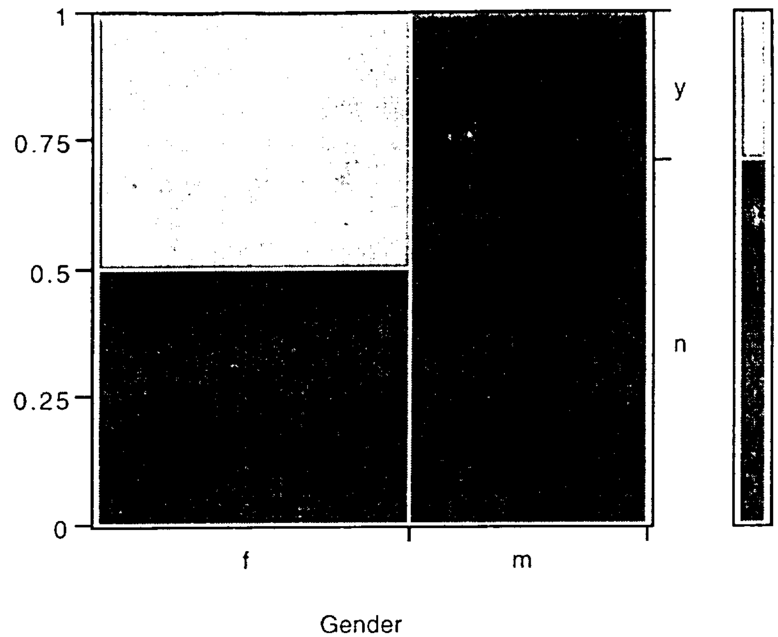
Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	1	0.0982255	0.0205
Error	5	4.6821312	
C Total	6	4.7803567	
Total Count	7		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	0.196	0.6576
Pearson	0.194	0.6592

Warning: average cell count less than 5, LR Chi-square suspect

Fisher's Exact Test	**Prob**
Left	0.8857
Right	0.6286
2-Tail	1.0000

2 Career Learning By Gender



Crosstabs

Gender			
Count Total % Row % Col %	f	m	
n	2 28.57 40.00 50.00	3 42.86 60.00 100.00	5 71.43
y	2 28.57 100.00 50.00	0 0.00 0.00 0.00	2 28.57
	4 57.14	3 42.86	7

Tests

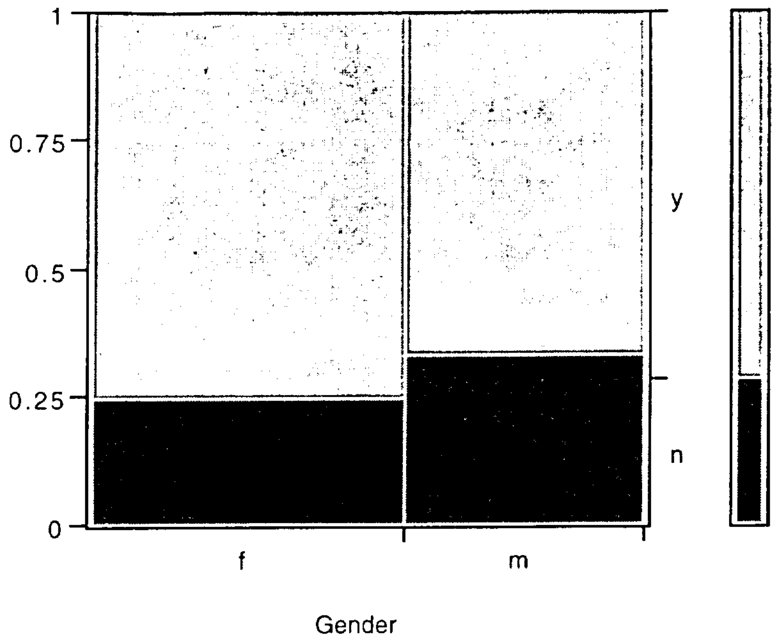
Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	1	1.4152984	0.3380
Error	5	2.7725887	
C Total	6	4.1878871	
Total Count	7		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	2.831	0.0925
Pearson	2.100	0.1473

··rning: average cell count less than 5, LR Chi-square suspect

·sher's Exact Test	**Prob**
·eft	0.2857
Right	1.0000
2-Tail	0.4286

2 recommend By Gender



Crosstabs

Gender

Count Total % Row % Col %	f	m	
n	1 14.29 50.00 25.00	1 14.29 50.00 33.33	2 28.57
y	3 42.86 60.00 75.00	2 28.57 40.00 66.67	5 71.43
	4 57.14	3 42.86	7

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	1	0.0290040	0.0069
Error	5	4.1588831	
C Total	6	4.1878871	
Total Count	7		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.058	0.8097
Pearson	0.058	0.8091

