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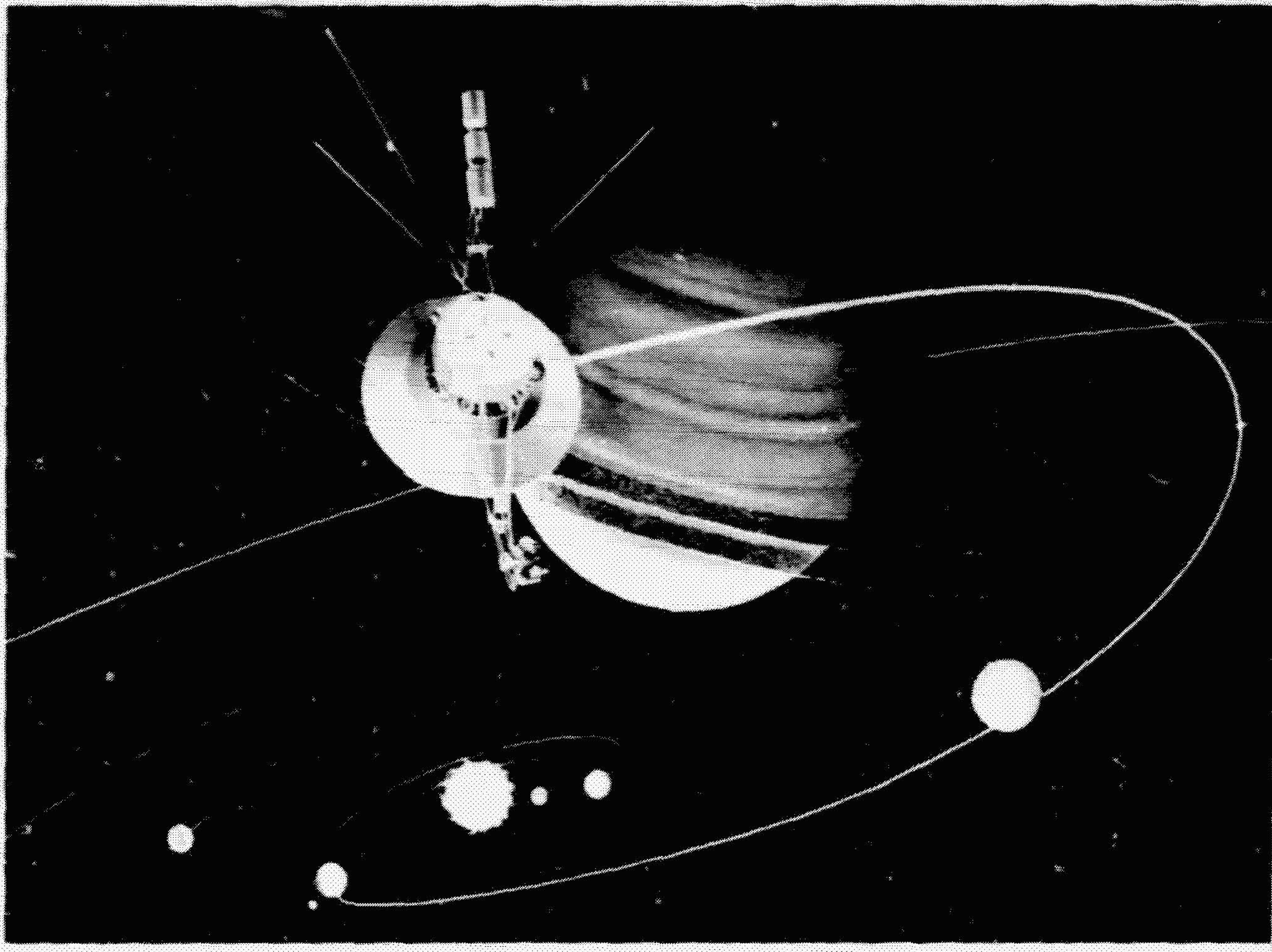

Careers in Aerospace

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EP-171

LIMITLESS HORIZONS

Careers in Aerospace

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Hampton, Virginia

Academic Affairs Division
National Aeronautics and Space Administration
Washington, D.C. 1980

Preface

I have written this manual to acquaint readers with pertinent information relating to career choices in aerospace science, engineering, and technology. I am indebted to many individuals who have permitted, encouraged, and participated in the process of preparing "Limitless Horizons."

Particular gratitude is due to Dr. William A. Anderson, Superintendent, Hampton City School System, Hampton, Va. Dr. Anderson's authorization granted me a leave of absence from my position as a guidance counselor so that I could pursue this project with NASA under the auspices of the Intergovernmental Personnel Act. I especially want to acknowledge the support and advice of Doris M. Ennis, Director of Guidance and Testing, and Nedra I. Harkavy, Director of the Gifted and Talented Program, Hampton City School System. These women have cooperated extensively with NASA during the preparation of this guidebook. Special thanks to "Nedra" for the time she spent reading the material and offering suggestions for improvements. Also thanks to her for negotiating my leave of absence from the school system.

A special "thank you" to those individuals at the NASA Langley Research Center, Hampton, Va., who were so helpful and considerate during the preparation of this document. I am grateful to Harold E. Mehrens, Head, Office of Education and Community Services for his supervision of this project. I am indebted to James H. Daus, Head, Graphics Branch, for designing the cover pages and arranging the graphics. I am also indebted to the NASA scientists, engineers, and technicians who devoted hours to familiarizing me with aerospace careers and reviewing my text. The Education Services Branch, NASA Headquarters, Washington, DC, also deserves my gratitude.

Special thanks to Carolyn Floyd, Susan Miller, and Susan Motley of the NASA Langley Research Center's Floyd L. Thompson Technical Library. These women diligently worked to research sources of information and compile this information for my review. Sincere thanks to Alice Eley, Rose Gaskins, and Janis Thomas, who typed and retyped the manuscript and provided other necessary clerical expertise. I am indebted to Brian D. Welch, Keith A. Koehler, and Jay Scott, who read the material and offered suggestions for improvements.

Finally, my sincerest gratitude to Dr. Kevin E. Geoffroy, Professor, School of Education, College of William and Mary. Dr. Geoffroy served as a technical consultant, an understanding counselor, and a supportive and patient friend during this project.

I shall be most happy if counselors find this manual helpful in their career guidance programs. I shall be delighted if the document serves as a motivator for students as they make decisions about future aerospace career choices which hopefully will lead to happy and productive career development.

Mary H. Lewis
Guidance Counselor
Hampton City School System
Hampton, Va.

How To Use This Manual

Carefully planned career decisions may mean the difference between career satisfaction and disappointing work experiences. The choice of a career reflects the quality of career guidance offered in the home and in the school. Thousands of occupational choices exist, with various paths for educational, vocational and technical training and preparation. Sometimes it is not an easy task to select an appropriate career from so many choices. Occasionally, once a career path has been selected, a person may decide to embark in an entirely different career direction.

This publication is designed to acquaint students and other readers with aerospace career choices. It is based on and designed to be used with the **Dictionary of Occupational Titles**, 4th edition, and the **Occupational Outlook Handbook**, 1978-79 edition. The first section presents information about the aerospace industry by describing disciplines typical of this industry. NASA's classification system provides an overview of these disciplines. A review of two approaches which classify the thousands of available careers is included in the first chapter also.

The second chapter describes the work typically performed by aerospace scientists, engineers and technicians. It includes the qualifications needed for these extremely specialized and diverse careers, the preparation and training associated with them, as well as predicted future trends in the field.

The third section offers suggestions for high school students as they begin to plan for future aerospace careers. Sources of career guidance information, high school subjects emphasized, and the selection of an appropriate college are discussed.

Academic achievement is crucial to success in aerospace careers. Accordingly, the fourth section addresses the issue of developing study skills necessary for academic success. Time management procedures and strategies for implementing study skills techniques are suggested.

The last section identifies some factors which influence career decisions. The student who is aware of factors affecting his/her career choices will be better prepared to make realistic career decisions.

Advice from individuals prominent in the aerospace field is included throughout the guidebook.

Valuable reference material is available in the appendices. Appendix A offers suggestions for activities counselors/teachers may use with students as they explore careers in the field of aerospace. Appendix B provides a listing of accredited colleges and universities offering degrees in engineering and engineering technology. Appendix C contains a comprehensive listing of additional sources of aerospace career information.

The most appropriate career decisions are based upon realistic information about careers available in the aerospace industry coupled with an awareness of one's interests, motivations, aptitudes and skills. This manual has been written to assist students explore their limitless horizons.

To The Student -- The manual is designed to be read and reread over a period of time in order to assist with career planning and exploration. Most students may want to read through the entire book first, at a leisurely pace. After the first reading, many students will want to begin organizing their plans for further exploration of possible careers. Other students will read some of the sections of interest to them and follow some of the detailed suggestions. Close attention should be given to the references in the appendices. These sources can be useful to the person interested in further information.

To The Counselor -- The counselor may want to have this publication available as a reference manual for students interested in aerospace careers. It can be used as a career guidance tool for use with groups or individuals. The counselor may be particularly interested in studying the sections on projected career trends in the aerospace field. Suggestions for career guidance activities are included in Appendix A. Special attention should be given to Appendix C which provides a listing of additional sources of aerospace career information.

To The Librarian -- The librarian may find this document useful when choosing reference material on aerospace research and technology and as a reference on career opportunities in the aerospace industry.

To The Teacher -- The teacher may use this publication as a focal point for career reference material. It may be useful in combination with articles, periodicals, films and filmstrips dealing with the aerospace industry.

To The Parent -- Parents are potentially the greatest sources of help to their sons/daughters as they plan for future careers. This material is designed to assist parents as they guide their offspring in the exploration of aerospace career options. The information is presented in a concise, easily readable format. Appendices B and C may be particularly useful to parents.

Introduction

"A boy's will is the wind's will,
And the thoughts of youth are long, long thoughts."

— Henry Wadsworth Longfellow

Whether male or female, whether you feel your thoughts are, as Longfellow suggested, powerful and unlimited as the wind, the fact that you are reading this now testifies to something within.

You are thinking about a career in aerospace, and along the way you may think about medicine or law or finances, as youth weighs one career against another before deciding to strike out. You have begun to ponder your chances, and in this book you will get an idea of what they are like for the aerospace field. In the process, you will be wondering many things. What are the limits, if any? What are the benefits? How far can I go?

The answer, as many who've been there will tell you, is that you can go as far as you are prepared to take yourself. Luck and timing play a role occasionally, but in all cases it boils down to what you want to do, and how earnestly you believe you can do it.

The next few decades will see tremendous strides in aerospace technology, some of which can take you into space, some of which can lead to the laboratory, some of which could put you into an aircraft streaking along at Mach 4. These things will be done, indeed, they are already on the drawing board; they await only the right time and the right people to accomplish them.

The message in this book is simple; you can be one of those people. In the following pages, we'll present the views of those who have lived and worked within this field whose ultimate limits have yet to be found. In large part they consider you lucky: no generation before yours ever had so many options. Some of you may walk on other planets and moons, some will take part in engineering feats which are now only being dreamed of, some will do things which cannot now even be suggested, and some will carry on the work which they have started.

Aerospace needs your talents; it cannot continue long into the future without your vision.

Brian Welch
NASA Cooperative Education Student

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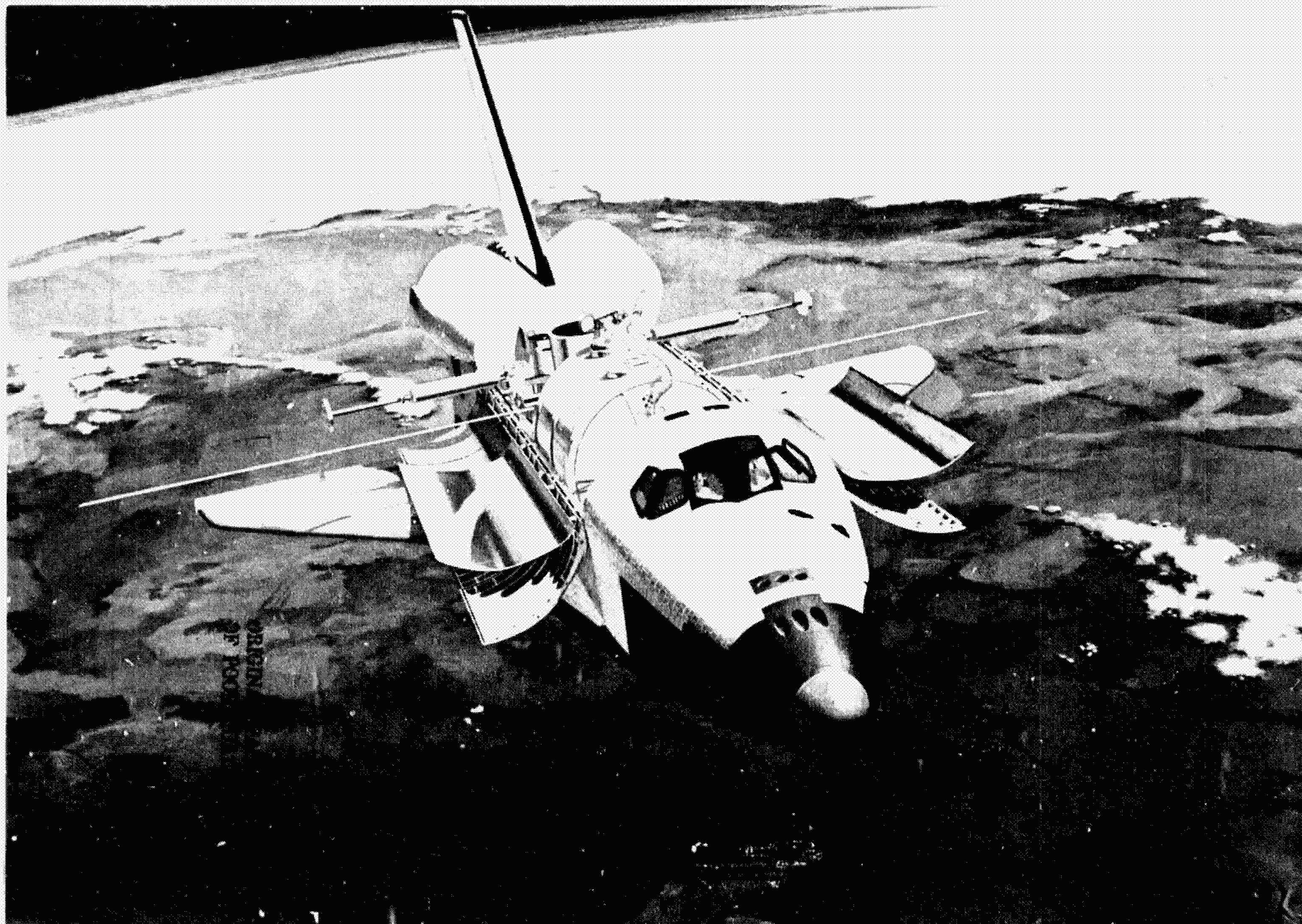


Chapter One

The Aerospace Connection . . .

You may have been thinking about what you will do in the years following graduation from high school. Perhaps you have thought about a career in aerospace science, engineering, or technology. If so, it is possible that you may become the first scientist to discover extraterrestrial life or the first scientist to hear interstellar communications from another civilization. Or you may become the engineer who develops a hyperbolic velocity propulsion system for solar system escape, necessary for missions to the nearest star, Proxima Centauri, which would take 10,000 years to reach. You may become the technologist or technician who assembles the components for a communications satellite which will allow people to place person-to-person calls over wrist radios. Or you might work in some other capacity associated with the aerospace industry.

This publication is designed to acquaint you with disciplines typical of the aerospace industry, careers available in those disciplines and the preparation necessary for those careers. At this point, it may be helpful to define the term "aerospace."

What does the term "aerospace" mean? Aerospace (from aeronautics and space) refers to the environment which includes the expanse extending upward and outward from the surface of the Earth. This expanse includes the atmosphere and space. The term also refers to a field of occupations in aeronautics (the study of flight within the Earth's atmosphere) and astronautics (the study of flight in space outside the Earth's atmosphere). It encompasses general, commercial, and military aircraft as well as spacecraft, satellites and probes for space exploration and utilization.

Aerospace represents many different things to many different people. It is delicate and sophisticated instrumentation and immense experimental facilities. It is a forward-swept-wing-design fighter. It is measuring pollutants in the atmosphere and combatting smog. It is composite materials lighter than aluminum, stronger than steel. It is spacecraft which carry precious payloads of humans and equipment into space. It is civilian and military aircraft that take-off and land vertically. It is research to develop an artificial heart. It is weather and communication satellites. It is robot probes which examine the surface of the Moon and planets. It is "spinoffs" and products which serve mankind and improve our daily lives. It is much, much more. The scientific and technological revolution perhaps is best exemplified by the research and development programs associated with aviation and space. Each new aerospace discovery ignites a chain reaction in industrial growth and an entirely new industry emerges on the contemporary business and industrial scene. Yesterday's fantasies created only in the imaginations of a few science fiction writers are today's aerospace realities.

On a typical day in the United States approximately a half million people board commercial airlines. In a single year, scheduled airlines transport over 200 million people--a number approximating the population of the United States. There are several hundred thousand general aviation aircraft and pilots, thousands of airports and approximately one million people who are employed in aerospace disciplines. In future years, these figures are projected to increase. We have worked and lived in outer space. We have landed on the Moon and left the safety of our space capsules to explore its surface and environment. Radio and television stations, newspapers and magazines report on the progress of aerospace projects and speculate on their implications. Aerospace science and technology impact our daily lives in many ways. Some of the contributions from aerospace programs are increased national security and a strengthened national economy. Improved standards of living have resulted from new jobs, new consumer goods, improved education, advances in medicine and stimulated business deals.

Past, present and future accomplishments in the field of aerospace arise from the partnership which exists among industries, civilian and military agencies of the government, and universities. This partnership emphasizes education, research and development, manufacturing, sales and service. Special attention is focused upon careers requiring scientific, engineering and technical backgrounds. There are also careers for people in administration, management, finance and other services including supply, repair and maintenance. Thousands of vocational and career possibilities exist within this field which offer job advancement and recognition. Aviation and space manufacturing firms, aerospace research and development companies, foreign, federal, state and local government agencies, commercial airlines, consulting firms and the educational community, to name a few, require the services of trained individuals.

The majority of people employed in careers relating to space science, engineering and technology are highly skilled individuals who take pride in their workmanship. They represent many racial and ethnic backgrounds and demonstrate multiple talents. They are men and women with varied educational experiences. Their common trait is the desire to pursue an understanding of unknown areas by applying the scientific method. They continue to update and increase their knowledge of science and technology by questioning and remaining openminded. They are pioneers whose frontiers range from the farthest areas of outer space to the deepest depths of the oceans.

A particularly significant aspect of the aerospace field is that it employs individuals working in almost every known science and technology -- astronomy, biology, chemistry, physics, geology, geodesy and cartography, heat studies and cryogenics. It requires the assistance of the entire industrial spectrum - electronics, metals, fuels, ceramics, machinery, plastics, instruments and many more.

Aerospace research and development has progressed at a rapid pace. Workers have important and fast-moving jobs. They are constantly working to improve the speed, range, power, reliability and safety of aircraft, missiles, rockets and space vehicles. These improvements are considered in relation to fuel conservation and environmental impact.

Before workers can begin the production of aerospace vehicles and their related systems and subsystems, designs must be completed and approved. Hundreds of experiments and feasibility studies are conducted to determine the best designs. Super computers are used to assist in these theoretical and experimental studies.

Once designs are accepted, scale models are designed and constructed according to rigid specifications. These models undergo hundreds of experimental tests in wind, temperature, and shock tunnels; on ballistic ranges; and in centrifuges. These tests simulate actual flight conditions including various Mach ranges (ratio of the speed of the vehicle's flight to the speed of sound) and various environmental conditions.

The next step is to develop full sized experimental models which are tested in the air and on the ground. If the experimental models prove satisfactory in all the tests, production may begin. Sometimes changes are made in the design during this process. Once the vehicles are flown, post flight analyses are conducted to evaluate flight performances. Modifications may be required.

A variety of tools and sophisticated equipment are used in aerospace research. These include digital and analog computers, technical sketching equipment, multi-view drawings and photographs, and many different types of wind tunnels.

Aerospace employees perform their assignments in many varied settings. For example, their mission to test microwave remote sensing devices may require that they fly in airplanes piercing the eye of a hurricane. They may be found on tropical beaches; in their laboratories atop a mountain or a skyscraper; or dressed in space suits as they perform experiments in huge tanks of water simulating the conditions of zero gravity.

The work is international with many countries sharing the benefits of space research. Cooperative activities of an international scope range from investigation of the solar system to aerospace applications in communication, transportation, weather forecasting, pollution control and resource and energy management, which affect the lives of people throughout the world. Spacelab, for example, is financially produced by the European Space Agency (ESA). It is the European orbital laboratory designed as a companion to the U.S. Space Shuttle. Spacelab will be carried by the Space Shuttle and will remain attached to the Orbiter during its mission phase.

International cooperative research focuses upon areas such as diplomacy and international relations. These areas require workers fluent in foreign languages and knowledgeable of international law. New fields of interest in space law, space medicine

Earth welcomes returning astronauts

and space communication are being developed.

The aerospace program in the United States consists of the civilian and military agencies of the government working with universities, industry and other research centers. Much of this work is monitored by the National Aeronautics and Space Administration.

NASA's Role

When people refer to the aerospace industry, they often think of the National Aeronautics and Space Administration (NASA). NASA is a civilian government agency which was established October 1, 1958. NASA's predecessor was the National Advisory Committee for Aeronautics, founded in 1915. NASA, the space agency, was created by an Act of Congress one year after the Russians "electrified" the world by launching the first man-made satellite (Sputnik) into orbit around the Earth. The agency was formed to pursue peaceful uses of space for the benefit of all mankind. NASA plans, directs and conducts activities pertaining to civilian aeronautical and space research and development. It manages the development, construction, testing and operation of manned and unmanned aeronautical and space vehicles for basic and applied research purposes.

The Space Act of 1958 directs NASA to:

- Expand human knowledge of phenomena in the atmosphere and space.
- Improve the usefulness, performance, speed, safety and efficiency of aeronautical and space vehicles.
- Develop vehicles capable of carrying instruments, supplies, and living organisms through space.
- Study the benefits to be gained from aeronautical and space activities.
- Preserve the role of the United States as a leader in aeronautical and space work.
- Cooperate with other nations in aeronautical and space work.

Broad programs conducted by the agency are: space flight; space sciences and their applications, advanced engineering and physical science research; and tracking and data acquisition.

In order to fulfill program objectives, members of NASA's technical team pursue research and development activities within their own facilities and laboratories. Scientists, technicians, and support personnel employed by NASA produce data generated from basic and applied research. The agency's engineers, technicians, and craftsmen apply this data, advancing aerospace technology and the state-of-the-art. These research and development activities represent one part of the agency's responsibility for the nation's overall aerospace program.

Approximately ninety percent of the agency's funds are extended for research and development conducted by organizations outside the government, with NASA overseeing the work. Grants, scholarships, and contracts are awarded by the agency to qualified scientists and engineers. The specifications for this "contracted" work include quality, performance, time schedules and costs which are developed by NASA.

In order to fulfill their technical and administrative tasks, the agency's scientists and engineers coordinate their efforts with their peers employed within the aerospace community. Together they plan and conduct appropriate research and develop the necessary technology. Through their combined efforts, the benefits of aerospace technology are enjoyed by the United States and other nations.

Some activities are shared by NASA and other agencies of government. For example, NASA and the National Oceanic and Atmospheric Administration (NOAA) work jointly in the research and development of techniques and instruments that can improve weather forecasting. NASA has joined efforts with several states (California, Colorado, and Arizona) and federal agencies (Departments of Agriculture, Interior, Energy and the Army Corps of Engineers) to use satellite data for improved snow mapping and water run-off predictions. NASA and the Federal Aviation Administration (FAA) evaluate advanced aircraft and equipment for automatic flight control and guidance. Through combined efforts with the Environmental Protection Agency (EPA) and the Department of Transportation (DOT) technology is being developed to reduce fuel consumption and pollution from exhaust emissions of automotive engines. The Department of Defense (DOD) and NASA are working together in the Space Shuttle program. NASA is also an active participant in international groups. NASA and the World Meteorological Organization (WMO) monitor global ozone levels.

In summary, the agency is a producer of data and some hardware within its own research program. It is a supporter and a monitor of further research and the development of hardware produced by industrial organizations and institutions of higher learning. It is a consumer of hardware designed, fabricated, and assembled as a result of contracted work. It is a member of aerospace related government programs--both civilian and military.

Reviewing the World of Work

The principal activity during the adult years is "work." The activity commonly referred to as "work" begins for most adults when they reach the early twenties and continues until the mid to late sixties. This role as "worker" consumes 8 hours per day, 5 days per week, 50 weeks per year from the time the individual enters the work force until he or she retires, and for some, beyond retirement. The work an individual selects often establishes his or her life style, including financial status, friends, geographic location and activities pursued during leisure time. It is clear that planning is crucial to career development.

Ideally, a primary responsibility of the adolescent years is planning and preparing for future careers. The school has become the center for educating students about their future choices for work. To emphasize the importance of career preparation during the school years, many state legislatures have mandated that school systems prepare graduates with identifiable career- objectives and demonstrable job skills. This preparation of students for the selection of and entrance into rewarding career paths requires team effort on the part of students, parents, counselors and potential employers.

In most school systems, guidance counselors have been identified as instructors for career guidance programs. They usually emphasize the following processes in their work with students.

- Acquaint students with systems that categorize the thousands of occupations;
- Orient students to job classifications and specialties within these classifications;
- Acquaint students with their unique interests and abilities by administering and interpreting the results of assessment instruments such as interest inventory tests and/or aptitude tests;
- Assist students to identify potential career goals suitable to their identified interests, skills, and abilities;

- Provide students with the opportunity to engage in a variety of simulated work settings;
- Assist students in planning courses of action necessary to prepare them for these potential careers;
- Provide students with opportunities for specialization in skill development and training for particular career goals.

Counselors engaged in the early phases of career guidance usually offer descriptive information about characteristics and requirements of broad occupational categories. They refer to career orientation manuals and computerized career information programs. Students aware of broad categories are then encouraged to relate their own interests, skills and potentials to appropriate and specific careers within the general categories.

During the process of exploring career options, some students may find themselves attracted to careers in the aerospace industry. Some may decide to enter immediately into the aerospace work force. These students require counselor assistance in the process of selecting an appropriate entrance level job, preparing for it during high school and applying to begin work upon high school graduation. Others may be inclined to prepare for acceptance into specialized technical, vocational or apprenticeship programs culminating in the attainment of positions as aerospace technicians. These students must select programs appropriate to their aspirations and educational backgrounds. Others may be committed to preparing for careers as aerospace scientists or engineers. For them, college or university training is required, and their goals necessitate counselor assistance in the process of planning their high school curricula with the anticipation of entering a college or university.

Information describing some careers in the aerospace industry will be addressed in the following pages. Especially emphasized will be careers for scientists, engineers and technicians. An indepth study of these careers is beyond the scope of this publication.

The following documents published by the United States Department of Labor are suggested for further exploration: **Dictionary of Occupational Titles**, **Occupational Outlook Handbook**, **Occupational Outlook Quarterly**, **Guide for Occupational Exploration**, **Job Guide for Young Workers** and **Occupations in Demand at Job Service Offices**.

"There is virtually no 'mature' aspect in aerospace, and many advances will be seen in aircraft as well as space systems. Many of the aerospace technologies in the next century are predictable now and only await "institutional release," that is, the desire and financing to accomplish them. This includes further manned exploration of the moon and our nearest planetary neighbors, the initiation of a permanent space station in which people will do useful work as well as extending the reach of scientific endeavors."

Daniel J. Fink
Senior Vice President
for Corporate Planning and Development,
General Electric Company

In order to offer a clearer perspective of aerospace careers, an overview of all occupations and a discussion of worker functions will be presented. These will be followed by a survey of occupational groups representing NASA's classification of aerospace careers. It may be helpful for counselors to encourage students to note the occupational categories, worker functions and finally aerospace subgroupings which are most attractive to them. These selections will reflect students' views of their interests, abilities, skills and desired educational levels. This information combined with the results of standardized assessment instruments will assist counselors who are engaged in the process of guiding students through the various phases of career guidance education.

DOT's Classification System

Approximately 20,000 occupations have been categorized into nine groupings and published by the Department of Labor in the **Dictionary of Occupational Titles*** (DOT), fourth edition, 1977. This classification system is one means of facilitating the task of acquainting students with a variety of descriptions about occupations. The following outline summarizes the nine categories presented in the DOT. The outline also offers examples of aerospace careers with their corresponding occupational codes in the DOT to serve as reference guides for further exploration.

Professional, Technical and Managerial Occupations

This category includes occupations which require substantial educational preparation, usually at the university, college, junior college, or technical level.

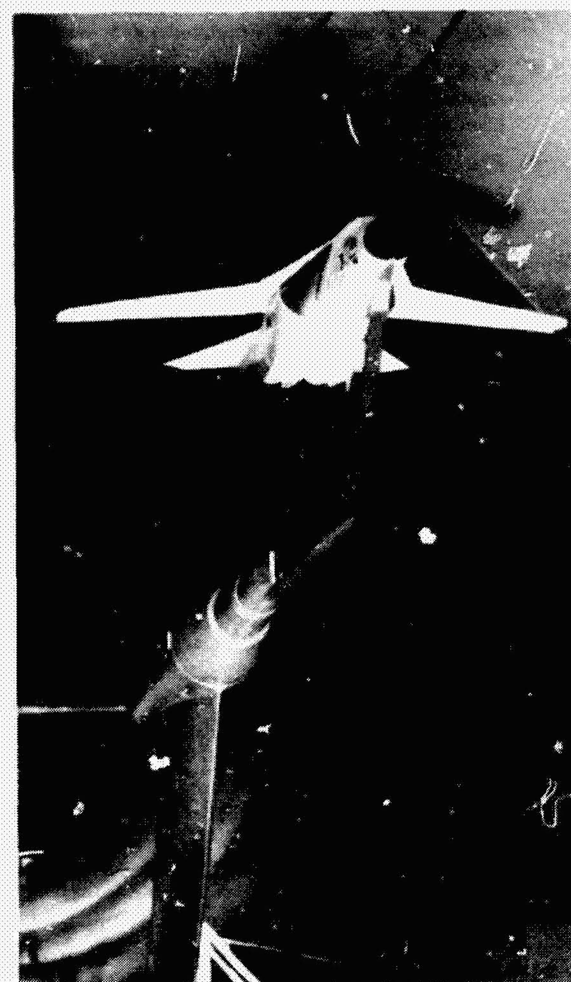
These jobs include theoretical and practical aspects of such fields as architecture, engineering; mathematics; physical sciences; social sciences; medicine and health; education; museum, library and archival sciences; law; theology; the arts; recreation; administrative specialties; and management.

Also included are occupations in support of scientists and engineers and other specializations.

Examples of aerospace jobs are:

- Aeronautical Design Engineer (002.061-022)
- Aerospace Physiological Technician (199.682-010)
- Air Traffic Controller (193.162-018)
- Airline Radio Operator (193.162-002)
- Astronomer (021.067-010)
- Biomedical Engineer (019.061-010)
- Ceramic Research Engineer (006.061-010)
- Chemist (022.061-010)
- Engineering Assistant, Mechanical Equipment (007.161-018)
- Mathematician (020.067-014)
- Meteorologist (025.062-010)
- Microbiologist (041.061-058)
- Statistician (020.167-026)

*Hereafter referred to as DOT.



Model of variable-swept wing fighter

Clerical and Sales Occupations

This category is composed of two occupational subcategories. They are clerical and sales occupations.

Clerical occupations include those activities concerned with preparing, transcribing, systematizing, and preserving written communications and records; distributing information; and collecting accounts. This is routine work which requires speed and accuracy.

Sales occupations are those activities concerned with influencing customers in favor of a commodity or service and include jobs associated with the completion of sales transactions.

There are two types of sales occupations, classified according to the type of customer. Retail sales occupations are involved with selling directly to the consumer. On the other hand, wholesale selling occupations sell to businesses, industries, and stores.

Examples of aerospace occupation titles include:

Airplane Charter Clerk (295.367-010)

Computer Tape Librarian (222.367.026)

Computer Terminal Operator (203.582-054)

Sales Representative, Aircraft Equipment (273.357-010)

Statistical Clerk (216.382-062)

Service Occupations

This category includes occupations characterized by the performance of duties for another person or other people. The four generally accepted groups are:

Domestic: Providing domestic services in private households; preparing and serving food and drink in commercial, institutional or other establishments; providing lodging and related services.

Personal: Providing grooming, cosmetic, and other personal and health care services for children and adults; maintaining and cleaning clothing and other wearing apparel.

Protective: Providing protection for people and property; attending to the comfort or requests of patrons of amusement and recreation facilities.

Building Services: Performing cleaning and maintenance services to interiors and exteriors of buildings.

Aerospace occupational examples are:

Airplane Flight Attendant (352.367-010)

Airport Guide (353.367-014)

Maintenance Engineer (382.664-010)

Agricultural, Fishery, Forestry and Related Occupations

This category emphasizes outdoor work. Workers in this category will be found in the following areas:

Agriculture: Propagating, growing, caring for and gathering plant, animal life, and products.

Forestry: Logging timber tracts; catching, hunting, and trapping animal life; and caring for parks, gardens, and grounds.

Fishery: Breeding, caring for, planting, transplanting, harvesting aquatic animals or plant life.

Notice that involvement with technologies such as processing, packaging, and stock checking are not included in this category.

Processing Occupations

This category includes occupations concerned with refining, mixing, compounding, chemical treating, heat treating, or similar work with materials in solid, fluid, semifluid or gaseous states to prepare them for use as basic materials or stock for further manufacturing treatment or for sale as finished products to commercial users. Vats, stills, ovens, furnaces, mixing machines, crushers, grinders and related machines and equipment are involved.

Examples of aerospace jobs are:

Cerrobend-Die Caster (502.381-014)

Glass Inspector (579.687-022)

Molder (502.381-014)

Machine Trades Occupations

Working with machines is emphasized. The more complicated jobs require an understanding of machine functions, blueprint reading, making mathematical computations, and exercising judgments to attain conformance to specifications. Some jobs require eye and hand coordination.

This category includes occupations concerned with the operation of machines that cut, bore, mill, print and similar work with such materials as metal, paper, wood, plastics, and stone. Installation, repair and maintenance of machines and mechanical equipment, as well as weaving, knitting, spinning, and similar work with textiles are included.

Examples of aerospace jobs are:

Aircraft Mechanic (621.281-014)

Flight Engineer (621.261-018)

Model Maker (693.361-010)

Statistical Machine Servicer (633.281-030)

Technical Specialist, Aircraft Systems (621.221-010)

Benchwork Occupations

This category includes occupations concerned with using handtools and bench machines to fabricate, inspect or repair relatively small products, such as jewelry, phonographs, light bulbs, musical instruments, tires, footwear, pottery, and garments. Workers in more complex jobs may be required to read blueprints, follow patterns and use a variety of handtools.

The work is usually performed at a set position or station in a mill, plant or shop.

Examples of aerospace jobs are:

Airplane Gas Tank Liner Assembler (759.684-010)

Aircraft Interior Fabricator & Installer (769.281-010)

Airplane Woodworker (769.281-010)

Patternmaker, Plaster (777.381-030)

Structural Work Occupations

Workers must be familiar with handtools, power tools and stationary machines. Work is performed usually outside, except for factory production line occupations.

These occupations involve fabricating, erecting, installing, paving, painting, and repairing structures and structural parts. Their work produces such products as: bridges, buildings, roads, motor vehicles, cables, internal combustion engines, girders, plates and frames.

Aerospace jobs include:

Airplane Radio Tester (823.281-010)

Assembler, Aircraft, Structures and Surfaces (806.381-026)

Electronics Mechanic (828.281-010)

Inspector, Assemblies and Installations (806.281-022)

Radio - Maintenance Repairer (823.281-010)

Miscellaneous Occupations

This category includes occupations concerned with:

- Transportation of people and cargo from one geographic location to another by various methods;
- Extraction of minerals from the Earth;
- Production and distribution of utilities;
- Production of graphic art work;
- Packaging of materials and the moving of materials in and around establishments;
- Modeling for painters, sculptors, and photographers;
- Providing various production services in motion pictures and radio and television broadcasting;

Jobs include:

Aircraft Launch and Recovery Technician (912.682-010)

Airport Attendant (912.364-010)

Parachute Packer (912.684-010)

Photofinishing Laboratory Worker (976.687-018)

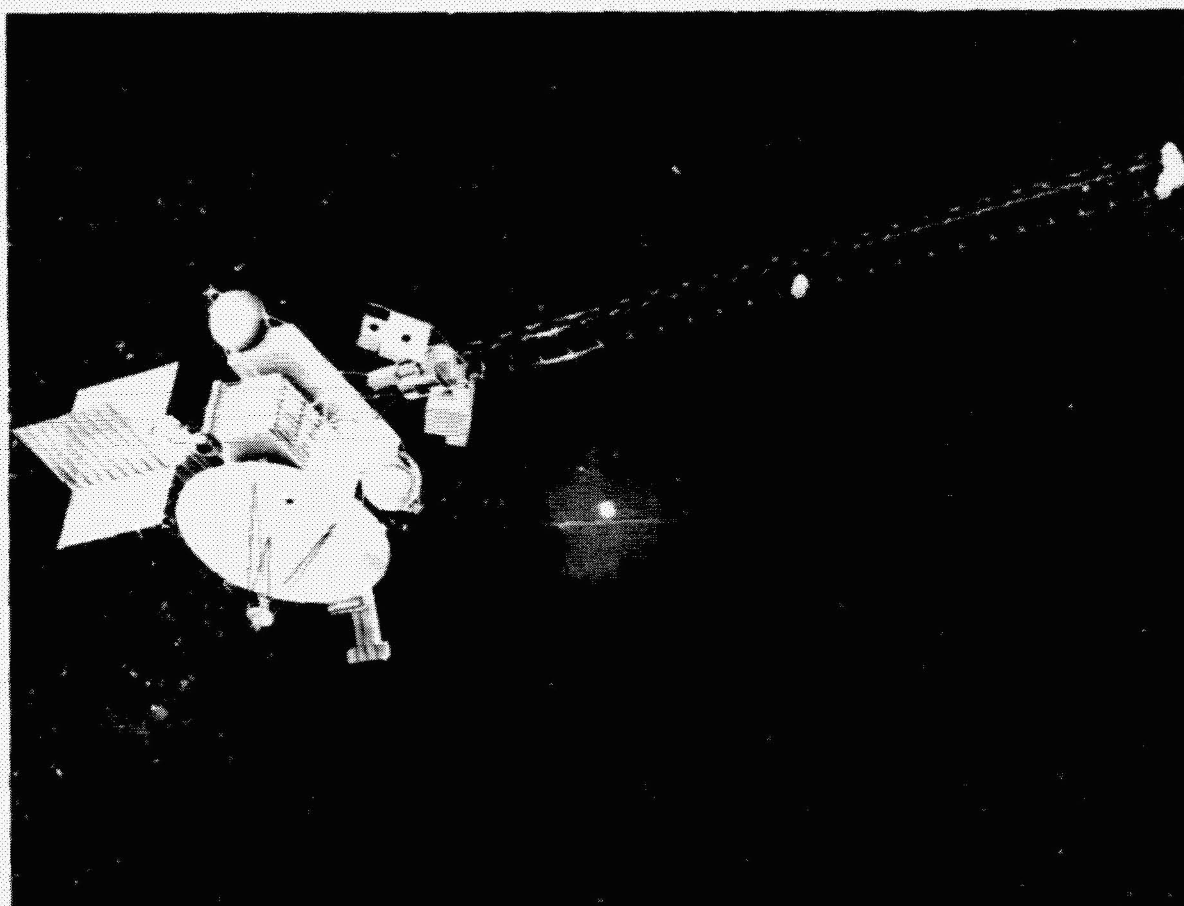
Tower Operator (910.362-010)

Obviously, not all nine groups in the DOT include jobs directly related to the aerospace industry. However, some relationships between groups and aerospace careers can be established. The majority of jobs in the industry require the skills and expertise of scientists, engineers and technicians. These jobs are classified by the DOT in the Professional, Technical and Managerial grouping. The work of scientists, engineers and technicians would not be successful without the support of employees represented in other occupational groups.

USES' Approach to Presenting Career Information

The United States Employment Services (USES) has contributed to a publication entitled **Guide for Occupational Exploration*** which categorizes occupations into 12 homogeneous groups according to interests, abilities and traits required by workers for successful performance. By referring to the twelve interest areas, students can explore areas of work in which they have strong interests. Each of the twelve interest areas is divided into work groups and

*__Guide for Occupational Exploration.__ U.S. Department of Labor, Employment and Training Administration, 1979. This publication is a supplement to the **Dictionary of Occupational Titles**. The definitions of interest areas are found on page 8.



Shuttle-launched spacecraft will explore the polar regions of the Sun

subgroups. Information describing the kinds of job activities performed, the requirements expected of workers and the preparation necessary for entrance into these jobs are discussed in these work groups. Students match their skills and potentials to jobs by studying this information.

Definitions of Interest Areas

The following definitions of interest areas provide brief descriptions of the vocational interests of individuals employed in jobs in these areas.

I. Artistic

Interests in creative expression of feelings or ideas.

II. Scientific

Interests in discovering, collecting, analyzing information about the natural world and in applying scientific research findings to problems in medicine, life sciences, and natural sciences.

III. Plants and Animals

Interests in activities involving plants and animals.

IV. Protective

Interests in the use of authority to protect people and property.

V. Mechanical

Interests in applying mechanical principles to practical solutions using machines, handtools, or techniques.

VI. Industrial

Interests in repetitive, concrete, organized activities in a factory setting.

VII. Business Detail
Interests in organized, clearly defined activities requiring accuracy and attention to details, primarily in an office setting.

VIII. Selling
Interests in bringing others to a point of view through personal persuasion, using sales and promotion techniques.

IX. Accommodating
Interests in catering to the wishes of others, usually on a one-to-one basis.

X. Humanitarian
Interests in helping others with their mental, spiritual, social physical, or vocational needs.

XI. Leading-Influencing
Interests in leading or influencing others through activities involving high-level verbal or numerical abilities.

XII. Physical Performing
Interest in physical activities performed before an audience.

Scientific Interest Areas

The following information on **PHYSICAL SCIENCES** illustrates the approach found in the **Guide for Occupational Exploration** (pp. 38-40) and *offers one example of scientific careers characteristic* of the aerospace industry. The reference codes refer the reader to the DOT.

PHYSICAL SCIENCES

Workers in this group are concerned mostly with non-living things, such as chemicals, rocks, metals, mathematics, movements of the Earth and the stars, etc. They conduct scientific studies and perform other activities requiring a knowledge of math, physics, or chemistry. Some workers investigate, discover, and test new theories. Some look for ways to develop new or improved materials or processes for use in production and construction. Others do research in such fields as geology, astronomy, oceanography, and computer science. Workers base their conclusions on information that can be measured or proved. Industries, government agencies, or large universities employ most of these workers in their research facilities.

What kind of work would you do?

Your work activities would depend upon your specific job. For example, you might

- study (serial) photographs for indications of possible oil or gas deposits.
- examine rock formations to develop theories about the Earth and its history.
- use information about wind, temperature, humidity, and land formations to predict weather.
- help solve environmental problems such as pollution.
- develop chemical formulas for making fine perfumes.
- conduct experiments to develop new metals.
- gather and interpret information about movements in the Earth.
- use advanced math to solve very complex problems.

What skills and abilities do you need for this kind of work?

To do this kind of work, you must be able to:

- use logic or scientific thinking to deal with many different kinds of problems.
- use non-verbal symbols (such as numbers) to express ideas or solve problems.
- understand and express complex, technical, and scientific information.
- recognize textures, colors, shapes, and sizes.
- make decisions using your own judgments.
- gather and interpret data about Earth movements.
- make decisions based on information that can be measured or verified.

The above statements may not apply to every job in this group.

How do you know if you would like or could learn to do this kind of work?

The following questions may give you clues about yourself as you consider this group of jobs.

- Have you taken courses in Earth science or space science?
- Have you read articles or stories about scientific expeditions? Do you understand scientific terminology?

- Have you collected rocks or minerals as a hobby? Can you recognize differences in ores or mineral deposits?
- Have you watched television weather shows? Do you understand the terms and symbols used?
- Have you owned a chemistry set or microscope? Do you enjoy testing new ideas with this type of equipment?

How can you prepare for and enter this kind of work?

Occupations in this group usually require education or training extending from four years to over ten years, depending upon the specific kind of work. A bachelor's degree with a major in mathematics or a specific physical science is the minimum requirement for entrance into this type of work. Graduate degrees are preferred for most research work or college teaching. A master's degree may qualify an individual for work in laboratory teaching or applied research in a college, university, or industrial setting. Advanced studies or a Ph.D. are usually required for work in basic research. Important courses include algebra, geometry, advanced math, physics, and Earth and space science. Chemistry and technical writing courses are helpful and in some cases required.

What else should you consider about these jobs?

Physical scientists may be required to work irregular hours to meet research deadlines or to study phenomena. Frequent relocation or travel to remote areas may be required. Workers should keep informed of developments in their field by attending seminars, reading professional journals, and being active in professional organizations.

If you think you would like to do this kind of work, look at the job titles listed on the following pages. Select those that interest you, and read their definitions in the **Dictionary of Occupational Titles**.

Free-flying model of F-16

Job Title	DOT Reference Code
Geophysicist	024.061-030
Hydrologist	024.061-034
Mathematician	020.067-014
Meteorologist	025.062-010
Mineralogist	024.061-038
Paleontologist	024.061-042
Petrologist	024.061-046

Physicist	023.061-014
Physicist	023.067-010
Seismologist	024.061-050
Aerial-Photograph Interpreter	029.167-010
Geologist, Petroleum	024.061-022
Environmental Analyst	029.081-010
Materials Scientist	029.081-014
Metallurgist, Physical	011.061-022
Project Manager, Environmental Research	029.167-014

Worker Functions

At this point, more information about careers will be provided by focusing upon a discussion of worker functions, as defined by the DOT, and their relationship to occupations in the aerospace industry. The "Data" - "People" - "Things" approach associated with worker functions has been selected because it relates to all individuals and all occupations.

In order to select a career best suited to the unique nature of each student, he or she must be aware of his/her special talents, interests, abilities and achievements as well as personal motivation. The more information the student can formulate about himself/herself, the more satisfied he/she is likely to be with the chosen career(s). The process of preparing for one's career requires self awareness as well as career awareness. Self awareness may be gained through a systematic analysis of one's experiences and one's reactions to these experiences.

An important consideration when examining careers is deciding what types of relationships the student most enjoys. The DOT suggests that every job requires a worker to relate in some degree to either "Data," "People," or "Things." The student can decide whether he/she prefers to work with "Data," "People," or "Things" by completing interest inventory instruments provided by guidance counselors. The student then reviews these results in combination with memories of past accomplishments and successes. These remembered successes involve "People," "Data," "Things," or some combination of them. A student may enjoy assemblying model airplanes. Activities such as this require a "Things" oriented approach. This same student, however, may not enjoy teaching someone else to do those activities required to assemble the model. This requires a "People" orientation. Furthermore, this student may not delight in researching the history of aviation which demands a preference for working with "Data". Another student, on the other hand, may enjoy all three activities and all three preferences or combinations of preferences. Realizing which relationships one most enjoys provides self awareness and an understanding of oneself in relation to future career choices.

Once the student has decided about his/her preference or combination of preferences, he/she is ready to consider Worker Functions -- what a worker does with "Data," "People," or "Things." Worker functions describe relationships between worker preferences and the difficulty of tasks associated with a particular job. They summarize the responsibilities of a job and arrange the responsibilities according to levels of difficulty. Responsibilities or job tasks are arranged from complex to simple.

Students best suited to working in particular orientations or preferences are exhibiting behaviors characteristic of that preference(s). They are functioning at several levels of the corresponding hierarchy of worker functions. Hummel and McDaniels* encourage people significant to the lives of students to observe their selection of school courses, their participation in clubs and other extracurricular activities as well as their choice of leisure time activities and part-time jobs. They are instructed to make students aware that these preferences are clues for the selection of potentially rewarding careers.

Each worker preference is defined in the following section. A representation of the tasks associated with each preference is also included. Examples of aerospace occupations and characteristics of students who might be attracted to these occupations are related to each preference. Combinations of worker preferences are discussed in this section as well.

Work Involving Data

Individuals who work with information, knowledge, ideas or concepts which are obtained by observation, investigation, interpretation or visualization are working with data. Data is

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intangible, that is, it cannot be touched or handled. It is expressed in numbers, words or symbols. All individuals relate in some degree to data in their work or leisure.

The DOT organizes the tasks associated with data work from complex to simple. Each level indicates the degree of task complexity performed by the worker on that job.

Complex Tasks

Synthesizing: Discovering facts and/or developing conclusions or interpretations of ideas by analyzing data.

Coordinating: Analyzing data in order to determine the time, place, and order of operations or actions to be performed. Carrying out and/or reporting on these actions.

Analyzing: Examining and determining the value of data. Presenting alternative plans in order to choose the best course of actions.

Average Tasks

Compiling: Gathering, comparing, or classifying information about data, people, or things. Reporting and/or carrying out activities indicated by the information.

Computing: Performing arithmetic operations, reporting results, or carrying out activities indicated by the results. Tasks involving counting are not included.

Copying: Rewriting data from one copy to another or entering data in ledgers or accounts books.

Simple Tasks

Comparing: Judging data, people, or things according to what can be observed (what they do, how they look, how they are made or whether they are usual or different from the usual).

These workers are involved mainly with information or conceptual knowledge. The more complex tasks require more specialized training and experience.

Occupations Associated Primarily With Data:

Accountant	Mathematician
Contract Clerk	Stenographer
Clerk-Typist	Statistician
Editor	

Students who enjoy mathematics and/or English courses may enjoy careers involving data. Their roles in school activities and part-time jobs will reflect interests in numbers, words or symbols.

Work Involving People

"People" work involves working with people and animals when they are given care and consideration similar to that given human beings. The DOT arranges the hierarchy of worker functions for the "People" category in the following manner:

Complex Tasks

Mentoring: Advising or counseling individuals with problems that may be resolved by legal, scientific, clinical, spiritual, and/or other professional principles.

Negotiating: Exchanging ideas, information, and opinions with others to formulate policies and programs, and/or arrive jointly at decisions, conclusions, or solutions.

Instructing: Teaching subject matter to others, or training others (including animals) through explaining, demonstrating, or supervising practice; or making recommendations on the basis of knowledge gained through specialized training in such areas as medicine, law, or engineering.

Supervising: Determining or interpreting work procedures for a group of workers, assigning specific duties to them, maintaining harmonious relations among them and promoting efficiency.

Diverting: Amusing others. (Usually accomplished through the medium of stage, screen, television, or radio.)

Average Tasks

Persuading: Influencing others in favor of a product, service, or point of view by talks or demonstration.

Speaking-Signaling: Talking with and/or signaling people to give or exchange information. Includes assigning tasks or giving directions to helpers or assistants.

Serving: Attending to the requests or needs of people or animals. Immediate response is involved.

Simple Tasks

Taking Instructions Helping: Helping applies to "nonlearning" helpers. No variety of responsibility is involved in this function. Attending to the work assignments, following instructions, or responding to orders of a supervisor.

Over the last thirty years more workers have become involved in rendering services (teaching, cooking, managing) than in producing goods (manufacturing, mining, farming). This trend is predicted to continue in the years ahead and implies a growing number of jobs primarily involving working with people in occupationally significant ways. A key factor to understand is that the complexity of worker tasks in this orientation is directly related to the degree to which one must interact with people. This is different from working in a setting where many other people may be found, but who do not interact with each other in significant ways.

Occupations Associated Primarily With People:

Airplane Flight Attendant
Labor Relations Expert
Passenger Service Representative
Security Guard

These individuals relate to human beings in an occupationally significant manner. They do not relate significantly to "Data" or "Things," however.

Students who enjoy conversing with others, who express an interest in others or who select to work with others rather than alone are likely candidates for careers emphasizing "People." They tend to engage in activities that emphasize people or animals. Activities such as planning a dance or managing the activities of a service organization are indicative of this orientation. Baby sitting and caring for pets are characteristic behaviors. School courses include distributive education, humanities and social sciences, including sociology and psychology.

Work Involving Things

"Things" work involves working with lifeless objects such as substances or materials, machines, tools, equipment, or products. Sex-role stereotyping that excluded women from occupations oriented towards things is disappearing. The DOT categorizes these worker functions as follows:

Complex Tasks

Setting Up: Adjusting machines or equipment by replacing or altering tools, jigs, fixtures, and attachments to prepare them to perform their functions, change their performance or restore their proper functioning if they break down. Workers set up one or a number of machines for other workers or set up and personally operate a variety of machines.

Precision-Working: Using body parts and/or tools or work aids to work, move, guide, or place objects or materials in situations requiring that rigid standards be met. Judgment is required in the selection of appropriate tools, objects, or materials and the adjustment of the tool to the required task.

Average Tasks

Operating Controlling: Starting, stopping, controlling, and adjusting the progress of machines or equipment. Operating machines involves setting up and adjusting the machine or material(s) as the work progresses. Controlling involves observing gages, dials, and turning valves and other devices to regulate factors such as temperature, pressure, flow of liquids, speed of pumps, and reactions of materials.

Driving-Operating: Starting, stopping, and controlling the actions of machines or equipment which must be steered or guided in order to manufacture, process, and/or move people or things. Observing gages and dials; estimating distances and determining speed and direction of other objects; turning cranks and wheels; pushing or pulling gear lifts or levers are involved. Such machines as cranes, conveyor systems, tractors, furnace charging machines, paving machines, and hoisting machines are included.

Manipulating: Using tools, special devices, or parts of the body to work, move, guide, or place objects or materials. Workers use some judgment to maintain the needed degree of accuracy and to select the proper tool, object, or materials. However, such judgments are usually not difficult to make.

Simple Tasks

Tending: Starting, stopping, and watching the operation of machines and equipment. It involves adjusting materials or controls of machines. Activities include changing guides, adjusting timers and temperature gages, turning valves to allow flow of materials, and flipping switches in response to lights. Little judgment is involved in making these adjustments.

Feeding-Offbearing: Throwing, dumping, putting, or feeding materials into or removing them from machines or equipment. These machines or equipment may be automatic or may be tended or operated by other workers.

Handling: Using parts of the body, handtools, and/or special devices to work, move, or carry objects or materials. Little or no judgment is involved in meeting standards or in selecting the proper tool, object, or material.

Significant numbers of people are employed in the production of goods. Agricultural, mining, manufacturing and construction industries emphasize a worker's relationship to "Things."

Occupations Associated Primarily With Things:

In the following aerospace occupations, the individual works directly with "Things" in an occupationally significant way:

Airplane Gas Tank Liner Assembler
Electronics Mechanic
Engine Installation Inspector

Students who enjoy "working with their hands" by using tools, equipment or machines may be interested in this category of occupations. These students demonstrate manual dexterity and hand-eye coordination. They enjoy exploring the operating mechanisms of radios or stereos, for example. Their part-time jobs might include working as an assistant in a small engine repair shop or as an assistant to a television repair service mechanic. High school courses in industrial arts, home economics or trade and industrial education tend to emphasize student abilities and interests in this area.

Combinations of Worker Preferences

Some occupations require workers to demonstrate combinations of preferences, according to Hummel and McDaniels. These occupations require interests, abilities and preparation appropriate to the level of worker functions.

Occupations Associated Primarily With Data and Things:

Workers in this category relate not only to words or numbers, but also to objects or things. Their relationship with people is not occupationally significant, however. Examples of aerospace careers are:

Astronomer	Keypunch Operator
Chemical Engineer	Meteorologist
Food Chemist	Tool and Die Maker

Students who enjoy collecting things--stamps, pictures, coins, model airplanes--may be interested in pursuing careers involving "Data" and "Things." Students who enjoy participating in courses such as industrial arts, home economics or music should also be encouraged to explore careers in this category. Courses in advanced math, chemistry and physics are suggested for students interested in these careers. Self-exposure to extracurricular activities such as membership in math or science clubs or in Explorer Scouts represents paths for exploring interests in "Data" and "Things."

Occupations Associated Primarily With Data and People:

In some occupations, workers relate to people and also to words, numbers, or ideas. Their working relationships with "Things" is not considered occupationally significant. Aerospace occupations include:

International Relations Officer	Physiologist
Laser Surgery Physician	Public Affairs Officer
Neurobiologist	Research Psychologist
Nuclear Medical Technologist	

Workers in this category who perform complex worker functions may be required to obtain specialized training. These individuals are employed in some of the most prestigeous and well known occupations.

Occupations Associated Primarily With Data and People and Things:

This category represents a rare combination of preferences; therefore, the number of jobs is small. Most of these jobs involve a direct relationship with people and require some technical and "Things" orientation as well. Examples are airport manager or airline radio operator.

The scientific, engineering and technical orientation of the jobs in the aerospace industry emphasize complex worker functions relating primarily to "Data" or a combination of "Data" and "Things." However, all three preferences and all levels of worker functions are represented in this diverse field.

Survey Completed

This information has been offered in an attempt to assist counselors and students explore several approaches which organize thousands of occupations into manageable categories. It is hoped that students with the assistance of counselors, will review these classification systems in order to define realistic occupational goals for themselves.

Students are encouraged to keep in mind that there is no one job that is perfect in all respects. There are many jobs that will help make life happy and productive. Many people seem capable of entering many different occupations. However, choosing and finding the work best suited for an individual may be the hardest job an individual

"I was turned on by Charles Lindburgh's flight across the Atlantic when I was a child. I built model airplanes and read and studied about airplanes and aerospace vehicles continually through grade school, high school and college. It's been my experience that students interested in pursuing a career in aerospace should know that the work will be hard, the competition will be tough, and the opportunities will be many."

W. T. Hamilton
Vice President for Research and Engineering,
Boeing Commercial Airplane Company

undertakes. Even if a student knows what he or she wants to do, it may not be easy to get that job. That is why planning ahead is so important.

Often as an individual's interests and goals change, so do his or her career goals. A career that seemed so attractive to the sixteen year old may not seem so appealing to the twenty-two year old. For many, career development is a life long process. By becoming knowledgeable about a variety of different career choices, with the assistance of career counselors, an individual may feel more comfortable making career choices at different stages of his or her life.

Classifying Aerospace Occupations

At this point, more information about aerospace careers will be discussed. NASA's scientific and engineering classification system will provide an overview of these careers. There are hundreds of occupations represented by the aerospace industry. Therefore, broad categories encompassing similar positions have been formulated. These groups, such as the Space Sciences Group or the Flight Systems Group, provide descriptions of typical work assignments. They are based on the work performed by aerospace specialists, rather than on their educational backgrounds.

Aerospace science, engineering and technology is one of the most diversified fields. Yet, it represents a collection of many interrelated specialties. The interdisciplinary nature of aerospace technical positions can be demonstrated quickly. Individuals with the following scholastic majors are classified according to the NASA system in the Flight Mechanics category: aeronautical engineering, physics, mathematics, mechanical engineering, engineering, civil engineering, chemistry, nuclear engineering, and mining engineering.

The complex nature of the challenges facing this industry requires that scientists, engineers and technologists strive to approach issues from many different points of view as well as from one single, indepth point of view. Some aerospace researchers and engineers tend to be generalists who study problems from several different theoretical and technical positions. They attempt to solve problems by investigating them in terms of the entire system which represents many disciplines. Their knowledge of flight systems, fluid mechanics and propulsion systems, to name a few, is incorporated in order to arrive at solutions to problems. In many instances their interdisciplinary pursuits lead them beyond the traditional academic degree which they have earned. Generalists specialize in one academic area in college. Yet, they demonstrate technical proficiency in several other areas as well. For example, a meteorologist may serve as a consultant for an airborne observation program or a lubrication specialist may offer technical advice to the managers of a project studying liquid rocket propulsion systems. NASA's responsibility to remain at the "cutting edge" of research and development requires the more narrowly channeled efforts of specialists. Specialists approach problems with an indepth understanding of one single discipline. They are experts in exobiology, data systems or controls and guidance, for example. Both generalists and specialists employed by NASA possess knowledge and skills which will allow them to pursue investigations into unprecedented areas. They approach technical challenges with specialized knowledge gained through academic preparation and diverse work experiences.

Private aerospace industries responsible for the production of aerospace hardware reflect interests in specialized aspects of aerospace science and technology. They tend to employ specialists trained in their particular technical area of interest. For example, companies or divisions of companies are established to engage exclusively in such activities as the production of missile and jet engine structural components. Others research and develop aircraft wheels, brakes, and accessories. Other companies hire experts who only engage in research activities involving solar energy, for example. Scientists, engineers, and technicians employed in these companies tend to pursue indepth investigations and applications relating to single disciplines.

The following presentation is limited to an occupational review of the NASA classification system of scientific and engineering positions and defines work unique to that agency. Each company within the aerospace industry has developed its own classification system. In most cases, these systems are different from NASA's framework as industry tends to define positions more specifically. However, NASA's system does encompass all of the disciplines one would find in the aerospace industry.

The student reviewing the following classification of aerospace occupations should recall the multidisciplinary nature of the NASA groups. He or she also should remember that the unique problems in this field demand the knowledge and skills of both generalists and specialists. The student must take into account the fact that new work areas related to aerospace technology emerge continuously as technology solves existing problems and simultaneously generates new demands. These demands consequently modify existing job characteristics and create new career options. Therefore, aerospace technology specialties are reviewed and their classification is revised and redefined on a continual basis.

NASA's Aerospace Technology System

There are 13 subgroups in NASA's Aerospace Technology System (AST)*. Each subgroup includes positions for scientists, engineers and support personnel who are engaged in aerospace research and development. It also includes the work of those who develop and operate specialized facilities and supporting equipment. The AST structure establishes a basic occupational framework. The classification system is designed to contribute to the most effective and efficient management of scientific and engineering personnel.

***Position Classification Handbook**, NHB 3510.5, May 1972.

The title "Aerospace Technology" was selected because it is recognized as the best single term designating research and development activities conducted by NASA. The professional community, which includes industry, government, and academic institutions, also employs this term.

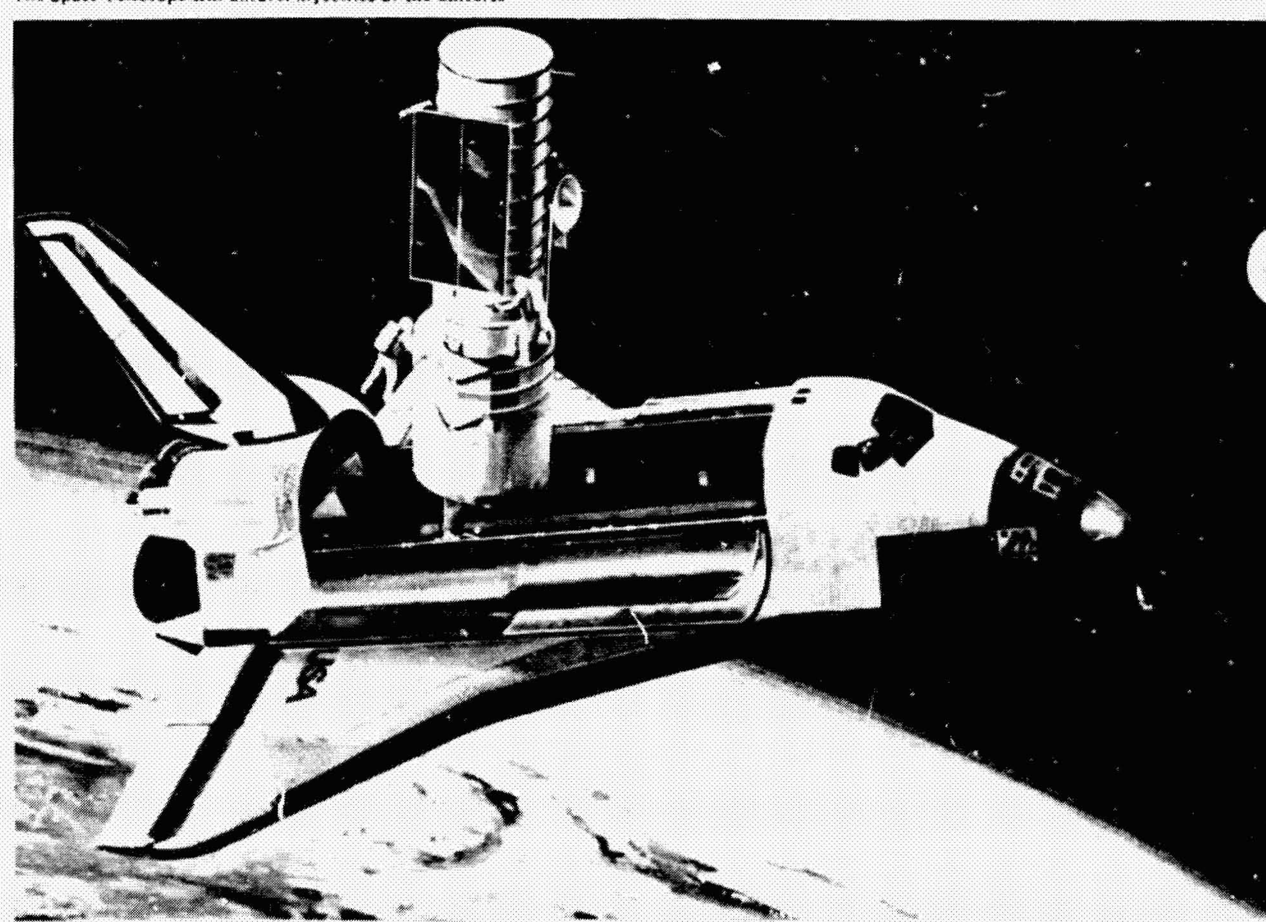
Space Sciences

Fitting the tiny Earth into the cosmic puzzle! That is the vocation of some scientists, engineers and technicians in this group. They unravel mysteries about the Earth and its place in the cosmic puzzle through a process known as "comparative planetology" which relates phenomena associated with one planet to conditions on another.

Intricately interwoven into the vast mosaic of the cosmos lie the clues to the origin, the evolution and the structure of the universe. Space scientists transformed into space-age Sherlock Holmes' vigorously pursue these clues for information about the universe. Aerospace detective tools -- satellites, planetary probes and radio and optical telescopes -- are crucial to the discovery of these secrets. The Space Telescope, the most powerful of astronomical tools, will serve as an orbiting astronomical observatory operating above the obscuring influence of Earth's atmosphere. Celestial objects 50 times fainter than previously observable will be detected by this telescope. With this tool, designed to operate at least through the end of the twentieth century, scientists will be able to view the universe in both the visible and ultraviolet light portions of the spectrum. The volume of the universe which can be observed by optical systems will be expanded from three percent to 95 percent. The telescope will be visited periodically for maintenance by Shuttle crews.

Planetary investigations are pursued by aerospace specialists in the Space Sciences program. Robot explorers designed to investigate planets have transmitted photos and data over hundreds of millions of miles to Earth for analysis by scientists and engineers. As a result of planetary research such as the Mar's Viking Project, scientists have hypothesized that frost formation on the Martian ground is initiated by the condensation of ice on dust particles in the atmosphere. Over time, they gain enough weight to settle to the Martian ground. Information transmitted from the Viking lander indicates that the frost lasts about 100 days and then is dissipated by the Sun's warmth. In the future, outer planet studies include a mission by a

The Space Telescope will unravel mysteries of the universe



Voyager Spacecraft to Uranus. This planet is two billion miles from Earth. Planetary investigations such as these offer immense scientific potential.

Planetary investigations are only one aspect of the comprehensive Space Sciences program. Other elements also designed to learn about the origin, evolution, and structure of the universe include:

- Astrophysics research which involves the observation of distant stars, galaxies, and other extra-terrestrial phenomena; and
- Solar terrestrial research which includes the study of the processes that generate energy in the Sun and transport it to the Earth and the study of the interactions of that energy with the Earth's environment.

Studies conducted from ground and space observatories examine the Sun, a sphere of hot gases whose temperatures are measured in millions of degrees. Solar activity such as massive eruptions, particle discharges and intense radiation output are monitored by seven different instruments associated with the Solar Maximum Mission spacecraft, for example. A concept of enormous potential for meeting future energy needs relies upon current solar research. An orbiting power station known as the Satellite Power System is envisioned to draw upon the energy from the Sun to produce enough electricity for the needs of a large city. It appears feasible that a number of these satellites could generate a significant portion of the nation's power requirements in the twenty-first century. This power system constructed in orbit from materials delivered by Space Transportation System vehicles would consist of a large platform several miles in length. A "farm" of solar cells capable of converting sunlight into electricity would be contained on the platform. The electricity would be beamed as microwaves to an Earth "rectenna," and then reconverted into electricity for consumers' use.

Improving the quality of life on Earth is another goal pursued by individuals in the Space Sciences group. Landsat, a remote sensing satellite, acquires voluminous data about the surface features of the Earth from orbital altitudes. Landsat reports continuously on the changing faces of the planet and offers potential for more effective management of Earth's resources. Sensitive on-board detectors pick up energy emitted or reflected from the Earth and paint a picture of the scene far below. This results in the capability to distinguish among different surface features. Applications include: agricultural inventorying, prospecting for new oil and mineral resources, charting sources of fresh water, monitoring pollution, delineating urban growth patterns, studying floods to lessen their devastation and plotting changes in ecology resulting from forest fires, earthquakes or strip mining activities.

Concern for the environmental quality of the fragile stratosphere, which begins at an altitude of about eight miles and ends at about 30 miles, has prompted a number of scientific investigations -- in laboratories, from balloons, aircraft and satellites. Two objectives of these investigations are to determine if man's industrial and technological activities adversely influence the stratosphere and to determine how the stratosphere reacts to such natural particle injections as those caused by volcanic eruptions.

This region of the atmosphere contains ozone which protects the Earth from much of the Sun's ultraviolet, skin cancer-producing radiation. An aerosol concentration of tiny solid particles or liquid droplets also resides in the stratosphere and serves as a sunlight filter which also plays a role in the radiation balance of Earth's environment. The Stratopheric Aerosol and Gas Experiment (SAGE) spacecraft is a major contributor to investigations of the Stratosphere. It carries an instrument known as a photometer which "looks" at the Sun during spacecraft sunrises and sunsets. It measures the amount of ozone and aerosols attenuating (reducing) the Sun's light. The photometer also measures the abrupt change in aerosol concentrations caused by the eruption of volcanoes, for example, and maps the global spread of the volcanic "veil." Tracking these aerosol dispersions is important to radiation balance studies and also offers insights as to how atmospheric pollutants might be transported globally.

Individuals fascinated with the principles of meteorology or astronomy and who enjoy technological application of scientific theory are attracted to careers in this group. College majors often include: astronomy, astrophysics, geology, geophysics, mathematics, meteorology, and physics. These majors frequently are supplemented with at least one physics or one engineering laboratory course in electronics, optics, materials, vibration, high vacuum theory, heat transfer or a comparable field relating to aerospace instrumentation.

Life Sciences

Have you ever noticed that some people -- your friends or even yourself -- feel car sick or sea sick while others traveling in the same car or boat do not? Do you know what causes this motion sickness or how to prevent it? Did you know that plants living within the Earth's gravity will grow with their roots down and their stems and shoots up, even if they are turned upside down and supplied with nutrients (food and water) from above the roots? Do you know why plants behave like this? The desire to discover the answers to many, many questions like these attracts the curiosity of some people. These people are primarily scientists (biologists, chemists, physicians, psychologists, physiologists) who work in Life Sciences Programs. In order to answer these questions, they pursue basic and applied research. Their research is complemented by the skills of engineers (especially bioengineers) and technicians.

Two central topics are explored through research and technology in Life Sciences Programs. One topic deals with studying the effects of exposing biological organisms to the space environment. Hundreds of studies and experiments are conducted. The outcomes of these experiments are: more accurate recognition, better understanding and more precise correction of the adverse effects of space missions on humans. The goal of these studies is to understand the causes of problems so they can be prevented. These problem areas have been identified from previous manned space flights or are anticipated to occur in future space flights. Solving these problems is crucial as greater numbers of astronauts and payload specialists fly repeated and longer missions. Understanding the origin, evolution and distribution of life on Earth and throughout the universe offers a challenging second topic. Biology, the science of living organisms, ties together these two themes. Programs in Life Sciences include five closely overlapping programs: Biomedical Research, Operational Medicine, Space Biology, Biological Systems, and Exobiology.

Members of the **BIOMEDICAL RESEARCH PROGRAM** investigate the major physiological (bodily) and psychological (mental and behavioral) problems experienced by humans traveling and working in space. Some issues they study are: motion sickness, radiation, and human behavior, motivation, and relationships.

Problems associated with each of these issues interfere with the performance of assignments in space. This interference is costly because many different activities are designed and carefully scheduled into a flight plan. Interruptions in the schedule may eliminate important experiments. Therefore, many different studies are directed toward exploring and eliminating these problems.

Some scientists study characteristics of people who suffer from motion sickness. They compare these characteristics with those people who do not experience dizziness, nausea or other symptoms. Then criteria are determined with the hope of selecting astronauts who will not experience these adverse symptoms. Medications and their effects also are investigated. Biofeedback techniques are being developed

"The only advice that I would offer high school students if they are interested in pursuing a career in aerospace is to concentrate on getting a good technical education with particular emphasis on complete familiarity with our revolutionary new tool called "computing." This dedicated pursuit of technical subjects should not take place without at least some courses from the liberal arts side."

H. W. Withington
Vice President for Engineering,
Boeing Commercial Airplane Company

to help astronauts recognize the beginning symptoms. Once symptoms are identified, astronauts are taught to control their breathing, heart rate and other body functions to control the sick feelings.

Understanding and preventing the hazardous effects of exposure to radiation also is crucial to space exploration. The longer astronauts are exposed to radiation, the more damage they experience.

Some researchers in this program study human behavior and motivation in order to maximize astronauts' performances in space. Psychological stability and resistance to stress are basic characteristics of astronaut candidates. Researchers also study human relationships. They determine characteristics of people who are best suited to working and living in the confinement of spacecraft. Compatibility among members of astronaut teams is crucial to reducing or preventing tensions and conflicts in space.

Physicians working in the **OPERATIONAL MEDICINE PROGRAM** (Space Medicine) are doctors for space travelers. They work closely with other members of Life Sciences Programs. They apply the knowledge gained from biomedical research to the prevention and treatment of occupational injuries or diseases resulting from space missions.

These physicians establish health requirements for the selection of astronauts. They certify astronauts for flight, monitor their health during flight and examine and care for them following the flight. Medical certification determines when they are permitted to return to their duties as crew members.

Since doctors at this time cannot make house calls in space, astronauts must be trained to prescribe medical care to themselves and payload specialists. Their "doctors' kits" are prepared by physicians in this program. They also work with bioengineers to design life support systems (G suits). They monitor space environments in order to protect the health of crew members.

The **SPACE BIOLOGY PROGRAM** emphasizes the biological role of gravity in the evolution and normal life processes of living things on Earth. Scientists in this program use zero gravity and cosmic radiation as research tools. These tools are used to explore adaptative responses of plants and animals to the unfamiliar conditions of space. For example, on Earth plants seem "to know" which direction is up and which is down. In space there are no such directions as up or down. Scientists in this program are studying the attraction of plants to gravity (geotropism). Understanding how terrestrial plants will grow in zero gravity is crucial. Scientists also are studying the effects of weightlessness on the developmental stages of animals. Developing frog eggs are subjects of these investigations.

This research has practical application for the health and welfare of plant and animal life on Earth and in space. It is a key to the future use of plants and animals in biological support systems. Long-term space missions will require spacecraft that are closed ecological systems. These eco systems will be artificially produced by the interaction of the metabolism of plants, animals and humans living on board. The long term survival and reproduction of many generations of life in space will be based partly on research in this program.

Research in the **BIOLOGICAL SYSTEMS PROGRAM** studies the relationship between living things (mostly people) and external systems. Four distinct and related divisions are included in this program. They are: Aids to Work in Space, Environmental Control and Life Support Systems, Closed Ecological Life Support Systems and Global Ecology Studies.

Scientists and engineers working in the first division design and develop aids for humans living and working in space. These include improved space suits, advanced space equipment and human controlled manipulators ("teleoperators") for remote operations. This research and technology is aimed at maximizing the effectiveness of future spacecraft crews. The most efficient exploration and exploitation of space will include various

Space suits–protective environments for space travelers

combinations of activities. Some activities will involve only humans. Other tasks will require either equipment remotely controlled by humans or fully mechanized operations requiring no human assistance.

People working the second and third divisions research the best ways to produce life supporting environments in space vehicles. As missions require spacecraft to remain in space for longer and longer periods of time, it will not be possible to carry along sufficient amounts of water, food or air. They would weigh too much and take up too much room in the space vehicle. Therefore the craft must be designed and equipped to represent a miniature Earth, where oxygen, food, water, temperature and pressure are produced on board. Today's researchers are matching human and plant metabolic processes in order to discover the best exchange of life supporting requirements. "Used" materials from metabolism are purified and recycled by systems designed in this program. Electrical, chemical and mechanical devices are designed to control and maintain the delicate balance of this life-supporting system.

Scientists learn about closed ecological systems by studying the characteristics of the Earth. They apply this information to creating artificial eco-systems in spacecraft. The Global Ecology Division involves an international community of scientists that study land masses, oceans and the Earth's atmosphere. Global ecology and "planetary engineering" are practiced today when polluted rivers and streams are cleaned and restored. Planning an entire planet may someday become a reality.

Pure research scientists in the **EXOBIOLOGY PROGRAM** search for the origin of life in the universe. They study the evolution and distribution of life. Fossils of microorganisms dating as far back as 3.5 billion years offer clues to the origin of life. Searching for evidence of life on other planets also helps scientists understand the origin of life on Earth. As part of their investigations, they examine the chemical ingredients of materials found in space and on other planets. The chemical processes which formed organic molecules capable of self regeneration are also investigated. After years of study, research scientists hypothesize that primitive life emerged from an "organic soup." This "soup" was brought to a boil by heat energy formed during the process of chemical evolution. Mysteries about the origin of life still remain. Future research is the key which will unlock secrets from billions of years ago.

Suggested college majors for careers in Life Sciences Programs are:

Anatomy	Biophysics	Physiology
Bioengineering	Botany	Psychology
Biochemistry	Chemistry	Zoology
Biology	Geology	
Biomedical Science	Microbiology	

Fluid and Flight Mechanics

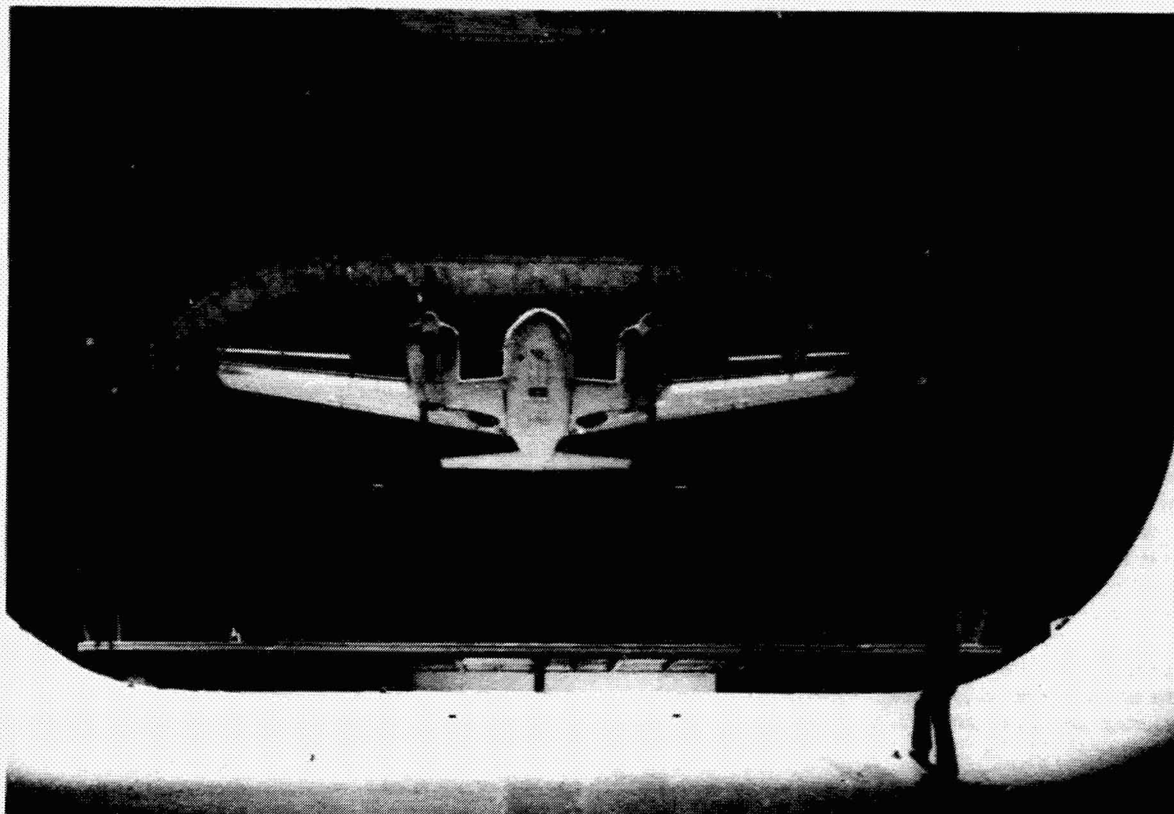
Imagine boarding a commercial aircraft at an airport on the east coast, flying 3,000 miles across the United States and in only a few hours deplaning at a West Coast destination. This scene occurs hundreds of times weekly. It is partially the result of accomplishments of specialists concerned with fluid and flight mechanics. Few passengers are aware of the hours of research required to provide them with safe, comfortable flights. Hundreds of experiments are conducted to determine the most advantageous and efficient methods of providing the necessary lift for an aircraft while minimizing accompanying drag (resistance to movement). Determining the best methods for stabilizing the pitch and roll motions, enhancing the controllability and improving the overall safety of flight requires complex investigations. Such investigations include both testing, which utilizes sophisticated ground and flight facilities, and theoretical analyses which involve the application of computer technology.

Experts in this group study the principles of aerodynamics and gas dynamics. Their research involves exploring the characteristics of flight both within planetary (Earth and other celestial bodies) atmospheres and in outer space. This information is crucial because a different set of laws or aerodynamics applies to flight within an atmosphere of known composition as compared to flight in the void of outer space where there is no atmosphere. Researchers must apply these laws when they develop and evaluate specifications for the design and development of advanced aerospace vehicles and their associated subsystems.

Researchers working in Fluid Mechanics investigate how aircraft and space vehicles are affected by the flow of fluids in different flight regimes (atmosphere and environments). They formulate theories and conduct experiments to study such fluid flow around and through various body shapes. Fluids are a general classification of air, other gases and liquids. Also of interest are the physical, dynamic and fundamental behavioral characteristics of such fluids, which include pressures, forces, energy content and how such characteristics are affected by speed (i.e., subsonic, supersonic or hypersonic flight). Specific topics investigated are boundary layers, flow separation, shock waves, skin friction, heat transfer and real gas dynamics. These studies require a combination of the principles of aerodynamics, fluid mechanics, thermodynamics, heat transfer and mathematics.

This research results in improved design concepts for: general aviation aircraft, subsonic and supersonic transport aircraft, advanced vertical/short take off and landing aircraft, highly maneuverable supersonic aircraft, reentry vehicles and advanced space transportation systems. Recent design concepts which could provide improved flight characteristics of future aircraft include supercritical wings, winglets (vertical extensions of wings at the tip) and laminar flow control. Each concept results in altering the airflow about the wing in such a manner that either the lift is increased, the drag reduced or both, causing the overall efficiency to improve.

Researchers in the area of Flight Mechanics study the force and motion mechanics of vehicles in various flight regimes. The term "motion mechanics" refers to the characteristics describing the motion of vehicles or bodies in flight. Their ultimate laboratory is flight! Identification and development of optimum vehicle designs require the application of knowledge in the fields of aerodynamics, celestial mechanics, propulsion dynamics and guidance



Testing the efficiency of general aviation aircraft

and control.

The study of automated controls and displays is an example of the research conducted in this specialty. Researchers involved in the Terminal Configured Vehicle (TCV) Program seek to define the best interaction between automated control systems and aircraft pilots. One of the outcomes of this program will be to increase pilots' proficiency while reducing their work load. The TCV program involves in-flight experiments conducted in an internally modified 737 jetliner. This airplane contains a variety of advanced electronic equipment, such as landing aids and cockpit displays, navigation and guidance systems and computerized automatic controls. Research pilots are seated in a second cockpit, designed to be a twin of the standard forward cockpit. Pilots fly the aircraft "blind" from this totally enclosed aft cockpit. They rely upon advanced instrumentation and displays. Two pilots in the standard flight deck monitor safety aspects of the flight. The TCV research focuses upon the descent, approach and landing phases of flight. These represent times when most air traffic control problems occur, especially during adverse weather conditions. These studies are projected to result in more efficient use of airport terminals, improved aircraft safety, fuel conservation and reduced delay time for travelers. It is predicted that these studies will lead to the routine operation of aircraft in most weather conditions.

Experts in the Control and Guidance Systems specialty study automated, semi-automated and manual systems which provide control, navigation and guidance for flight vehicles. Small trajectory (the curve which a vehicle follows in flight) errors occurring early in a space flight could produce errors of hundreds of thousands of miles later in the mission, if uncorrected. Control and Guidance System specialists analyze the effects of error on the missions and develop techniques for correcting or eliminating such errors. This specialty requires knowledge of aerodynamics, vehicle dynamics, mechanical systems design and propulsion dynamics.

Educational requirements for work in this group include majors in engineering physics, engineering mechanics, astronautics, aeronautical engineering, mechanical engineering, physics and electrical engineering. Majors in mathematics supplemented by at least 18 hours in some combination of physical sciences or engineering courses are also acceptable.

Materials and Structures

As a spacecraft moves up through the Earth's atmosphere and out of this atmosphere, it combats relentless forces of noise, vibration, erosion and extreme temperature variations. Its structure and materials must be designed, for example, to withstand air pressures equal to forty times the force of a 100-mile-per-hour hurricane. Teams of engineers and scientists research and develop materials and structures that affect the performance of near term and futuristic aircraft, spacecraft and launch vehicles. The selection of optimum structural designs, materials, and fabrication techniques require complex investigations. In order to operate in the Earth's atmosphere, in outer space and in the atmospheres of planets, materials and structures must be designed to resist extreme conditions. Engineers in this group study the effects of supersonic and hypersonic flight as well as atmospheric re-entry conditions on materials and structures. They must determine the effects of these conditions in order to design the most advanced vehicles. One of their goals is to develop materials and structures featuring minimum weight and maximum strength and durability.

Two basic questions challenge structures experts. Is the framework of the vehicle strong enough to withstand loads which will be applied to it? Is the framework stiff enough to avoid excessive deflections and deformations? To answer these questions, engineers design, develop, fabricate, assemble and test structures and their components. They research the responses of structures to loads, temperatures, noise and vibrations during simulation and in-flight tests representing various atmospheric conditions.

Specific problem areas include thermal control, insulation and corrosion protection systems. Friction associated with aerospace vehicles requires special lubrication techniques. Engineers conduct operational and environmental studies in order to discover lubrication peculiar to aerospace problems. Some structures under consideration are: lightweight, membraneous inflatable structures; solar collectors and sails; and paddlewheel satellites.

Work related to research and development of materials for aerospace applications is generally divided into four areas. These areas are Structural Materials, Metals, Polymers and Refractory Materials. Structural Materials engineers research the most effective use of various kinds of materials (metals, plastics, laminates, composites, adhesives and refractory compounds) alone and in combination in aircraft, missile and spacecraft structures. Aerospace Metals experts conduct research to establish properties of metals and alloys. They investigate the failure of metals due to fatigue, fracture, exposure to other materials and other causes. Polymers have various uses in aerospace systems and are used in several forms (plastic structural materials, foams, ablative materials, adhesives and seals). Workers in this area conduct research activities to determine how production, handling, fabrication and quality assurance methods affect the properties of polymers when they are exposed to aerospace environments such as high vacuum, elevated and cryogenic temperatures. Ceramic engineers study refractory compounds such as ceramics, cermets, carbides, borides and nitrides.

Researchers using electronmicroscopes, various radiation-generating devices and microwave techniques investigate the molecular, atomic and subatomic structures of materials. They study the reactions of these structures to oxidation, temperature, pressure, heating and cooling.

College majors in the following disciplines will prepare candidates for careers in this group:

aeronautical engineering	physics
ceramics	materials
ceramic engineering	mechanical engineering
chemistry	metallurgical engineering
civil engineering	metallurgy
engineering physics	

Knowledge of solid state physics or high temperature chemistry and pertinent aspects of metallurgy and mathematical physics is useful.

Propulsion Systems

Since ancient times, people have been fascinated by flight. For centuries they studied the flight of birds and attempted unsuccessfully to copy them. Finally, the first powered and sustained flight was achieved. This success depended partially on the development of an engine system. The system proved to be strong enough to propel the plane and the pilot into the air and keep them from crashing back to Earth. Advances in aircraft, rockets, missiles and spacecraft were achieved only after engine systems of increased reliability and power were designed. The future of advanced aerospace vehicles will depend upon technological breakthroughs in propulsion systems.

Propulsion involves the analysis of matter as it flows through various devices. These devices are combustion chambers, nozzles, diffusers and turbines of various jet and rocket motors. The goals for aircraft propulsion during the early years of the jet age were "higher, faster and further." Today's goals for aircraft propulsion systems are fuel conservation, quieter flight, and cleaner exhaust. The search for aircraft engine systems which conserve fuel has become an international priority. Some members of NASA's Aircraft Energy Efficiency Program are studying engines which have the potential for increasing fuel efficiency. These specialists have determined that one method of reducing fuel consumption is by using advanced turbine propeller engines (turbo prop). It is expected that the utilization of these engines will result in fuel savings of as much as 20-30 percent over that of jet engines. Future propulsion specialists will study engines which use alternative fuels such as hydrogen. They will design systems for supersonic and hypersonic aircraft, as well.