'arning: average cell count less than 5, LR Chi-square suspect

'isher's Exact Test	Prob
Left	0.7143
Right	0.8571
2-Tail	1.0000

WWW activity By Gender

Crosstabs

Gender

WWW activity / Count	f	m	
chat room	1	0	1
everything	0	1	1
games	0	1	1
jobs	0	1	1
projects	1	1	2
sports	0	1	1
	2	5	7

Tests

Source	**DF**	**-LogLikelihood**	**RSquare (U)**
Model	5	2.801593	0.2290
Error	-3	9.433484	
C Total	2	12.235077	
Total Count	7		

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	5.603	0.3468
Pearson	4.550	0.4732

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 1, Pearson Chi-square suspect
Warning: average cell count less than 5, LR Chi-square suspect

Career 1 By Gender

Crosstabs

Career 1 by Gender

Count	f	m	
pilot	3	3	6
science	1	0	1
scientist	1	0	1
	5	3	8

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	2	1.1336228	0.1926
Error	4	4.7513527	
C Total	6	5.8849755	
Total Count	8		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	2.267	0.3219
Pearson	1.600	0.4493

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 5, LR Chi-square suspect

Career 2 By Gender

Crosstabs

Career 2 by Gender

Count	f	m	
accountant	1	0	1
astronaut	1	2	3
computer	1	0	1
mechanic	0	1	1
science teacher	1	0	1
	4	3	7

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	4	2.870814	0.2780
Error	-1	7.454720	
C Total	3	10.325534	
Total Count	7		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	5.742	0.2193
Pearson	4.278	0.3697

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 1, Pearson Chi-square suspect
Warning: average cell count less than 5, LR Chi-square suspect

Career 3 By Gender

rosstabs

Career 3 \ Gender: Count	f	m	
astronaut	0	1	1
engineer	0	1	1
mecanic	1	0	1
scientist	1	0	1
	2	2	4

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	3	2.7725887	0.5000
Error	-2	2.7725887	
C Total	1	5.5451774	
Total Count	4		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	5.545	0.1360
Pearson	4.000	0.2615

Warning: 20% of cells have expected count less than 5, Chi-squares suspect
Warning: average cell count less than 1, Pearson Chi-square suspect
Warning: average cell count less than 5, LR Chi-square suspect

D. Teacher Focus Group Notes

Present: Roger Blumberg coordinator, Brian Marcotte secretary, Teachers: Issiah Floyd (E. Boston), Ed Rogers (Danvers), Ken Goldblatt (Randolf), and Beth Massey (Malden).

Q1: Describe your involvement with the *Take Off* project.

A: Three years with Take Off including aviation days. 120 students in a cluster. Math and science teachers work together, none had a background in aviation. Incentives to join *Take Off* included free computer and internet access. Involvement was easier in year one: fewer restrictions in school curriculum that year. Fitting *Take Off* into the curriculum was more difficult in years two and three, we had to be more selective in what information was presented. In year three we took an interdisciplinary approach. We used parts of the taped broadcast that the students liked most such as the timeline, and different teachers chose to use different parts of the *Take Off!* materials. Careers were covered in social studies. Other activities were dispersed throughout the curriculum. Activities such as pressure/vacuum relations, design of a plane experiment, the use of independent and dependent variables and the use of balsa planes to measure variables were very helpful to the students. Concepts of form following function were clearly communicated. In year two, all videos were given in one day; this was a very bad decision. Voice quality was poor. The second set of tapes were O.K. We took the best parts of the tapes and showed these parts to students. A quiet small group of students were very interested in aviation. Most students liked Archie.

B: Eighth grade students participated in the *Take Off* project. Activities were dispersed among the students. In year one, we had time and energy for the project. In year two, we did not have time; the computer gave us much trouble--we had little internet access. In year two we showed the second edition of the tapes; two were played, the others ignored. In year three there was no time for *Take Off*. The Massachusetts curriculum frameworks and tests compelled our attention. We integrated aviation across the curriculum. There was no support for *Take Off* from our cluster colleagues. The computer was upgraded and the Randolf Aviation Club had lots of after school and weekend activities for interested students.

C: In year one we had good support from school administrators. The timing of the broadcasts in year two defeated inclusion of *Take Off* in the curriculum; we cannot do after school activities. In year three, *Take Off* was considered an add-on and was not integrated in the curriculum. MA curriculum standards changed in an effort to improve test results and this took energies away from the *Take Off* program.

D: 1997-98 was the first year of Danvers' participation in the program, and the timing of live broadcasts did not permit integration of *Take Off* in year one. In year one there were two levels of physics involved in the program. Concepts such as lift and drag and the model planes were used in physics class. The computer given must be upgraded to be useful in the future. The video tapes were good in part but of very limited value - not all have been seen yet. 60% of students have access to the internet and regularly explore it.