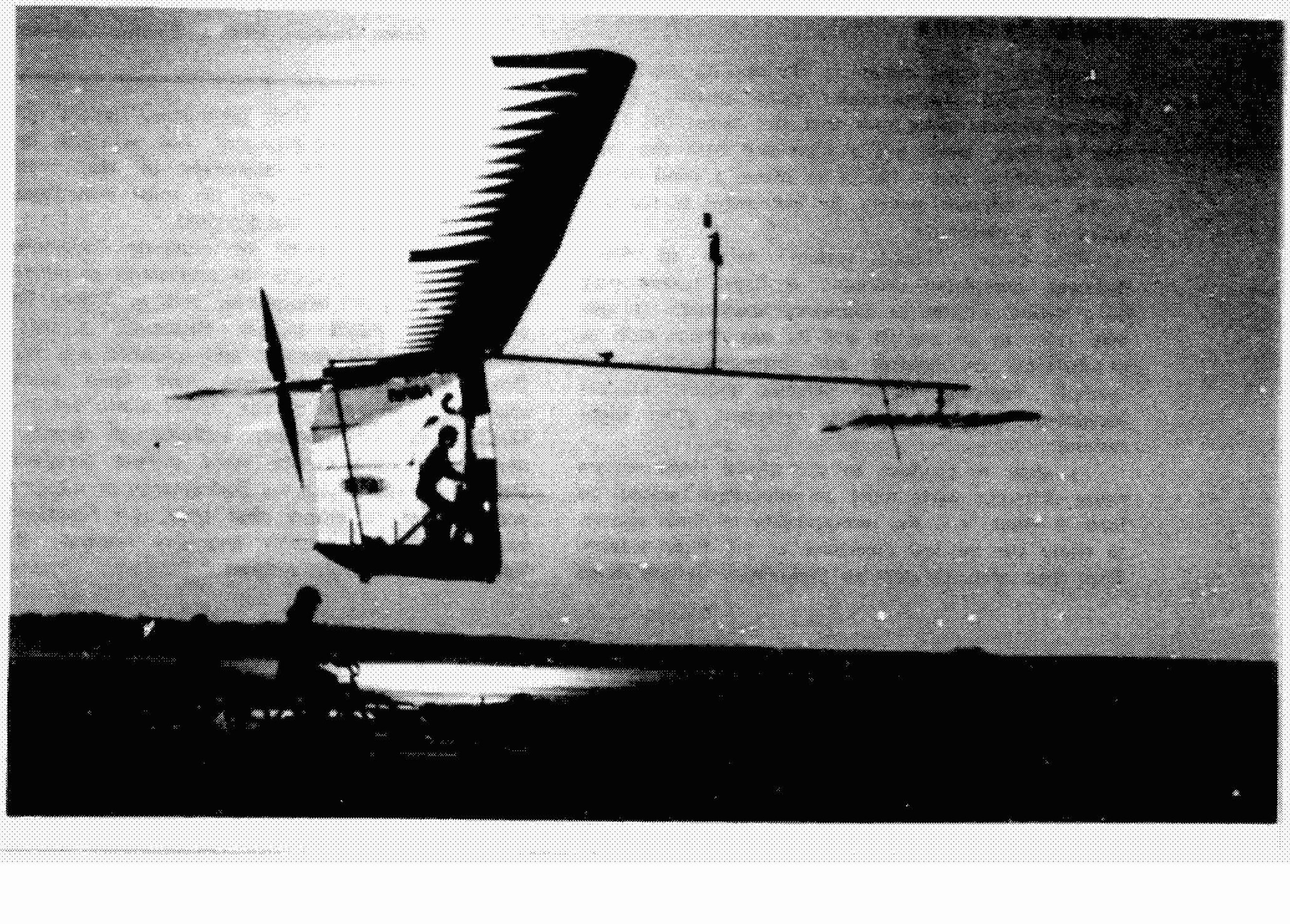
The research and development efforts in space propulsion systems are directed at reducing the costs of space transportation by making the vehicles reusable and at developing systems which will allow deep space exploration. Two types of reusable vehicles are needed: a transportation system to go from Earth to low orbit and a vehicle to transfer payloads between orbits. Research activities in chemical rocket propulsion systems are advancing the technology required to develop rocket systems for future space transportation vehicles. Also included is research on air-breathing engines for launch vehicles.

Research in electric, solar and nuclear propulsion systems is directed toward increasing the durability and efficiency of existing systems as well as exploring new concepts. At this time, electric rockets powered by solar energy are launched into orbital flight to test their endurance. Thruster systems for auxiliary propulsions for altitude control and station-keeping and for prime propulsion for deep space flight are being designed and developed.

Scientists, engineers and technicians research, design, develop, test and evaluate aerospace propulsion systems with special emphasis on the following issues:

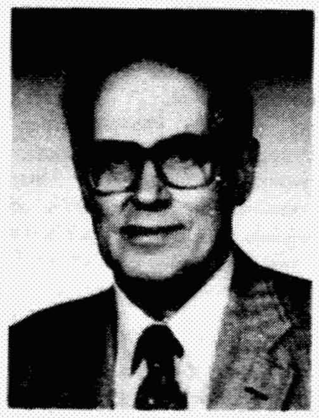
- Fuel/Air mixing;
- Induction and exhaust systems;
- Heat transfer and aerodynamic heating analysis;
- Engine performance for advanced aircraft systems and spacecraft;
- Design of nozzles for advanced aircraft and missile systems;
- Direct energy conversion devices such as solar cells, fuel cells, thermionic converters, batteries and thermoelectric generators which provide electrical power for space vehicles;

Solar power propels gossamer aircraft



- Stage separation devices, ignitors and other components for altitude and velocity control, gas generation and auxiliary power;
- Prototype systems to advance technology;
- Solar, chemical, and nuclear energy sources associated with electrical power generation systems;
- Generators which convert heat into electrical energy;
- Problems associated with nuclear shielding, radiation and reactor core;
- High temperature materials;
- Bearings, lubricants and seals;
- Chemical kinetics of reacting flow;
- Computational methods for mixing and reacting flows.

Educational requirements for work in this area include college majors in chemical engineering, chemistry, nuclear engineering, electrical engineering, engineering physics, engineering mechanics, physics, aeronautical engineering, mechanical engineering or astronautics. A major in mathematics supplemented by at least 18 semester hours in physics, thermodynamics, or chemistry is a suggested alternative.



"At this point in my life the aerospace industry means work at the frontiers of science and technology, while earning a pretty fair living. For students looking to the future, I believe they will find in the aeronautical field both bigger and smaller, as well as faster airplanes made of advanced materials such as reinforced composites. Space transportation and operations in space will become broadly available, allowing for much better communications, weather prediction, the use of solar power and geological exploration, to name a few. In the sciences, looking outward, we shall be able to see the sky in many frequencies, without the blinding blanket of the atmosphere. We will explore the solar system, the origin of the Universe, and the origin of life."

Leo Steg, Ph.D.
Chief Scientist,
Space Division, General Electric Company

Flight Systems

Building a flight system is like putting together a gigantic and complicated jigsaw puzzle. Flight Systems experts make sure that the pieces fit! They take an idea, work out a plan and turn the plan into something real — like a jet plane, a wind tunnel model, an infrared camera, an instrument to measure ozone or a parachute.

The term "flight system" refers to many different, completed products. A flight system may be a probe, orbiter or planetary spacecraft. It also may refer to an aircraft and its subsystems such as propulsion or control and instrumentation, for example. Payloads, launch vehicles, ground support equipment and test facilities represent other flight systems.

In order to produce an operational flight system many different parts must be integrated (united) to form a whole. It is the responsibility of these experts to study the mission objectives of the flight system. Then they originate detailed preliminary designs based upon the objectives. Their preliminary designs reflect the size, shape, weight, cost and schedule limits appropriate to the objectives of the mission. Modifications are made and the most advantageous, final blueprint designs are accepted.

With the assistance of computer technology, engineers expose concepts for subsystems to hundreds of tests both in laboratories and in flight. These subsystems might include structures, propulsion, electrical, thermal controls and guidance and fluids. Once optimum subsystems have been selected, engineers plan and direct their manufacturing. Quality assurance experts evaluate all phases of development and certify every minute component. Reliability experts test the performance of subsystems and systems to ensure that they will function as expected. Flight systems engineers integrate these subsystems into flight systems.

The development of flight systems requires that engineers conduct indepth investigations in order to:

- Evaluate vibration capabilities;
- Study fluid and heat transfer capabilities;
- Evaluate the effects of aerodynamic characteristics and thermal environments on subsystems;
- Analyze stability;
- Evaluate boundary layer characteristics and design concepts for providing boundary layer suction;
- Predict the noise generated by jet flow, fans and resonance vibration of structures;
- Design concepts for noise attenuation (reduction) with absorbers, resonators and deflectors;
- Analyze aircraft flutter, fin flutter and wing divergence;
- Analyze loads, stresses and deflections of structures due to atmospheric disturbances, maneuvers and landings, for example.

College majors that relate to this area are aeronautical engineering, electrical and electronic engineering, engineering physics, mechanical engineering, physics, engineering mechanics, mathematics and computer science. It is desirable that mathematics or computer science majors complete supplementary courses in basic engineering. Some of these courses include dynamics, thermodynamics and statics.

Measurement and Instrumentation

Winking, blinking dials and gauges "talk" to specialists who measure and record their messages using electrical, optical or mechanical instruments. Each wink or blink symbolizes data which will be analyzed and applied to further research. Sensor development, data acquisition and control equipment, calibration techniques, meteorological measurements, radars, television and electro-optical systems are representative of the technological instrumentation areas supporting aeronautical and space research.

All aspects of the aerospace program rely upon the capabilities of electrical, electronics, mechanical and optical instrumentation systems. Specialists in this group design, develop, test, evaluate and utilize such instruments and systems to measure and record data associated with aerospace research. The calibration, maintenance and standards for certifying the accuracy of these instruments are responsibilities of these workers also.

Specialists in this group measure and record gas composition, velocity, pressure, density, temperature, thermal radiation, force, material strain, displacement, acceleration, direction, noise, etc. This information is gathered from ground research facilities such as wind tunnels, from experiments conducted in atmospheric environments and from orbiting satellites and space probes. The application of these instrument systems during flight simulations in ground facilities, for example, provide measurements critical to the development of future flight vehicles. Tiny, threadlike sensors are designed to detect minute changes in material exposed to simulated aerodynamic conditions. Electrical signals from these sensors are relayed through mazes of wires through specially designed "black boxes" to computers and data systems waiting to record and analyze the data.

Advanced measurement systems use lasers and remote detection devices designed by these experts to gather data associated with space, atmospheric and marine environments. Theories about these environments are verified or modified as a result of laboratory and field measurements taken in simulation facilities, from balloon and aircraft flights and from orbiting spacecraft or space probes.

Some scientists, engineers and technicians develop systems which detect environmental data and provide operational inputs and controls of aerospace vehicles. Unique and standard telemetry systems which transmit data from aerospace vehicles are developed and used by some of these specialists. For instance as part of the manned space program, a tiny radio transmitter was designed to be swallowed by an astronaut. This nondigestible capsule contained circuits which measured and transmitted the astronaut's core temperatures during missions in space. It was eliminated from the body through wastes. This tiny transmitter -- no larger than a vitamin -- represents one by-product of miniaturization technology. In addition, during manned space flights and during many unmanned probe missions, hundreds of communication, data transmission and tracking systems are in radio contact around the clock with both the space vehicle or satellite and a world wide network of ground stations.

College majors necessary for preparation for these specialties are: electronics or electrical engineering, physics, mechanical engineering or computer science. At least two of the following courses should be included in the course work: solid-state physics, materials, optics, statics and dynamics, electricity, electronics, electron optics, kinetic theory of gases, heat transfer, electromagnetic propagation or radiation, semiconductors, vibration or high-vacuum theory.

Data Systems

Which came first - the computer or aerospace research and development? For certain, the accomplishments in aerospace would have been nearly impossible without the assistance of super computers. Likewise, aerospace research has provided a powerful stimulus to the advancement of computer technology. Super computers routinely perform a hundred million arithmetic operations per second. In the future, billions of operations per second will be necessary to support analytical computation, simulation studies, and data reduction tasks.

This relationship between computers and aeronautical and space research is crucial to the solution of a wide spectrum of national and international aerospace concerns. People studying problems in aerodynamics, structures, flight safety, the air transportation system and the exploitation of space for the benefit of mankind require the assistance of computers. Advanced scientific computing, mathematical modeling, research data processing and flight simulation capabilities are tools indispensable to technological advancement.

Analytical computation involves specialists proposing theories, formulating models of the theories and then translating these mathematical models into computer programs (software) so they can be analyzed. In this way, theories are tested quickly, safely, at less cost and with reduced energy consumption. The applicable hardware (a wind tunnel model, for example) is constructed only after the theory has been proven feasible by computer analysis. An understanding of computer theory as well as aerospace research and development concepts is required of these specialists.

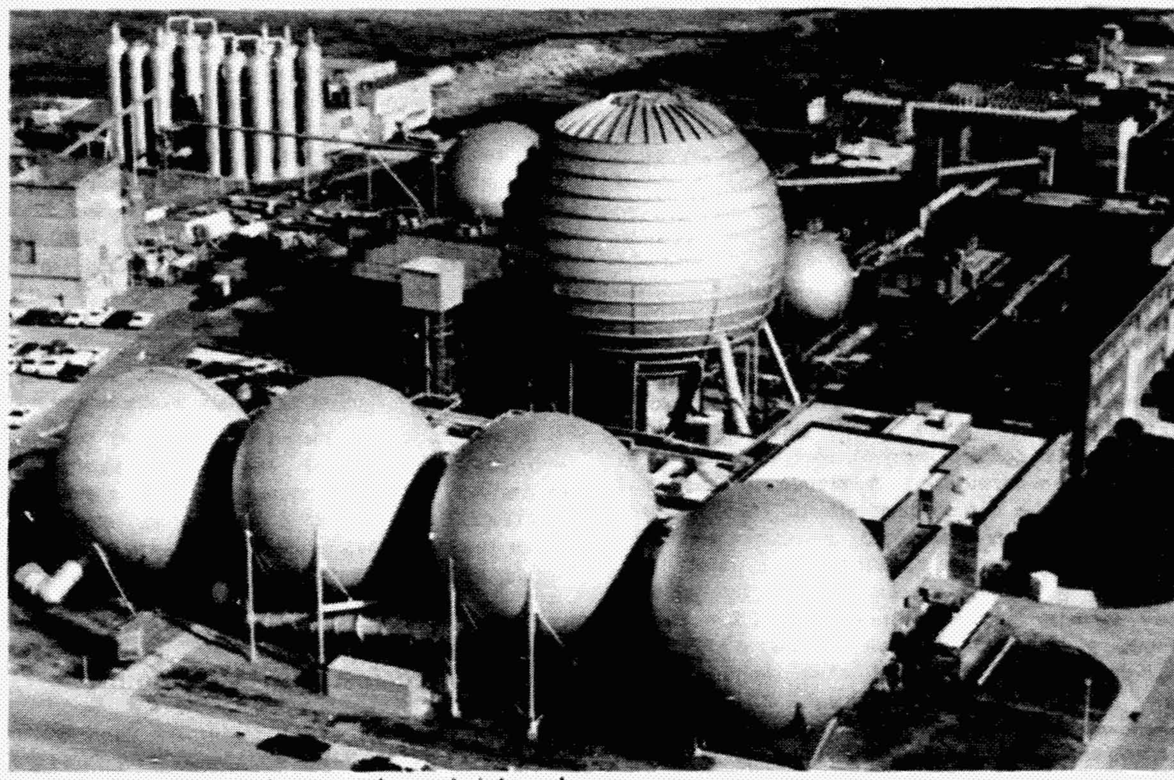
The design of advanced aircraft and other aerospace vehicle systems is studied by scientists and engineers using computer technology. The drawing board is replaced by the computer terminal and keyboard. Numerical information (mathematical models) is supplied by a systems design team to a computer. The computer analyzes the data and translates it into a vehicle configuration. A three dimensional vehicle design appears on a terminal screen similar to a television screen. This design may appear on the screen in stationary form or in moving form. It also may be color coded for greater detail. These features are controlled and determined by the data supplied to the computer. Validated mathematical models for subsystems such as propulsion, controls or structures can be applied to the configuration by supplying appropriate numerical data to the computer. The performance of subsystems in relation to the configuration can be predicted by computer analysis (analytical computation). Months of design work can be completed more rapidly by analytical computation.

Analytical computation helps scientists and engineers avoid the risks of possible exposure to chemical explosions or to radioactivity. Computer analyses can be used to study and predict chemical or nuclear reactions, for example.

Many training tasks which were conducted in the sky now are simulated on the ground. Specialists now solve engineering problems and train pilots and astronauts through the application of flight simulators. Flight simulators in conjunction with wind tunnels and flight testing add to the development of new concepts for aerospace vehicles.

The sensations associated with flight are provided by computer controlled displays in flight simulators. Mathematical models of a vehicle's aerodynamics, controls, propulsion systems, structures, avionics and environmental characteristics are translated by computers into realistic flight conditions. The pilot is given the illusion of actual flight, without ever leaving the test facility. The Differential Maneuvering Simulator, one example of a flight simulator, is constructed of two hemispheres, each containing realistic cockpit environments. Projected on the inside of each sphere is a realistic simulation of the sky, the horizon and the image of a plane controlled by a pilot in the adjoining sphere. Kinesthetic cues such as a G-suit pressurization system and a G-seat provide realistic "seat of the pants" sensations associated with acceleration and so forth. A computer continuously monitors the pilots' actions, solves physical equations to determine the vehicles' responses and changes displays constantly to present this information to the pilots. In this way computer-controlled simulations expand knowledge of the performance capabilities of new aircraft designs. In addition, military aircraft can be assessed, traffic-control systems can be tested and collision avoidance techniques can be analyzed. Pilot skill and judgment are revealed also.

The empirical test method is still the only way known to analyze many of the technological problems of the present and the future. Data involved in aeronautical and space exploration programs are received and processed on data recording, retrieval and computing equipment



Basic tools of aerospace research--vacuum spheres and wind tunnels

(hardware). Specialists apply mathematical and computer theory to data generated from such sources as space vehicles, orbiting satellites, planetary probes, experimental aircraft and simulation facilities. Research data reduction also plays a key role in experimental programs associated with environmental studies. Data are transmitted from investigations of noise, Earth resources, ocean state, water pollutants and systems for measuring the constituents of the atmosphere. Problems are solved by people who apply mathematics to data analysis and reduction processes. The data reduction process includes all the operations from the measurement of the physical quantities to the analysis of the computed results. Often, appropriate data reduction procedures must be developed and then applied to the data resulting from these experimental investigations.

Computer operation also involves people who assess performance to assure the efficient use of the hardware and software. Related workers install, modify, and maintain the equipment.

The key to the effective use of the computer system is **PEOPLE**. People provide the expertise to assure the quality of present and future capabilities.

Educational requirements are majors in computer science or mathematics, supplemented by at least 12 semester hours in some combination of physical science or engineering. Other suggested majors are physical science or engineering, supplemented by at least 6 semester hours of mathematics beyond calculus. Courses related to data systems or data systems equipment are advantageous.

Experimental Facilities, Equipment, and Operations

Multiplying man's muscles -- mental and physical -- with facilities and equipment promotes advancements in aerospace research and technology. Vacuum spheres, vibration and shock machines, flight trainers and simulators, fabrication shops and laser photography equipment typify equipment and facilities conceived and developed to meet the unique requirements of aeronautical and space research programs.

Engineers and technicians in this group are responsible for the design, planning, construction and operation of a variety of wind tunnel facilities. For example, the National Transonic Facility at NASA's

Langley Research Center, Hampton, Virginia, has been designed and constructed with the capability of simulating actual flight conditions requiring cryogenic temperatures of about -320^{o} F. This wind tunnel provides more simulation capability than ever before possible. A wide range of other types of wind tunnels simulating flight conditions at subsonic, supersonic and hypersonic speeds illustrates the creativity of these aerospace workers.

Engineers, especially mechanical engineers, and support personnel in this group consult with scientists in order to develop specially designed experimental equipment, tools and models. For instance, solar collector systems, wind mills and other energy conversion and generation devices have become realities due to their efforts. These men and women also apply advanced aerospace technology towards reducing the consumption of fossil fuels. Advanced automotive systems powered by hydrogen may someday become routinely operational by the public as a result of their current studies. Test facilities designed for aircraft crash safety programs and for landing gear experiments represent other examples of their accomplishments. Oftentimes experiments require the capabilities of hydraulic systems to move objects faster, quicker and with reduced effort to men and women. These systems are realities as a result of the work of engineers in this specialty.

Other engineers design and develop systems and equipment for changing or controlling the physical state of gases and liquids used in experimental research. Cryogenic liquids and gases as well as electricity, air, steam and water are stored and distributed to test facilities by these workers. Electrical and nuclear specialists monitoring appropriate equipment, components and systems create specialized environments in test facilities. The accomplishments of engineers and technicians in this specialty demonstrate their knowledge of experimental programs as well as an understanding of the operational characteristics of the facilities and equipment.

Also included in this group are specialists who work with test pilots to evaluate the performance of aircraft and space vehicles during simulated ground missions. They provide information required before actual flights are scheduled. They observe phenomena associated with aircraft such as stability and control characteristics, pilot presentation needs and escape systems. They also evaluate the tolerance and efficiency of pilots exposed to various conditions.

Others plan, develop and coordinate launch operations for aerospace flight vehicles. Their duties include: planning flight objectives; developing procedures for preflight assembly and checkout of the space vehicles; formulating a launch and flight plan which includes count down procedures; and launching of the space vehicle and preparing reports of the operation. Others coordinate activities associated with manned and unmanned flight missions. Their duties may include the overall planning of flight missions or just one phase such as recovery operations, flight control or system monitoring.

Suggested college majors for work in this area include: aeronautical engineering, architecture, ceramics, chemical engineering, civil engineering, electrical or electronic engineering, electronics, engineering mechanics, engineering physics, metallurgy, nuclear engineering, physics and structural engineering.

Administration and Management

Scientific and engineering fields are supported by a variety of administrative and management functions. Individuals in this group are found in personnel, staffing and training, public affairs, financial and budget management, business data systems, procurement and contracting, technology utilization, management support and program development.

This group includes jobs associated with the management of aerospace projects and programs. Managers make decisions regarding significant aspects of their programs. Their decisions determine such issues as: funding estimates on projects, research necessary to complete projects, production of test equipment and negotiations for services provided by associated companies. They must coordinate policy, manpower, scheduling, resources and technology.

Responsibilities associated with managing projects and programs demand a combination of technical competence, good interpersonal communication skills and self-control. Managers must seek and understand technical information regarding their projects while influencing and supervising others. They must possess the capacity to withstand the pressures associated with responsibility. This often requires self discipline in terms of controlling emotions during periods of stress. Managers must be capable of delegating responsibilities to others and monitoring their progress. Flexibility and adaptability seem to be two key personality characteristics of successful managers.

Other people in this group manage spacecraft tracking and telemetry stations located throughout the United States and in overseas locations. These managers supervise engineers and technical staff contracted to install, modify, maintain and operate the tracking, telemetry and communications equipment and systems.

This group also includes the dissemination of information about technology developed in the aerospace industry for the benefit of all mankind. Medicine, agriculture, musical instruments, athletic equipment and construction are just a few of the areas that have benefited from aerospace "spinoffs."

Aerospace technology is partially responsible for people being able to enjoy the convenience of preparing freeze-dried foods. Meals for spacecraft crews must be tasty, nutritionally balanced, light in weight, compactly packaged, storable without refrigeration and easy to prepare. These requirements spawned several types of space meal systems. Among them are various compressed and freeze-dried foods. A variety of freeze-dried foods, reconstituted by adding water, and "retort pouch" meals which require no reconstitution, only heating, are prepared by many Americans. The retort pouch is a flexible package that combines the advantages of a metal can with those of the boil-in-bag.

The public benefits from "spinoffs" from aerospace technology such as astronaut type meals as a result of the work of some individuals in this group. These people evaluate advances in aerospace science and technology to determine their maximum applicability to use by industry, government and the public. They conduct tests to discover the practicality and feasibility of products resulting from aerospace research and development. Identifying new ways to employ technology and making this technology more readily available to prospective users increases the return on the national aerospace investment.

Appropriate college majors for positions in this group are:

- Accounting
- Behavioral Science
- Business Management
- Computer Science
- Economics
- Finance
- Journalism
- Physical Sciences
- Political Science
- Psychology
- Public Administration

Tiny models create sonic booms for study

The following chart* matches occupational characteristics and requirements with occupations typical of the aerospace industry. The table was designed to assist the reader in comparing personal interests, capacities, abilities, and educational qualifications with characteristics usually associated with occupations in the aerospace industry.

The reader will find the chart helpful in three ways. First, it can be read to discover the general characterisitcs of an aerospace occupation of particular interest to the reader. Second, if the reader has not decided upon a particular job, it can be read to discover the characteristics of several different occupations in the general field of aerospace. Third, if the reader is aware of personal skills and talents and is unaware of the characteristics of aerospace occupations, the table can be read as an introduction to representative occupations, with the reader matching individual talents with appropriate occupations.

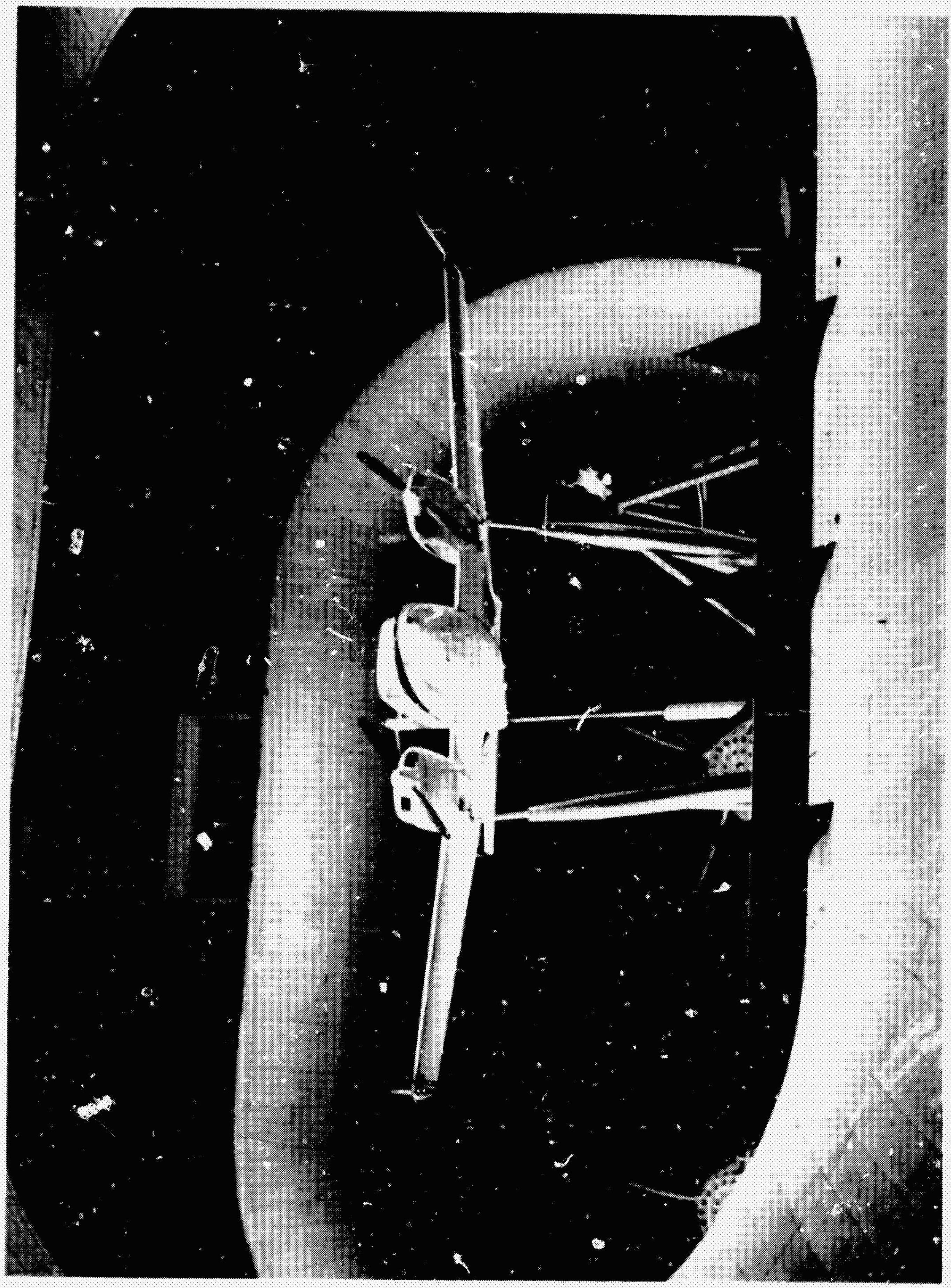
The job characteristics presented describe typical jobs. Therefore, the reader is encouraged to explore further by reading more about the occupation and by discussing it with the school counselor and with someone employed in that job.

*Adapted from Kathy Wilson, "Matching Personal and Job Characteristics," **Occupational Outlook Quarterly** (Fall 1978), 2–13.

	High School 1	Tech. sch/Apprenticeship trng. 2	Junior college 3	College 4	Problem-solving ability 5	Uses tools, machinery 6	Instructs others 7	Repetitious work 8	Hazardous 9	Outdoors 10	Physical stamina 11	Generally confined 12	Precision 13	Works with detail 14	Frequent public contact 15	Part-time 16	Able to see results 17	Creativity 18	Influences others 19	Competition on the job 20	Works as part of a team 21	Jobs widely scattered 22	Initiative 23
OCCUPATIONS IN TRANSPORTATION ACTIVITIES																							
Air transportation occupations																							
Air traffic controllers	●	T			●		●					●	●	●							●	●	●
Airplane mechanics	●	T			●	●			●	●	●		●				●				●	●	
Airplane pilots	●	T			●	●						●	●								●	●	●
Flight Attendants	●						●	●			●				●						●		
Reservation, ticket and passenger agents	●				●		●	●				●		●	●						●	●	
OFFICE OCCUPATIONS																							
Computer and related occupations																							
Computer operating personnel	●	T			●	●		●				●	●	●							●	●	
Programmers		(1)	(1)	(1)	●							●	●	●							●	●	
Systems Analysts					●		●					●	●	●									●
SCIENTIFIC AND TECHNICAL OCCUPATIONS																							
Engineers																							
Aerospace				●	●								●	●			●	●			●		●
Agricultural				●	●								●	●			●	●			●	●	●
Biomedical				●	●								●	●			●	●			●	●	●
Ceramic				●	●								●	●			●	●			●	●	●
Chemical				●	●								●	●			●	●			●	●	●
Civil				●	●								●	●			●	●			●	●	●
Electrical				●	●								●	●			●	●			●	●	●
Industrial				●	●								●	●			●	●			●	●	●
Mechanical				●	●								●	●			●	●			●	●	●
Metallurgical				●	●								●	●			●	●			●	●	●
Mining				●	●								●	●			●	●			●	●	●
Petroleum				●	●								●	●			●	●			●		●
ENVIRONMENTAL SCIENTISTS																							
Geologists				●	●	●				●												●	●
Geophysicists				●	●	●			●	●			●	●				●				●	●
Meteorologists				●	●	●			●				●	●				●				●	●
Oceanographers				●	●	●			●	●			●	●				●			●		●
LIFE SCIENCE OCCUPATIONS																							
Biochemists				●	●	●							●	●			●					●	●
Life scientists				●	●	●							●	●			●					●	●
Soil scientists				●	●	●							●	●								●	●
MATHEMATICS OCCUPATIONS																							
Mathematicians				●	●								●	●				●				●	●
Statisticians				●	●								●	●				●				●	●
PHYSICAL SCIENTISTS																							
Astronomers				●	●	●							●	●				●				●	●
Chemists				●	●	●							●	●				●				●	●
Food scientists				●	●	●							●	●				●				●	●
Physicists				●	●	●							●	●				●				●	●
OTHER SCIENTIFIC AND TECHNICAL OCCUPATIONS																							
Broadcast technicians	●	T			●	●						●	●	●								●	
Drafters	●	T				●		●				●	●	●			●				●	●	
Engineering and science technicians	●	T			●	●							●	●							●	●	
Surveyors	●	T				●			●	●			●	●							●	●	

(1) Education requirements vary by industry or employer. See Occupational Outlook Handbook for details.

T Represents Technical School.



Chapter Two

Aerospace . . . The Team Approach

Scientists, engineers, technologists and technicians challenge issues relating to aerospace science and technology by combining their skill, talent and knowledge. They work together as a team to pursue one common goal -- technological progress for the benefit of mankind. Their achievements in aerospace research and development generate new industries and new products which create life styles enjoyed by people living in technologically advanced societies.

This team has accomplished much in the past. Their achievements range from developing deep-diving vessels for oceanographic research to exploring the surface of the planet Mars. Much remains to be accomplished in the future, which is just as exciting and challenging as the past. Through a team effort they will strive to solve complex, world-wide problems such as feeding the world's population; developing additional energy and fuel sources; answering the need for more and better transportation and communication systems; cleaning up the environment; and improving health care.

Working as a team maximizes the potential of each specialist. The **Scientist** pursues knowledge through theoretical and experimental research. He or she probes the unknown seeking answers to the question "why." The **Engineer** applies the knowledge generated by the scientist and develops tangible products and new technologies as he or she answers the question "how." He or she consumes or uses knowledge to create a new machine, device or process which will serve a specific purpose or perform a specific task. At times, an engineer may encounter unexpected performances or deviations which must be explored and understood. He or she may discover improvements in materials, fabrication or production processes. At these times, an engineer's work resembles that of a researcher. Through engineering research, advances in knowledge are applied to design and development programs.

The **Technologist** and the **Technician** work closely with the scientist and the engineer and serve as a link between them and skilled workers. They demonstrate some knowledge of scientific and engineering theories and methods. Their practice-oriented skills distinguish them from scientists and engineers who have obtained more academic training. The **Technologist** applies knowledge of scientific and engineering principles to the solution of technical problems. He or she also organizes people, materials and equipment assigned to a project. The **Technician** assists the other team members by combining a variety of skills with practical as well as theoretical knowledge. Technical plans formulated by the scientist or engineer are carried out by the technician.

Worker Traits

An individual's own special interests, skills and abilities ultimately will determine which technical role he or she is suited best to pursue. The following characteristics are typical traits of the scientists, engineers, technologists and technicians working in the aerospace industry. If these characteristics seem to be present after careful self study, a career in aerospace science and technology may be rewarding for the student.

- Demonstrated high degree of general intellectual aptitude -- usually top ten percent of the population for scientists and engineers.
- Ability to understand and apply advanced mathematical and scientific concepts.

- Curiosity about why and how things work as they do.
- Ability to read, interpret and apply technical formulas, scientific equations, tables and graphs dealing with mathematics or science.
- Ability to work with abstract variables (ideas, concepts, formulas or theories) as well as with concrete variables (instruments and equipment).
- Ability to mentally picture images in three dimensions of fixed or moving objects which are presented in blueprints or drawings.
- Ability to convert mental images into tangible products using tools, instruments, computers, devices or other equipment.
- Ability to use hands, fingers and eyes together in order to operate test equipment or use delicate instruments.
- Willingness to challenge problems analytically and patiently until they are resolved satisfactorily -- define problems, collect data, establish facts and reach valid conclusions.
- Ability to communicate clearly with others and cooperate with others.
- Commitment to several years of academic work beyond high school graduation.

Advantageous personality traits for aerospace team members include: ingenuity, resourcefulness, initiative, insightfulness, powers of concentration, patience, perseverance, tolerance of ambiguity and demonstration of sound judgment and a sense of responsibility. These individuals enjoy the challenge of mastering problems and improving current systems and methods. In general, they enjoy recognition for their accomplishments.

Clues for High School Students

Students who respond positively to the following questions and who enjoy them may have or can develop characteristics mentioned above.

- Do you like mathematics and science classes? Do you earn above average grades in these courses?
- Have you participated in a research project involving math or science?
- Have you belonged to a science or math club? Have you entered a science project into a science fair?
- Have you owned a microscope, telescope or chemistry set? Do you enjoy experimenting with equipment like this?
- Do you like to read scientific, mechanical or automotive magazines? Can you understand the language and symbols used in these magazines?
- Have you built a model airplane or model car? Can you read and follow directions provided in model building kits? Can you picture the finished product as you read the directions?
- Do you like to tinker with electrical or electronic gadgets and equipment such as stereos?
- Have you taken courses in mechanical drawing? If so, have you enjoyed them and have you earned above average grades in these courses?
- Do you like machines and enjoy watching the inner workings of a complicated machine or engine?
- Do you enjoy collecting things like rocks, coins or models? Do you like to organize things or people?
- Have you been elected to an office of leadership in a school, church or social club?

Worker Functions

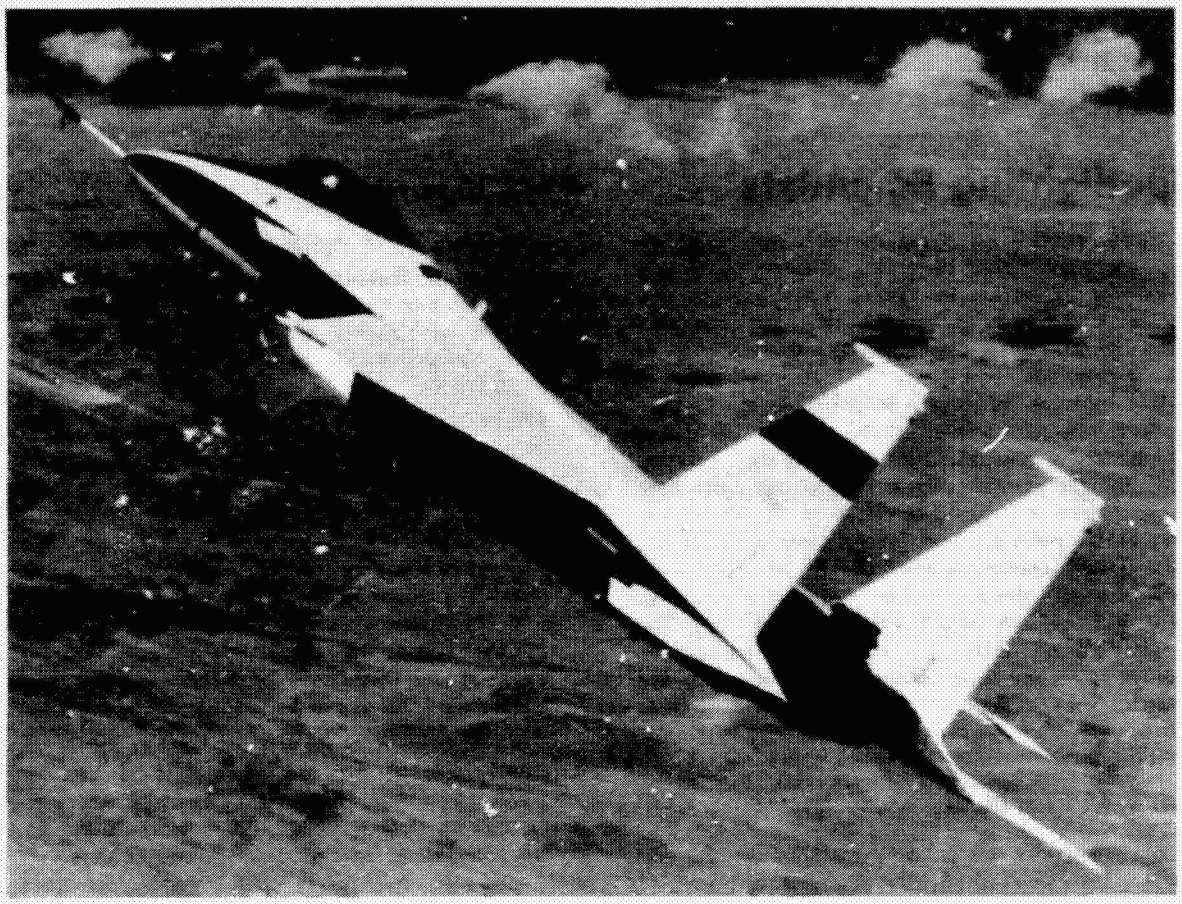
Members of the aerospace team perform work activities dealing primarily with data and things of a scientific and technical nature. The most complex functions associated with data and things are:

DATA	THINGS
Synthesizing	Setting-Up
Coordinating	Precision-Working
Analyzing	

These occupations also require individuals who express themselves well both in oral and written communication.

Work Settings

Members of the aerospace team work in a variety



At work aloft . . . F-15 Eagle

of settings, according to the job assignment. Most aerospace scientists, engineers, technologists and technicians work for aircraft and aerospace equipment manufacturers. Others work for the Federal Government (especially the National Aeronautics and Space Administration, Federal Aviation Administration and the Department of Defense). Some work for commercial airlines, consulting firms and colleges and universities. They work both indoors and outdoors. Their work is sedentary which involves sitting and some walking and standing. Objects lifted or carried are usually light in weight. The senses of sight, hearing, and touch are emphasized.

Preparation and Training

Formal education, training programs, and/or work experiences beyond the high school level offer competencies and credentials required to enter and advance in these occupations.

Related High School Courses

The following high school courses are helpful in preparing for these occupations:

- Algebra
- Geometry
- Advanced Mathematics
- Chemistry
- Earth Science
- Physics
- Composition, Literature, Grammar
- Mechanical Drawing and Pre-Engineering Drawing
- Industrial Arts Courses
- Any courses required to enter colleges, universities, technical programs or vocational training programs.

Spotlighting Scientists ...

Ninety percent of all the scientists who have ever lived are alive today! Scientists observe, study and experiment in order to expand knowledge of the physical world and of nature's laws and materials. Their interests are directed generally towards theories and abstractions and less towards practical and physical qualities of issues. Scientists engage in pure or basic research, applied study and research or a combination of the two approaches. In the narrowest sense of the term, scientists who conduct pure research have no particular goals in mind at the onset of the research. Their experiments primarily are designed to generate knowledge for its own sake. They develop theories which explain phenomena. Their theories are based on discoveries and the organization of facts. Universities or foundations employ most scientists who are engaged in pure research. They develop and apply scientific methods appropriate to resolving particular issues under investigation.

Work Performed

Work activities are based upon skills, abilities and interests mentioned previously and depend upon the aerospace assignment. Some activities might include studies of:

- Earth's atmosphere and its influences on mankind.
- The stars and planets and their relationship to Earth.
- Flights into and out of the Earth's atmosphere.
- Materials and products associated with aerospace vehicles.
- The properties and applications of energy sources.
- The effects of space travel on plants, animals and humans.
- The effects of noise on the design and operation of aerospace vehicles.
- Alternative fuels for more energy efficient propulsion systems.
- New applications of mathematical concepts.

Work Settings

Scientists work in several aerospace settings:

Industrial Research and Development: New products and processes discovered by scientists working in industry are crucial to the research and development programs of aerospace organizations.

Private and Government Laboratories: New theories generated from pure scientific research broaden the state of the science while applied scientists develop or extend theories to explain specific phenomena.

Academic Research: Some scientists choose to teach in colleges or universities where the purest form of research thrives. They advance the state of the science by conducting research, sharing their findings with potential future scientists and modeling scientific principles through their teaching.

Aerospace scientists may be required to relocate or to travel to observe scientific phenomena whenever or wherever they occur. Their work may be conducted inside laboratory facilities, offices or classrooms or outside in the "field." Scientists engaged in aerospace research and development may be expected to work irregular hours and to meet research deadlines.

Studies of permanently employed scientists in the United States showed that about 50 percent work in schools or universities, about 20 percent are employed by industries, 8 percent work for the Federal Government, 8 percent work in a variety of miscellaneous pursuits and 14 percent have switched from one category to another.

Preparation and Training

Training necessary to enter scientific fields requires a bachelor's degree with a major in mathematics or another specific science area. A master's degree is needed for most research work or college teaching, and a doctoral degree and advanced studies are required usually in order to pursue pure or basic research. Scientific knowledge and skills must be updated regularly by attending seminars, completing advanced courses, and by reading professional journals.

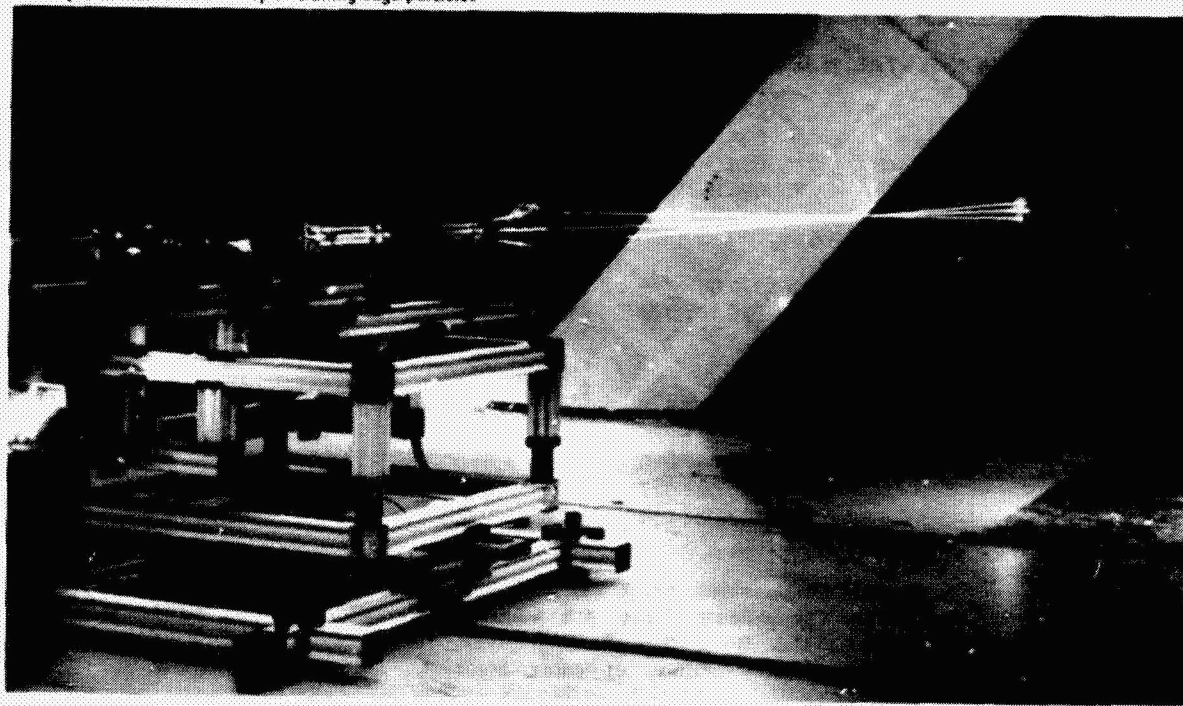
"The onversion and storage of energy is of immense importance to the space program. Energy used by spacecraft must either be transported there as chemical or nuclear energy or as radiant energy. Radiant energy is particularly important because the transport medium is the intervening space.

Development of new energy conversion systems requires a joint effort among many specialists in physics, chemistry, and engineering. As a theoretical physicist, it is my job to understand the basic mechanisms by which energy is absorbed and transferred by atoms and molecules and to develop mathematical equations describing how those basic processes can be used in an energy conversion device. My first such study was to investigate the mechanisms for conversion of nuclear energy to excited gases followed by conversion to a high power laser beam. Laser beams are particularly useful for transmission of power through space.

We now study the absorption of sunlight by different gases in search of means to store solar energy for conversion to a laser beam. Such solar pumped lasers could be very important in future space activity where large amounts of power will be required."

John W. Wilson, Ph.D.
Theoretical Physicist

Laser system measures velocity of trailing edge particles



"Man's activities sometimes damage the quality of the environment in which we live. Air pollution, as an example, is a by-product of our modern technology. It can be categorized into two types: one is the local urban air pollution which gives us immediate unpleasant effects on our daily living, and the other is the global pollution which may be causing long term effects on climate, for instance. The Earth's ozone layer, which shields the Sun's strong ultraviolet radiation, is (possibly) being disturbed by man-made gases such as "freons" or spray-can-aerosols.

In order to investigate the possible effects of man's activities on the environment, several research groups are developing remote sensing techniques to measure concentrations of various gases and the pressure and temperature of the atmosphere. I am very proud to be a member of one of these research teams.

I have had eleven years of college education in atmospheric physics and eight years of research experience. I always believe that a person should have not only some talent in his work, but also strong interests in what he does. I strongly recommend that young people develop personal goals in life as soon as they can."

Jae H. Park, Ph.D.
Research Scientist

Specific Careers

Several major science areas and examples of aerospace career titles with DOT occupational codes* follow:

ENVIRONMENTAL SCIENCES

Geologist	024.061-018
Geophysicist	024.061-030
Meteorologist	025.062-010
Oceanographer	024.061-018

MATHEMATICS

Mathematician	020.067-014
Statistician	020.167-026

PHYSICAL SCIENCES

Astronomer	021.067-010
Chemist	022.061-010
Geographer	029.067-010
Metallurgist	011.061-022
Physicist	023.061-014

LIFE SCIENCES

Agronomist	040.061-010
Biochemist	041.061-026
Biophysicist	041.061-034
Microbiologist	041.061-058
Zoologist	041.061-090

MEDICAL SCIENCES

Audiologist	076.101-010
Medical Officer	070.101-046
Occupational Physician	070.101-078
Psychiatrist	070.107-014
Radiologist	070.101-090

*For specific job descriptions, worker requirements and employment outlooks, individuals are encouraged to refer to the **Dictionary of Occupational Titles**, 4th edition. U.S. Department of Labor, Bureau of Employment, Washington, D.C.: U.S. Government Printing Office, 1977 and to the **Occupational Outlook Handbook**, U.S. Department of Labor, Bureau of Labor Statistics, Washington, D.C.: U.S. Government Printing Office, 1978-79.

Earnings

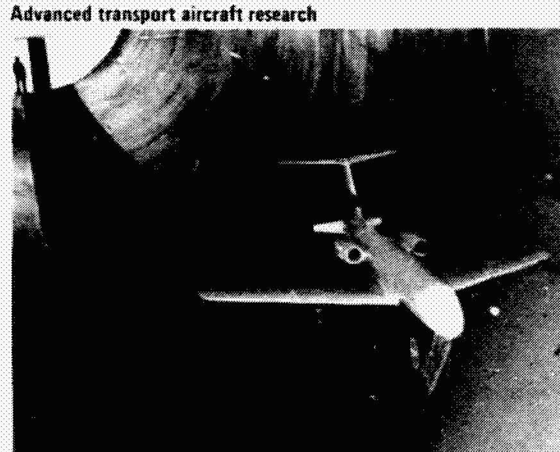
Salaries are determined by such factors as national economy, geographic location of the job, type of employer -- state or Federal government, private industry, university --, years of training and experience of the scientist and job performance. Usually more advanced training is compensated with higher salaries. Scientists with graduate degrees earn above average salaries. However, the extra years of study do not bring monetary rewards equivalent to those of lawyers or medical doctors with comparable years of training.

Employment Outlook

The kinds of career choices available in science and the number of job openings in different science fields are influenced by National priorities. Predicting future employment opportunities in science depends upon forecasting future international situations and opportunities and how the United States Government will respond to these changes. Basically, science careers in aerospace fields are dependent upon the amount of funds spent by the Federal Government for basic research and development and by the needs of the aerospace program. These funds are expected to continue to increase through the mid 1980's and at a slower rate than during the 1960's.

Forecasts predict the following employment trends for the next decade:

Advanced transport aircraft research



"As a research chemist at NASA-Langley Research Center I have had many interesting experiences working in a variety of research projects. My first job was an analytical chemist in a general chemistry laboratory. I performed all types of chemical analyses such as testing materials to determine compliance with specifications, making up chemical standards, analyzing system's components to predict or determine system performance or devising new test methods to solve a particular chemical problem like oxidation or degradation of a metal component. It was particularly rewarding when the results from a chemical analysis provided the needed clue to solve a problem in a wind tunnel or with an instrument or aircraft model.

My job as a research chemist involves various aspects of chemistry. For example, I am studying methods for evaluating water recovery systems for spacecraft and for home use. I am providing chemical analysis of river and ocean waters to help in the evaluation of pollution sensors. I also provide chemical data from laboratory tests to determine characteristics of aerosol species. As a researcher I am responsible for defining the problem, justifying the work, formulating the approach, estimating the cost and interpreting and analyzing the results to be reported."

Carmen Batten
Chemist

*These predictions and the ones which appear in the following sections are adapted from the **Occupational Outlook Quarterly, Spring, 1978 issue.**

Occupations	**Employment Prospects**
Environmental Scientists	
Geologists	Employment is expected to grow faster than average as domestic mineral exploration increases.
Geophysicists	Employment is expected to grow faster than average as petroleum and mining companies need additional geophysicists trained to use sophisticated electronic techniques.
Meteorologists	Employment is expected to increase about average. Favorable opportunities exist with weather consulting firms and radio and television stations.
Oceanographers	Competition for openings is likely even though employment is expected to grow about average. Best opportunities are for those with Ph. D.'s.
Life Science Occupations	
Biochemists	Employment is expected to grow about average due to increase in funding for biochemical research and development.
Life Scientists	Employment is expected to grow faster than average due to increasing expenditures for medical research and environmental protection.
Mathematics Occupations	
Mathematicians	Slower than average employment growth is predicted. Keen competition for jobs will exist, especially for academic positions. Best opportunities will exist for advanced degree holders in applied mathematics who seek jobs in government and private industry.
Statisticians	Employment is expected to grow faster than average as use of statistics expands into new areas. Individuals majoring in combinations of statistics with fields of application may expect more favorable job opportunities.
Physical Scientists	
Astronomers	Competition for jobs is likely to be seen due to limited growth produced by slight increases in funds for basic research.
Chemists	Employment is expected to grow about average as a result of increasing demand for new products and rising concern about energy shortages, pollution control and health care. Good opportunities should exist except for positions in colleges and universities.
Physicists	Generally favorable job opportunities are expected for persons with advanced degrees. Persons seeking college and university positions as well as graduates with only a bachelor's degree will face keen competition.

"Why are we here? What's happening here? What is there? How do we get there?

There are an endless number of questions which philosophers have pondered for years. Building on the theories of these great minds, scientists and engineers over the ages have sought to develop experiments which could provide definitive answers to these broad questions or at least answers for more specific questions which could lead to insights necessary for finding the ultimate solution.

I believe that the aerospace industry today offers the greatest opportunity in history for those persons with curious minds to contribute to the solution of problems which have perplexed mankind since the beginning of time. In addition, the diversity of challenges available within NASA is incredible. I began my career as a physicist by studying materials called "charring ablators" which are used to protect spacecraft during their fiery re-entry into the earth's atmosphere. Examples of this kind of material can be seen on the Apollo spacecraft which are on display at various museums around the country. My next assignment was a study to modify the basic electrical properties of materials such as silicon which are used in solid state circuits in TV's, radios and calculators. Next, I worked on the processes involved in producing light from semiconducting materials such as are used for numeric displays on calculators and in aircraft cockpits. This work led to studies by others into the development of flat-panel displays which could lead to video displays no more than one-inch thick so that TV's could be built in a form suitable for wearing on a person's wrist (straight out of the old **Dick Tracy** *comic strip!). My current work is involved with materials which are used for remote measurement of atmospheric pollutants from satellites. A system of such satellites could allow engineers to monitor the level and source of pollution on a world-wide basis in order to maintain the quality of the Earth's environment so that it will be a healthier place for us to live as well as a suitable place for future generations to live.*

In summary, during my career at NASA, I have had an opportunity to contribute results which have been utilized by others seeking answers about the origin of the solar system, improving the quality and efficiency of our lives here on earth, and maintaining a habitable planet that will continue to support a higher quality of life for generations to come. I have found this work stimulating and fun. If it sounds interesting to you, I invite you to consider a career in the aerospace industry which offers continuing challenges, opportunities to contribute and excitement on a daily basis."

Roger, K. Crouch, Ph.D.
Solid State Physicist

"The earth's ozone layer acts as a shield to protect all of us from harmful solar ultraviolet radiation. My job as a research scientist is to help determine how human activities down on the ground affect the ozone layer about 18 miles up in the atmosphere. I do this by analyzing the spectra of invisible infrared light which contain the "fingerprints," unique absorption patterns, of various chemicals in the atmosphere. Many of these molecules occur naturally and do not upset the delicate balance of the ozone layer. However, other chemicals, such as those used in certain spray cans and in refrigerators, may cause significant destruction of ozone when they are released into the atmosphere.

The infrared spectra I examine for the "fingerprints" of potentially harmful chemicals are measured by several types of sensors on research aircraft, high-altitude balloons and orbiting satellites. From these data it is possible to determine the amounts of various chemicals in the atmosphere and how these amounts vary with altitude. This information is important to other scientists in my research division who construct mathematical models of the chemistry of the atmosphere in order to predict the long-range effects of various chemicals on the ozone layer.

I also work closely with other NASA scientists and engineers who are designing new remote-sensing instruments to monitor the atmosphere and keep track of the relative amounts of ozone and the chemicals which affect the ozone layer. Several of these instruments are scheduled to fly on the Space Shuttle and others may be mounted on future satellites. It's exciting to be part of the development team for a remote-sensing project, especially when it is related to an important scientific problem such as the possible reduction in the thickness of our ozone shield.

My choice of a career in atmospheric science was not too difficult. I have always been fascinated by the weather. The study of the atmosphere involves three of my favorite subjects - math, physics and chemistry. The ability to communicate with other scientists and with the general public is also important in my field. I really appreciate the time I spent studying English and foreign languages in school.

Although I decided on an atmospheric science career while I was still in high school, many of my colleagues entered this field midway through college or graduate school. Some of them had completed advanced degrees in physics, astronomy, mathematics, chemistry or engineering before beginning work in atmospheric science. I enjoy my work in this field, and I feel that a career in atmospheric research would be a rewarding option for anyone with a strong interest in the physical sciences."

Mary Ann H. Smith, Ph.D.
Research Scientist

"To err is human, but to really mess things up takes a computer."

"I know the truth in this whimsical bit of graffiti. I am an applied mathematician and computer specialist who works with computers nearly every day. These amazing machines can magnify a simple copying error into an intriguing detective game. On the other hand, computers now routinely solve problems which my college textbooks deemed impossibly complex. I can give you some samples from my own work in acoustics and aircraft noise prediction.

To make airplanes quieter, we must design and operate them with noise reduction in mind. We are learning to predict how an aircraft will fly and how noisy it will be even before it is built. This helps aircraft manufacturers to design better products and guides regulatory agencies to set reasonable and enforceable noise limits. It also points to new areas of noise research.

Current noise prediction methods are computerized formulas based on experimental measurements of actual aircraft flyovers. However, as we understand noise generating mechanisms better, analytical noise prediction methods will be developed.

For instance, the noise produced by supersonic jet flows can be studied by mapping the predicted pressure field in the jet as a function of time. The computer displays the results on a color television screen using a "paint by numbers" approach. High pressure areas are colored orange and red; low pressure areas are blue and purple. If a succession of pictures representing increasing time are stored on video tape and then played back, we can see a pressure disturbance move through the jet and reflect off the jet boundaries. This fast moving disturbance is what our ears recognize as jet noise. By studying the computer generated pictures we see how the sound is focused and how the intensity of the sound depends on jet conditions.

The best thing about my job is that I'm learning something new all the time. I never guessed that my degree in mathematics would lead to understanding how airplanes fly or to predicting the noise produced by a jet."

Sharon L. Padula
Applied Mathematician/Computer Specialist

Spotlighting Engineers . . .

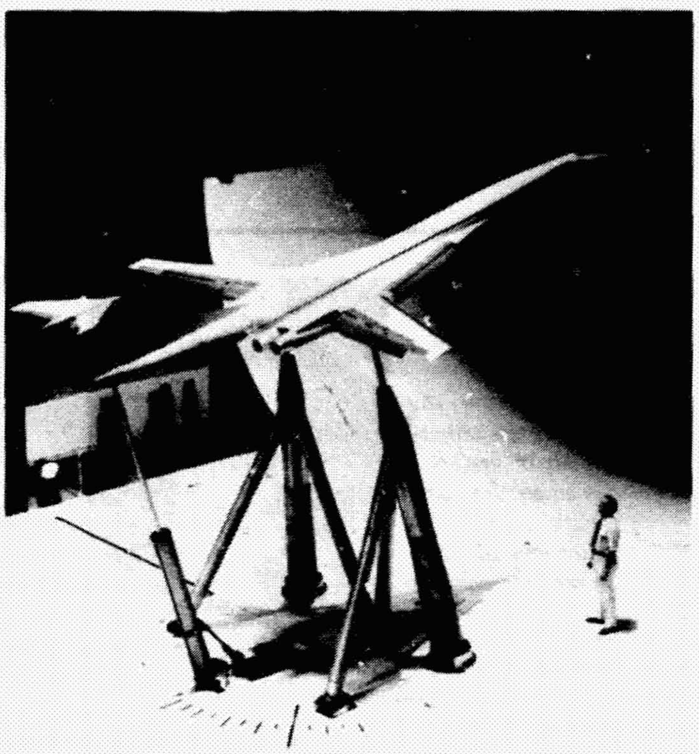
Engineering is the second largest profession in the United States. Among professional careers, only teaching employs more people. The total number of working engineers in this country is approximately 50 percent greater than the number of lawyers, doctors, dentists and pharmacists combined. It has been said that engineering has had a more direct effect on the way we live than any other profession.

Basically, engineers transform ideas and theories into realities. They use science and mathematics to solve problems, develop new products and improve systems and processes. They take the knowledge discovered by scientists and apply it to produce tangible products such as aircraft, stereos, telephones, hydroelectric systems or pocket calculators. Engineering serves as the link between scientific discovery and practical, technological applications.

Work Performed

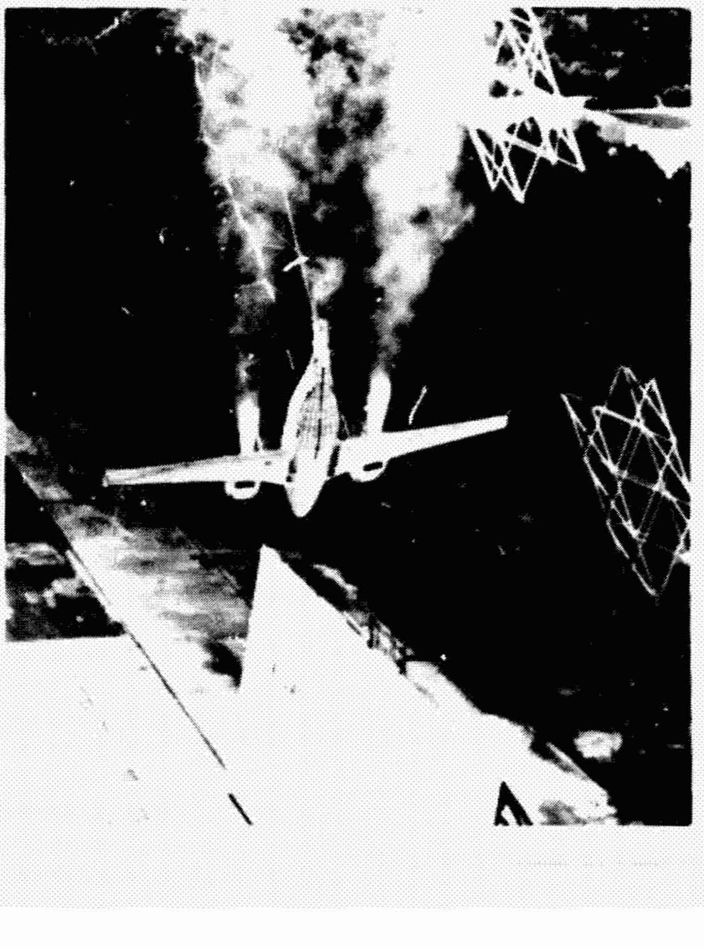
There are more than 50 major specializations or branches within the field of engineering. Within an engineering branch, a wide variety of job opportunities exist. These include research, development, planning, design, construction, operation, sales and management. Distinctions between one branch and another are not clearly defined. Yet each branch has certain unique characteristics. Because engineering activities overlap, team effort is often essential. Engineers doing similar work can be found in totally different environments. For example, an electrical engineer may apply his/her skills to problems associated with aerospace medicine, computer technology or electrical power generation and distribution. Some engineering activities associated with work in the aerospace industry are:

- Designing aircraft and spacecraft to meet aerodynamic specifications.
- Planning the layout of experimental wind tunnels.
- Designing mechanical, electrical or electronic equipment or instrumentation.
- Conducting research to develop new materials required for advanced aerospace transportation systems.



Wings pivot on this advanced supersonic cruise transport

Study of crash testing may save lives



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- Calculating the effects of heat, radiation and pressure on the structure of satellites or interplanetary probes.

Through activities such as these, engineers explore, devise and produce new products, systems and materials.

Work Settings

Engineers may be found wearing hard hats and jeans at outdoor work sites or working inside at a drafting board, a research laboratory or a conference room. Some assignments provide opportunities for travel and chances to shift from job sites.

Preparation and Training

Individuals preparing for engineering careers are encouraged to take college courses relating to the general nature of engineering as well as its various branches. Since basic knowledge is required for all areas of engineering, it is possible for engineers to shift from one field of specialization to another. Increasing in popularity are interdisciplinary programs in which an engineering education is combined with other non-engineering college majors, such as medicine (bioengineering), law (patent attorney) or business management. An emphasis in social sciences or humanities is to be included also.

Usually a bachelor's degree in engineering (a minimum of four years of college study) is required to enter this field. College graduates with majors in mathematics or science may qualify for some entrance level jobs. Experienced technicians who have studied courses in engineering sometimes advance to engineering positions. Some positions require a master's degree (five years of college study). A doctorate which requires a minimum of seven years of college and graduate study is necessary for research and teaching positions.

Specific Branches of Engineering

Descriptions of well-known branches of engineering* and their DOT reference codes are included.

Aerospace Engineers (002.061-014) are involved in all phases of research and development in aeronautics and astronautics. The terms "aeronautics," "astronautics" and "aerospace" may cause some confusion. An **Aeronautical Engineer** works with aircraft and other issues associated with flight in the Earth's atmosphere. An **Astronautical Engineer** works with spacecraft, missiles, rockets and related systems associated with flight in space. The **Aerospace Engineer** works with spacecraft such as the Space Shuttle, which combines features of both aircraft and spacecraft. As a result of the space age, two interrelated industries—aeronautics and astronautics—have merged into one "aerospace industry." The **Aerospace Engineer** studies flight in all of its aspects. He or she works with spacecraft, conventional aircraft, missiles, rockets and even hydrofoil boats. The aerospace engineer designs, constructs and tests the bodies, engines and parts of air and spacecraft for safety, maneuverability and stability. He or she may supervise the assembly of aircraft and spacecraft and the installation of equipment on these vehicles. Usually he or she is a specialist in one of the many disciplines such as propulsion, aerodynamics, fluids or flight mechanics. Future aerospace engineers may develop safe, comfortable and high-speed mass transportation systems as well as advanced systems which will help streamline the work of air traffic controllers. This branch of engineering is changing and diversifying continually. In recent years, its technology has been applied to fields such as bioengineering, medical systems, environmental engineering and communications.

Ceramic Engineers (006.061-014) study materials, how they react, their applications and use. The ceramic engineer is concerned with developing methods for processing clay and other non-metallic materials into a variety of products. These products range from glassware, cement and bricks to heat resistant materials for missile nose cones.

*For more information refer to the **DOT**, 4th edition, 1977, and to the **Occupational Outlook Handbook**, 1978-79 edition. Another source of information is the **Accreditation Board for Engineering and Technology, Inc.**, 345 East Forty-Second St., New York, N.Y. 10017.

"Have you ever wondered why people living in different parts of the world ,experience different types of climate during the year? I did, and now I am trying to find reasons why this happens.

Because it would be extremely costly and difficult to collect climatic information from all places on the Earth simultaneously for an entire year, I am attempting to simulate the earth's climate using physics, mathematics and the computer. To do this, mathematical statements are defined which approximate various atmospheric conditions. Then, with the use of the computer, I approximate the temperature of different parts of the earth.

Also, to aid in answering this question, I use information which has been obtained from satellites which circle the earth. Satellites can be extremely helpful because they collect climatic information over places which would be difficult for man to explore for extended periods of time, such as a mile above the Southpole or the middle of an ocean.

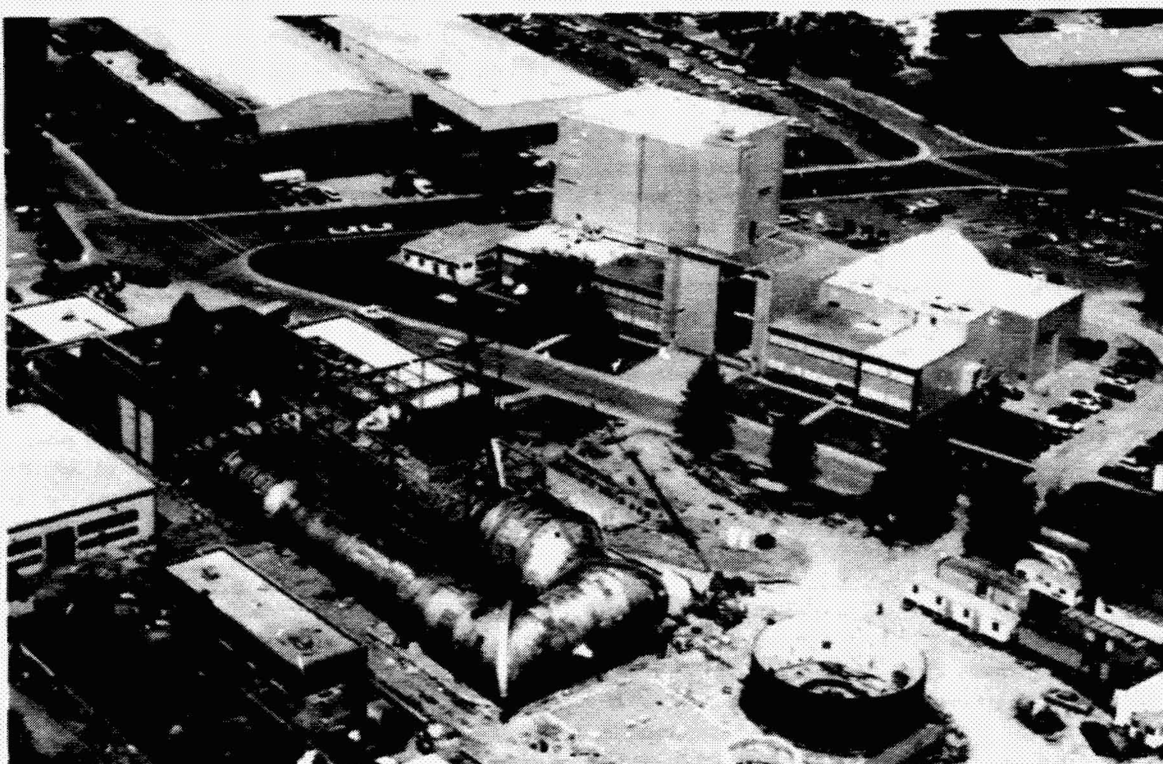
Deciding upon a career involving our changing environment was not difficult for me. I enjoy mathematics and physics. Studying the atmosphere not only gives me the opportunity to use these skills but also the chance to seek answers to other questions, such as why the sky appears blue at times and gray at others or what causes rainbows to sometimes appear.

My job allows me to explore new fields of interest while at the same time continuing to broaden myself into a more creative, productive and responsible individual. Most importantly, I believe that if you are happy with the type of work that you select to do, you will not only learn more but you will also do a much better job."

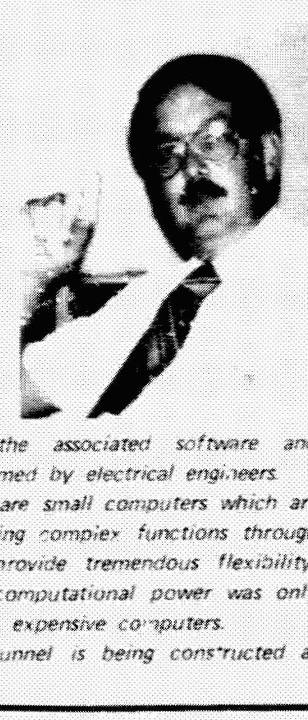
Denise Stephenson-Graves
Aerospace Engineer

Chemical Engineering (008.061-018) is the youngest of the major engineering disciplines. It is not just one field, but many areas. Each area requires specialization that might be by type of operation (oxidation, polymerization, etc.) or by product (plastics, rubber, etc.). Chemical engineers apply chemical, physical and engineering principles to methods of mass producing such materials as plastics, synthetics, medicines, detergents and other chemical products. Today's chemical engineers can point to many accomplishments. Synthetic turf covering football and baseball fields is one example of what their work can produce. They also have combined petroleum and natural gas to produce two primary chemicals used in aspirin.

Civil Engineering (005.061-014) is an outgrowth of military engineering and is the oldest branch of the profession as it is known today. Civil engineers attempt to solve problems such as air pollution and transportation snarls. They design and build roads, harbors, airfields, tunnels and bridges. They design and build sewer systems, develop projects to restore central-city areas and design and supervise the construction of airport runways and terminal facilities. In the future, civil engineers must help revolutionize the nation's existing transportation system to optimize modes of travel. Civil engineers pay serious attention to the well being of humans and the environment. When they build a dam, the are concerned with preserving the wildlife and scenic beauty. When they design a skyscraper, they consider layouts that are psychologically pleasing and safe for the humans who will be living and working there.



The National Transonic Facility will operate at -320° F



"The advent of microprocessors in the mid-seventies provided a new tool for engineers. A low cost computer was available for controlling testing facilities such as wind tunnels where airplane designs are checked and verified. The implementation of microprocessors and the design of the associated software and hardware are performed by electrical engineers.

Microprocessors are small computers which are capable of performing complex functions through programming and provide tremendous flexibility. In the past such computational power was only available from large, expensive computers.

A new wind tunnel is being constructed at NASA Langley Research Center, Hampton, Va. and all of its operations are controlled by microprocessors. They are used to position the airplane model in the tunnel, control the temperature, pressure and air velocity in the tunnel as well as monitor the "health" of the facility and alert operators if a problem is detected. A team of engineers from several disciplines provided the design of this system. I headed a group of electrical engineers which selected the appropriate computer components, designed custom printed circuit boards, and dictated the type of software language to be used.

Electrical engineering is an exciting field to me because it is constantly changing with new advances such as microprocessors. I look forward to new advances in this field during the next decade which are only one's dream today."

Kenneth L. Jacobs
Electrical Engineer

Electrical Engineers (003.061-010) study all areas of electrical and electronic systems and their components. They design, develop and supervise the manufacture of everything electrical from super computers and tiny electrical circuits for spacecraft to electric toothbrushes and can openers. Areas of specialty are: circuit theory, communications sciences computers and automation control systems, electromagnetic fields, energy sources and systems and solid-state materials and devices. They developed detection and transmitting devices such as radar and sonar. Later, they applied the principles of radar to cooking and the microwave oven was created. They are involved also in various medical programs—hospital safety, electronically-oriented patient care and computer study of tumors. In the future, electrical engineers will help to establish new sources of power while suggesting uses for present resources in ways that do not harm the environment. This is the largest branch of engineering. Most electrical engineers are employed in the manufacturing of electrical and electronic equipment, aircraft, business machines and professional and scientific equipment.

Industrial Engineers (012.167-030) analyze and plan ways to increase the efficiency of workers, materials, and equipment for the most effective production of goods and services in all types of industries. They select processes or methods to be used in manufacturing a product. They develop plant layouts for machinery and decide the sequence of making the parts. Standards for the performance of workers and wage scales are established by industrial engineers. More pleasant working environments and improved productivity result from their work. Often industrial engineers are found in management because they can evaluate technical situations, make improvements and communicate with workers.

Mechanical Engineers (007.061-014) are concerned with the design manufacture and operation of a wide range of components, devices or systems. They may design a microscopic part for a gauge or gigantic gears for bulldozers. Mechanical engineers study such areas as cryogenics, fluidic devices and lasers. They develop new ways to provide power more efficiently and in ways that will not damage the environment. All forms of energy--the sun, water, wind, oil, gas and nuclear fuels--are used by mechanical engineers to produce and use power. New work areas in environmental control and atomic and solar energy will provide challenges to mechanical engineers. Some of these engineers design machines that produce power. These machines may be internal combustion engines, steam and gas turbines, jet and rocket engines or nuclear reactors. Others design devices and equipment that use power such as air conditioning equipment, elevators and printing presses. Mechanical engineering is the broadest of all the engineering disciplines and nearly one-fourth of all engineers in the United States fit into this branch.

Metallurgical Engineering (011.061-018) is among the most modern of technological areas. These engineers develop processes which extract metals from ores, refine the impurities from the metals and convert the metals into useful products. They find ways to pound metals into paper thin razor blades or shape them into massive forms for locomotive engines. These engineers have gained new understandings of the structure of metals. This knowledge has enabled them to produce alloys with great strength, light weight and resistance to corrosion and high temperatures. Today, metallurgical and material engineers are designing and helping produce new refractory alloys and ceramics. This branch of engineering is important because it offers more efficient ways to utilize this country's mineral wealth.

Nuclear Engineers (015.061-014) are important in helping to solve world-wide energy shortages. Their work is significant in the area of power generation. They design, construct and operate nuclear power plants and fuel processing facilities. Some nuclear engineers design reactor systems which control the release of nuclear energy for electric power generating equipment. Others install and maintain the reactors at utility plants. Some study the detection and measurement of radiation. Improved mass transportation systems are evidence of their work. Nuclear powered ships can travel two to five years without refueling. Controlling fusion--a potentially inexhaustible supply of energy--is the goal of some nuclear engineers. In the future, nuclear energy might be used to fuel trains, cars and aircraft. The work of nuclear engineers in the areas of water supply (desalination plants), food supply (food preservation) and health (diagnosis and treatment) has contributed to improved living conditions for mankind.

"With the foreseeable depletion of both domestic and world crude oil resources, aviation faces both increasing fuel prices and potential fuel shortages. More plentiful energy sources such as coal, oil shale, nuclear, and solar can be utilized to produce a variety of fuels which might be used by aircraft. My job is to determine how well aircraft would perform if they used the various fuels, how much the fuels are likely to cost, and whether the fuels could be used safely.

The most promising fuels for aviation are synthetic aviation kerosene produced from coal or oil shale, liquid methane produced from coal, and liquid hydrogen, which can be produced from virtually any energy source. By analyzing the many processes which can be used to produce the fuels, we can determine how much of a particular energy resource (such as coal) would be required to produce the fuels, and estimate the relative costs of the fuels as well.

Liquid hydrogen and liquid methane pose peculiar problems in that they are cryogenic fuels; cold enough to freeze a carrot into something having the properties of a railroad spike. Cryogenic fuels require containment in well-insulated tanks. We formulate and direct experiments aimed at developing insulation systems capable of housing the cryogenic fuels onboard an aircraft.

We are currently conducting a series of safety-related experiments involving large spills of liquid hydrogen. When liquid hydrogen is spilled, it forms a flammable vapor cloud. Our experiments will provide us basic data on the behavior of the flammable vapor cloud and help us assess the hazards associated with the ignition of the cloud at any time.

My college majors were physics and mathematics, and my course work included valuable courses in chemistry as well. On-the-job engineering experience has allowed me to put to use the basic principles learned during college.

Energy is one of our nation's most pressing problems, but energy related work also provides one of the greatest opportunities available today and in the future."

Robert D. Witcofski
Aerospace Research Engineer

Employment Outlook

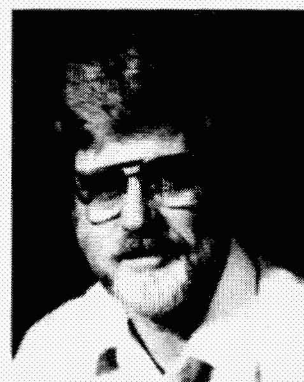
In the past decades engineering has been one of the fastest growing occupations, and increasing opportunitie are expected for the future. It is predicted that a demand will exist especially for graduates who can apply engineering principles to computer technology or to issues associated with medicine or biology. Individuals trained with engineering skills will be needed to develop new technologies and to offer techn cal solutions to solving issues such as reducing or eliminating environmental pollution and developing new sources of energy.

Opportunities for engineers fluctuate periodically due to population growth and industrial expansion to meet the demands for goods and services. Government and industry expenditures for research and development also affect employment for engineers. It is projected that these expenditures will continue to increase. The demand for engineers is influenced also by spending for defense purposes, general business conditions, shifting national priorities and non-defense-related Federal programs and policies.

In general the number of openings for engineers is expected to be in balance with the number of applicants. Prospects for the following specific branches of engineering are:

Engineering Branch	**Employment Outlook**
Engineers	Employment is expected to grow slightly faster than average. Good employment opportunities exist for most specialties.
Aerospace Engineers	Employment is expected to grow slower than average due to limited increases in Federal expenditures for space and defense programs.
Agricultural Engineers	Employment is expected to grow faster than average in response to increasing demand for agricultural products, modernization of farm operations and increasing emphasis on conservation of resources.
Biomedical Engineers	Employment is expected to grow faster than average but the actual number of openings is expected to be small. Increased research funds could create new jobs in instrumentation and systems for delivery of health services.
Ceramic Engineers	Employment is expected to grow faster than average as a result of the need to develop and improve ceramic materials for nuclear energy, electronics, defense and medical science.
Chemical Engineers	Employment is expected to grow about average. Growing complexity and automation of chemical processes will require additional chemical engineers to design, build and maintain plants and equipment.

Engineering Branch	Employment Outlook
Civil Engineers	Employment is expected to grow about average as a result of the growing need for housing, industrial buildings, electric power generating plants and transportation systems. Work related to environmental pollution and energy self-sufficiency also will create openings.
Electrical Engineers	Employment is expected to increase about average due to the growing demand for computers, communications equipment, military electronics and electrical and electronic consumer goods. Increased research and development in power generation also should create many openings.
Industrial Engineers	Employment is expected to grow faster than average due to industry growth, increasing complexity of industrial operations, expansion of automated processes and greater emphasis on scientific management and safety engineering.
Mechanical Engineers	Employment is expected to grow about average due to the growing demand for industrial machinery and machine tools. The need to develop new energy systems and to solve environmental pollution problems also will create openings.
Metallurgical Engineers	Employment is expected to grow faster than average due to the need to develop new metals and alloys, adapt current ones to new needs, solve problems associated with efficient use of nuclear energy and develop new ways for recycling solid waste materials.
Mining Engineers	Employment is expected to grow faster than average due to efforts to attain energy self-sufficiency and to develop more technologically advanced mining systems.
Petroleum Engineers	Employment is expected to grow faster than average as the demand for petroleum and natural gas requires increased drilling and more sophisticated recovery methods.



"Most of my work is in the field of Controls which refers to the use and design of special circuits and the selection of components and devices. Sometimes my work is for aircraft, sometimes for spacecraft and sometimes to fulfill the needs of scientists and engineers trained in other fields.

After high school, I spent four years in the Air Force as a Radar Technician. After college, I elected to work for an aircraft manufacturer in the development and testing of Radar and Flight Control Systems. Later I joined NASA at the Langley Research Center in Virginia where I have been for nearly 20 years. Here, we often work in teams to develop improvements for aircraft, satellites and in the application of small computers, called micro-processors.

We design and build "one of a kind" things such as a buoy that will tell us how much pollution is in the water and "radio" the information back to us, a laser device that can be placed on an aircraft to "read" the pollutants in the air or in rivers, or a computer program to predict the performance or action of a small component or of an entire control system.

If I had it to do again, there isn't much I would change. I know that soon, tomorrow or next month, I will be learning something new – trying something different."

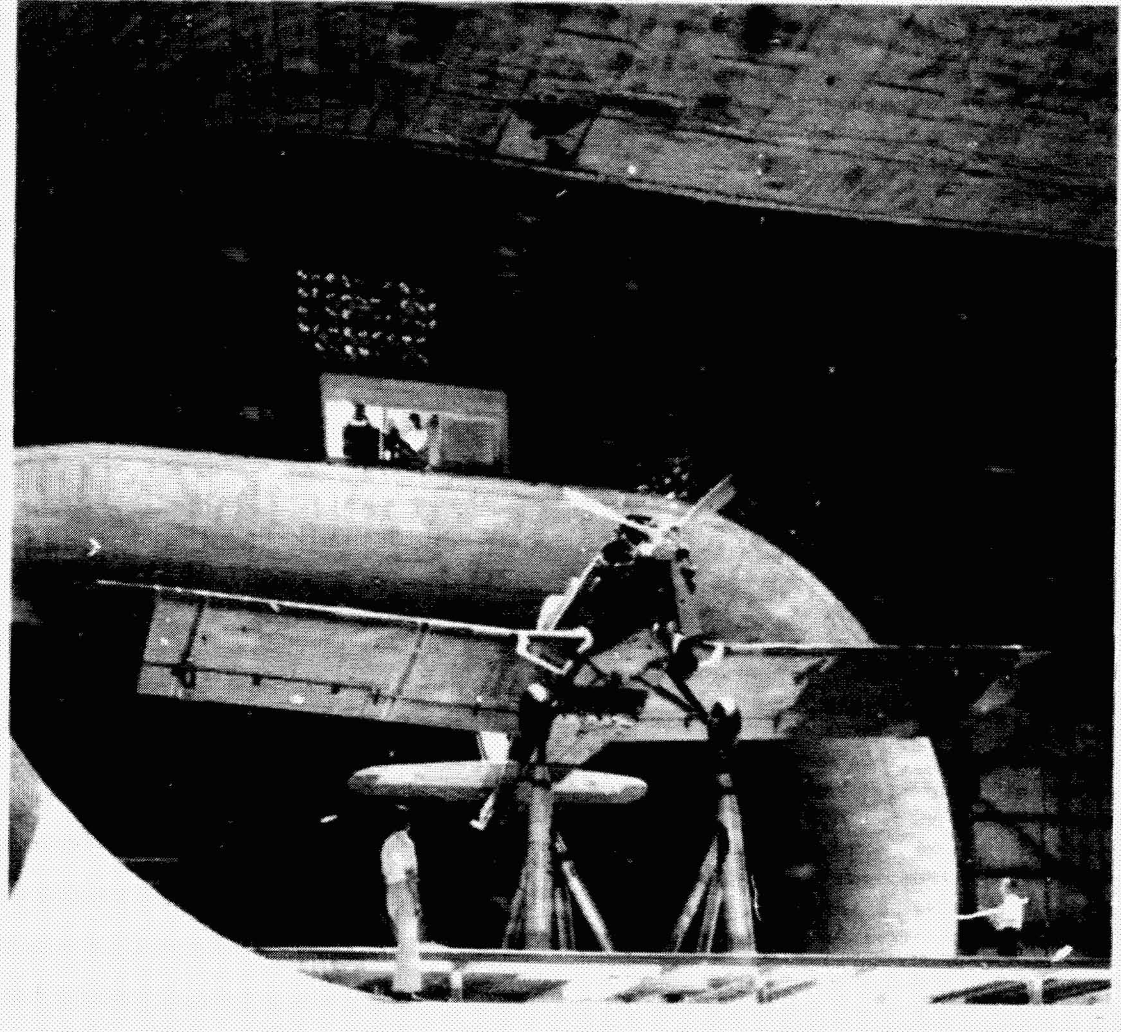
Eugene L. Kelsey
Electrical Engineer

Investigating structural behavior of aircraft during controlled crashes

Earnings

Today engineering offers more income to the four year college graduate than does any other profession. Most engineers can expect an increase in earnings as they gain experience.

Improving the unique characteristics of an agricultural aircraft



Spotlighting Technologists and Technicians . . .

Technologists and technicians work in all the specialized fields of science and engineering described above. They work in all phases of the aerospace industry, from theory through construction, testing and operation. They play a supporting role by assisting scientists and engineers. These people are the "doers" who carry out technical plans formulated by scientists or engineers. They help engineers translate their plans into useful products and services.

The technological revolution has created thousands of career opportunities that require technical training. Technologists are graduates of four year engineering technology education programs. Technicians are those people who have completed two year technical training programs, apprenticeship programs or on-the-job training programs.

Aerospace technologists often organize people and supervise systems developed by scientists and engineers. They supervise production workers to make sure that they follow prescribed plans and procedures.

Aerospace technicians help design and produce aircraft, helicopters, rockets and spacecraft. Some of these technicians who work in research and development set up, calibrate and operate different kinds of instruments. They make calculations and report on the results of experiments. They assist scientists and engineers in developing experimental equipment and models. Some design layouts and diagrams of structures, control systems and equipment installation, for example. Others check drawings for technical accuracy, practicability and economy. In production, technicians follow the plans and general directions of scientists and engineers. They prepare specifications for materials and devise tests to ensure product quality. They also study ways to improve the efficiency of operations. They may recommend modifications in equipment or processing which would help with more efficient and consistent equipment performance.

The aviation industry employs many different kinds of technicians. Some help keep airplanes flying safely. Airline dispatchers and air-traffic controllers are examples of technical careers in the aviation industry. The dispatcher consults with the pilot before take-off. Together they determine the best route, amount of fuel to take, the altitude to fly and the approximate flying time. Air traffic controllers work for the Federal Aviation Administration (FAA). They give instructions, advice and other information by radio to pilots.

Work Performed

Technologists and technicians support work in all the specialized fields of engineering and science described above. A few typical assignments include:

- Taking aerial photographs and preparing maps.
- Making detailed drawings of machinery or vehicles.
- Measuring radiation.
- Analyzing flight test data and writing engineering reports about aircraft performance.
- Setting up and operating a metal lathe to make a part for a motor.
- Repairing aircraft engines.
- Operating turbines.
- Following blueprints and diagrams to inspect electronic assemblies.
- Hand polishing lenses for optical instruments.

Work Settings

Technologists and technicians work in the same settings as engineers and scientists. For instance, they may work wherever electronic engineers are employed. Several career specialties in this area involve electronics, computers, radio, radar, sonar or telemetry equipment. They may help industrial engineers design automated systems, conduct time and motion studies and plan work flow. They may help mechanical and metallurgical engineers process metals and convert them into finished products. Technologists and technicians are active in all areas where technological breakthroughs are accomplished.

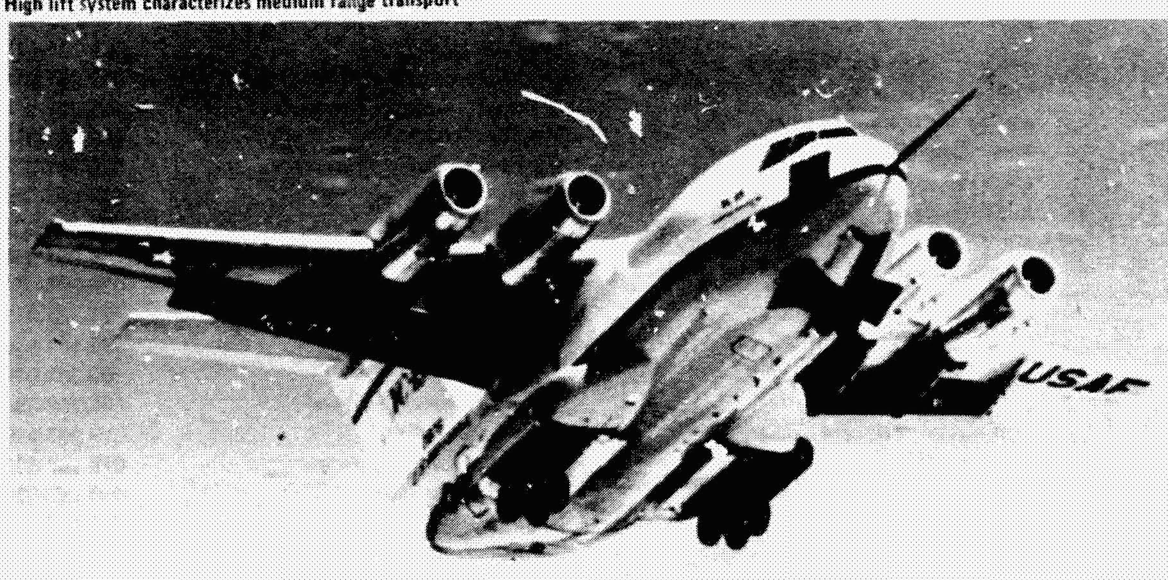
"Engineering researchers are constantly coming up with new ideas to make aircraft better. It is my job as an Aerospace Engineering Technician to translate those ideas into a wind tunnel model to test their validity. I talk with the engineers to find out exactly what they are looking for and I talk with the technicians in fabrication to get their input on the building of the model. Then I do preliminary design layouts as well as structural design, sometimes with the help of computer-aided design. I make the working drawings that the model will be built from.

I started in this field by going through an apprenticeship training program for five years. During my training, I worked closely with other designers to learn the complexities of wind-tunnel design. Even though I am finished with my formal training program, I will never be finished learning as new ideas in research, materials and design aids are always coming along.

There is great diversity in this field. For example, one project dealt with performance of speed brakes on a drone aircraft. A set of brakes was designed and fitted to a small scale model to test their effectiveness at a fraction of the cost for the full scale drone. In another project, the researchers are investigating a vehicle that could be put into orbit by carrying it up in the Space Shuttle. It would stay there in case of an emergency so the astronauts could fly it back down. Before this vehicle becomes a reality countless designs will be studied and several models will be built and tested to produce the final design that will best meet the requirements."

Sharon K. Crockett
Aerospace Engineering Technician

High lift system characterizes medium range transport



Preparation and Training

Each career requires its own type of technical education beyond high school.

A career as a technologist usually requires a bachelor of science degree in engineering technology. This requires the satisfactory completion of four years of college level work.

For a career as a technician a high school diploma is the only educational requirement. Technical training for high school graduates can be obtained through apprenticeship programs. These apprenticeship programs offer on-the-job training opportunities combined with classroom instruction. The usual apprenticeship program is four to five years. Another path leading to a career as a technician is the satisfactory completion of a two-year college program resulting in an associate degree in applied science. A graduate with an associate degree in applied science may transfer into a four-year engineering technology program. The skills and experience necessary to become a technician may be acquired in several other ways as well:

Technical Institutes provide intensive training for entry-level technician jobs. Usually emphasized are practical and laboratory work.