Q2: What is / has been the greatest impact of *Take Off* project from your perspective?

A: *Take Off* provides practical applications for abstract scientific concepts and for teaching them.

B: The practical applications of physical concepts leads students to new insights. The flight simulator was the best part for the students in the program.

C: The greatest impact was in math class where pattern recognition using graphs is important; the landing and take off experiments using the balsa model airplanes was very helpful in applying abstract concepts to real life.

D: The program's emphasis on aviation careers was important for directing student career choices and helped involve students more in the program.

Q3: Did exposure to *Take Off* change student career choices?

B: Yes! Absolutely.

A: Interested students began to wonder about aviation careers for themselves.

C: Students involved were too young for much interest but it did diversify their interests and provoked some thinking about careers.

Q4: Did teachers have e-mail and internet access before *Take Off*?

A: E-mail was new when *Take Off* was introduced. Now there are 25 students sharing one computer, but the one-computer classroom is not a success. Some students do internet research out of class and then report their findings to the class.

B: We had hard wiring before *Take Off*. Internet access worked for about three weeks before computer problems limited its use. Now MCET as our ISP and provides e-mail accounts for us. Software to restrict student access to some sites on the internet frequently cause users to be dumped from legitimate internet sites for no discernible reason! This is very frustrating for the students.

Q5: Please evaluate the *Take Off* web site.

C: I get to the web site about two times per month. Students do not have internet access at home; computers must be used at school only and this use is limited to club meeting times twice a month. I make students use the computers that are available.

B: when the computer is working, we visit the site once a week; when the computer is down, there is no use.

A: In the first year of *Take Off* we used it often to download activities and career cards. In year two the site became a cob-web site: there were no changes in content. There is much information at the *Take Off* web site but it is more fun to visit other sites on the WWW.

D: there has been little or not change in the web site after year one and therefore I have not visited it recently. A Hypertext link to an applet is needed.

A&B: Further integration of *Take Off* requires more computers. Time and equipment limit use of the program.

A&C: Career pictures and profiles are very useful and can be printed and distributed to students away from computers.

Q6: Were glossary links used?

All: No.

Q7: Has *Take Off* changed the way teachers used technology?

A&B: Yes. It has increased computer and internet use. It has had a major impact. We need multiple computers and internet access to make this kind of program work well.

Q8: What was the impact of *Take Off* on the curriculum?

All: Time constraints caused by schools focusing on curriculum implementations directed at improving student test scores caused a reduction (elimination) of time devoted to *Take Off*. The activities in *Take Off* were useful but time limited their implementation.

B: Curriculum materials were good.

A: *Take Off* needs better graphics and print materials.

C: the *Take Off* curriculum was good.

Q8: Did you have contacts with the *Take Off* staff? Were your questions answered?

B: Yes. The tech advisor provided by MCET did not talk to Ken's level of understanding/skill/knowledge. Often issues were not resolved.

C: Yes.

Q9: What was the highlight of the program for you and your students?

B: The first year contest was very exciting. The students loved it!

C: Students found the balsa plane experiments very interesting. The trial and error approach to the activity was very good. The visit to the Volpe Transportation Center with its simulator was of the greatest interest.

A: Personally, the computer and concepts of aviation were most interesting. The model airplane experiment with its concept of experimental design was easy to do and easy for the students to learn. All variables and their measurement--clear, practical hands-on activities--were liked most by students. The Challenger Center at Framingham State College was an EXCELLENT activity.

D: A wider world opens for the students in *Take Off*.

Q10: Will you continue to use the tapes?

B: Yes - if time permits.

C: Yes, if I am still in my teaching cluster next year.

A: Yes, the careers program and a few science activities/demonstrations selected from all the tapes. *Take Off.* Should categorize activities and demonstrations on the tape series and list them with tape positions to facilitate selective use of the tapes.

Q11: What were the best parts of the tapes? What was the student response to the tapes?

A: People actually doing real things, that was the best part for me and the students. The presentation style of the in-studio presenters was a problem. One presenter was likable and the other talked down to the students and was not eighth-grade friendly. Demonstrations which can be duplicated in a real classroom were very good. The demonstration using the hair dryer, plastic tube and ping-pong ball is a good example of this. It is easy and cheap to do and makes the scientific point in understandable terms. There should be a workshop for teachers on how to make demonstrations for use with the videos. Students should be brought into the workshop to see how they would do it. Separate key concepts and provide basic activities and then build on these encouraging more exploration.

D: Polished and inexpensive demonstrations would help. Field trip opportunities should be expanded.

C: Acclimate the teachers to the concepts before they are presented.

Q12: Any additional suggestions for the Take Off! staff?

B: *Take Off* needs an answer person through the web site who can talk in the language of the consumer.