Junior and Community Colleges offer programs similar to technical institutes. Their programs place more emphasis on theory, plus some course work in liberal arts (English and social sciences).

Vocational Schools usually offer subjects related to work available in the local community. They also offer high school level and adult education courses.

Many schools offer classes during the evening so that high school graduates can work and continue their education. Many companies offer training opportunities for technician jobs.

Specific Careers

A few examples of aerospace occupations in engineering technology and their DOT occupational codes are:

Air Traffic Control Specialist, Station	193.162-014
Air-Traffic-Control Specialist, Tower	193.162-018
Chief of Party	018.167-010
Construction Inspector	182.267-010
Die-Drawing Checker	007.167-010
Dispatcher	912.167-010
Drafter, Aeronautical	002.261-010
Drafter, Assistant	017.281-018
Drafter, Cartographic	018.261-010
Drafter, Civil	005.281-010
Drafter, Commercial	017.261-026
Drafter, Electrical	003.281-010
Drafter, Electronic	003.281-014
Drafter, Geological	010.281-014
Drafter, Marine	014.281-010
Drafter, Mechanical	007.281-010
Drafter, Oil and Gas	017.281-030
Drafter, Structural	005.281-014
Engineering Assistant, Mechanical Equipment	007.161-018
Field Engineer	193.262-018
Flight Engineer	621.261-018
Industrial Engineering Technician	012.267-010
Inspector, Quality Assurance	168.287-014
Material Scheduler	012.187-010
Observer, Seismic Prospecting	010.161-018
Packaging Engineer	019.187-010
Pattern Grader-Cutter	781.381-022
Patternmaker	781.281-026
Pollution-Control Technician	029.261-014
Production Clerk	221.382-018
Radiation Monitor	199.167-010
Radiographer	199.361-010
Radiotelephone Operator	193.262-034
Specification Writer	019.267-010
Surveyor Assistant, Instruments	018.167-034
Surveyor, Geodetic	018.167-038
Surveyor, Marine	018.167-046

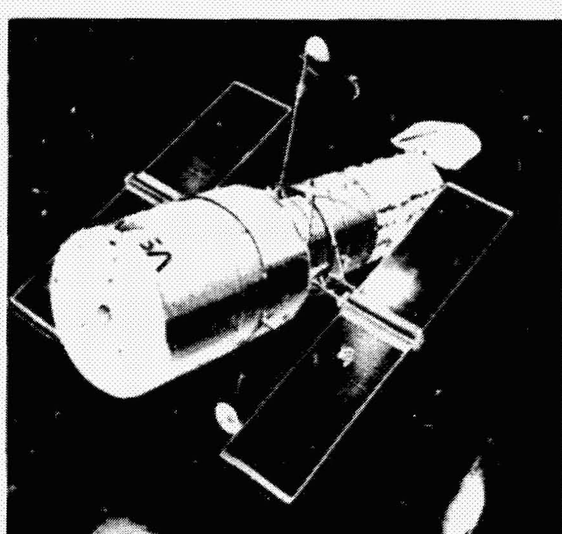
Surveyor, Mine	018.167-050
Technical Illustrator	017.281-034
Tool-Drawing Checker	007.167-022
Tower Operator	910.362-010
Traffic Technician	199.267-030
Transmitter Operator	193.262-038
Video Operator	194.282-010

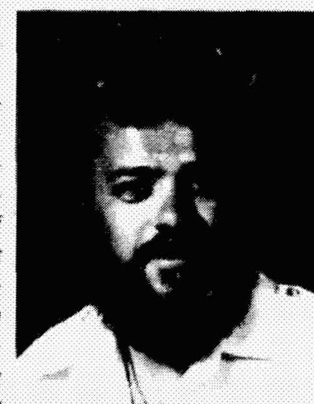
Employment Outlook

The employment outlook for engineering and science technologists and technicians is expected to grow faster than average. More technicians will be needed to support the growing number of engineers and scientists. There are favorable job opportunities predicted for graduates of post secondary school programs. Remember that the fields of aerospace are affected by such factors as the national economy and the continued Federal support of the aerospace program. Increases or cutbacks in Federal funding will increase or reduce career opportunities in this industry.

Earnings

Earnings for technologists and technicians depend upon education, technical speciality, ability and work performed. Other important factors influencing earnings are type of firm, specific duties, and geographic location. A technician's salary is approximately double that of the average high school graduate in an entry level job.





"Electronics is an ever changing realm of technology. Everyday advances are made in both research and application. It was an interest in the field of electronics that prompted me to pursue a profession in this area. Upon completion of high school, I entered a Cooperative Education Program between NASA, Langley Research Center and a local community college. After the Co-Op program, I completed a NASA apprenticeship program and was graduated as an Electronics Technician.

In addition to being an ever changing field, electronics is a diverse field. Presently, I am involved in an area known as microelectronics. Much of my work is conducted under a microscope. Circuit design, photography, chemical etching, wiring and soldering techniques all come into play in this area.

Some of my more interesting projects in the microelectronics field have been the doping of Gallium Arsenide Solar Cells in order to increase efficiency so that in the near future power from the sun can be converted into useful energy at low cost. Also, I worked on a project involving the etching of thin film circuit patterns and heat transfer gauges onto the surface of a gold plated, quartz model for Reentry Vehicle Configurations. These models will be tested in a high pressure wind tunnel at velocities from 20,000 to 30,000 feet per second, with model surface temperatures reaching several thousand degrees Fahrenheit.

It is this challenge of the future that I find rewarding in today's field of electronics."

Alexander J. Witkowski, III
Electronics Technician

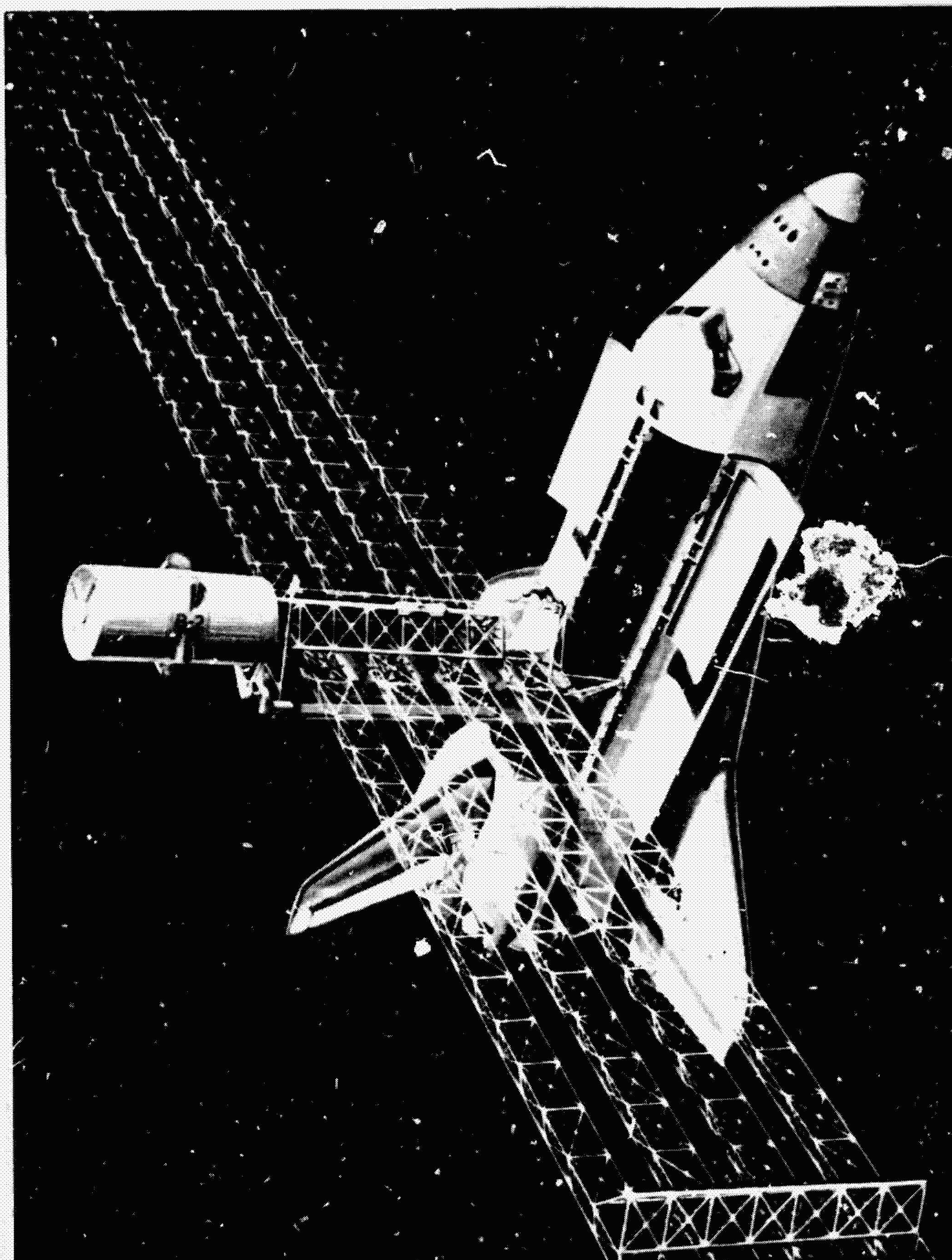
NASA's Space Telescope will assist scientists in exploring the origin of the universe

THE ENGINEERING TEAM:
ENGINEERS, SCIENTISTS, TECHNOLOGISTS, CRAFTWORKERS, and TECHNICIANS

Types of Team Member	Main Function	Preparation Required to Enter the Field
Engineer	The Engineer is primarily an innovator or creator of new products, processes, procedures, or systems. He or she is interested in solving practical problems economically through the use of mathematics, a knowledge of science, experience, and practical judgment. The Engineer puts science to work for mankind.	High School: Good grades in 3½ to four years of college preparatory mathematics, and in 1 to 2 years of laboratory science, average or better grades in English, good reading and study skills. (For specific advice on courses, check the engineering college you wish to attend.) College: 4 to 5 year full-time day engineering program, a 5 to 6 year evening program. College study is rigorous and demanding. Related summer work experience is helpful.
Scientist	Most often, the Scientist is the searcher for truth, the discoverer and categorizer of knowledge who formulates and disseminates basic ideas or theories upon which the practical applications of other team members are based.	High School: A strong college preparatory program in mathematics, laboratory science, English, and usually Latin or a modern foreign language. College and Graduate Education: Typically 7 to 8 years of undergraduate college and graduate school through the Ph.D. degree based in part on research.
Engineering Technologist	The Engineering technologist typically is a practical person with a good knowledge of the field who applies engineering principles (1) in organizing or supervising construction, production, operations, or maintenance, or (2) in improving devices, equipment, methods or processes. If technologists are not available, engineers may carry out this function.	High School: Some flexibility but usually includes 2 to 4 years of college preparatory mathematics, some science, required English and other credits for graduation. College: Usually a 4-year bachelor of engineering technology degree program. Frequently, the first 2 years may be in a community or junior college. Work experience in the chosen field is desirable.
Craftworker	The Craftworker uses hand or power tools to make, install, maintain, or repair things. An electrician for example, connects switches, circuit-breakers, lamps, and electrical equipment (such as motors) with insulated wires. A mechanic sets up and operates power driven machine tools.	Trained either through on-the-job experience or more formally through 2 to 4 years of formal apprenticeship program sponsored by employers and labor unions. This may include some classroom instruction at a local high school or college.
Technician	The Engineer or Physical Science Technician often serves as a technical assistant to an engineer or scientist. Knowing and understanding the basic ideas or technical plans, the technician carries out the detailed work necessary for the project. An electronics technician, for example, may make the standard calculations for estimating the cost of electronic equipment or prepare service manuals for it. He or she may check, test, maintain, or repair equipment according to standards set by an engineer. Or sell or operate electronics equipment and facilities.	High School: Either general or college preparatory with a specialty course or high school equivalency plus military service training in specialty. After high school the better prepared technicians complete the equivalent of 2 full years of training at a community college or technical institute leading to an associate degree. This may be taken in an evening program lasting 3 to 4 years.

*Published with permission from the "The Engineering Team," one of a series of 25 Career Education Wall Charts distributed by the Garrett Park Press, Garrett Park, Maryland 20756.

Personal Qualifications Desirable	Possible Job or Position Titles	Personal Rewards and Demands
Energy, intelligence, inquisitiveness, honesty, realism, industriousness, creativity (with ideas or things) and ability to get along well with others.	To Start: Junior Engineer, Assistant Engineer. Later: Bio-medical Engineer, Design Engineer, Project Engineer, Sales Engineer, Chief Engineer, Manager, President.	Satisfaction of having created something new and useful, helping mankind, tackling challenging problems, or working with other scientific and creative people. Good pay, sometimes long hours. Usually excellent working conditions, prestige. An engineering license and continuing study are desirable in many positions.
Scholarly, thoughtful, intelligent, dedicated, studious, verbally fluent, and creative with ideas.	To Start: Junior Scientist, Research Assistant, Assistant Scientist. Later: Chemist, Physicist, Life Scientist, Research Scientist, Laboratory Director, Vice-President for Research.	Knowing something well, discovering new knowledge, developing new hypotheses. Usually adequate pay and good to excellent working conditions but sometimes face problems in financing research. Prestige.
Practical outlook, action rather than idea-oriented but able to think and use tools and equipment well, able to motivate and work well with people.	To Start: Engineering Assistant, Technical Aide. Later: Technical Specialist; Construction, Production, or Technical Supervisor; Engineer (in some states, not in others); Manager.	Enjoyment of accomplishment while effectively using knowledge of science, people, and technical devices and equipment. Good pay, active work life. Since this is a relatively new occupation (in the last 10 to 15 years) some may not understand its role and qualifications.
Physical requirements to meet job demands including good eye-hand coordination and good manual skills. Willingness to work off-hours (shifts, emergency calls, etc.). Able to work under whatever conditions of noise, weather, or heights characterize the job. Pride in own work and skills. Knowledge of, and interest in, materials, tools and equipment.	To Start: Apprentice or Assistant (Electrician, Machinist, etc.) Later: Electrician, Machinist, or other craft title.	Creating or repairing things with own hands, tools, and brains. Being useful. Having widely-accepted skills. Good pay and working conditions.
Practical outlook and sound understanding of scientific principles of testing and measuring, practical techniques, and skill with tools. Desire to learn from technical manuals or on the job.	To Start: Engineering, Scientific or Technical Aide or Assistant. Later: Electronic, Hydraulic, Mechanical, or Scientific Technician.	Enjoyment of a technical skill. Close association with engineers, scientists, or technologists from whom to learn. Greater pay and somewhat more prestige than all but the most skilled craftworkers. May have many detailed or routine duties.



Chapter Three

Plan . . . Your Future Begins Today

Choosing a future career requires that you learn about yourself -- your interests, abilities, qualifications and goals. Choosing a career also requires that you know about the requirements, responsibilities and rewards of various careers. The process leading to self and career awareness involves planning to ensure that you take advantage of experiences which will provide appropriate information. Choosing a career is much too important a decision to leave to chance! Selecting a satisfying career may seem like an overwhelming task. However, careful planning and guidance will make the selection process easier for you.

If you believe that a career in a science, engineering or technical field may someday be in your future, begin preparing yourself today. This involves developing a plan of action. **First**, analyze your interests, abilities, and aptitudes. This will help you select a career tailored to fit you. Consider school courses you like and dislike. Hobbies, sports, extracurricular activities and your personal characteristics are factors to be considered. **Second**, take all the available high school courses related to your potential career goals. Professional and technical occupations in aerospace science and technology necessitate specialized education and training beyond the high school level. In order to be qualified to apply to these programs, you must plan a course of action while in high school. You must plan ways to gather information about available options for further education and training and about the entrance requirements for these programs. Use the time during the high school years to prepare yourself to qualify for these entrance requirements. **Third**, if you can get a part-time job, choose one that will offer you some experience in a field that corresponds with your future goals and aspirations. Observe and learn as much as you can about the career field represented by your part-time job. Observe the qualities of workers who seem to be enjoying their work and receiving commendations and promotions based on their performance. Also consider volunteer work which will offer practical on-the-job training in areas of interest to you. **Fourth**, think of part-time jobs and volunteer work experiences as steps towards your long-term career goals. Jobs in fields corresponding to your interests and abilities will benefit you most in the long run. They may not be the best paying jobs, however. You may develop future job contacts as a result of them. **Fifth**, seek out and consult various sources of career information. Discuss career paths with many different people. Read all you can about factors that apply to your tentative career. **Sixth**, learn how to fill out employment application forms and how to interview for a job. Application forms tend to be standard. Your forms must be complete, legible, and accurate. Interviewing for a job takes practice and is crucial to being hired.

The world of aerospace careers presents many diverse opportunities for the prepared person. Therefore, spend the years while you are in high school laying a good foundation for that world. Take advantage of every opportunity to get the training and experience you will need for a tentative aerospace career. Advanced planning will prepare you to qualify for careers that are satisfying and rewarding.

Personal Qualifications Inventory

The completion of a qualifications sheet will help you get a clearer picture of your profile. A personal profile can assist you as you plan. Use the following form or develop one of your own. Be as objective as possible. List your strengths and weaknesses as you complete this personal inventory.

Personal Inventory

My current age: ____________

Date: ____________

Educational Background

Types of courses I have studied: Vocational _____, Commercial _____, College Preparatory _____

Titles of courses I have enjoyed: | Grades I earned: | Reasons for enjoying the courses:

Titles of courses I have disliked: | Grades I earned: | Reasons for disliking the courses:

Titles of courses I plan to take: | Expected grades: | Reasons for taking the course:

Hobbies

Hobbies I enjoy: | Reasons I enjoy each:

Hobbies I think I might like: | Reasons:

I do not have a hobby because ____________

Extracurricular Activities

Titles of my extracurricular activities: | Reasons for participating in each:

Job Experience

Summer, part-time, or volunteer jobs:

What I learned about my goals for a future career:

Three jobs that are most appealing to me:

My reasons for being attracted to each:

Three unappealing jobs:

My reasons for disliking each:

My ideal job would be

This would be ideal for me because

My most important personal ambitions are:

I want to achieve this ambition because:

Personal Data

My outstanding abilities, talents, strong points are:

My weaknesses are

I plan to overcome my weaknesses by

I plan to gather more information about careers by

Other information which I feel is important to my personal inventory

Sources of Career Information

The goals and objectives of the aerospace industry are continually changing. These changes affect job requirements and responsibilities in the industry. Therefore, in order to get the most up-to-date information about job descriptions and entrance requirements, you are encouraged to consult with many different sources. Some available sources are right at your finger tips.

Your **Teachers** can help acquaint you with information about jobs that pertain to their professional specialty. They also can discuss your interests and abilities with you.

Your **Guidance Counselor** is specially trained to assist you in the exploration of careers. He or she is usually the career guidance expert in your school. Literature pertaining to careers is located in the guidance office and the library of your school. Publications such as the **Dictionary of Occupational Titles** and the **Occupational Outlook Handbook** and other career guidance materials are crucial to your career search. Your counselor can help you locate these materials and assist as you review them. You can learn about hundreds of occupations by reading these publications. They include information about:

What a person does on the job;

What abilities and interests are required by the job;

What types of education and training are required;

What the working conditions are like;

What future job opportunities are predicted to be.

As you read through this material, match your abilities, skills, and interests to the jobs which seem appealing to you. A list of organizations and societies that relate to your career interests can be obtained through the guidance office. A comprehensive listing of these agencies is included in an appendix of this publication. By writing or phoning them you can obtain more information about careers of interest to you. Sometimes, guidance departments sponsor Career Days or Career Nights. Local employers set up booths, exhibits, and displays in order to acquaint students and their parents with information about the work their companies perform. Be sure to take advantage of these opportunities. Prior to these career exploratory sessions, students may be taught how to complete job application forms. They also may practice job interview skills.

Information about colleges and military academies, vocational and technical schools, apprenticeship and cooperative education programs and military services also is found in the guidance office. For your convenience, lists of colleges offering degrees in engineering and engineering technology are included in another appendix of this document. Your guidance counselor is prepared to interpret information about financial assistance to you and your parents. This information may help you with the expenses of education or training beyond high school graduation.

Your guidance counselor is trained to help you learn about your abilities and interests. He or she can administer and interpret achievement tests, aptitude tests and interest inventories. He or she can help you match your qualifications with appropriate career goals. At the beginning of each school year, you, your parents and your counselor should review thoroughly your high school courses with your future educational plans, aspirations and tentative career goals in mind.

Your **Part-Time Job Employers** can offer information about their particular occupations and related occupations. They can evaluate your work performance and interest you have displayed in your part-time job. It is wise to seek the advice of individuals employed in specific careers of interest to you as well. They can offer advice based on their practical work experiences. Visit their work settings, and if possible, spend a few days with them on the job. Observe them as they engage in typical work duties. Visits to companies will help you understand the work environment and the types of jobs that workers perform.

Your **Parents And Friends** can be a great help in the development of career plans. Ask questions about your parents' careers. Friends of your family who are employed in occupations related to your field of interest can be helpful in your exploration. Discussions with your own friends can also help you clarify your goals.

Other Sources of Career Information Include:

Individual Firms, Including Manufacturing Firms and Stores;

Local Trade Unions and Apprenticeship Programs;

Local Office of the State Employment Service;

Local Employment Agencies;

Newspaper Classified Advertisements.

School Subjects Emphasized

Careers in aerospace emphasize science, mathematics and technical skills. Your mastery of these three areas will help determine your selection for entry level positions and how quickly you advance in your work assignments. There are places for men and women who have different levels of competency in these skills. You may find that a person with your abilities may specialize in one of these areas, or it is possible that you might prove to be competent in all three areas.

"I cannot imagine many other areas of effort where the technical demands are as high and the excitement of being near the cutting edge of many different technologies as gratifying. I would urge students to consider those special disciplines which seem to offer the most progress and growth in the next 10 to 20 years. These include the field of electronics and new construction materials. I would then urge at least 5 years of college and include adequate attention to at least the lowest levels of study of a few of the humanities. I would strongly urge taking whatever courses are necessary to learn to communicate rapidly, precisely, and convincingly, both orally and in writing. Finally, I would suggest that they be avid readers, always full of curiosity, extremely logical thinkers, have enough understanding to tolerate society as it really is, and be willing to work very hard at any job they undertake."

F. A. Cleveland
Vice President for Engineering,
Lockheed Aircraft Corporation

Science and Your Career

There are many sciences related to aerospace careers. A few of these are: physics, chemistry, biology, psychology, physiology, psychiatry, and geology. However, nearly all scientists must be familiar with the elements of three basic sciences: biology, chemistry, and physics. You will need to study different amounts and kinds of science courses for different occupations. For some jobs, such as skilled trades like welding, high school science courses are sufficient. The training of engineering and science technicians usually includes science courses like those offered at technical institutes or junior colleges. Many professions require only one or two years of college science courses. Some careers demand four years of college work in science while others require several additional years of graduate study.

Even if you do not plan to be a scientist, a knowledge of science will help you in many other careers. A good understanding of scientific principles may lead to a better understanding of the world. With a background in science, you will be able to discuss more intelligently and make better decisions regarding many community issues. For example, an understanding of chemistry and biology will help you decide upon systems to control air and water pollution. A knowledge of science will help you enjoy life in a highly advanced technological society.

Mathematics and Your Career

Mathematics is important to you every time you buy a record album, a pizza or gas for your car. You will use some mathematics throughout your entire life. Mathematics is a science and is sometimes referred to as the most exact science. Mathematics is essential to scientific, engineering and technical careers. It is a precise and universal language, understood all over the world. Actually it would be difficult to find any type of work where mathematics is not useful. The mathematics you study in high school is used in many career fields.

Different occupations require varying amounts and kinds of mathematics courses. For some jobs, high school vocational math courses are sufficient. These courses will help you prepare for apprenticeship training required for many skilled trades. Skilled machine tool operators rely upon their mathematical backgrounds to set up their machines to precise dimensions. To prepare for careers as technicians, individuals will be expected to complete successfully courses offered on a level beyond those of high school vocational math. If you aspire to scientific or engineering careers, you must complete advanced math courses in high school. These courses will prepare you for college level selections. Scientists and engineers must complete three to four years of college level study. Additional years of graduate study often are required.

The trend in aerospace careers requires more and more emphasis on mathematical and related competencies, such as computer science. Statistical and mathematical models are used to solve non-mathematical problems. The person skilled in this discipline probably will find favorable employment opportunities in future years. Even if you do not plan to continue studying math after high school, it is a good idea to take all of the courses available to you. Some day you may change your mind about a career. At that time, you may be required to complete math courses you have not taken.

Emphasis on Technical Skills

Technical skills also are important in a person's training for aerospace careers. Your choice of a career field and your level of aspirations in that field will be influenced by the technical skills you demonstrate. These skills include hand-eye coordination and quickness and ease in using your hands to manipulate objects. Technical jobs include polishing lenses, technical report writing, drawing blueprints for a satellite and micro-welding. Scientists, engineers, and technicians use different technical and manual skills. As is true with science and math courses, the kinds of technical subjects (vocational and industrial arts courses) you select will be determined by your career interests.

To establish a clearer picture of your preparation in these areas of emphasis complete the following chart.

Science and Mathematics Skills

What science and mathematics courses have you completed?

What grades did you earn in each course?

What are your strengths and weaknesses in these areas?

What is your plan to improve in these courses?

What future science and mathematics courses do you plan to take?

Science & Math Courses	Grades	Need to Improve	Plan for Improvement	Future Courses

Special Skill Courses

Drafting, Woodworking, Metal Working, Graphic Arts

What special skill courses have you completed?

What grades did you earn in each?

What are your strengths and weaknesses in these special skill areas?

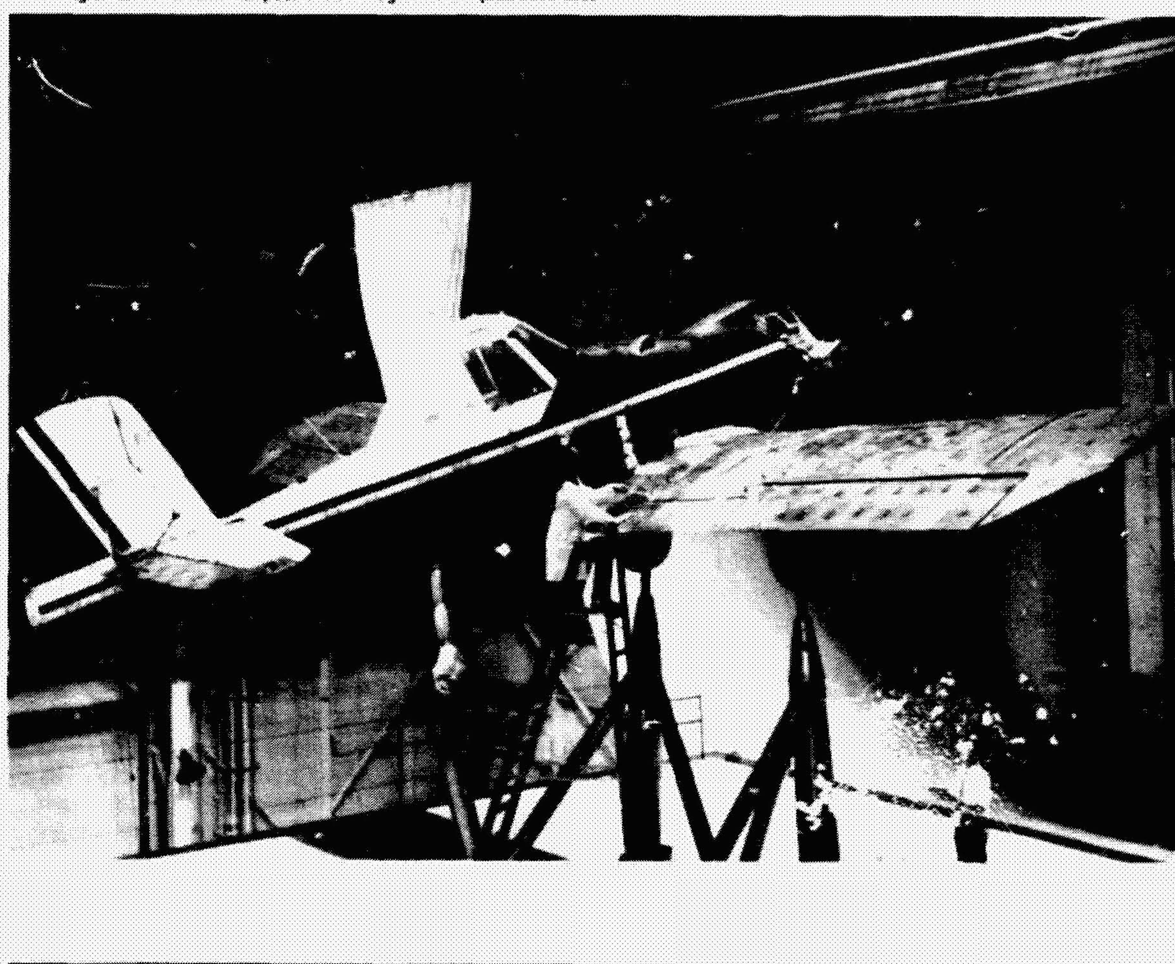
What other courses do you plan to take?

Special Skill Courses	Grades	Need to Improve	Plan for Improvement	Future Courses

Other Important Courses

Although special emphasis is placed on science, mathematics and technical courses, a well rounded high school education is essential. A well rounded program gives the student the flexibility to respond to new, and sometimes unexpected, opportunities. You must be able to communicate your thoughts simply and clearly. Even the most brilliant engineer must be able to explain the significance of his or her ideas if the ideas are to be accepted. Therefore, English literature, grammar, speech and composition courses must be completed with above average grades. Effective oral and written self-expression is crucial to success in any career field. Courses in history, civics, economics, political science, geography, sociology, psychology and foreign language (s) will stimulate your thinking and expose you to new concepts and ways of living. Foreign languages are recommended because international cooperation has become important to aerospace activities. For the scientist, a knowledge of Russian and German might prove valuable. Many scientific documents are published originally in these foreign languages. Students are encouraged to take a wide variety of advanced subjects so that they will be prepared for several possible career fields. Courses in manual skills (woodworking, basic electricity, typing, and mechanical drawing) will help you recognize your aptitudes for technical work. They will acquaint you with material covered in college courses. Skills taught in a typing course will be appreciated when college assignments are due. If time permits, a shorthand course will be a tremendous asset to a student taking notes during class lectures and laboratory periods.

Fluttering tufts reveal air flow patterns over agricultural plane surfaces



Scientific and engineering careers require college degrees. To gain admission to colleges, students must earn good grades in college preparatory courses. Grade point average, class rank, scores on standardized tests, recommendations and participation in extracurricular activities are considered by selection committees at colleges.

Extracurricular activities are an important part of a well rounded high school program. Sports, student government, clubs, school publications and programs offered through the community provide enjoyable opportunities to meet new friends and explore interests. They are evidence of an active, interested student. Participation in these activities may offer clues about your interests for future careers. Admission committees at colleges usually study a student's academic record and participation in extracurricular activities.

Generally, most colleges require good grades in college preparatory courses. The following courses represent typical college preparatory selections:

ENGLISH . . . . 4 credits

MATHEMATICS
(Algebra, Geometry, Trigonometry,
Calculus) . . . . 3 credits

NATURAL SCIENCES
(Biology, Chemistry,
Physics, Physiology) . . . . 2 or 3 credits

SOCIAL SCIENCES
(History, Economics, Sociology,
Psychology, Political Science) . . . . . . 3 credits

FOREIGN LANGUAGE(s) . . . . 2 or more credits

APPROPRIATE ELECTIVES
(Technical subjects, Art,
Music, Gym) xxxxx

Make certain that you have completed all required courses for high school graduation before you select elective courses. Graduation requirements will vary from state to state.

"Aerospace will always offer the maximum challenges in a wide range of advanced technologies. For the years beyond 2000 I would suggest that Buck Rogers is alive and well, living in the 25th century. Propulsion technology will remain the key to progress."

H. Bard Allison
Director of Engineering
Lockheed-Georgia Co.

Looking Ahead to College

Plan your high school courses with the assistance of your guidance counselor, teachers, and parents. It is important to review the entrance requirements of several colleges before you plan your high school curriculum. College catalogs and admissions officers at colleges of your choice will provide specific details about their requirements. Knowing entrance requirements will provide a basis for the selection of the most appropriate courses. This will prevent you from being required to complete additional courses prior to admission to college. It also will prevent your rejection by a college of your choice on the basis of inappropriate or insufficient course work.

Most colleges require scores on standardized college entrance examinations. This information is found in college catalogs. The Scholastic Aptitude Test (SAT) and the American College Test (ACT) are the names of these entrance examinations. Check with your counselor for the dates of these tests and procedures for registering to take them.

Some school systems offer accelerated students the option of taking Advanced Placement Examinations. Certain colleges offer college credits to student who distinguish themselves with high scores on these tests. In this way, advanced students may earn college credits while in high school. This reduces the time and expense required to earn a college degree, and allows students to register for additional, supplementary course work of particular interest. College catalogs and guidance counselors are sources of information about this opportunity.

Selecting a College

Choose your college or university carefully. Gather information about several colleges before you decide upon your favorite choice. You are encouraged to apply to several colleges of your choice just in case you are not selected by the one first on your list. Check the advantages and disadvantages of each school with your tentative career goals in mind. It is a good idea to begin the application process during the summer months preceding the senior year. This will give you a head start over the thousands of seniors also applying to the schools you select. Perhaps you will know of your acceptance or rejection by Christmas. This will be a relief and reduce the tension and suspense of waiting to learn of your status. It will give you an opportunity to apply to other colleges if you are not accepted.

Factors to Consider when Selecting a College

- Available housing
- Accreditation
- Curriculum offered
- Entrance requirements
- Financial assistance programs
- Life style of the students
- Location and size of the college or university
- Travel and social expenses
- Tuition; fees for textbooks, laboratories, student activities; room and board

Since the selection of a college is a major decision in your life, you are wise to gather information from your family, your guidance counselor, the admissions officer at the college, college catalogs and your friends who have attended college. Visits to the campus are suggested. Remember, sometimes compromises and alternate choices must be made. So be flexible!

Cost?

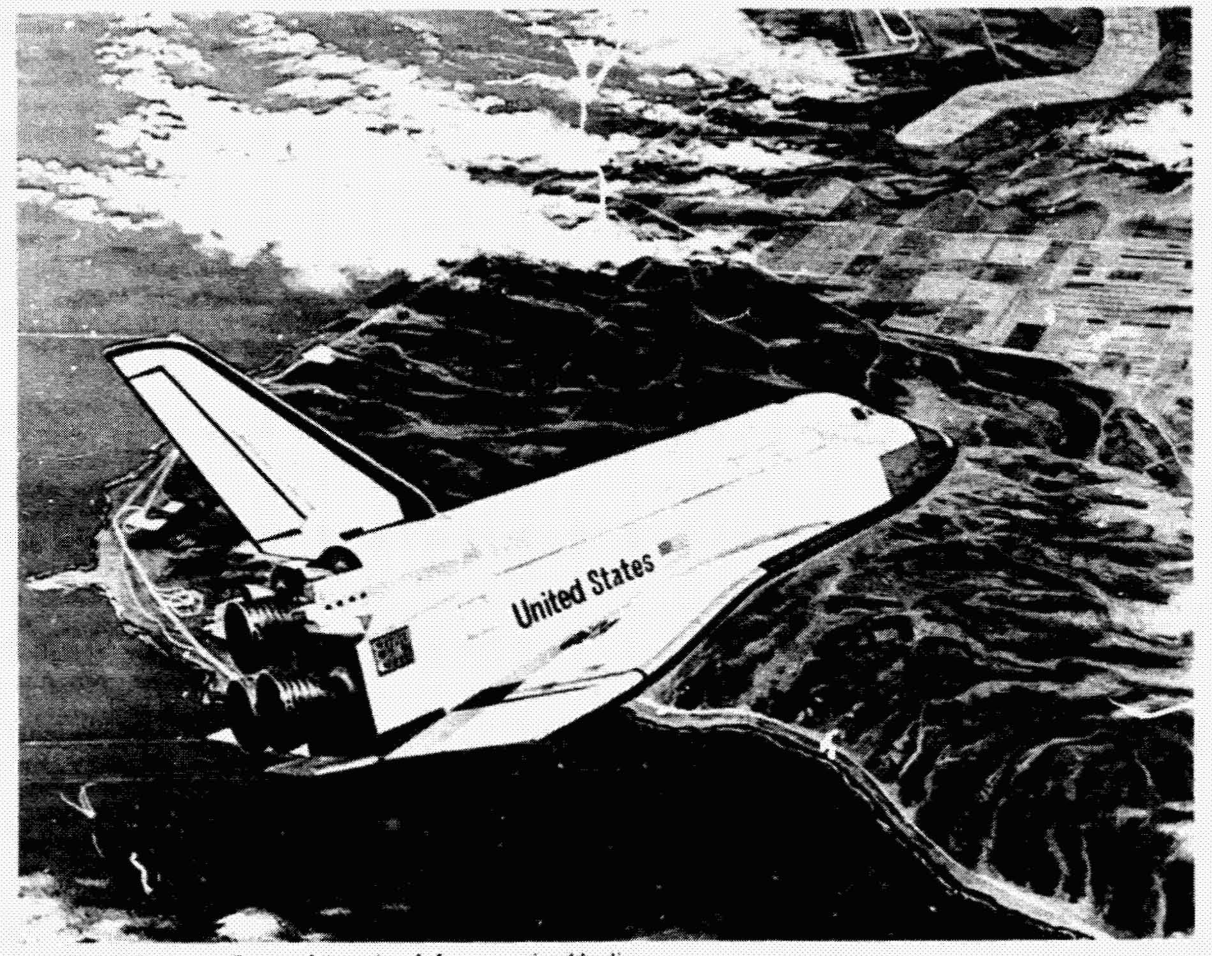
The cost of an education to prepare for aerospace careers will vary. High school graduates with good grades and a sincere interest in a college education usually can find ways to finance the costs of earning a college degree. Costs are determined by such factors as choice of institution, choice of curriculum, and your eligibility for and acceptance of scholarships or other forms of financial assistance. Scholarships, loans, grants-in-aid, fellowships, work-study programs, part-time jobs and cooperative education programs are available to qualified students. Guidance counselors can assist you in your attempt to locate sources of financial aid. Several recent books on scholarships are available in libraries and in the guidance office. This information changes and requires planning and correspondence to ensure your eligibility for funds. The extra effort may pay off in thousands of dollars for your education.

Many colleges offer cooperative education programs. Students in these programs alternate periods of college work and work at job sites. This opportunity provides practical work experiences which bring "life" to classroom y. Practical on-the-job experiences will help decide if you really enjoy the work. These experiences may reinforce your career plans, or you may decide to change your plans. A student in this program can help finance the costs of his or her education. Valuable contacts are established for permanent employment after college graduation as well.

There are hundreds of colleges and universities that can prepare a student for an entry level position in the aerospace industry. The school you select should offer advantages and opportunities related to your unique needs, qualifications, interests, and goals. It should be affordable for you and your family.

Basic College Courses

Undergraduate programs leading to degrees in traditional fields of life sciences, physical sciences, mathematics o engineering are basic foundations for most aerospace specialties. Any accredited college or university is acceptable. Students planning to become aerospace scientists or engineers must master the fundamentals of college level science and mathematics courses. Their knowledge of basic principles will enable them to adapt to the continually changing priorities and requirements which are characteristic of occupations within the industry. This basic understanding provides a solid foundation for comprehending the ever expanding body of knowledge in the fields of science, engineering and technology. An aerospace scientist or engineer completes a basic undergraduate curriculum in his or



Space Shuttle Orbiter . . . Spacecraft into aircraft for conventional landing

her chosen field. He or she then becomes an aerospace specialist through work experiences in research and development and through additional courses. Continuous learning is one of the stimulating characteristics of aerospace careers. Learning new techniques, cooperating with new people and working in different environments provides challenge to this profession.

Preferred College Majors

A number of college majors can provide a solid educational background for the type of engineering, scientific and technical work accomplished by workers in the aerospace industry. The following are suggestions of preferred college majors:

Astronautics	Aeronautical Engineering
Astronomy	Ceramic Engineering
Ceramics	Chemical Engineering
Chemistry	Civil Engineering
Electronics	Electronic Engineering
Electronic—Materials	Electrical Engineering
Geology	Engineering Mechanics
Geophysics	Engineering Physics
Mathematics	Engineering Sciences
Metallurgy	Industrial Engineering
Physics	Mechanical Engineering
	Metallurgical Engineering

TYPICAL DISCIPLINES IN AEROSPACE AND CORRESPONDING EDUCATIONAL SPECIALTIES

This chart matches typical scientific and engineering fields represented in the NASA classification system with appropriate academic preparation. Notice the multidisciplinary orientation of the educational backgrounds.

Academic specialties \ Fields	Data systems	Experimental facilities & techniques	Flight systems	Fluid & flight mechanics	Launch & flight operations	Materials & structures	Measurement & systems	Propulsion systems	Space & earth sciences
Aeronautical Engineering		X	X	X	X	X	X	X	X
Astronautics		X		X	X			X	X
Astronomy									X
Astrophysics				X					X
Ceramics		X	X			X			
Ceramic Engineering			X			X			
Chemistry			X			X		X	X
Chemical Engineering		X	X	X		X		X	
Civil Engineering		X				X			
Electrical Engineering	X	X	X		X		X	X	X
Electronic Engineering	X	X	X		X		X		
Electronics	X	X	X		X		X		
Engineering Mechanics		X	X	X		X	X	X	
Engineering Physics	X		X	X		X	X	X	X
Geology									X
Geophysics									X
Mathematics	X		X	X		X		X	X
Mechanical Engineering		X	X	X	X	X	X	X	
Metallurgy		X				X			X
Meteorology					X				X
Nuclear Engineering		X		X		X		X	
Physics	X	X	X	X		X	X	X	X

Educational Levels for Typical Aerospace Careers

Many diverse occupational choices are available in the aerospace industry. These choices reflect many different levels of specialized training. The following chart* categorizes the titles of a few selected aerospace occupations by the education required for entry level positions.

Specialized Training—specific occupational training including high school, trade and technical education, on-the-job training, and formal study at a community college.

Aerial Photographer
Aerospace Mechanic
Assembler
Communication Technician
Computer Technician
Drafting Technician
Fabrication Inspector
Machine Operator
Millwright
Modelmaker
Model
Patternmaker
Pilot
Skilled Craftsperson
Technical Illustrator
Technician
Teletypist
Tool and Die Maker

Advanced Study and Specialized Experience—graduate study and specific work experiences.

Aeronautical Engineer
Astronaut
Astronautical Engineer
Astronomer
Biomedical Engineer
Chemist
Chief Flight Mechanic
Dietician
Engineer
Environmental Engineer
Flight Surgeon
Geographer
Geologist
Group Engineer
Industrial Engineer
Mechanical Engineer
Metallurgist
Meteorologist
Molecular Biologist
Operations Analyst
Physicist
Research Mathematician

College and University Training—training which leads to a baccalaureate degree after four years of study.

Architect
Communication Specialist
Computer Programmer
Data Systems Analyst
Development Technician
Industrial Planner
Mathematician
Model Designer
Production Technician
Quality Control Inspector
Research Technician
Safety Engineer
Sanitarian
Science Writer
Test Technician

New Careers—emerging occupations in the field.

Aerospace Telemetry Specialist
Biological Adaptations Specialist
Energy Conversion Engineer
Laser Surgery Physician
Medical Telecommunication Specialist
Nuclear Medical Technologist
Satellite Communication Engineer
Solar Energy Engineer

*This chart appears in **Educators' Guide To Careers in Aerospace**. This kit was prepared by the National Career Information Center of the American Personnel and Guidance Association in cooperation with the National Aeronautics and Space Administration.

Chapter Four

Steps to Scholastic Success . . .

If one hundred students were asked to describe what it means to be successful in high school, one hundred different interpretations could be reported. Success for some would mean being: the best athlete, the most talented, the best dressed, the most friendly or the most studious. Students equate high school success with ideas chosen for specific reasons, all different, all important, all extremely personal.

Careers in aerospace science and technology require success in higher learning. Therefore, the term "success" as it is used in this discussion, means that a student is a consistent achiever in academically challenging classes and has distinguished himself/herself in the academic disciplines.

For some students earning good grades seems to happen naturally, with little expended effort. For others, more study is required. What causes this difference? It has been suggested that a combination of factors seem to affect a student's scholastic success.* The most significant factors are intelligence and special abilities, motivation to succeed and management of effective study methods. Chance, or luck, also plays a part in academic success. The extent is not really known.

Obviously, each individual possesses different abilities, skills, competencies and capabilities. Each person is born with certain potentials. The key to success is to identify these special potentials and make the best use of them. Some people are born with strong, healthy, agile bodies. If they exercise diligently and train these special physical capabilities, they may become outstanding athletes. Other people are gifted with musical talent. They can mentally "hear" and arrange musical notes and then translate them into musical compositions using instruments. After hours of practice, they may become expert musicians. Some students are born with special intellectual capabilities. These natural abilities also must be developed in order to produce academic success.

Careers in aerospace demand serious consideration of your intellectual abilities and interests. They require special abilities in mathematics, science, and technical subjects. What school subjects do you like best? What are your strengths and weaknesses? What examples do you have as evidence of your abilities? Grades you have earned in past courses are good indicators of your abilities. Other indicators of intellectual ability are scores on achievement and aptitude tests. Your guidance counselor will interpret these scores for you. By carefully examining these indicators, you will get an idea of your capacity to perform. It is important to understand your special abilities and match them with potential career fields. Your career will be more rewarding if it challenges you with work appropriate to your abilities and interests.

Your interests and abilities go hand-in-hand when planning for potential careers. If you have a great deal of interest in an area but little natural ability, you will not have the capability to perform the

*Special thanks to Mr. Jack Becherer, who served as a consultant for this section. Mr. Becherer is an Assistant Professor, Counseling at Thomas Nelson Community College, Hampton, Va. He is a doctoral candidate at the College of William and Mary in Williamsburg, Va.

tasks with competence. Likewise, if you have the ability to perform but little interest in an area, you are likely to be unhappy with that career. Natural ability plus an interest in a particular career will lead to more satisfaction from your work. Interest inventory tests have been designed to help you become aware of areas of interest to you. You may want to ask your guidance counselor to arrange for you to take one of these tests.

Many extremely bright students fail courses and many students with average intelligence excell. What accounts for this difference? Experts say it is partially the desire to study hard. A strong desire and intention to learn results from interest in courses, the ability to comprehend the material and a purpose for mastering the material. Motivation or desire to succeed academically supplies the energy necessary to plan and practice routine study procedures. It is the driving force that triggers action -- effective study habits. Motives are among the strongest influences on your behavior. They affect the amount of time and effort you are willing to exert in order to succeed. The most powerful motives arise from your goals and aspirations. For example, if you really feel successful and happy when you have mastered complex mathematical equations, your career goal may be to become a mathematician. You will be motivated to study and learn basic mathematical principles. If your goal is acceptance at an Ivy League college and that depends upon earning straight A's, you will dedicate yourself to efficient study patterns. If the praise of your parents depends upon academic success and you want their praise, you will develop and follow study schedules. For these reasons, students with average intelligence and strong interests and goals usually will succeed in their studies. On the other hand, students gifted with intellectual abilities, but lacking interest and purpose for studying, may not be successful.

Goals and aspirations reflect how you picture yourself in terms of other people. They reflect your estimate of your chances of succeeding. Past successes and failures influence your goals and aspirations. Successful academic experiences increase confidence in your ability to succeed. They motivate you to continue the work necessary for repeated successes. Goal setting requires that you recognize your interests and abilities. Past experiences are good indicators of your interests and abilities. The most satisfied students seem to tie their aspirations closely to their levels of performance. They set flexible goals so that changes can be made. These changes may result from acquiring more information, more self-awareness and more maturity. Flexible and attainable goals will prevent frustrations and disappointments.

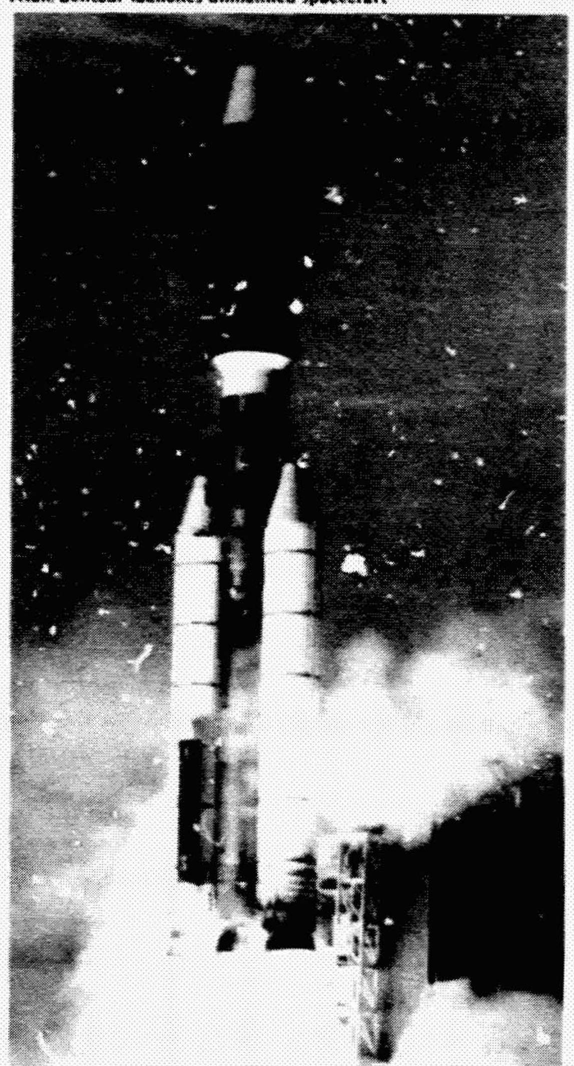
If your goal is to become a scientist, engineer, or technician, you must have natural abilities, interests and past successes in math, science and technical subjects. Science and engineering careers require at least a bachelor's degree. This implies developing study patterns which will lead to success in college courses.

The following questions may help you clarify your goals and motives for pursuing a career in aerospace. Spend some time thinking about these questions.

1. Do I really enjoy studying mathematics and science courses?
2. Do I have natural ability to succeed in these courses?
3. Why have I considered a career in science, engineering, or technology?
4. What special qualifications do I possess for these kinds of jobs?
5. Do I really want to go to college?
6. Am I going because my friends are going?
7. Am I afraid that I'll disappoint my parents if I don't attend college?
8. Can I handle the freedoms of college life -- no curfews or handling my own expenses?
9. Am I responsible enough to complete assignments on time without the watchful eye of my parents or teachers?
10. Can I establish short term educational goals for each semester or quarter?

Efficient management of time and study procedures is also a significant factor in the formula for academic success. Efficiency implies maximum learning from the least work. It also implies organizing your time into effective study patterns that work for you. Planning a study schedule takes real effort. It means that you must decide upon priorities. As you develop a study schedule, you may find it necessary to give up or postpone activities that are fun. Imagine the amount of time you spend watching T.V., going to the movies, talking on the phone or just visiting with friends. Leisure time activities are important to all of us. However, they must be scheduled in relation to the study schedule. A sensible balance between leisure activities and study increases a student's chances of success. Your schedule for study should become a habit. Having a set time to study a certain subject increases the likelihood that you will retain the material and decreases the amount of time that you are likely to waste. Regularity seems to be the key.

Titan/Centaur launches unmanned spacecraft



"Space travel will change life on earth in ways that even those who are in the profession cannot presently imagine. The Space Shuttle is quite a vehicle—one that gets to Earth orbit in little more than 8½ minutes. My job for this first launch is that of a member of the vehicle support team. It's an exciting job and a challenge, and I love every minute of it.

It takes extensive preparation academically and a lot of experience to prepare for the astronaut program. After high school I studied engineering, math and science. Then I trained in the Air Force as a helicopter and jet pilot. Later I went through the military test pilot program and was qualified to test and research experimental aircraft.

Space has always held a special fascination for me. When the chance to apply for the astronaut program came, I took it and felt really fortunate to be selected.

Now I know that it takes a lot of hard work and all kinds of people to make up a successful space program. My military background taught me the value of teamwork. I've also learned to ask questions and how to find the answers. It's essential to believe in yourself and believe that you "can do" whatever is important to you, if you work hard and you are always willing to try a new experience."

Frederick D. Gregory
Lt Colonel, USAF
NASA Astronaut

DAILY RECORD OF ACTIVITIES AND TIME USAGE

DAY ____________________

DATE ________________________

TIME	DESCRIPTION OF ACTIVITY
6:00 – 6:30 a.m.	
6:30 – 7:00 a.m.	
7:00 – 7:30 a.m.	
7:30 – 8:00 a.m.	
8:00 – 8:30 a.m.	
8:30 – 9:00 a.m.	
9:00 – 9:30 a.m.	
9:30 – 10:00 a.m.	
10:00 – 10:30 a.m.	
10:30 – 11:00 a.m.	
11:00 – 11:30 a.m.	
11:30 – 12:00 a.m.	
12:00 – 12:30 p.m.	
12:30 – 1:00 p.m.	
1:00 – 1:30 p.m.	
1:30 – 2:00 p.m.	
2:00 – 2:30 p.m.	
2:30 – 3:00 p.m.	
3:00 – 3:30 p.m.	
3:30 – 4:00 p.m.	
4:00 – 4:30 p.m.	
4:30 – 5:00 p.m.	
5:00 – 5:30 p.m.	
5:30 – 6:00 p.m.	
6:00 – 6:30 p.m.	
6:30 – 7:00 p.m.	
7:00 – 7:30 p.m.	
7:30 – 8:00 p.m.	
8:00 – 8:30 p.m.	
8:30 – 9:00 p.m.	
9:00 – 9:30 p.m.	
9:30 – 10:00 p.m.	
10:00 – 10:30 p.m.	
10:30 – 11:00 p.m.	

PLANNING A SCHEDULE FOR STUDY

Before you can plan a schedule of study, you must be aware of exactly how your time is spent. This can be done by keeping a detailed daily record of activities for one week. Use the following form to record your activities and the times each day for one week.

Once you have recorded your daily activities for one week, examine them. Study the activities and the time spent on each. Classify the activities according to type. This chart will help you become aware of the types of activities and the time you spent on each.

WEEKLY SUMMARY OF ACTIVITIES

WEEK OF ______________________

TYPE OF ACTIVITY	NUMBER OF HOURS SPENT ON EACH ACTIVITY
CLASSES	
WORK	
STUDY	
SLEEP	
MEALS	
RECREATION	
a. INDIVIDUAL ACTIVITIES	
b. SOCIAL ACTIVITIES	
OTHER ACTIVITIES	

Ask yourself the following questions as you study your chart

1. Do my activities correspond with my goals?
2. Do I spend enough time on study?
3. How can I schedule more time for study?
4. Which activities require less time?
5. Which ones should be eliminated from my schedule?
6. Am I spending too much time on any one particular activity?

Now you are aware of how your time is spent. You are ready to organize yourself and your time. A schedule is the best way to organize your time. These steps will help you plan a schedule for study.

1. Record all **fixed time** commitments such as time in classes, work schedules, church, etc. These are activities that do not change from week to week.
2. Schedule activities **essential to living**, such as meals, sleep, dressing, etc.
3. List the amount of **study time** needed for each class on a daily basis. Ask yourself: How many hours do I need to study in order to earn the grades I want?
4. Schedule periods for **study and review.**
5. Schedule periods for **relaxation and recreation.**

Use this form to schedule your time.

STUDY SCHEDULE

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
8:00 – 9:00							
9:00 – 10:00							
10:00 – 11:00							
11:00 – 12:00							
12:00 – 1:00							
1:00 – 2:00							
2:00 – 3:00							
3:00 – 4:00							
4:00 – 5:00							
5:00 – 6:00							
6:00 – 7:00							
7:00 – 8:00							
8:00 – 9:00							
9:00 – 10:00							
10:00 – 11:00							
11:00 – 12:00							

Developing study habits means finding study tips and developing a plan to use these tips. Counselors and teachers are sources of information on study skills. Other sources are reference books. These books are suggested sources:

HOW TO READ AND STUDY FOR SUCCESS IN COLLEGE, 2nd edition, Maxwell H. Norman & Enid S. Kass Norman. (New York: Holt, Rinehart, and Winston, 1976).

HOW TO STUDY, 6th edition, Thomas F. Staton. (Distributor: How to Study, P.O. Box 6133, Montgomery, AL. 36106, 1977).

STUDENT's GUIDES TO EFFECTIVE STUDY, William F. Brown. (Effective Study Materials, P.O. Box 603, San Marcos, TX., 1970).

Remember that knowledge of study tips is not enough -- you must practice them in order to produce scholastic success!

This publication is not designed to teach study skills. However, the following tips are suggested to acquaint you with some tips and strategies available to you.

STUDY HABITS FOR THE STUDENT

The Physical Setting for Study:

The physical setting for study affects concentration. A good room for study makes it easy to start studying and helps concentration. Here are some points which may help:

1. Locate a good study desk or table located in an area away from distractions;
2. See that your study area is well lighted;
3. Study by yourself most of the time;
4. Keep study materials and books near at hand;
5. Make efficient use of study periods during school.

Planning Your Time for Study:

Planning, or budgeting, your study time is very important. It is essential not to fall behind. Once you fall behind, it is very hard to catch up because there is always new work to be done. This is true of all subjects, but particularly so of mathematics,

Supersonic engine inlet investigation

science and foreign language. Here are some points to remember in planning your study time:

1. Make and keep a study schedule;
2. Budget your study time;
3. Use "odd moments" for studying--take advantage of brief times during the school day or en route to school.

Better Listening and Note-taking:

In school, as well as out of school, listening is very important. Good listening is an active process. The good listener is constantly thinking, evaluating, and drawing conclusions. In school, be alert to important ideas which are discussed in class. Your teachers and classmates will present material and explanations which you may not find in your textbooks. No one else can listen for you. Improving your listening habits and skills will improve all of your school work.

Here are some aids that will help you to train yourself to listen better:

1. While listening, look for main ideas;
2. While listening, take notes;
3. Revise notes later to clear up points, and fix the material more firmly in your mind for future use.

Preview:

1. Read over the title for the chapter. From the title try to get an idea of what the chapter will be about.
2. Look over the section headings.
3. Read the first and last paragraphs of the assignment.
4. Study the pictorial aids:
   a. pictures
   b. tables
   c. maps
   d. charts
   e. outlines
5. Take an inventory--ask yourself, "What do I know about the chapter?"

Previewing is important. It will save you time because it prepares you for better understanding and faster reading. It will also help you remember better.

Reading the Assignment:

Reading an assignment requires active thinking. What you derive from your reading depends largely on what you bring to it. Good reading requires interest, knowledge, and curiosity. For good reading:

1. Make up questions suggested by the main headings. Turn chapter headings and sub-headings into questions.
2. Read to answer your questions. As you read, watch for the answers to the questions you have raised. It means reading all the material required by your assignment, but you should be looking for your answers as you read.
3. Check your understanding by reciting the answers. After finding the answer to your question, repeat it to yourself. Stop reading at the end of each section, take time out, and repeat in your own words the answers to your question.
4. Re-read when necessary to clarify any ideas of which you are unsure.

Note-taking:

1. Jot down the **key words** and phrases in a preliminary outline. These notes are for your personal use, and should be helpful to you. Notes will not supply all the information in detail, but they will give you a picture in outline form. When taking notes, keep these points in mind:
   a. Use your own words whenever possible
   b. Confine your notes on a chapter to one side of a notebook sheet, if possible.
   c. Look over your notes a day or so after taking them. If they lack clarity, and are cluttered or poorly organized, revise them.
2. Underline key words and phrases. **If you own the book**, you may prefer to underline key words and phrases in the book.
3. Make diagrams to clarify ideas, whenever this seems necessary or appears to be helpful.

Remembering:

1. Find an interest in what you are studying.

2. Have a clear-cut grasp of the basic ideas. Clear understanding is necessary for good remembering.
3. Learn by wholes. Before you begin to study, know what the author's main theme is, and how the main ideas are related. Then study the parts, the details which support the principal ideas.
4. Use more of your time in reciting than in re-reading. Reciting helps you to remember better than re-reading, because it forces you to think harder, as you try to recall what you have learned.
5. Spot the key words and phrases. They will help you remember the ideas for which they stand.
6. Use as many of your senses in as many ways as possible. Try reading, reciting, writing out the answer, or sketching diagrams where appropriate.
7. Distribute your practice in learning over several study periods. You will remember more of an assignment if you divide your learning of any subject over two or more separate periods of moderate length.
8. Learn for the future. If you memorize something only well enough to pass an examination, you will probably forget it quickly. If a fact or idea is worth learning at all, it is worth retaining. You should overlearn to compensate for the "curve of forgetting."
9. Try to use what you learn. You tend to remember the things which you put to use. You might explain a lesson to someone, use a new idea during a discussion, try to relate new facts or concepts to ideas already studied in the same subject, in other subjects, in conversations, and in your own personal experience.

Taking Examinations:

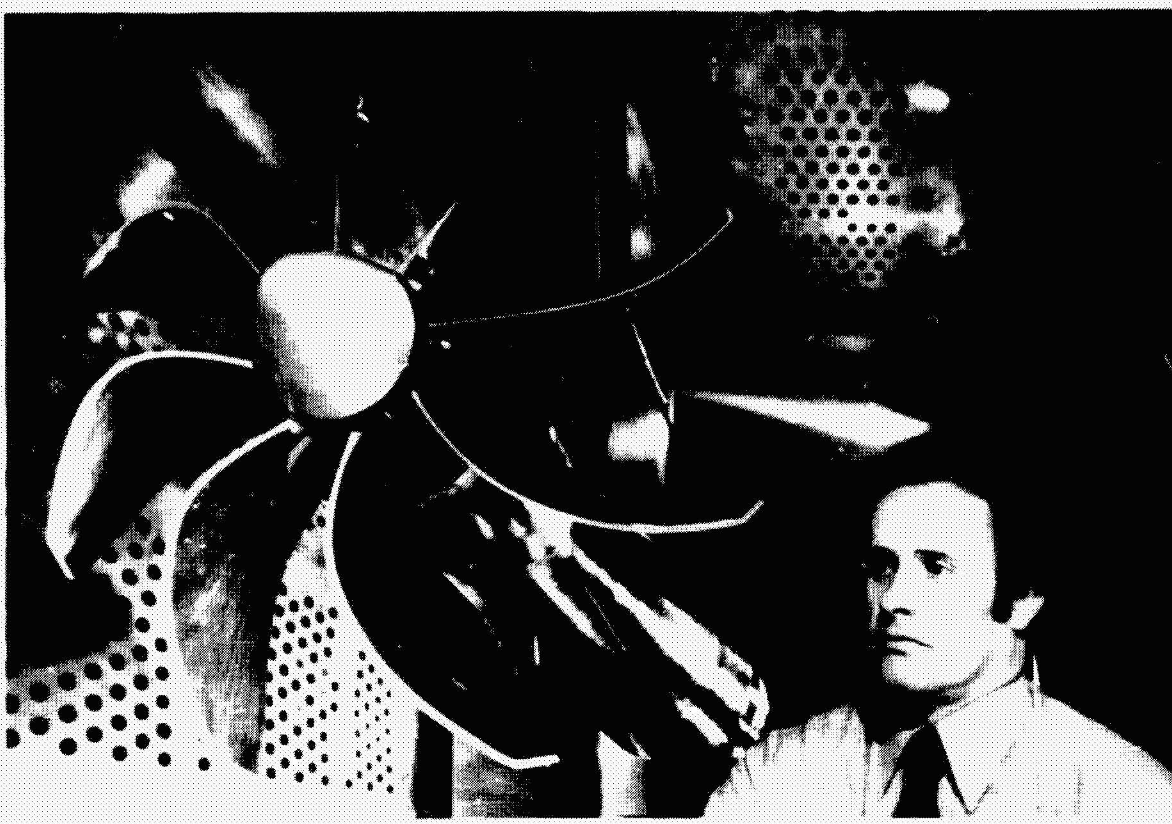
Your best preparation for examinations is regular, day-by-day study. You should set some time aside for periodic review; at least one hour for each subject per week should consist of review.

Here are some aids in preparing for examinations:

1. Plan a definite examination **study schedule** and stick to it.
2. Prepare and study a master outline of the subject. The master outline is a condensed version of all your notes on lectures, discussions, and readings.
3. Try to make up an exam for each course in which you expect to be tested. Then take it, check it. Be serious about it.
4. Pay special attention to troublesome points.
5. Get a good night's sleep before the examination.

Study Helps: Five Sources of Information

1. Use your own resources as much as possible.
   a. Get in the habit of relying on yourself. Do not lean on others any more than necessary. But **know when and whom to ask for help**.
   b. Take an active interest in your studies.
   c. Use initiative when studying. Do some extra reading, whether or not it is assigned. Be alert for current events which may have a bearing on what you are studying.
   d. Prepare carefully for class. Carry out the required assignments and master them. Do not let yourself fall behind.
   e. Participate actively in class. Enter into discussion. If there is something you do not understand, ask questions. Listen attentively and take notes during class.
2. Master your **textbook**. After yourself, your textbook is your most important study help. Get thoroughly acquainted with it.
3. Learn from **other students**. Listen actively to what your fellow students have to say during class discussions, recitations, question periods, and when they report on books read or projects undertaken. You may not agree with what they say, this in itself contributes to learning.
4. Talk over with your teacher any questions you have concerning your work. When a question comes up about your work which you cannot answer, do not let the matter drop. Ask the question in class. If the answer given in class does not satisfy you, make an



Advanced propellers improve fuel consumption

appointment with your teacher to discuss the matter further.

5. Browse in the library. Browsing in the library means reading here and there in books and magazines. You can browse for recreation or for study purposes. Browsing for information should be systematized and purposeful. You browse for information on a specific topic or to enlarge your background and knowledge of a particular subject.

Some of the tools in the school library and in the public library which you should become familiar with are:

a. Dewey Decimal System

b. Card catalogue Microfiche

c. Encyclopedia and its supplements

d. Reader's guide to Periodical Literature

e. Library of Congress Classification System

f. Indexes and Abstracts

Read Faster:

A problem which faces students in planning study time is the periods which can be set aside for that purpose. Reading faster (while keeping the level of comprehension high) can be a great asset.

To be an efficient reader you must be a flexible reader. This means that you must realize that you cannot read everything at the same rate. You need to read technical books, or thought-provoking essays more slowly in order to think them through. Other materials may be covered more rapidly. Set your pace in accordance with the material to be covered.

If you plan to increase your speed, set reasonable goals. If you set too high a goal for yourself at first, you may soon become discouraged and give up altogether.

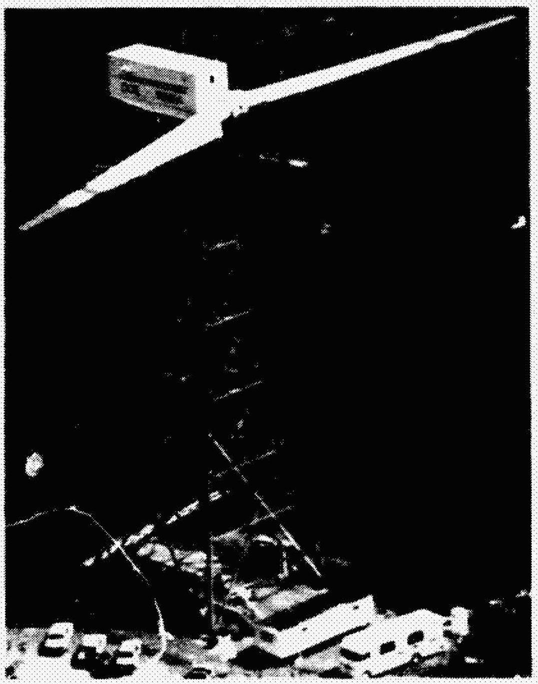
Spell Correctly:

Misspelled words will lower grades. Your best friend is the dictionary.

"I was motivated to pursue a career in aeronautical engineering from the time I was 9 or 10. While I cannot explain what was the original stimulus, I do remember visiting the local airport in Springfield, Illinois on Sunday afternoons when the arrival of the mail plane was a big occasion. It came all the way from St. Louis, a hundred miles away. I recall at the age of 15 or 16 I hitchhiked there, and slept in a corn field in order to attend a big air show at Lambert Field. There was never any hesitation about what I wanted to do or what I wanted to study in college. Today, if I were to counsel high school students who are interested in aerospace, I would advise them to spend enough time in college, probably at least five years, and learn not only the technical disciplines, but also how to write, how to speak, and how to present one's self and one's material. In addition, I would suggest that they pursue as many courses in systems engineering as possible, and be sure to include courses in data processing and computer applications. In all of my career, I have observed that the people that move ahead fastest were not necessarily the very best technical people, but those who had adequate technical skills combined with the various communications skills that are required in today's society.

In the years beyond 2000 I predict that aerospace engineers will be designing, testing and operating large supersonic transports and will probably be designing hypersonic transports, to fly at Mach 4 or 5 (four or five times the speed of sound). In addition, there may within 70 or so years be intercontinental ballistic vehicles carrying people from Washington to Sydney, Australia in an hour or less. There will certainly be manned communities in space, factories in space, and serious development work in interplanetary travel. Astronauts will be landing on Mars and maybe some of the moons of Jupiter."

James S. Martin, Jr.
Vice President and General Manager
of Martin Marietta's Baltimore Division,
and former Viking Project Manager for NASA



Wind-driven turbines produce electrical power

Build Vocabulary:

Vocabulary building is necessary in all subject areas. The specialized vocabularies necessary to the understanding of science, social studies, math, foreign language, and English are your responsibility. You can reserve a special place in your notebook for definitions which are necessary in each subject. Another approach is that of keeping "vocabulary cards;" put the word on one side and the definition on the other side of a small index card. You can use different colors for different subjects, and keep the cards in a file box for handy reference and study.

Solve Mathematics and Science Problems Efficiently:

Math and science problems require a different kind of reading, with more attention to details. Here are some pointers that may help you:

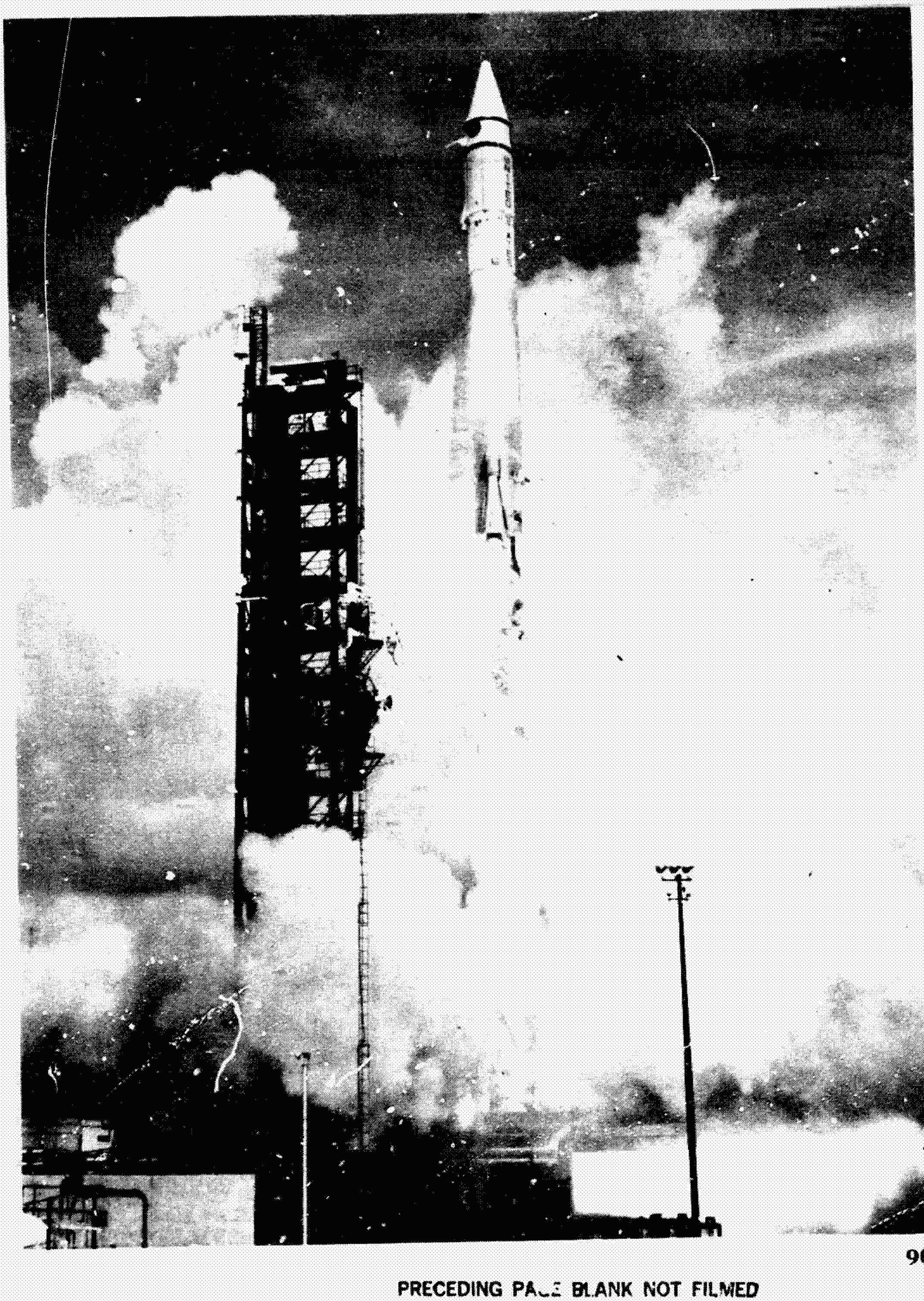
1. Find the question and state it in your own words;
2. Determine what process or formulas you need;
3. List the facts and figures required to answer the question;
4. Estimate your answer;
5. Check your answer; compare it with your estimate.

Skimming:

You skim a page or paragraph by moving your eyes rapidly over the material in search of specific information. Headings, topic sentences, key words, and guide words can help you.

IMPROVING RATE AND COMPREHENSION

1. **Read regularly:** Practice is extremely important. Read as much as you can. Practice at least half an hour a day, more if possible.
2. **Begin with easy material.** At the outset read material with a familiar vocabulary and ideas that can be grasped without effort. Get the feeling of moving along the lines of print quickly and comfortably. Begin with fictionized biography, science fiction, adventure stories, or other materials high in interest value to you.
3. **Work toward more difficult materials.** When you begin to see progress, step up to the next level of difficulty. Read news magazines and nonfiction on topics of current importance. Eventually you will work to your rate on all types of reading. As soon as possible, turn your attention to your textbooks, etc.
4. **Understand what you read.** Rate is determined primarily by the ability to comprehend. Read aggressively to answer questions. Before you start, turn the title into a question and keep asking, "What is the answer? What is the author saying?" Go in with a question; come out with an answer.
5. **Determine your purpose before you begin.** Decide why you are reading the particular selection and estimate its difficulty. Then set yourself to read at your most efficient rate in terms of these factors.
6. **Reduce vocalization in all silent reading.** Resolve to get the point by thinking the meaning, not by saying the words. Press to read faster than the top speed at which words can be pronounced.
7. **Read under progressive pressure.** During practice, read as rapidly as you can without jeopardizing comprehension. Read as if you were to take a quiz in 10 minutes and hadn't studied the lesson.
8. **Improve your vocabulary.** Strange words interfere with understanding. Since speed is a function of understanding, you will profit with a systematic attempt to increase your word knowledge.
9. **Increase your store of knowledge.** Intelligent reading requires more than a mere knowledge of what the word means. The more you know about a subject, the better and faster you can read it.
10. **Don't make a fetish of speed.** Slow down as the occasion demands. Experts use many speeds, not just one.
11. **Be persistent.** There is no magic formula to show you how to double your rate overnight. Pressing to read faster and answer questions may be fatiguing at first. For a time you may even seem to be more inefficient than before. But keep at it. Use any free time for additional practice. With a little persistence, more effective reading will become habitual.



Chapter Five

Career Choices . . . Eliminate Chance

It is generally accepted that at different stages during life most of us will make decisions about full time employment. Our society is based upon the Puritan work ethic which implies that adults are expected to be productive members of society. Their productivity is based upon full time, permanent employment. Even small children refer to the time when they will go to work. They seem to realize that they will be expected to work once they reach adulthood. Think back to the times when adults posed the question to you, "What do you want to be when you grow up?" What were your answers to this question? Listen to kindergarten and early elementary school children as they project themselves into the future. Little girls typically imagine themselves as nurses, teachers, movie stars or mommies. Little boys fantasize about working as firemen, truck drivers, policemen, spacemen or football players. Their play activities reflect their work fantasies, preferences and aspirations. Have your career aspirations changed since you were in elementary school? Usually as people mature, their career goals change. Your career goals as an adolescent are probably different from those during your childhood. It is highly probable that these goals will be modified during your adult years. There are many theories which attempt to explain people's typical behaviors during the process of making decisions about careers.

These theories are demonstrated by the decision making processes of the people in your life. Ask your parents, neighbors, teachers and others how they selected their first permanent job. Some of these people might respond by stating that they just drifted into the field by accident. Their decisions were based on chance. Others might admit that their first job was the only one available for someone with their background and living in that location. Others might complain of basing their decisions on inadequate or incorrect information available to them. Other people you survey might reflect for a moment and state that they chose the type of job they always dreamed about. It offered them status, prestige or financial rewards which were important to them. Or they chose a job because they wanted to express themselves in creative ways through music, art or writing, for example. They may have wanted a job helping or assisting others. They characterize their jobs as fitting their needs, personalities and interests. They carefully selected the jobs and thoroughly planned a route to acquire the necessary training to enter the chosen field. Some might say that they elected to follow in their father's, mother's or some admired person's footsteps. And finally, some might acknowledge that their jobs were reflections of the expectations of their parents. They felt pressured to succeed in careers chosen for them by their families.

Have you ever wondered what factors will influence your career decisions? Some of you may have formed career aspirations which are idealistic and inappropriate. These goals may be based on information learned from watching fictional characters on the television or in the movies. Some of you have developed realistic and appropriate career objectives. You have considered your intelligence and special abilities; the values you have learned from your families and friends; the social and economic situation of your family; your past work experiences and other occupational information.

It appears that determinants of your occupational aspirations include combinations of interrelated factors The mixture of these factors differs from person to person, depending upon social and economic backgrounds, as well as inherited traits.

Factors that will affect your career choices include your personal experiences in your home environment with your family members. The values and attitudes transmitted to you from your family are extremely important to your career development. You may not even be aware of them. You probably accept them as ways of life without questioning them. Basic attitudes toward work are learned in the home. Take a moment and consider your answers to these questions:

Do your parents value productivity?

Do they tend to believe that any job is acceptable as long as it pays a good salary?

Do your parents appreciate an education or do they think school is a waste of time?

Do they encourage you to express your dreams, fears and concerns about future jobs?

Are there books and magazines in your home for you to read about different types of careers? Do you read them?

Do your parents encourage you to explore non-traditional jobs which in the past were characteristic of only one sex or race?

Have your parents taken you to visit where they work? Have they explained what tasks are required of them?

Answers to these questions will expose your ideas of how you think your family views the process of career development. Your answers will offer hints about how well you are progressing towards satisfying career choices. The support of your family and the resources available to you for your training are crucial to your career plans. The social and economic status of your family influences the types of occupations with which you become acquainted. Different social classes encourage different expectations, values and aspirations. The life styles of the people living in the same community and attending the same schools also influence your outlooks, motives and actions. If most of your friends plan to attend college, you are likely to attend college also. If most of them seek jobs following graduation from high school, you may be inclined to join them.

Personal characteristics such as your intelligence, physical attributes, sex and your own appraisal of your abilities, aptitudes and interests are interrelated with environmental factors. Social factors such as your citizenship, religion and race frequently are related to the process of selecting occupational choices. The prosperity of the local and national economy, the state of technological advancement and the political situation of the nation, including war time conditions, affect your attitudes and chances of obtaining the jobs you aspire to enter.

Some experts* believe that you are attracted to vocational preferences because they are a means for you to express your ideas about the kind of person you believe you are. The occupations you select are based upon how you picture yourself performing the requirements of the jobs. Occupational choices then are one means of implementing your self-concept. Your self-concept is your picture of the kind of person you are, your views of how you relate to others and your ideas of how you behave in certain situations. Your satisfaction in a job may be related to the degree to which your self-concept fits the role requirements of the job. The following questions may help you clarify your ideas about yourself in relation to work assignments.

Do you see yourself typically working alone or with other people?

Do you picture yourself working with things, ideas, or people?

Do you tend to be inquisitive and scholarly or intuitive and imaginative?

Do you prefer solving problems using orderly scientific and mathematical procedures or are you more nonconforming and impulsive in your methods?

Do you aspire to a job allowing you to be an aggressive leader or a conforming follower? Neither of these positions is good or bad; they merely represent your particular preference.

Do you prefer structured work situations or do you want to be free to establish your own time schedules and work objectives?

Do you feel most comfortable with work assignments which are repetitive and routine or do you enjoy a variety of different responsibilities?

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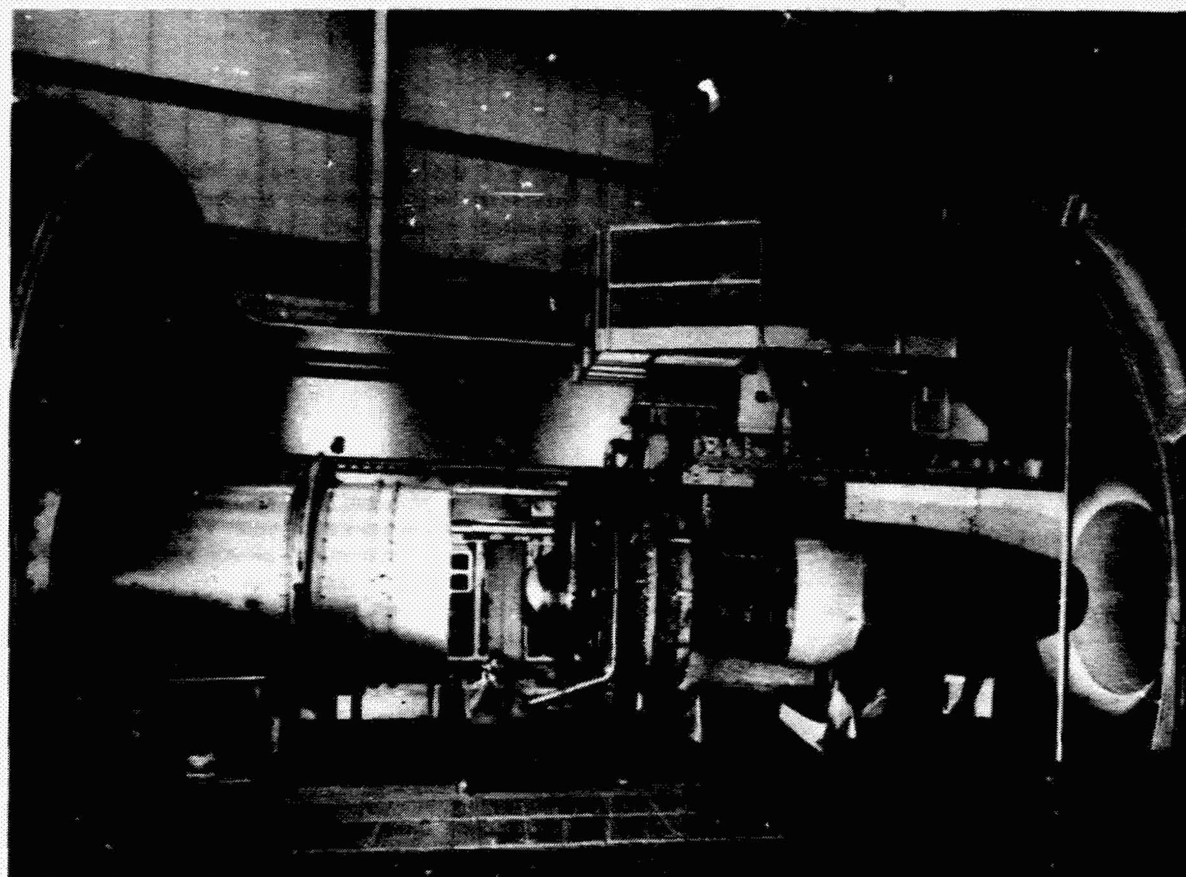

Altitude chambers expose aircraft engines to a variety of flight conditions

Are your abilities more clerical, more verbal, more analytical, more social or more artistic?

Carefully examine your responses to these questions. You may want some assistance from your guidance counselor. Your counselor can assist you in further exploring your vocational self-concept, clarifying it and checking it against the reality of your personal experiences, test results and perceptions about you from others. It is generally accepted that a person can enjoy a wide variety of jobs and that a specific job can attract a variety of personality types.

The process of forming a self-concept in relation to a career is a continuous process of observing yourself and your environment. It involves a phase known as "self-differentiation," which means that you notice differences between yourself and others. You begin to ask the question, "What am I like?" The phase referred to as "identification" occurs at about the same time as self-differentiation.

During the phase of identification, you become aware of similarities existing between you and the parent of the same sex. If you are a male, you usually attempt to be like your father. Typically, the male child associates "maleness" with occupations because most of the men in his life leave home, go to work, and when they return home they talk about work. The young boy sees men come to his home in connection with work. They may be electricians, meter readers, plumbers, furniture movers or salesmen. The boy discovers that he can resemble a number of males, assume a variety of masculine roles and choose an occupational role based on what appeals to him.

Little girls tend to select occupations similar to those chosen by females who are important to them. Especially in the past, the female child was exposed to female role models who most often worked in the home. If their mothers left home to go to work, they tended to talk less about their work at home

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than did the fathers. The mothers also continued to perform the domestic chores while they were home. This pattern is becoming less true as more mothers are pursuing careers which take them away from the home. Today and in the future young girls and boys probably will observe their mothers and fathers in a variety of traditional and nontraditional occupational roles. Females will engage more in engineering and similar careers and males will feel more comfortable becoming nurses or other roles typically dominated by females.

Role-playing behaviors accompany the identification phase. Watch children as they play. You will notice that they pattern their behaviors after adults who are important to them. In their imaginations and behaviors they perform as they "see" adults perform. Through role-playing you "tried out" a role to see if it matched your vocational self-concept. You may have discovered new things about yourself. You may have decided that the role was uncongenial and so you chose another occupational role to explore.

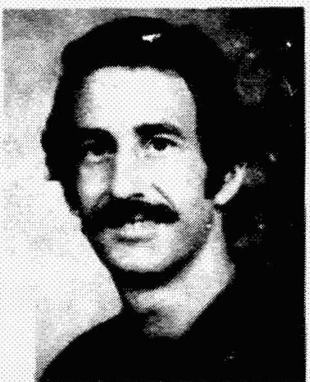
Adolescents also aspire to pattern themselves after admired adults. As an adolescent, you are viewed as being in the process of investigating the world around you, exploring the roles you are expected to play and considering the career opportunities which will allow you to express your self-concept. During adolescence, your self-concept is clarified and modified. Experiences not specifically vocational exert influences on your career choices. You are expected to begin to formulate ideas about work appropriate to yourself. You are forming tentative choices about careers. These tentative choices require your commitment to a type of education or training which will lead toward some specific occupational goal.

Reality testing follows role playing. This phase strengthens or modifies self-concepts and confirms or contradicts the possibility of translating self-concepts into occupational roles. Many opportunities for reality testing exist. For example, the individual with successful experiences assemblying model airplanes may one day become a structural analyst assigned to an advanced aircraft. Successful experiences with algebra and physics may reinforce a student's interests in mechanical engineering which were motivated through admiration of an adult. Th student who ‹ ..ys serving as president of the senior class may be inclined towards a managerial position as a ·roject manag.. for an aerospace industry. The cooperative education student who spends a semester in a research lab ratory may discover that this type of work is not rewarding and may decide to select a different career.

The translation of self-concepts into occupational roles proceeds in several hypothesized ways or combinations of ways. The first is identification with an adult of significance to you. You see yourself as similar to this "important" person because you want to be like this individual. You create a picture of the occupation of that person based on how you perceive the person. You select a similar career. Your perceptions may have been misleading. If so, your career selection may not be suitable for you. Experiences created by chance may lead you to discover a vocational role congenial with your self-concept. Sometimes the awareness that you possess qualities important to a certain field may lead you to fully explore occupations in that field. This process of awareness occurs in steps. For example, you earn A's in advanced algebra and consequently register for physics in the junior year of high school. Good progress in physics encourages you to believe that you possess mathematical and scientific abilities. You pursue your interests in science and build upon your analytical abilities. Once in college, you discover that a career as a solid-state physicist seems appealing to you.

Implementing your self-concept is the final step in this process. The entry level position you accept represents the conversion of your self-concept into a vocational reality. Individuals who see themselves in positive terms continue to expand their career options. Individuals with poor self-concepts tend to lack confidence in themselves and limit their possibilities.

Hopefully your career decisions will be based on adequate information about yourself and occupations. You are more in control of your decisions if you are aware of the factors influencing those decisions.



"Space is our most exciting frontier. Trying to understand it stretches our minds, and physically reaching out for it stretches our technology. I spent the first part of my professional life doing the former as an astronomer. I am now fortunate to be doing the latter as an astronaut.

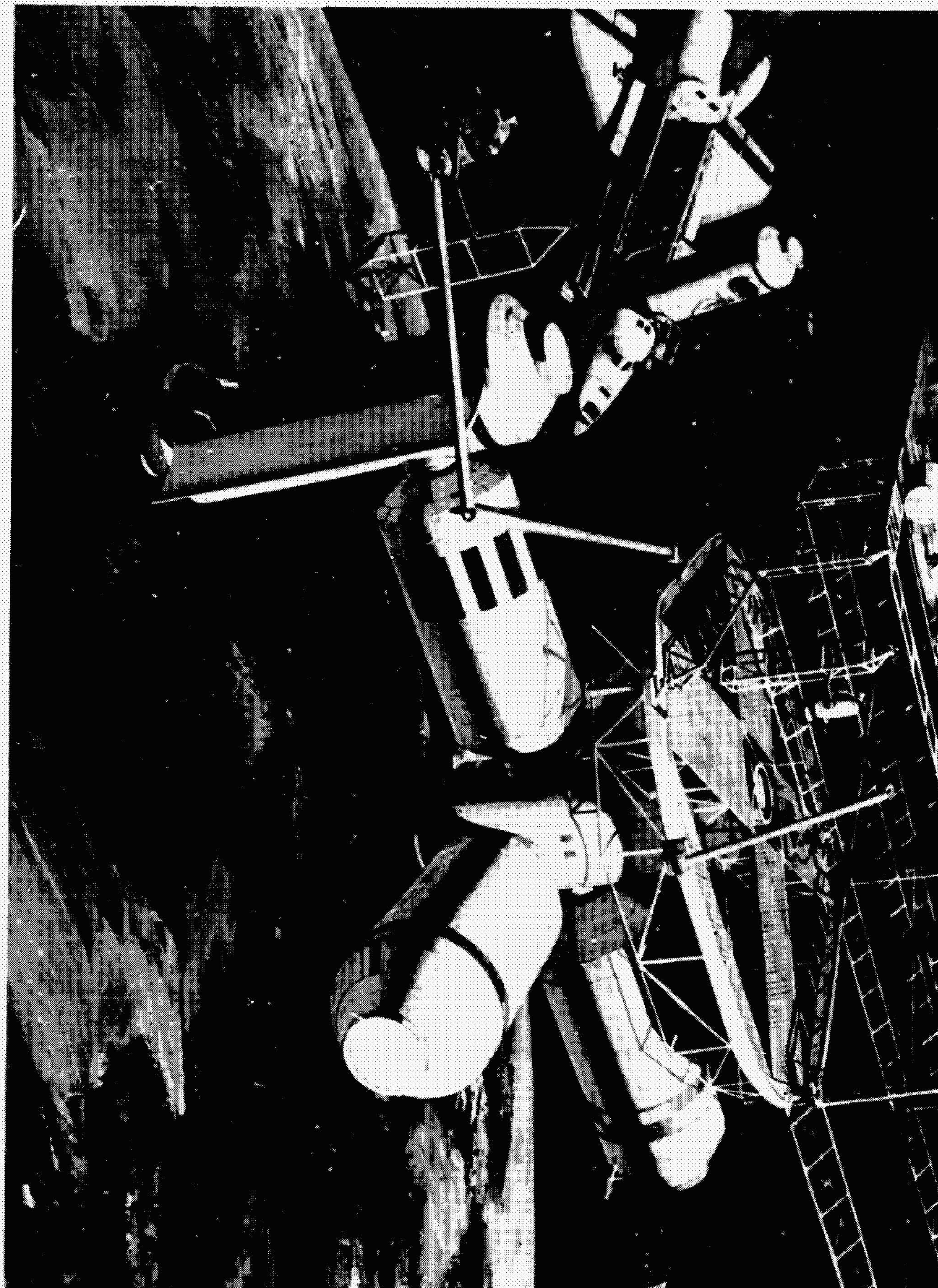
When I started studying astronomy, there was no such thing as space flight, except in fiction. Rockets were just probing the outer reaches of the earth's atmosphere - the edge of space. Now I look forward to helping personally bring new, more powerful astronomical instruments into space, to expand further man's astronomical horizons. This is only a small part of our work in the space program, however. Our activities in the future are going to expand beyond launching satellites and carrying out experiments. We will learn how to build in space, how to work there, and how to live there.

As an astronaut, I work even more closely with aerospace engineers than when I was an astronomer. We will be flying the most complex space vehicle ever built, and learning how all its parts work and how to use it effectively is an exciting challenge. The sense of teamwork is tremendous, and every space flight depends critically on the work of thousands of workers on the ground, people who come from all types of technical backgrounds.

Astronauts are no longer science fiction, and many young people ask me how they can become one. Only a small number of people are currently selected for astronaut training. However, I believe that the next generation will see an explosion in the uses of space and consequently in the number of people who go up there and in the variety of backgrounds that are represented. The people who succeed in getting into space will be those who, in addition to being experts in their own technical fields, have taken the time to learn as much as possible about the space program and have been perceptive enough to see how it might relate to their special interests. Looking out for ways to use results from the space program on the ground can eventually lead to new projects in space and to flight opportunities for the people involved.

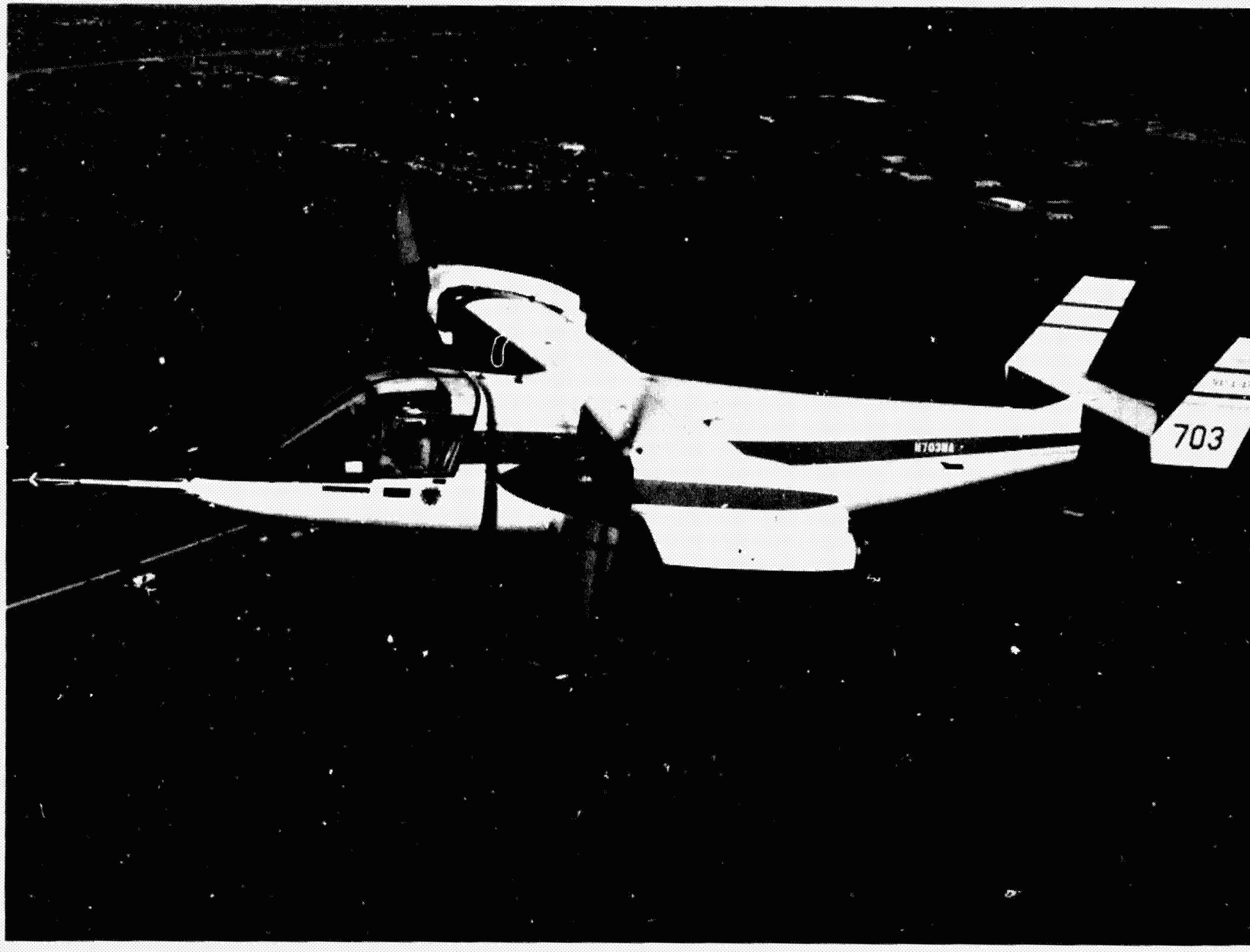
As we make the transition from a global to a cosmic civilization, the most important things required from people are knowledge, initiative, courage and imagination."

Jeffrey Hoffman, Ph.D.
NASA Space Shuttle Astronaut



Facing the Aerospace Challenge

Great opportunities lie ahead in science and aerospace research and development. Today's dreams are predicted to become tomorrow's realities. We are on the threshold of exciting and challenging ventures. Pharmaceutical and high technology firms await the advantages of weightless orbiting conditions to simplify the manufacturing processes of enzymes, vaccines, single crystal semiconductors and metal alloys that cannot be formed in Earth's gravity. Oil, gas and engineering firms look forward to inventorying Earth's resources using sensors in space. Large gossamer structures constructed in space by remotely controlled devices will fully exploit the space environment. Unmanned exploration of the solar system will continue. Aerospace technology will continue to tackle two of the most serious issues facing the world -- energy supply and environmental protection. Commercial aviation will enjoy the benefits of the next generation of transport aircraft, designed for fuel efficiency and emissions control. Lightweight materials, gas-turbine engines, microprocessors and high energy batteries will lead to significant reductions in fuel consumption and will lead to energy self-sufficiency. Advanced technology will assist in developing new ground transportation systems to shift commuters away from private automobiles and towards public automated transportation. To help maintain the strength of the United States and other nations, air-to-air missiles, electro-optical systems, and air defense systems will continue as areas of special consideration. As you become aware of the many career choices available to you, you may want to consider the opportunities for career development in space science, engineering and technology. The future belongs to you! Your contributions to the future will depend upon the preparation you pursue today.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APPENDIX A:

Suggested Activities for Career Educators

This section* contains a series of suggested activities designed for counselors, teachers and other career educators to use with students exploring careers in the field of aerospace. Included are specific guidelines for program design and the resources that can be collected and used in the school.

CAREER CONSULTANTS

Within each community resides a reservoir of career resource people waiting to be tapped by the career counselors in the schools. These career consultants can be powerful motivational models for high school students. They are individuals who live in the community and who are employed in the aerospace industry or in related occupations. These aerospace practioners represent real life examples of those who are engaged in the aerospace effort. The industry as exemplified by their lives becomes real to the students and not just information gathered by reading pages of occupational handbooks. The involvement of these people in informational guidance services will contribute to a greater understanding of the role of aerospace in our nation.

*This material has been adapted from a kit entitled "Educators' Guide to Careers in Aerospace." The kit was designed and developed by the National Career Information Center of the American Personnel and Guidance Association in cooperation with NASA, March 1976.

INFORMATION CAREER CONSULTANTS PROVIDE

Career consultants can provide accurate, current and relevant information regarding all aspects of their occupations. It is beneficial if the presentation to groups includes the following elements:

- Emphasis on the interdependence of occupations within the aerospace team. The consultant or counselor may present a horizontal and vertical lattice of jobs at different levels of responsibility and with different education requirements. The consultants can then locate their own specialty and talk about their careers relative to others.
- Discussion of the typical situations or problems presented by their occupations, the tools or knowledge necessary, etc.
- Role-playing of some typical situations they encounter in their work.
- Definition of the characteristics of the people they serve and the individuals with whom they work.
- Discussion of the effect which change and automation have had on their work.
- Discussion of how one advances or moves to other occupations within the particular career cluster.
- Description of the greatest personal satisfaction and the most serious frustration in the work.
- Discussion of the immediate employment situation in the career fields and project

trends which may have bearing on future entry.

- Review the different routes, occupationally and educationally, one might take to get into the particular career, including licensing, certification and other special requirements.
- Avoidance of any emphasis on occupation conditions such as salary, fringe benefits, etc., as these can be more appropriately discussed during a personal interview or meeting.
- Allowance of time for relevant questions by student participants.

SUGGESTED FORMAT FOR PRESENTATIONS

Arrange to record each career program, with the consent of the consultant. Then relevant sessions will be available for playback to other student groups. Each new tape adds to the school's library of local career information.

Small group sessions involving the career consultant(s), 10 to 12 students and the counselor are most desirable. Full utilization of these valuable human resources means more than a once-a-year program which offers students only a token opportunity to relate to representatives in the career cluster.

An ongoing career consultant project with bi-weekly or monthly programs will result in the following benefits: (1) students will be exposed to more workers, (2) repeat programs will permit small groups and more meaningful dialogue between students and consultant, (3) external pressure (peer and parental) to confer with certain consultants will be reduced if a broad offering of workers representing the entire career cluster are presented and (4) counselor participation will be increased.

Ideally, the group interaction with career consultants might lead to additional informational experiences such as field visitations, personal observation/interviews and possibly real work experiences of a part-time, summer or work-study nature. Observation and related experiences provide the added information which assists the student in making a career decision.

FOLLOW-UP BY THE CAREER EDUCATOR

Counselors and teachers are encouraged to hold follow-up sessions with students to: (1) answer any post-experience questions, (2) assist students in identifying additional sources of information, (3) plan an extended informational experience or (4) engage in a direct planning activity (e.g., application to a training program).

These questions will provide a framework for the follow-up sessions.

- Does aerospace include more than just "space" related jobs? How might the role of the scientist be tied to aerospace? Name some of the engineering specialties involved in aerospace. Name some of the many ways computer science might be used in the aerospace industry.
- Why are aerospace vehicles the product of a "team" of skilled workers?
- Discuss the educational background/typical training routes of several of the aerospace careers listed on the career chart.
- What are the implications of aerospace spinoffs on other career fields such as medicine, meteorology, environmental science, etc.

CAREER CHARTS

The development of career charts will provide visual representations of the group discussions. Use the blackboard or large tablets to list aerospace occupations supplied by the group. Many occupations will fit into more than one grouping on the career chart. Repetition of the occupations is encouraged. Career charts can be set up in several ways. Consider the following:

SETTING -- List careers by the setting in which the people work.

AEROSPACE INDUSTRY WORKERS (NON-GOVERNMENT)	AEROSPACE WORKERS (NASA, FAA, etc.)	RELATED OCCUPATIONS IN SCIENCE, AVIATION AND ENGINEERING	OTHER
Tool and Diemaker Industrial Engineer	Astronaut Launch Technician	Air Traffic Controller	Meteorologist

FILL IN AS MANY AS POSSIBLE

TRAINING LEVEL -- List careers by the training required to enter the occupation.

SPECIALIZED TRAINING OCCUPATIONAL TRAINING AT HIGH SCHOOL TRADE AND TECHNICAL SCHOOL ON-THE-JOB TRAINING COMMUNITY COLLEGE	COLLEGE AND UNIVERSITY 4 YEAR Baccalaureate Program	ADVANCED STUDY SPECIALIZED EXPER. GRADUATE WORK WORK EXPERIENCE
Pilot Technician	Mathematician Quality Control Inspector	Astronaut Flight Surgeon Astronomer

CAREER RELATIONSHIPS -- List related occupations that are affected by aerospace endeavors.

SCIENCE	HEALTH & MEDICINE	MANUFACTURING	TRANSPORTATION
Geologist	Physician	Industrial Engineer	Topographer

FILL IN AS MANY AS POSSIBLE

DESIGNING AN AEROSPACE CAREER GUIDANCE EXHIBIT

Once the career lists have been generated by the students display boards can be designed. The bulletin boards and display cases in the career resource center or in the halls can serve as focal points for aerospace career information.

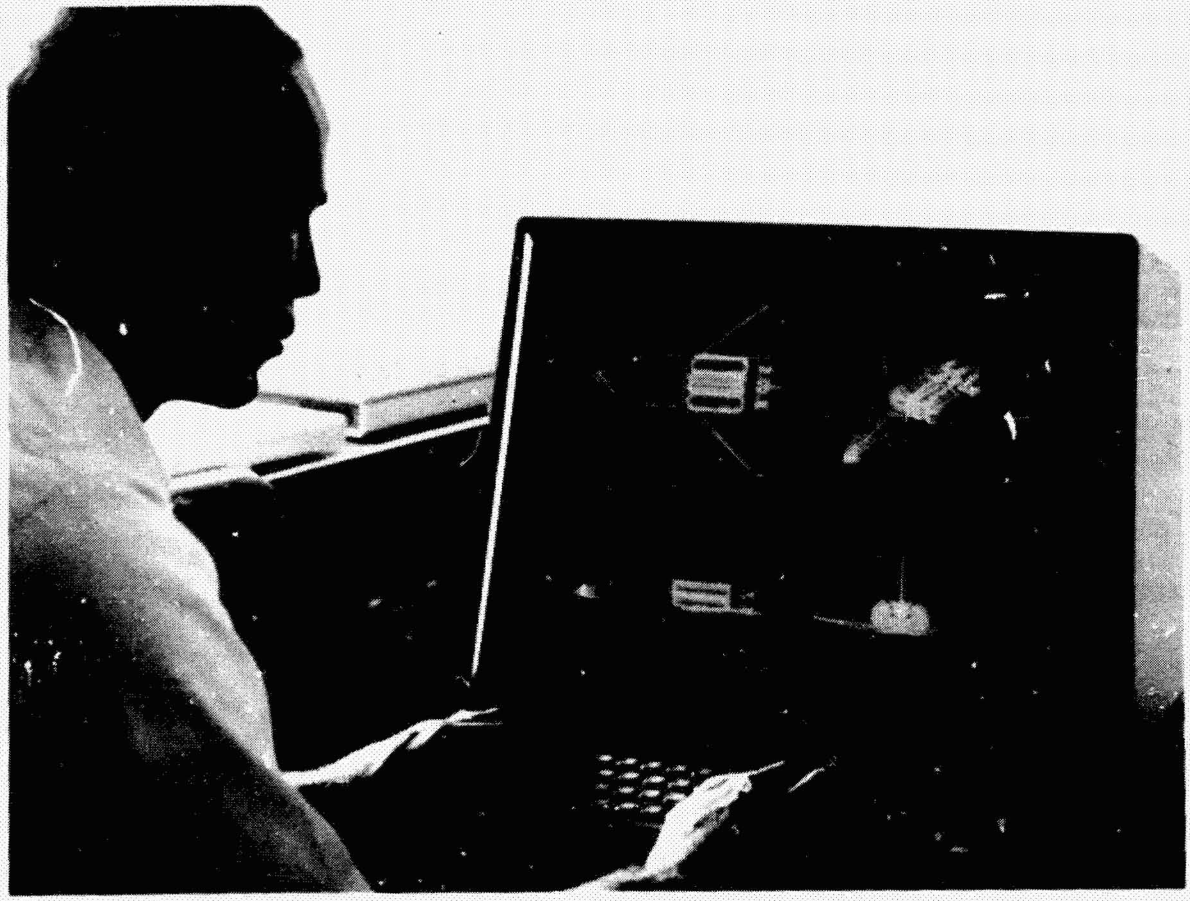
Many weekly news magazines and periodicals from scientific, governmental and business-industrial sources will have pictures of America's aerospace endeavors. (Related posters and other materials can be obtained from the airlines and other aviation industries.) Do not over emphasize the astronaut careers. Rather, look for general pictures of the scientists, engineers, technicians, computer specialists and others from the chart of typical aerospace careers.

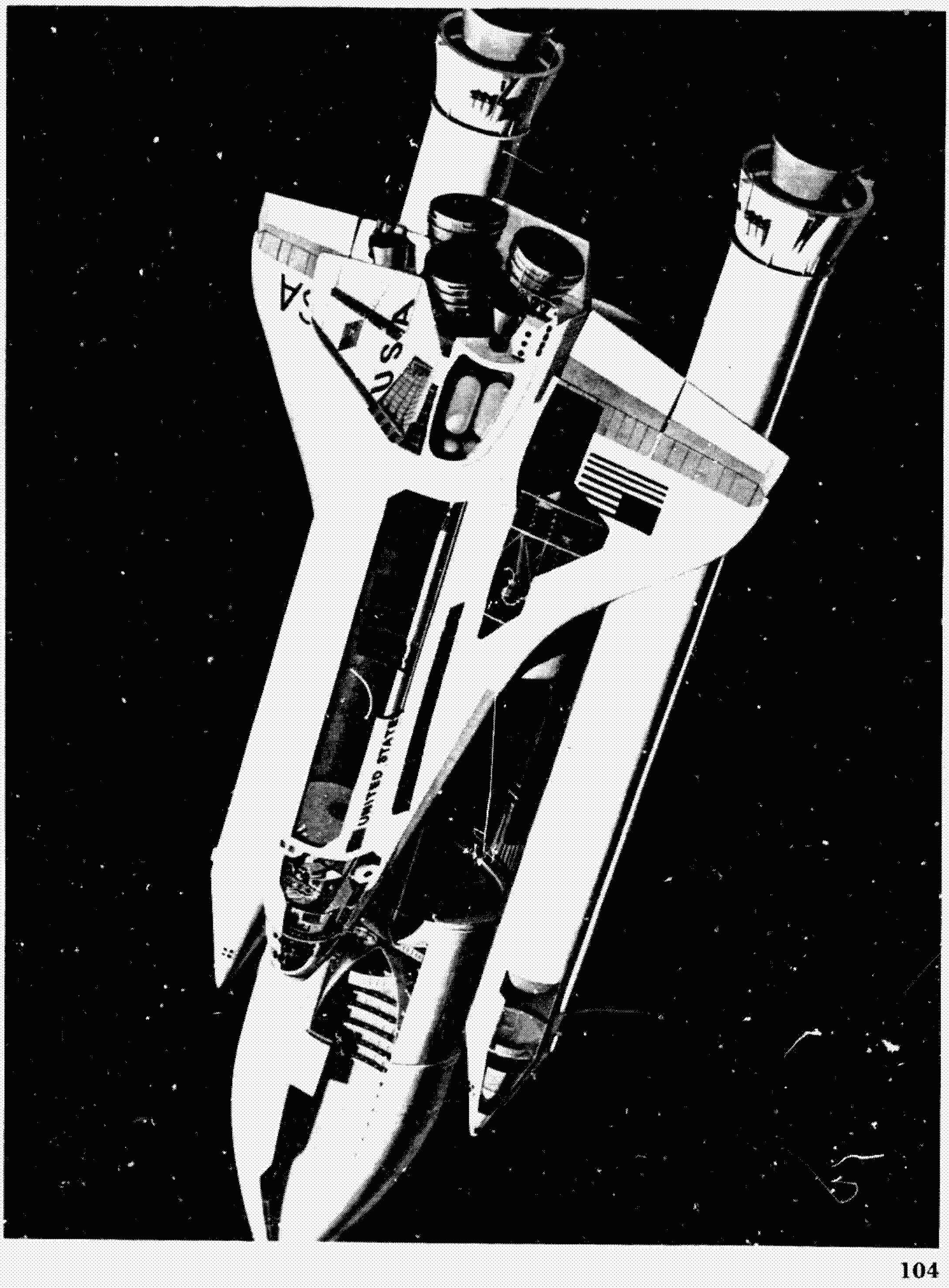
Keep in mind that careers in aerospace encompass more than aerospace careers and that persons can enter this field from a variety of training routes.

Use bulletin boards to refer students to career information materials in the guidance office, library or career resource center. Student volunteers and career clubs are viable candidates to assist in the design and development of career information displays.

All exhibits will become "old" in a few weeks. Change the exhibit every few weeks by designing similar displays for other career fields.

Computer magic "checks out" Shuttle systems





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APPENDIX B:

Accredited Programs in Engineering/Engineering Technology*

Accreditation Board for Engineering and Technology, Inc., 345 East 47th St., New York, N.Y. 10017, is the accrediting authority for engineering and engineering technology programs offered by educational institutions in the United States. This board compiles a listing of the institutions which offer programs leading to degrees in engineering or engineering technology.

The first listing which follows reflects the names of colleges and universities which award baccalaureate degrees in engineering. Their specific engineering programs are indicated.

The second listing refers to institutions offering associate and/or baccalaureate degrees in engineering technology. Specific programs are indicated for these institutions also. The following categories of institutions are included in this listing: technical institutes, junior/community colleges, colleges of technology, polytechnic colleges, divisions of colleges and universities and proprietary schools ooerated by individuals or corporations.

See explanatory notes for an explanation of abbreviations.

EXPLANATORY NOTES

Aeron.—	Aeronautical
Aerosp.—	Aerospace
Agric.—	Agricultural
Arch.—	Architectural
Astron.—	Astronautical
Biol.—	Biological
Chem.—	Chemical
Civ.—	Civil
Elect.—	Electrical
Engrg.—	Engineering
Geo.—	Geological
Ind.—	Industrial
Manu.—	Manufacturing
Mat.—	Materials
Mech.—	Mechanical
Metall.—	Metallurgical
Mgmt.—	Management
Nuc.—	Nuclear

*These two lists of accredited institutions are printed with the permission of Accreditation Board for Engineering and Technology, Inc. These lists are updated regularly. Therefore, interested individuals should contact the Accreditation Board or the educational institution for specific information.

COLLEGES AWARDING BACCALAUREATE DEGREES IN ENGINEERING

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
AIR FORCE INSTITUTE OF TECHNOLOGY Wright-Patterson Air Force Base, Ohio	X		X	X			X	Astron. System
AKRON, UNIVERSITY OF Akron, Ohio		X	X	X		X		
ALABAMA IN BIRMINGHAM, UNIVERSITY OF Birmingham, Alabama								Engineering
ALABAMA IN HUNTSVILLE, UNIVERSITY OF Huntsville, Alabama				X	X	X		
ALABAMA, UNIVERSITY OF University, Alabama		X	X	X	X	X	X	Aerospace Metall. Mineral
ALASKA, UNIVERSITY OF Fairbanks, Alaska			X	X				Geo. Mining
ALFRED UNIVERSITY, NEW YORK STATE COLLEGE OF CERAMICS AT Alfred, New York								Ceramic Ceramic Science Glass Science
ARIZONA STATE UNIVERSITY Tempe, Arizona		X	X	X	X	X		Engrg. Mech. Engrg. Science
ARIZONA, UNIVERSITY OF Tucson, Arizona		X	X	X		X	X	Aer[illegible] Ag[illegible] Geo. Metal Mining
ARKANSAS STATE UNIVERSITY State University, Arkansas								Agric.
ARKANSAS, UNIVERSITY OF Fayetteville, Arkansas		X	X	X	X	X		Agric. Engrg. Sci.
AUBURN UNIVERSITY Auburn, Alabama		X	X	X	X	X		Aerospace Agric. Mat.

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
BOSTON UNIVERSITY Boston, Massachusetts								Aerospace Manu. Systems
BRADLEY UNIVERSITY Peoria, Illinois			X	X	X	X		
BRIDGEPORT, UNIVERSITY OF Bridgeport, Connecticut				X		X		
BRIGHAM YOUNG UNIVERSITY Provo, Utah		X	X	X		X		
BROWN UNIVERSITY Providence, Rhode Island			X	X		X		Bio Med. Materials
BUCKNELL UNIVERSITY Lewisburg, Pennsylvania		X	X	X		X		
CALIFORNIA INSTITUTE OF TECHNOLOGY Pasadena, California	X	X						Eng. & Applied Sci. Environ. Engrg.
CALIFORNIA POLYTECHNIC STATE UNIVERSITY San Luis Obispo, California	X		X	X	X	X		Agric. Arch. Electr. Envir. Metal
CALIFORNIA STATE POLYTECHNIC UNIVERSITY POMONA Pomona, California		X	X	X	X	X		Aerospace Electr.
CALIFORNIA STATE UNIVERSITY, CHICO Chico, California			X	X		X		Electr.
CALIFORNIA STATE UNIVERSITY, FRESNO Fresno, California			X	X		X		Surveying & Photogrammet
CALIFORNIA STATE UNIVERSITY, FULLERTON Fullerton, California								Engrg.
CALIFORNIA STATE UNIVERSITY, LONG BEACH Long Beach, California			X	X		X		Comp. Science Engrg. Material Ocean
CALIFORNIA STATE UNIVERSITY, LOS ANGELES Los Angeles, California			X	X		X		
CALIFORNIA STATE UNIVERSITY, NORTHRIDGE Northridge, California								Engrg.
CALIFORNIA STATE UNIVERSITY, SACRAMENTO Sacramento, California			X	X		X		

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
CALIFORNIA, UNIVERSITY OF Berkeley, California		X	X	X	X	X	X	Mat Sci./Engrg. Naval Arch. Sanitary Transportation
CALIFORNIA, UNIVERSITY OF Davis, California		X	X	X		X		Agric.
CALIFORNIA, UNIVERSITY Irvine, California			X	X		X		
CALIFORNIA, UNIVERSITY OF Los Angeles, California								Engineering
CALIFORNIA, UNIVERSITY OF Santa Barbara, California		X		X		X	X	
CARNEGIE-MELLON UNIVERSITY Pittsburgh, Pennsylvania		X	X	X		X		Metall. & Mat. Sci.
CASE WESTERN RESERVE UNIVERSITY Cleveland, Ohio		X	X	X		X		Biomedical Computer Fluid and Thermal Science Metal and Material Science Polymer Science Systems and Control
CATHOLIC UNIVERSITY OF AMERICA Washington, D.C.		X	X	X		X		
CENTRAL FLORIDA, UNIVERSITY OF Orlando, Florida				X	X	X		Engineering Mathematics and Computer Systems Environmental
CHRISTIAN BROTHERS COLLEGE Memphis, Tennessee				X		X		
CINCINNATI, UNIVERSITY OF Cincinnati, Ohio		X	X	X		X	X	Aerospace Environmental Metall.
CITADEL, THE Charleston, South Carolina			X	X				
CLARKSON COLLEGE OF TECHNOLOGY Potsdam, New York		X	X	X		X		
CLEMSON UNIVERSITY Clemson, South Carolina		X	X	X		X		Agric., Ceramic Environmental Systems

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
CLEVELAND STATE UNIVERSITY Cleveland, Ohio		x	x	x	x	x		Metal
COLORADO SCHOOL OF MINES Golden, Colorado								Chem. & Petroleum Refining Geolog. Geophysical Metal Mineral Engineering Physics Mining Petroleum
COLORADO STATE UNIVERSITY Fort Collins, Colorado			x	x		x		Agric. Engrg. Sci. Environ.
COLORADO, UNIVERSITY OF Boulder, Colorado		x	x	x		x		Aerospace Architectural Engrg. Design & Economic Evaluation
COLUMBIA UNIVERSITY New York, New York		x	x	x		x	x	Engrg. Mechs. Ind. & Mgmt. Metall. Mining
CONNECTICUT, UNIVERSITY OF Storrs, Connecticut		x	x	x		x		Computer Sciences
COOPER UNION, THE New York, New York		x	x	x		x		
CORNELL UNIVERSITY Ithaca, New York		x	x	x	x	x		Aerospace, Agric. Applied & Engineering Physics Ind. Engrg. & Operations Research Mat. Sci. Engrg.
DARTMOUTH COLLEGE, THAYER SCHOOL OF ENGINEERING Hanover, New Hampshire								Engineering
DAYTON, UNIVERSITY OF Dayton, Ohio		x	x	x		x		
DELAWARE, UNIVERSITY OF Newark, Delaware		x	x	x		x		

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
DETROIT, UNIVERSITY OF Detroit, Michigan		X	X	X		X		
DISTRICT OF COLUMBIA, UNIVERSITY OF Washington, D.C				X				
DREXEL UNIVERSITY Philadelphia, Pennsylvania		X	X	X		X		Material
DUKE UNIVERSITY Durham, North Carolina			X	X		X		Biomedical
EMBRY-RIDDLE AERONAUTICAL UNIVERSITY Daytona Beach, Florida	X							
EVANSVILLE, UNIVERSITY OF Evansville, Indiana				X		X		
FAIRLEIGH DICKINSON UNIVERSITY Teaneck, New Jersey				X	X	X		
FLORIDA ATLANTIC UNIVERSITY Boca Raton, Florida				X		X		Ocean
FLORIDA INSTITUTE OF TECHNOLOGY Melbourne, Florida				X		X		
FLORIDA, UNIVERSITY OF Gainesville, Florida		X	X	X	X	X	X	Aerospace Agric. Ceramics Coastal & Ocean Engrg. Sci. Metals Systems
GANNON COLLEGE Erie, Pennsylvania				X		X		
GENERAL MOTORS INSTITUTE Flint, Michigan				X	X	X		Auto. Mat. Mech.-Elect. Plant Process
GEORGE WASHINGTON UNIVERSITY Washington, D.C.			X	X		X		

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
GEORGIA INSTITUTE OF TECHNOLOGY Atlanta, Georgia		X	X	X	X	X	X	Aerospace Ceramic Engrg. Sci. Sanitary Textile
GEORGIA, UNIVERSITY OF Athens, Georgia								Agric.
HARTFORD, UNIVERSITY OF Hartford, Connecticut			X	X		X		
HARVARD UNIVERSITY Cambridge, Massachusetts								Engrg. Sci. Environmental
HARVEY MUDD COLLEGE Claremont, California								Engineering
HAWAII, UNIVERSITY OF Honolulu, Hawaii			X	X		X		Ocean
HOFSTRA UNIVERSITY Hempstead, New York								Engineering Science
HOUSTON, UNIVERSITY OF Houston, Texas		X	X	X	X	X		
HOWARD UNIVERSITY Washington, D.C.		X	X	X		X		
IDAHO, UNIVERSITY OF Moscow, Idaho		X	X	X		X		Agric. Geol. Metall. Mining
ILLINOIS INSTITUTE OF TECHNOLOGY Chicago, Illinois		X	X	X	X	X		Mech. Aerospace Metall.
ILLINOIS AT CHICAGO CIRCLE, UNIVERSITY OF Chicago, Illinois		X			X	X		Applied Mech. Bio-Engineering Communication Computer/Info. System Electro Magnetic & Electronics Fluids Metall. Structural Engrg. & Material Thermo Mechanical Engrg. & Energy Cons.

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
ILLINOIS AT URBANA-CHAMPAIGN Urbana, Illinois	x	x	x	x	x	x	x	Agric. Astro. Ceramic Computer Engrg. Mechs. General Metall.
INDIAN UNIVERSITY-PURDUE UNIVERSITY AT INDIANAPOLIS Indianapolis, Indiana				x		x		
IOWA STATE UNIVERSITY Ames, Iowa		x	x	x	x	x	x	Aerospace Agric. Ceramic Computer Construction Eng. Sci. Metall.
IOWA, UNIVERSITY OF Iowa City, Iowa		x	x	x	x	x		
JOHNS HOPKINS UNIVERSITY Baltimore, Maryland				x				
KANSAS STATE UNIVERSITY Manhattan, Kansas		x	x	x	x	x	x	Agric.
KANSAS, UNIVERSITY OF Lawrence, Kansas		x	x	x		x		Aerospace Archit. Engrg. Phys. Petroleum
KENTUCKY, UNIVERSITY OF Lexington, Kentucky		x	x	x		x		Agric. Metall.
LAFAYETTE COLLEGE Easton, Pennsylvania		x	x	x		x		Metall.
LAMAR UNIVERSITY Beaumont, Texas		x	x	x	x	x		
LAWRENCE INSTITUTE OF TECHNOLOGY Southfield, Michigan				x		x		Construction
LEHIGH UNIVERSITY Bethlehem, Pennsylvania		x	x	x	x	x		Engrg. Mechs. Metall. & Mat.
LE TOURNEAU COLLEGE Longview, Texas				x		x		

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
LOUISIANA STATE UNIVERSITY Baton Rouge, Louisiana		X	X	X	X	X		Agric. Engrg. Sci. Petroleum
LOUISIANA TECH UNIVERSITY Ruston, Louisiana		X	X	X	X	X		Agric. Biomedical Petroleum
LOUISVILLE, UNIVERSITY OF Louisville, Kentucky		X	X	X		X		
LOWELL UNIVERSITY OF Lowell, Massachusetts		X	X	X		X		Plastics
LOYOLA MARYMOUNT UNIVERSITY Los Angeles, California			X	X		X		
MAINE, UNIVERSITY Orono, Maine		X	X	X		X		Agric. Engrg. Physics Forest
MANHATTAN COLLEGE Riverdale, New York		X	X	X		X		Environ.
MARQUETTE UNIVERSITY Milwaukee, Wisconsin			X	X		X		
MARYLAND, UNIVERSITY OF College Park, Maryland		X	X	X		X	X	Aerospace Agric. Fire Protection
MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, Massachusetts	X	X	X			X		Astron. Computer Science & Engrg. Electrical Science & Engrg. Mat. Sci. & Engrg. Naval Arch. & Marine Ocean
MASSACHUSETTS, UNIVERSITY OF Amherst, Massachusetts		X	X	X	X	X		Computer Systems Environ. Manufacturing
MEMPHIS STATE UNIVERSITY Memphis, Tennessee			X	X		X		
MERRIMACK COLLEGE North Andover, Massachusetts			X	X				
MIAMI, UNIVERSITY OF Coral Gables, Florida			X	X	X	X		Arch.

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
MICHIGAN STATE UNIVERSITY East Lansing, Michigan		X	X	X		X		Agric.
MICHIGAN TECHNOLOGICAL UNIVERSITY Houghton, Michigan		X	X	X		X		Geol. Mat. Sci. & Engrg. Mineral Process Mining
MICHIGAN, UNIVERSITY OF Ann Arbor, Michigan		X	X	X		X	X	Aerospace Computer Environmental Sciences Industrial Operations Materials & Metall. Naval Archit. & Marine
MICHIGAN, UNIVERSITY OF Dearborn, Michigan				X	X	X		
MINNESOTA, UNIVERSITY OF Minneapolis, Minnesota		X	X	X		X		Aerospace Agric. Geol. Metall. Mineral
MISSISSIPPI STATE UNIVERSITY Mississippi State, Mississippi		X	X	X	X	X	X	Aerosp. Agric. Biol. Petroleum
MISSISSIPPI, UNIVERSITY OF University, Mississippi		X	X	X		X		Geol.
MISSOURI, UNIVERSITY OF Columbia, Missouri		X	X	X	X	X		Agric.
MISSOURI AT ROLLA, UNIVERSITY OF Rolla, Missouri		X	X	X		X	X	Aerospace Ceramic Engrg. Management Geological Metall. Mining Petroleum
MONMOUTH COLLEGE West Long Branch, New Jersey								Electronics

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
MONTANA COLLEGE OF MINERAL SCI. & TECH. Butte, Montana								Geological Geophysical Metall. Mineral Process Mining Petroleum
MONTANA STATE UNIVERSITY Bozeman, Montana		x	x	x	x	x		Agric.
MOODY COLLEGE (TEXAS A&M UNIVERSITY SYSTEM) Galveston, Texas								Marine
NAVAL POSTGRADUATE SCHOOL Monterey, California	x			x		x		
NEBRASKA, UNIVERSITY OF Lincoln, Nebraska		x	x	x	x	x		Agric.
NEVADA, UNIVERSITY OF Reno, Nevada			x	x		x		Geol. Metall. Mining
NEW HAMPSHIRE, UNIVERSITY OF Durham, New Hampshire		x	x	x		x		
NEW HAVEN, UNIVERSITY OF West Haven, Connecticut			x	x	x	x		
NEW JERSEY INSTITUTE OF TECHNOLOGY Newark, New Jersey		x	x	x	x	x		
NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY Socorro, New Mexico								Metall. Mining
NEW MEXICO STATE UNIVERSITY Las Cruces, New Mexico		x	x	x	x	x		Agric.
NEW MEXICO, UNIVERSITY OF Albuquerque, New Mexico		x	x	x		x		Computer Science
NEW ORLEANS, UNIVERSITY OF New Orleans, Louisiana				x		x		
NEW YORK, CITY COLLEGE OF THE CITY UNIVERSITY OF New York, New York		x	x	x		x		
NEW YORK, POLYTECHNIC INSTITUTE OF Brooklyn, New York		x	x	x	x	x	x	Aerospace Metall.
NEW YORK AT BUFFALO, STATE UNIVERSITY OF Buffalo, New York		x	x	x	x	x	x	Aerospace Engrg. Science

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
NEW YORK AT STONY BROOK, STATE UNIVERSITY OF Stony Brook, New York				X		X		Engrg. Sci.
NEW YORK MARITIME COLLEGE, STATE UNIVERSITY OF Fort Schuyler, Bronx, New York				X				Marine Naval Arch.
NORTH CAROLINA AGRICULTURAL AND TECHNICAL STATE UNIVERSITY Greensboro, North Carolina				X		X		Arch.
NORTH CAROLINA STATE UNIVERSITY AT RALEIGH Raleigh, North Carolina		X	X	X	X	X	X	Aerospace Biol. & Agric. Construction Engrg. Sci. & Mech. Mat.
NORTH CAROLINA AT CHAPEL HILL, UNIVERSITY OF Chapel Hill, North Carolina								Environmental
NORTH CAROLINA AT CHARLOTTE, UNIVERSITY OF Charlotte, North Carolina								Engrg. Analysis & Design Engrg. Sci., Mech., & Mat. Urban & Environmental
NORTH DAKOTA STATE UNIVERSITY Fargo, North Dakota			X	X	X	X		Agric.
NORTH DAKOTA, UNIVERSITY OF Grand Forks, North Dakota		X	X	X		X		
NORTHEASTERN UNIVERSITY Boston, Massachusetts		X	X	X	X	X		
NORTHERN ARIZONA UNIVERSITY Flagstaff, Arizona			X	X		X		
NORTHROP UNIVERSITY Inglewood, California				X		X		Aerospace
NORTHWESTERN UNIVERSITY Evanston, Illinois		X	X	X	X	X		Environmental Mat. Sci. & Engrg.
NORWICH UNIVERSITY Northfield, Vermont			X	X		X		
NOTRE DAME, UNIVERSITY OF Notre Dame, Indiana		X	X	X		X		Aerospace Engrg. Sci. Metall.

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
OAKLAND UNIVERSITY Rochester, Michigan				X		X		Computer General Systems
OHIO NORTHERN UNIVERSITY Ada, Ohio			X	X		X		
OHIO STATE UNIVERSITY Columbus, Ohio	X	X	X	X		X		Astron. Agric. Ceramic Ind. & Systems Metall. Welding
OHIO UNIVERSITY Athens, Ohio		X	X	X	X	X		
OKLAHOMA STATE UNIVERSITY Stillwater, Oklahoma		X	X	X	X	X		Aerospace Agric. Arch. General
OKLAHOMA, UNIVERSITY OF Norman, Oklahoma		X	X	X	X	X		Aerospace Engrg. Engrg. Physics Metall. Petroleum
OLD DOMINION UNIVERSITY Norfolk, Virginia			X	X		X		
OREGON STATE UNIVERSITY Corvallis, Oregon		X	X	X	X	X	X	Agric.
PACIFIC, UNIVERSITY OF THE Stockton, California			X	X				
PARKS COLLEGE OF ST. LOUIS UNIVERSITY St. Louis, Missouri								Aerospace
PENNSYLVANIA STATE UNIVERSITY University Park, Pennsylvania		X	X	X	X	X	X	Aerospace Agric. Arch. Ceramic Sci. & Engrg. Engrg. Sci. Environmental Metall. Mining Petroleum & Natural Gas
PENNSYLVANIA, UNIVERSITY OF Philadelphia, Pennsylvania		X	X	X		X		Metall. & Mat. Sci.

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
PITTSBURGH, UNIVERSITY OF Pittsburgh, Pennsylvania		x	x	x	x	x		Metall.
PORTLAND STATE UNIVERSITY Portland, Oregon								Structural
PORTLAND, UNIVERSITY OF Portland, Oregon				x		x		
PRAIRIE VIEW A&M UNIVERSITY Prairie View, Texas			x	x		x		
PRATT INSTITUTE Brooklyn, New York		x		x		x		
PRINCETON, UNIVERSITY Princeton, New Jersey		x	x	x		x		Aerospace Engrg. Physics Geol.
PUERTO RICO, UNIVERSITY OF Mayaguez, Puerto Rico		x	x	x	x	x		
PURDUE UNIVERSITY Lafayette, Indiana	x	x	x	x	x	x	x	Astron. Agric. Metall.
RENSSELAER POLYTECHNIC INSTITUTE Troy, New York	x	x	x	x		x	x	Biomedical Computer & Systems Electric Power Environmental Mgmt. Materials
RHODE ISLAND, UNIVERSITY OF Kingston, Rhode Island		x	x	x	x	x		
RICE UNIVERSITY Houston, Texas		x	x	x		x		Mat. Sci.
ROCHESTER INSTITUTE OF TECHNOLOGY Rochester, New York				x	x	x		
ROCHESTER, UNIVERSITY OF Rochester, New York		x		x		x		
ROSE HULMAN INSTITUTE OF TECHNOLOGY Terre Haute, Indiana		x	x	x		x		
RUTGERS UNIVERSITY, THE STATE UNIVERSITY OF NEW JERSEY New Brunswick, New Jersey		x	x	x	x	x		Agric. Ceramic

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
ST. MARTIN'S COLLEGE Olympia, Washington			X					
SAN DIEGO STATE UNIVERSITY San Diego, California			X	X		X		Aerospace
SAN FRANCISCO STATE UNIVERSITY San Francisco, California								Engrg.
SAN JOSE STATE COLLEGE San Jose, California		X	X	X	X	X		Mat.
SANTA CLARA, UNIVERSITY OF Santa Clara, California			X			X		Elect. Engrg. & Comp. Sci.
SEATTLE UNIVERSITY Seattle, Washington				X		X		
SOUTH CAROLINA, UNIVERSITY OF Columbia, South Carolina		X	X	X		X		
SOUTH ALABAMA UNIVERSITY OF Mobile, Alabama				X				
SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY Rapid City, South Dakota		X	X	X		X		Geol. Metall. Mining
SOUTH DAKOTA STATE UNIVERSITY Brookings, South Dakota			X	X		X		Agric.
SOUTH FLORIDA, UNIVERSITY OF Tampa, Florida		X		X	X	X		Structures, Materials and Fluids
SOUTHEASTERN MASSACHUSETTS UNIVERSITY North Dartmouth, Massachusetts			X	X		X		
SOUTHERN CALIFORNIA, UNIVERSITY OF Los Angeles, California		X	X	X	X	X		Aerospace Petroleum
SOUTHERN ILLINOIS UNIVERSITY AT CARBONDALE Carbondale, Illinois								Electrical- Sci. & Systems Engrg. Mech. & Mat. Thermal & Environ.
SOUTHERN ILLINOIS UNIVERSITY AT EDWARDSVILLE Edwardsville, Illinois			X	X				
SOUTHERN METHODIST UNIVERSITY Dallas, Texas			X	X		X		Engrg. Mgmt.
SOUTHERN UNIVERSITY Baton Rouge, Louisiana			X	X		X		

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
SOUTHWESTERN LOUISIANA, UNIVERSITY OF Lafayette, Louisiana		X	X	X		X		Petroleum
STANFORD UNIVERSITY Stanford, California	X	X	X	X	X	X		Astron. Petroleum
STEVENS INSTITUTE OF TECHNOLOGY Hokoken, New Jersey								Engineering
SWARTHMORE COLLEGE Swarthmore, Pennsylvania								Engineering
SYRACUSE UNIVERSITY Syracuse, New York		X	X	X				Aerospace Computer Ind. Engrg. & Operation Mech./Aerospace
TENNESSEE STATE UNIVERSITY Nashville, Tennessee			X	X		X		Arch.
TENNESSEE TECHNOLOGICAL UNIVERSITY Cookeville, Tennessee		X	X	X	X	X		Engrg. Sci.
TENNESSEE AT CHATTANOOGA, UNIVERSITY OF Chattanooga, Tennessee								Engineering
TENNESSEE, UNIVERSITY OF Knoxville, Tennessee		X	X	X	X	X	X	Aerospace Agric. Engrg. Sci. Envir. Metall.
TEXAS A&I UNIVERSITY Kingsville, Texas		X		X		X		
TEXAS A&M UNIVERSITY College Station, Texas		X	X	X	X	X	X	Aerospace Agric. Bioengineering Ocean Petroleum
TEXAS TECHNOLOGICAL UNIVERSITY Lubbock, Texas		X	X	X	X	X		Agric. Engrg. Phys. Petroleum
TEXAS AT ARLINGTON, UNIVERSITY OF Arlington, Texas			X	X	X	X		Aerospace

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
TEXAS AT AUSTIN, UNIVERSITY OF Arlington, Texas		X	X	X		X		Aerospace Arch. Engrg. Sci. Environmental Health Petroleum
TEXAS AT EL PASO, UNIVERSITY OF El Paso, Texas			X	X		X		Metall.
TOLEDO, UNIVERSITY OF Toledo, Ohio		X	X	X	X	X		Engrg. Phys.
TRINITY UNIVERSITY San Antonio, Texas								Engrg. Sci.
TRI-STATE UNIVERSITY Angola, Indiana	X	X	X	X		X		
TUFTS UNIVERSITY Medford, Massachusetts		X	X	X		X		
TULANE UNIVERSITY New Orleans, Louisiana		X	X	X		X		
TULSA, UNIVERSITY OF Tulsa, Oklahoma		X		X		X		Engrg. Physics Petroleum
TUSKEGEE INSTITUTE Tuskegee, Alabama				X		X		
UNION COLLEGE Schenectady, New York			X	X		X		
UNITED STATES AIR FORCE ACADEMY USAF Academy, Colorado	X		X					Astron. Engrg. Mech. Engrg. Sci.
UNITED STATES COAST GUARD ACADEMY New London, Connecticut			X	X				Marine Ocean
UNITED STATES NAVAL ACADEMY Annapolis, Maryland				X		X		Aerospace Marine Naval Arch. Ocean Systems
UTAH STATE UNIVERSITY Logan, Utah			X	X		X		Agric. & Irrigation Manu.

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
UTAH, UNIVERSITY OF Salt Lake City, Utah		X	X	X	X	X		Geol. Mat. Sci. & Engrg. Metall. Mining
VALPARAISO UNIVERSITY Valparaiso, Indiana			X	X		X		
VANDERBILT UNIVERSITY Nashville, Tennessee		X	X	X		X		Environ. & Water Resources Mat. Sci. & Engrg.
VERMONT, UNIVERSITY OF Burlington, Vermont			X	X		X		
VILLANOVA UNIVERSITY Villanova, Pennsylvania		X	X	X		X		
VIRGINIA MILITARY INSTITUTE Lexington, Virginia			X	X				
VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY Blacksburg, Virginia		X	X	X	X	X		Aerospace & Ocean Agric. Ceramic Engrg. Sci. & Mech. Mat. Metal Mining
VIRGINIA, UNIVERSITY OF Charlottesville, Virginia		X	X	X		X	X	Aerospace
WALLA WALLA COLLEGE College Place, Washington								Engineering
WASHINGTON STATE UNIVERSITY Pullman, Washington		X	X	X		X		Agric. Physical Metall.
WASHINGTON UNIVERSITY St. Louis, Missouri		X	X	X		X		Computer Sci. Systems Sci. & Math
WASHINGTON, UNIVERSITY OF Seattle, Washington	X	X	X	X		X		Astron. Ceramic Metall.
WAYNE STATE UNIVERSITY Detroit, Michigan		X	X	X	X	X		Metall.
WEBB INSTITUTE OF NAVAL ARCHITECTURE Glen Cove, New York								Naval Archit. & Marine

	Aeron.	Chem.	Civ.	Elec.	Ind.	Mech.	Nuc.	Other
WEST VIRGINIA INSTITUTE OF TECHNOLOGY Montgomery, West Virginia		X	X	X		X		
WEST VIRGINIA UNIVERSITY Morgantown, West Virginia		X	X	X	X	X		Aerospace
WESTERN MICHIGAN UNIVERSITY Kalamazoo, Michigan					X			
WESTERN NEW ENGLAND COLLEGE Springfield, Maine				X		X		
WICHITA STATE University Wichita, Kansas	X			X	X	X		
WIDENER COLLEGE Chester, Pennsylvania								Engineering
WISCONSIN, UNIVERSITY OF Madison, Wisconsin		X	X	X	X	X	X	Agric. Engrg. Mechs. Metall., Mining
WISCONSIN-PLATTESVILLE, UNIVERSITY OF Plattesville, Wisconsin			X					Mining
WORCESTER POLYTECHNIC INSTITUTE Worcester, Massachusetts		X	X	X		X		
WRIGHT STATE UNIVERSITY Dayton, Ohio				X		X		
WYOMING, UNIVERSITY OF Laramie, Wyoming		X	X	X		X		Agric. Petroleum
YALE UNIVERSITY New Haven, Connecticut								Electronic Sci. & Engrg. Engrg. Mech.
YOUNGSTOWN STATE UNIVERSITY Youngstown, Ohio		X	X	X		X		Mat. Sci.

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Mechanical Drafting and Design Technology
Mechanical Engineering Technology

Alabama, University of
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Bluefield, WV 24701

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Bronx, NY 10453

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Mechanical Technology

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Binghamton, NY 13902

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Electrical Technology
Mechanical Technology

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Vallejo, CA 94590

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California Polytechnic State University
San Luis Obispo, CA 93407

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Pomona, CA 91768

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Kensington, MD 20795

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Central Florida, University of
Orlando, FL 32816

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Environmental Control Technology
Operations Technology

Chattanooga State Technical Community College
Chattanooga, TN 37406

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Computer Science Technology
Electrical/Electronics Engineering Technology
Mechanical Engineering Technology

Cincinnati, University of Ohio College of Applied Science
Cincinnati, OH 45210

Architectural Technology
Chemical Technology
Civil & Environmental Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Clemson University
Clemson, SC 29631

Engineering Technology

Cogswell College
San Francisco, CA 94108

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Mechanical Engineering Technology
Safety Engineering Technology
Safety/Fire Protection Engineering Technology
Structural Engineering Technology

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Electronic Engineering Technology

Columbus Technical Institute
Columbus, OH 43215

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Connecticut, University of
Storrs, CT 06268

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Dayton, University of
Dayton, OH 45469

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Industrial Engineering Technology
Mechanical Engineering Technology

Del Mar College
Corpus Christi, TX 78404

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Electronics Engineering Technology

Delta College
University Center, MI 48710

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Mechanical Engineering Technology

DeVry Institute of Technology
Atlanta, GA 30308

Electronics Engineering Technology

DeVry Institute of Technology
Chicago, IL 60618

Electronics Engineering Technology

DeVry Institute of Technology
Dallas, TX 75235

Electronics Engineering Technology

DeVry Institute of Technology
Phoenix, AZ 85016

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University of the
Van Ness Campus
Washington, DC 20008

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Civil Engineering Technology
Digital and Electromechanical Systems Engineering
Electronic Engineering Technology
Mechanical Engineering Technology

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Bangor, ME 04401

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Eastern New Mexico University Technical Institute
Portales, NM 88130

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Electronics Technology

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Daytona Beach, FL 32015

Aircraft Engineering Technology

Erie Community College North Campus
Buffalo, NY 14221

Civil Technology
Electrical Technology
Mechanical Technology

Fayetteville Technical Institute
Fayetteville, NC 28303

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Electronics Engineering Technology
Environmental Engineering Technology

Florence-Darlington Technical College
Florence, SC 29501

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Electronics Engineering Technology
Engineering Graphics Technology

Florida A&M University
Tallahassee, FL 32307

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Electrical Engineering Technology

Florida International University
Miami, FL 33199

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Manufacturing Engineering Technology
Mechanical Drafting & Design Engineering

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Mechanical Engineering Technology

Franklin University
Columbus OH 43215

Electronics Engineering Technology
Mechanical Engineering Technology

Gaston College
Dallas, NC 28034

Civil Engineering Technology
Electrical Engineering Technology
Electronics Engineering Technology
Industrial Engineering Technology
Mechanical & Production Engineering

Georgia Southern College
Statesboro, GA 30458

Civil Engineering Technology

Glendale Community College
Glendale, AZ 85302

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Guilford Technical Institute
Jamestown, NC 27282

Civil Engineering
Electronics Engineering Technology
Mechanical Drafting and Design

Hartford State Technical College
Hartford, CT 06106

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Data Processing Technology
Electrical Engineering Technology
Manufacturing Engineering Technology
Mechanical Engineering Technology
Nuclear Engineering Technology

Hartford, University of Samuel I. Ward
Technical College
West Hartford, CT 06117

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Hawkeye Institute of Technology
Waterloo, IA 50704

Civil Engineering Technology
Mechanical Engineering Technology

Houston, University of College of
Technology
Houston, TX 77004

Civil Technology
Drafting Technology
Electrical Technology
Electronics Technology
Manufacturing Technology
Mechanical Environmental
Systems Technology

Hudson Valley Community College
Troy, NY 12180

Chemical Technology
Civil Technology – Architectural
Civil Technology – Highway
Electrical Technology
Environmental Technology
Mechanical Technology – Air Conditioning
Mechanical Technology – Design
Mechanical Technology – Production

Indiana University – Purdue University
at Fort Wayne
Fort Wayne, IN 46805

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Electrical Technology
Mechanical Engineering Technology
Mechanical Technology

Indiana University - Purdue University
at Indianapolis
Indianapolis, IN 46205

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Electrical Engineering Technology
Electrical Technology
Industrial Engineering Technology
Mechanical Engineering Technology
Mechanical Technology

Kansas Technical Institute
Salina, KS 67401

Civil Engineering Technology
Computer Science Technology
Electronic Engineering Technology
Mechanical Engineering Technology

Kent State University
Tuscarawas Campus
New Philadelphia, OH 44663

Electrical/Electronic Engineering Technology
Industrial Engineering Technology
Mechanical Engineering Technology

Knoxville, State Technical Institute at
Knoxville, TN 37919

Chemical Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Lake Superior State College
Sault Ste. Marie, MI 49783

Computer Engineering Technology
Drafting/Design Engineering Technology
Electronic Engineering Technology
Mechanical Engineering Technology

Lawrence Insttitue of Technology
Southfield, MI 48075

Electrical & Electronic Technology
Mechanical Technology

Longview Community College
Lee's Summit, MO 64063

Electronic Engineering Technology

Lowell, University of
Lowell, MA 01854

Civil Engineering Technology
Electronic Engineering Technology
Mechanical Engineering Technology

Maine at Orono, University of
Orono, ME 04473

Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Memphis State University
Memphis, TN 38152

Architectural Technology
Computer System Technology
Construction Technology
Drafting and Design Technology
Electronics Technology
Manufacturing Technology

Memphis, State Technical Institute at
Memphis, TN 38134

Architectural Engineering Technology
Biomedical Engineering Technology
Chemical Engineering Technology
Civil Engineering Technology
Computer Engineering Technology
Electrical Engineering Technology
Electronic Engineering Technology
Environmental Engineering Technology
Industrial Engineering Technology
Instrumentation Engineering Technology
Mechanical Engineering Technology

Mercer County Community College
Trenton, NJ 08690

Construction/Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Metropolitan State College
Denver, CO 80204

Civil and Environmental Engineering
Electronics Engineering Technology

Michigan Technological University
Houghton, MI 49931

Civil Engineering Technology
Electrical Engineering Technology
Electromechanical Engineering Technology

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Edison, NJ 08817

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Columbia, SC 29250

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Mechanical Engineering Technology
Safety & Health Engineering Technology

Milwaukee School of Engineering
Milwaukee, WE 53201

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Architectural and Building Construction
Bio-Engineering Technology
Computer Engineering Technology
Electrical Engineering Technology
Electrical Power Engineering Technology
Electronic Communications Engineering
Fluid Power Engineering Technology
Industrial Engineering Technology
Internal Combustion Engines Engineering
Mechanical Engineering Technology

Missouri Institute of Technology
Kansas City, MO 64108

Electronics Engineering Technology

Mohawk Valley Community College
Utica, NY 13501

Civil Technology
Electrical Technology
Mechanical Technology
Surveying Technology

Montana State University
Bozeman, MT 59715

Construction Engineering Technology
Electrical & Electronic Engineering Technology
Mechanical Engineering Technology

Montgomery College
Rockville, MD 20850

Electronic Technology

Morrison Institute of Technology
Morrison, IL 61270

Highway Engineering Technology
Design and Drafting Engineering Technology

Nashville State Technical Institute
Nashville, TN 37209

Architectural and Building Construction Engineering
Chemical Engineering Technology
Civil Engineering Technology
Electrical Engineering Technology
Electronic Engineering Technology
Industrial Engineering Technology
Mechanical Engineering Technology

Nassau Community College
Garden City, NY 11530

Civil Engineering Technology

Nebraska at Omaha, University of
Omaha, NB 68101

Construction Engineering Technology

Drafting/Design Engineering Technology
Electronics Engineering Technology
Industrial Engineering Technology

Nevada, University of College of Engineering
Reno, NV 89507

Electronics Engineering Technology
Architectural Design Technology

New Hampshire Technical Institute
Concord, NH 03301

Architectural Engineering Technology
Electromechanical Engineering
Electronic Engineering Technology
Mechanical Engineering Technology

New Jersey Institute of Technology
Newark, NJ 07102

Construction/Contracting Engineering
Electrical Systems Engineering Technology
Environmental Engineering Technology
Manufacturing Engineering Technology
Mechanical Systems Engineering Technology

New Mexico State University
Las Cruces, NM 88003

Civil Engineering Technology
Electronic Engineering Technology
Engineering Technology
Mechanical Engineering Technology

New York City Community College
Brooklyn, NY 11201

Civil Technology
Electrical Technology
Electromechanical Technology
Mechanical Technology

New York Institute of Technology
Metropolitan Campus
New York, NY 10001

Aeronautical Operations Technology
Electromechanical Computer Technology

New York Institute of Technology
Old Westbury Campus
Old Westbury, NY 11568

Aeronautical Operations Technology
Electromechanical Computer Technology

New York, State University of, Agricultural & Technical College
Alfred, NY 14802

Construction Technology
Electrical Technology
Mechanical Technology – Air-Conditioning
Mechanical Technology – Electromechanical
Mechanical Technology – Internal Combustion Engines
Mechanical Technology – Product and Machine Design
Surveying Technology

New York, State University of, Agricultural & Technical College
Canton, NY 13617

Air Conditioning Technology
Civil Technology
Construction Technology
Electrical Technology
Mechanical Technology

New York, State University of, Agricultural & Technical College
Farmingdale, NY 11735

Air Conditioning Technology
Automotive Technology
Civil Technology
Construction Technology – Architectural
Electrical Technology – Electronics
Mechanical Technology

North Carolina at Charlotte, University of
Charlotte, NC 18112

Civil Engineering Technology
Computer/Electronics Engineering Technology
Mechanical Engineering Technology

Northeastern University
Lincoln College
Boston, MA 02115

Civil Engineering Technology
Electrical Engineering Technology

Mechanical Engineering Technology
Mechanical/Structural Engineering

Northern Arizona University
Flagstaff, AZ 86001

Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Northrop University
Inglewood, CA 90306

Aircraft Maintenance Engineering

Norwalk State Technical College
Norwalk, CT 06854

Architectural Engineering Technology
Chemical Engineering Technology
Electrical Engineering Technology
Electro-Mechanical Engineering Technology
Manufacturing Engineering Technology
Materials Engineering Technology
Mechanical Engineering Technology

Ocean County College
Toms River, NJ 08753

Electronic Engineering Technology

Ohio Institute of Technology
Columbus, OH 43209

Electronics Engineering Technology

Oklahoma State University
School of Technology
Stillwater, OK 74074

Construction Management Technology
Electronics Technology
Fire Protection & Safety Technology
Mechanical Design Technology
Mechanical Power Technology
Petroleum Technology
Radiation & Nuclear Technology

Old Dominion University
Norfolk, VA 23508

Civil Engineering Technology

Electrical Engineering Technology
Mechanical Engineering Technology

Oregon Institute of Technology
Klamath Falls, OR 97601

Computer Systems Engineering Technology
Electronics Engineering Technology
Engineering Drafting Technology
Mechanical Engineering Technology
Public Works Engineering Technology
Structural Engineering Technology
Surveying Engineering Technology

Oregon State University
Corvallis, OR 97331

Civil Engineering Technology
Mechanical Engineering Technology
Nuclear Engineering Technology

Owens Technical College, Michael J.
Toledo, OH 43699

Civil Engineering Technology
Electrical Engineering Technology

Parkland College
Champaign, IL 61820

Electronics Engineering Technology

Pennsylvania State University
Altoona Campus
Altoona, PA 16603

Electrical Engineering Technology
Mechanical Engineering Technology
Nuclear Engineering Technology

Pennsylvania State University
Beaver Campus
Monaca, PA 15061

Electrical Engineering Technology
Mechanical Engineering Technology

Pennsylvania State University
Behrend College
Erie, PA 16910

Electrical Engineering Technology

Mechanical Engineering Technology

Pennsylvania State University
Berks Campus
Reading, PA 19608

Air Pollution Control Engineering
Chemical Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Pennsylvania State University
Capitol Campus
Middletown, PA 17057

Building Construction Technology
Electrical Design Engineering Technology
Mechanical Design Engineering Technology
Transportation Engineering Technology
Water Resources Engineering Technology

Pennsylvania State University
Delaware County Campus
Media, PA 19063

Electrical Engineering Technology

Pennsylvania State University
DuBois Campus
DuBois, PA 15801

Electrical Engineering Technology
Mechanical Engineering Technology

Pennsylvania State University
Fayette Campus
Uniontown, PA 15401

Architectural Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology
Mining Technology (Production Option)

Pennsylvania State University
Hazleton Campus
Hazleton, PA 18201

Electrical Engineering Technology
Mechanical Engineering Technology
Nuclear Engineering Technology

Pennsylvania State University
McKeesport Campus
McKeesport, PA 15132

Electrical Engineering Technology
Mechanical Engineering Technology

Pennsylvania State University
Mont Alto Campus
Mont Alto, PA 17237

Surveying Technology

Pennsylvania State University
New Kensington Campus
New Kensington, PA 15068

Electrical Engineering Technology
Mechanical Engineering Technology

Pennsylvania State University
Ogontz Campus
Abington, PA 19001

Electrical Engineering Technology
Mechanical Engineering Technology

Pennsylvania State University
Schuylkill Campus
Schuylkill Haven, PA 17972

Electrical Engineering Technology

Pennsylvania State University
Shenango Valley Campus
Sharon, PA 16146

Architectural Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Pennsylvania State University
Wilkes-Barre Campus
Wilkes-Barre, PA 18708

Bio-Medical Equipment Technology
Electrical Engineering Technology
Highway Engineering Technology
Mechanical Engineering Technology
Surveying Technology

Pennsylvania State University
Worthington-Scranton Campus
Dunmore, PA 18512

Architectural Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Pennsylvania State University
York Campus
York, PA 17403

Electrical Engineering Technology
Mechanical Engineering Technology

Phoenix College
Phoenix, AZ 85013

Electronic Engineering Technology

Piedmont Technical College
Greenwood, SC 29646

Electronic Engineering Technology
Engineering Graphics Technology

Pittsburg State University
Pittsburg, KS 66762

Construction Technology
Electronics Technology
Manufacturing Technology
Mechanical Design Technology
Plastics Technology

Pittsburgh at Johnstown, University of
Johnstown, PA 15904

Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Prince George's Community College
Largo, MD 20870

Electronics Engineering Technology

Purdue University
Calumet Campus
Hammond, IN 46323

Civil Engineering Technology
Construction Technology
Electrical Engineering Technology
Electrical Technology
Industrial Engineering Technology
Mechanical Engineering Technology
Mechanical Technology

Purdue University
West Lafayette Campus
West Lafayette, IN 47907

Electrical Engineering Technology
Electrical Technology
Mechanical Engineering Technology
Mechanical Technology

Queensborough Community
College of the City
University of New York
Bayside, NY 11364

Electrical Technology – Computer
Electrical Technology – Electronics
Mechanical Technology

Ricks College
Rexburg, ID 83440

Design and Drafting Engineering Technology
Electronics Engineering Technology

Rochester Community College
Rochester, MN 55901

Civil Engineering Technology
Electronics Engineering Technology
Mechanical Technology

Rochester Institute of Technology
Rochester, NY 14623

Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

St. Louis Community College at Florissant Valley
St. Louis, MO 63135

Civil Engineering Technology
Electrical Engineering Technology
Electronic Engineering Technology
Mechanical Engineering Technology

St. Petersburg Junior College
St. Petersburg, FL 33733

Electronic Engineering Technology

San Francisco, City College of
San Francisco, CA 94112

Civil Engineering Technology
Electrical/Electronics Engineering Technology
Electro-Mechanical Engineering Technology
Engineering Drafting Technology
Mechanical Engineering Technology

Sandhills Community College
Carthage, NC 28327

Architectural Engineering Technology
Civil Engineering Technology

Savannah State College
Savannah, GA 31404

Civil Engineering Technology
Electronics Engineering Technology
Mechanical Engineering Technology

Sinclair Community College
Dayton, OH 45402

Electronics Engineering Technology
Mechanical Engineering Technology

Southeastern Massachusetts University
North Dartmouth, MA 02747

Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Southern Colorado, University of
Pueblo, CO 81001

Civil Engineering Technology
Electronics Engineering Technology
Manufacturing Engineering Technology
Mechanical Engineering Technology
Metallurgical Engineering Technology

Southern Illinois University at Carbondale
Carbondale, IL 62901

Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Southern Mississippi, University of
Hattiesburg, MS 39401

Environmental Technology

Southern Technical Institute
A Division of Georgia Institute of Technology
Marietta, GA 30060

Apparel Engineering Technology
Architectural Engineering Technology
Civil Engineering Technology
Civil Engineering Technology – Structural Materials
Civil Engineering Technology – Surveying and Construction
Electrical Engineering Technology
Electrical Engineering Technology – Electronic Computer
Electrical Engineering Technology – Electronics Option
Electrical Engineering Technology – Nuclear Safety Option
Industrial Engineering Technology
Mechanical Engineering Technology
Textile Engineering Technology

Spartanburg Technical College
Spartanburg, SC 29303

Civil Engineering Technology
Electronics Engineering Technology
Mechanical Engineering Technology

Stark Technical College
Canton, OH 44720

Civil Construction Technology
Design & Drafting Technology
Electrical Engineering Technology
Electronic Engineering Technology
Mechanical Engineering Technology

Sumter Area Technical College
Sumter, SC 29150

Civil Engineering Technology
Environmental Engineering Technology

Temple University
College of Engineering Technology
Philadelphia, PA 19122

Building Construction Technology
Civil Engineering/Construction Technology
Electrical Engineering Technology
Electronics Engineering Technology
Environmental Engineering Technology
Mechanical Engineering Technology

Tennessee at Martin, University of
Martin, TN 38238

Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology

Texas A&M University
College Station, TX 77840

Engineering Technology

Texas Tech University
Lubbock, TX 79409

Construction Engineering Technology
Electrical/Electronics Engineering Technology
Mechanical Engineering Technology

Thames Valley State Technical College
Norwick, CT 06360

Chemical Engineering Technology
Electrical Engineering Technology
Manufacturing Engineering Technology
Mechanical Engineering Technology

Toledo, University of
Community & Technical College
Toledo, OH 43606

Electronic Engineering Technology
Industrial Engineering Technology
Mechanical Engineering Technology

Trenton State College
Trenton, NJ 08625

Electronic Engineering Technology
Mechanical Engineering Technology

Tri-County Technical College
Pendleton, SC 29670

Electronics Engineering Technology

Trident Technical College
Charleston, SC 29411

Chemical Engineering Technology
Civil Engineering Technology
Electrical Engineering Technology
Electronics Engineering Technology
Mechanical Engineering Technology

Triton College
River Grove, IL 60171

Electronics Technology

Vermont Technical College
Randolph Center, VT 05061

Architectural & Building Engineering Technology
Civil Engineering Technology
Electrical & Electronics Engineering Technology
Mechanical Engineering Technology
Surveying Technology

Virginia Polytechnic Institute & State University
Blacksburg, VA 24061

Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Design Technology

Wake Technical Institute
Raleigh, NC 27603

Architectural Technology
Chemical Technology
Civil Engineering Technology
Computer Technology
Electronic Engineering Technology
Industrial Engineering Technology

Waterbury State Technical College
Waterbury, CT 06708

Chemical Engineering Technology
Electrical Engineering Technology
Manufacturing Engineering Technology
Mechanical Engineering Technology

Weber State College
Ogden, UT 84408

Electronic Technology
Electronic Engineering Technology
Manufacturing Engineering Technology

Wentworth Institute of Technology
Boston, MA 02115

Aeronautical Technology
Architectural Engineering Technology
Architectural Technology
Building Construction Technology
Civil Engineering Technology
Electrical Engineering Technology
Electronic Engineering Technology
Electronic Technology
Environmental Engineering Technology
Industrial Engineering Technology
Manufacturing Processes Technology
Mechanical Design Engineering Technology
Mechanical Design Technology
Mechanical Power Engineering Technology
Nuclear Engineering Technology

West Virginia Institute of Technology
Montgomery, WV 25136

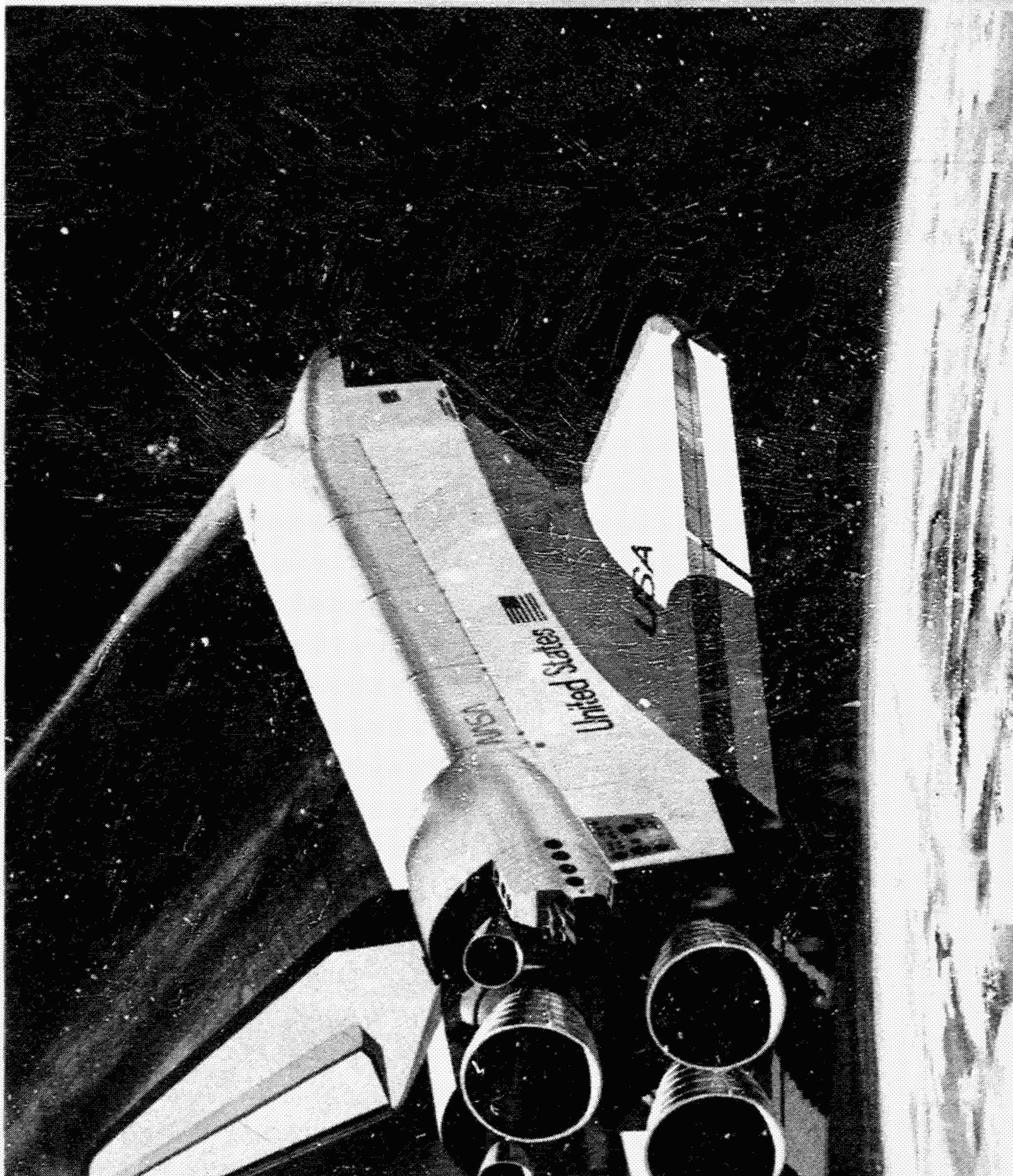
Civil Engineering Technology
Drafting & Design Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology
Mining Engineering Technology
Surveying Technology

Western Kentucky University
Bowling Green, KY 42101

Civil Engineering Technology
Electrical Engineering Technology
Environmental Engineering Technology
Mechanical Engineering Technology

Youngstown State University
Youngstown, OH 44503

Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology


NASA
United States
USA

APPENDIX C:

Additional Sources of Aerospace Career Information

CAREERS IN AEROSPACE AND RELATED FIELDS

A Listing of Information Sources

Prepared by the National Career Information Center of the American Personnel and Guidance Association in cooperation with the National Aeronautics and Space Administration.

Trade, Professional and Educational Sources

AEROSPACE AND AVIATION

Airport Management—A Profession, American Association of Airport Executives, 2029 K St., NW, Washington, DC 20006.

ALPA Occupational Guides, Air Line Pilots Association, 1625 Massachusetts Avenue, NW, Washington, DC 20036.

Aviation Education Materials, Going Up! . . . A Career as a Professional Pilot, Help-Mate . . . A Career Using Personal Flying, Sky-School . . . A Career as a Flight Instructor, Airworthy . . . A Career as an A&P Mechanic, General Aviation Manufacturers Association, Suite 1215, 1025 Connecticut Avenue, Washington, DC 20036.

Careers in Aerospace Medicine and Life Sciences, The Aerospace Medical Association, Washington National Airport, Washington, DC 20001.

Careers in Aerospace Within Your Lifetime, American Institute of Aeronautics and Astronautics, 1290 Avenue of the Americas, New York, NY 10019.

Flight Engineer Career Information, Flight Engineer International Association, 905 16th Street, NW, Washington, DC 20006.

Geophysics - The Earth in Space, American Geophysical Union, 2000 Florida Avenue, NW, Washington, DC 20009.

The People of the Airlines, Air Transport Association of America, 1709 New York Avenue, NW, Washington, DC 20006.

ENGINEERING AND TECHNOLOGY

A Career for the Future, American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

The Big Pond - Federal Jobs for Engineers, Physical Scientists, Mathematicians, U.S. Government Printing Office, Washington, DC 20302.

Can I Be A Technician? Let's Find Out, Can I Be an Engineer?, General Motors Corporation, Public Relations Staff, Detroit, MI 48202.

Career Guidance Reprints, Society of Women Engineers, 345 E. 47th St., New York, NY 10017.

Careers in Electrical Electronics Engineering, Institute of Electrical Electronics Engineering, 345 East 47th Street, New York, NY 10017.

Careers in Petroleum Engineering, Society of Petroleum Engineering, 6200 N. Central Expressway, Dallas, TX 75206.

The Certification of Engineering Technicians, Institute for the Certification of Engineering Technicians, 2029 K Street, NW, Washington, DC 20006.

The Chemical Engineer, The Expanding Domain of Chemical Engineering, American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017.

Civil Engineer Booklets: Careers in Civil Engineering—The Environmental Engineer, Careers in Civil Engineering—The Highway Engineer, American Society of Civil Engineers, 345 East 47th Street, New York, NY 10017.

Consulting Engineering . . . A Career with a Future, American Consulting Engineers Council, 1155 15th Street, NW, Washington, DC 20005.

Engineering—A Career of Dedication and Responsibility, National Society of Professional Engineers, 2029 K Street, NW, Washington, DC 20036.

Federal Jobs in Engineering, Physical Sciences, U.S. Civil Service Commission, 1900 E. Street, NW, Washington, DC 20415.

Industrial Engineering - The Humanized Profession, American Institute of Industrial Engineers, 25 Technology Park, Norcross, GA 30092.

Is Engineering for You? Engineering: Creating a Better World, Engineering - A Challenge, Accredited Curricula Leading to First Degrees in Engineering in the U.S., Engineers Council for Professional Development, 345 East 47th Street, New York, NY 10017.

The Many Paths to a Career in Ceramic Engineering, American Ceramic Society, 65 Ceramic Drive, Columbus, OH 43214.

The Naval Architect and Marine Engineer, Society of Naval Architects & Marine Engineers, One World Trade Center, Suite 1369, New York, NY 10048.

The Road to Graduate School in Engineering, The Engineering Technician, American Society for Engineering Education, One Dupont Circle, NW, Suite 400, Washington, DC 20036.

Scope and Functions of the Professional Safety Engineer, American Society of Safety Engineers, 850 Busse Highway, Park Ridge, IL 60669.

Should You Be a Coal Mining Engineer, Careers in Engineering in the Minerals Industry, Society of Mining Engineers, Caller #D, Littleton, CO 80235.

Should You Be a Manufacturing Engineer? Society of Manufacturing Engineers, 20501 Ford Road, Dearborn, MI 48128.

25 Technical Careers You Can Learn in Two Years or Less, U.S. Department of Education, Washington, DC 20202.

Technology, Engineering Manpower Commission/EJC, 345 East 47th Street, New York, NY 10017.

What's It Like to Be an Engineer?, What's It Like to Be a Technician? GE Corporation, Career Information, Room 901, 570 Lexington Avenue, New York, NY 10022.

Women in Engineering Professions, Agricultural Engineering and You, Agricultural Engineering - The Profession with a Future, Engineering Careers in the World's Largest Industry, Did You Ever Wish You Could Change the World?, Wanted: More Women Engineers in Agricultural Engineering, American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 49085.

ENVIRONMENT

Ask Any Forester, Forest Ecology and You, Society of American Foresters, 5400 Grosvenor Lane, Washington, DC 20014.

A Wildlife Conservation Career for You, Universities and Colleges Offering Curricula in Wildlife Conservation, Wildlife Society, Suite S-176, 3900 Wisconsin Avenue, NW, Washington, DC 20016.

Careers in Range Science, Society for Range Management, 2760 West 5th Street, Denver, CO 80204.

Careers in Wildlife Conservation and Management, Wildlife Management Institute, 709 Wire Bldg., Washington, DC 20005.

Conservation Careers, Careers in Resource Conservation, Soil Conservation Society of America, 7515 NE Ankeny Road, Ankeny, IA 50021.

The Environmentalist, Career Materials in Environmental Health & Sanitation, National Environmental Health Association, 1600 Pennsylvania Avenue, Denver, CO 80203.

Resources for Environment/Ecology Education: A Bibliography, Institute of Environmental Sciences, 940 E. Northwest Highway, Mt. Prospect, IL 60056.

So You Want to Be a Forester, A Job with the Forest Service, U.S. Department of Agriculture, Forest Service, Washington, DC 20250.

You Can Be a Conservationist, So You Want to Be a Forester, American Forestry Association, 1319 18th Street, NW, Washington, DC 20036.

HEALTH AND MEDICINE

A Career in Cytotechnology, American Society of Cytology, 130 South Ninth Street, Suite 1006, Philadelphia, PA 19107.

A Career in Pharmacology, American Society for Pharmacology, 9650 Rockville Pike, Bethesda, MD 20014.

Answers to Your Questions About .... Medical Technology, Accredited Medical Laboratory Schools, American Medical Technologists, 710 Higgins Road, Park Ridge, IL 60068.

Careers in Anatomy, American Association of Anatomists, Department of Anatomy, University of Arkansas Medicine Center, 4201 W. Markham Street, Little Rock, AR 72201.

Careers in Physiology, American Physiological Society, 9650 Rockville Pike, Bethesda, MD 20014.

Careers in the Health/Science Library, Medical Library Association, 919 North Michigan Avenue, #3208, Chicago, IL 60611.

Careers in the Medical Laboratory, American Society of Clinical Pathologists, PO Box 4872, Chicago, IL 60680.

Careers That Count, American Hospital Association, 840 N. Lake Shore Drive, Chicago, IL 60611.

Health Physics - A Challenging Profession, Health Physics: A New Profession in the Atomic Age, Health Physics Society, PO Box 156, E. Weymouth, MA 02189.

Horizons Unlimited, American Medical Association, 535 N. Dearborn Street, Chicago, IL 60610.

Medical Technicians and Assistant Schools, Accrediting Bureau of Health Education Schools, 29089 U.S. 20 West, Elkhart, IN 46514.

Modern Surgery, American College of Surgeons, 55 East Erie Street, Chicago, IL 60611.

Pathology: The Science of Disease, Intersociety Committee on Pathology, 4733 Bethesda Avenue, Suite 735, Bethesda, MD 20014.

Should You Be a Nuclear Medical Technologist, Society of Nuclear Medical Technologists, PO Box 284, Arlington Heights, IL 60006.

Where to Get Health Career Information, National Health Council, Inc., 1740 Broadway, New York, NY 10019.

INDUSTRY

A Career in Metallurgy Will Extend Your Reach, Metallurgical Engineering Technician, Career Opportunities in Metallurgy, The American Society for Metals, Metals Park, OH 44073.

A Rewarding Career, Instrument Society of America, 400 Stanwix Street, Pittsburgh, PA 15222.

Biological Photography—A Challenging Profession, Biological Photographic Association, PO Box 1057, Rochester, MN 55901.

Careers in Metallurgy, Materials Science & Metallurgical Engineering, The Metallurgical Society of AIME, 345 East 47th Street, New York, NY 10017.

Careers in Operation Research, The Operation Research Society of America, 428 Preston Street, Baltimore, MD 21202

Careers in Quality, American Society for Quality Control, 161 West Wisconsin Avenue, Milwaukee, WI 53203.

Careers in Statistics, American Statistical Association, 806 15th Street, NW, Washington, DC 20005.

Career Summaries, National Association of Pattern Manufacturers, 21010 Center Ridge Road, Rocky River, OH 44116.

Education for Technical Writers, Is Technical Writing Your Career, Society for Technical Communication, Suite 421, 1010 Vermont Avenue, NW, Washington, DC 20005.

Facts on Computer Careers, American Federation of Information Processing Societies, 1815 North Lynn Street, Suite 805, Arlington, VA 22209.

Giving Shapes to Ideas, Society of Die Casting Engineers, 16007 West 8 Mile Road, Detroit, Mi 48235.

Machine Tools: Exciting Careers, National Machine Tool Builders Association, 7901 Westpark Drive, McLean, VA 22102.

The Making of a Machinist, Career Opportunities, National Tool, Die and Precision Machining Association, 9300 Livingston Road, Oxon Hill, MD 20022.

Measurement & Control Industry, Scientific Apparatus Makers Association, 1140 Connecticut Avenue, NW, Washington, DC 20036

Photographer: A Professional With a Challenge, Professional Photographers of America, 1090 Executive Way, Des Plaines, IL 60018.

Planning a Career in Electronics, The Electronics, Service Technician - Futures Unlimited, Electronics Industries Association, 2001 "I" Street, NW, Washington, DC 20006.

Sources of Career Information in Scientific Fields, Probe Tomorrow as a Chemical Technician, Your Tomorrow, Careers for Adventures, Manufacturing Chemists Association, 1825 Connecticut Avenue, NW, Washington, DC 20009.

Systems Analysis: The Career, Association for Systems Management, 24587 Bagley Road, Cleveland, OH 44138.

Transport Career Opportunities, National Defense Transportation Association, 1612 K St., NW, Washington, DC 20006.

Your Career in Fluid Power, The Fluid Power Society (FPS), 432 E. Kilbourn Ave., Milwaukee, WI 53201.

Your Introduction to Photogrammetry, The American Society of Photogrammetry, 105 N. Virginia Ave., Falls Church, VA 22046.

SCIENCE

A Career in Astronomy, American Astronomical Society, Sharp Laboratory, University of Delaware, Newark, DE 19711.

A Career in Cartography, American Congress on Surveying and Mapping, 210 Little Falls Street, Falls Church, VA 22046.

A Giant Leap for Womankind Too, National Geographic Society, 17th & M Sts., NW, Washington, DC 20036.

A Guide to Opportunities in Cell Biology, Secretary, American Society for Cell Biology, Department of Anatomy, Albert Einstein College of Medicine, 1300 Morris Park Avenue, Bronx, NY 10461.

Can I Be a Scientist? General Motors Corporation, Public Relations Staff, Detroit, MI 48202.

Career Opportunities in Chemistry, Careers in Chemistry: Questions and Answers, Finding Employment in the Chemical Profession, List of ACS Approved Schools, Planning for Graduate Work in Chemistry, American Chemical Society, 1155 16th Street, NW, Washington, DC 20036.

Careers in Agronomy, Crop Science and Soil Science, American Society of Agronomy, 677 S. Segoe Road, Madison, WI 53711.

Careers in Animal Biology, American Society of Zoologists, Box 2739 California Lutheran College, Thousand Oaks, CA 91360.

Careers in Animal Biology, Society of Systematic Zoology, c/o U.S. National Museum of Natural History, Washington, DC 20560.

Careers in Atomic Energy, U.S. Atomic Energy Commission, PO Box 62, Oak Ridge, TN 37830.

Careers in Biochemistry, American Society of Biological Chemists, Inc., Educational Affairs Office, 9650 Rockville Pike, Bethesda, MD 20014.

Careers in Biology, Careers in Animal Biology, Careers in Botany, American Institute of Biological Sciences, 1401 Wilson Blvd., Arlington, VA 22209.

Careers in Exploration Geophysics, Society of Exploration Geophysics, Box 3098, Tulsa, OK 74101

Careers in Geography, Association of American Geographers, 1710 16th Street, NW, Washington, DC 20009.

Careers in Photographic Science & Engineering, Society of Photographic Scientists & Engineers, Suite 330, 1411 K Street, NW, Washington, DC 20005.

Careers in Plant Physiology, American Society of Plant Physiologists, 9650 Rockville Pike, Bethesda, MD 20014.

The Challenge of Meteorology, Opportunities in Meteorology, The American Meteorological Society, 45 Beacon Street, Boston, MA 02108.

Earth Scientists: Geologists, Geophysicists, Meteorologists, U.S. Government Printing Office, Washington, DC 20402.

Entomology - An Exciting Scientific Career, Entomological Society of America, 4603 Calvert Road, College Park, MD 20740.

Geology - Science and Profession, American Geological Institute, 5205 Leesburg Pike, Falls Church, VA 22041.

Mathematics and My Career, The National Council of Teachers of Mathematics, 1906 Association Drive, Reston, VA 22091.

Microbiology in Your Future, American Society for Microbiology, 1913 "I" Street, NW, Washington, DC 20006.

Occupations in Electronic Computing Systems, Electronic Computer Operating Personnel, Programmers, Systems Analysts, U.S. Government Printing Office, Washington DC 20402.

Oceanography Information Kit, National Ocean Industries Association, 1100 17th Street, NW, Suite 410, Washington, DC 20036.

The Oceans and You, Marine Technology Society, 1730 M Street, NW, Suite 412, Washington, DC 20036.

Opportunities in Oceanography, Smithsonian Institution, Publications Distribution, 1242 24th Street, NW, Washington, DC 20037.

Physics as a Career, Should You Be a Physicist? American Institute of Physics, 335 East 45th Street, New York, NY 10017.

Preparing for a Career in Oceanography, Scripps Information of Oceanography, PO Box 109, La Jolla, CA 92037.

Professional Opportunities in Mathematics, The Mathematical Association of America, 1225 Connecticut Avenue, NW, Washington, DC 20036.

Science and Engineering Careers, Test Yourself for Science, Science Manpower Commission, 1776 Massachusetts Avenue, NW, Washington, DC 20036, $1.00.

Science and Your Career, U.S. Department of Labor, Bureau of Labor Statistics, Washington, DC 20212.

Science Career Exploration, National Science Teachers Association, 1742 Connecticut Avenue, NW, Washington, DC 20009.

Science for Society - A Bibliography, American Alliance for the Advancement of Science, Education Department, 1776 Massachusetts Avenue, NW, Washington, DC 20036.

Seeking Employment in the Mathematical Sciences, The American Mathematical Society, PO Box 6248, Providence, RI 02904.

ADDITIONAL SOURCES OF INFORMATION

Aero Products Research, Inc. 11201 Hindry Avenue, Los Angeles, CA 90045.

Aerospace and Electrical Systems Society, 4000 Harlonwood Drive, Fort Worth, TX 76109.

Aerospace Education Foundation, 1750 Pennsylvania Avenue, NW, Washington, DC 20006.

American Astronautical Society, Key Towers, 6060 Duke Street, Alexandria, VA 22304.

Aviation Distributors and Manufacturers Association, 1900 Arch Street, Philadelphia, PA 19103.

Beech Aircraft Corporation, Education Department, Wichita, KS 67201.

Bendix Corporation, Bendix Center, Southfield, MI 48076.

The Boeing Company, PO Box 37037, M/S 11-48, Seattle, WA 98124.

Cessna Aircraft Company, PO Box 1521, Wichita, KS 67201.

Fairchild Industries, 20301 Century Blvd., Germantown, MD 20767.

Federation of American Scientists, 307 Massachusetts Avenue, NE, Washington, DC 20002.

Federation of Engineering and Scientific Association, 171 College Street, Toronto, Ontario, M5T 1P7.

Grumman Aerospace Corporation, Bethpage, NY 11714.

International Association of Machinists and Aerospace Workers, 1300 Connecticut Avenue, NW, Washington, DC 20036.

National Aeronautics Association of the USA, Suite 430, 821 15th Street, NW, Washington, DC 20005.

Singer Company, Kearfott Division 1150 McBride Avenue, Little Falls, NY 07424.

Sperry Flight Systems, PO Box 2111, Phoenix, AZ 85036.

United Automobile, Aerospace and Agricultural Implement Workers, 8000 East Jefferson Avenue, Detroit, MI 48214.

Vought Systems Division, LTV Aerospace Corporation, PO Box 5907, Dallas, TX.

THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Guidance workers wishing to make use of NASA professional educators, publications, and/or audiovisual materials in their programs may contact the Educational Programs Officer at the NASA Centers serving their respective states. See below:

NASA Ames Research Center, Moffett Field, California 94035
serving: Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming

NASA Goddard Space Flight Center, Greenbelt, Maryland 20771
serving: Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont

NASA Johnson Space Center, Houston, Texas 77058
serving: Colorado, Kansas, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, and Texas

NASA Kennedy Space Center, Kennedy Space Center, Florida 32899
serving: Florida, Georgia, Puerto Rico, and Virgin Islands

NASA Langley Research Center, Hampton, Virginia 23665
serving: Kentucky, North Carolina, South Carolina, Virginia, and West Virginia

NASA Lewis Research Center, 21000 Brookpark Road, Cleveland, Ohio 44135
serving: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin

NASA Marshall Space Flight Center, Marshall Space Flight Center, Alabama 35812
serving: Alabama, Arkansas, Iowa, Louisiana, Mississippi, Missouri, and Tennessee

Vacuum spheres—symbols of aerospace research and development