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# NAVAL POSTGRADUATE SCHOOL Monterey, California



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## THESIS

AN EDUCATIONAL SPACE SEMINAR TO  
INCREASE AMERICAN STUDENT INTEREST  
IN SPACE CAREERS

by

Gregory A. Heruth, Sr.

September 1991

Thesis Advisor

Dan C. Boger

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An Educational Space Seminar to  
Increase American Student Interest  
in Space Careers

by

Gregory A. Heruth, Sr.  
Lieutenant, United States Navy  
B.S., United States Naval Academy, 1984

Submitted in partial fulfillment of the  
requirements for the degree of

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY  
(SPACE SYSTEMS OPERATIONS)


from the

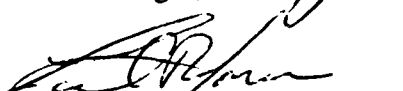
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## ABSTRACT

The ultimate goal of AMERICA'S YOUTH: Our Future In Space, an educational space seminar for college bound high school age students, is to inspire American youth with the wonders of space, providing them with the desire to overcome obstacles and prepare themselves properly for a career in America's space program. The problem is comprised of three parts: first, studies show a decline in math and science capabilities and interest in science and engineering degrees by America's youth. Second, with a decreasing population of high school age students, and an increasing number of "Apollo era" experienced scientists and engineers retiring, the U.S. is faced with a serious supply and demand problem. Finally, the aerospace industry has been the largest contributor to America's balance of trade for a number of years; unfortunately, international competition is quickly eroding the country's share of the world's commercial space 'pie'. A solution: (1) a detailed review of four major space related educational programs designed for young people in search of their most effective and most unique aspects when attempting to influence young students; (2) a space oriented seminar with well-known speakers, IMAX quality film, college/university information, aerospace career opportunities, and a group design project all brought together in a fast paced, one day session travelling to a different state each week. To assist the orator, A User's Guide is included which steps through the seminar.

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"I must succeed

For the sake of my country!

The price of my failure

Is stagnation!"

(from a MoonBeam to a Cosmic Fish)

## **I. IS THERE HOPE FOR AMERICA'S AEROSPACE PROGRAM?**

Studies show a decline in math and science abilities and interest in science and engineering degrees by America's youth. The National Science Board reports

Based on the plans of college-bound seniors who take the Scholastic Aptitude Test (SAT), there has been a decline in the proportion of students intending to major in the more quantitative sciences -- math and statistics, the physical sciences, engineering, and computer science. [Ref. 1:pg. 22]

Another area of concern comes from the U.S. Bureau of Census; projections show that within five years America will experience the lowest population of 17 and 18 year olds since 1970 [Ref 2]. These facts speak of supply, but what about demand? The National Science Foundation states "40 percent of all aeronautical engineers were over 50 years of age in 1986, an increase of 23 percent from 1976" [Ref 3:pg. 1] There are forecasts that report by the year 2010 the U. S. will be short at least 200,000 scientists and engineers. Combine a decrease in the number of high school students graduating and interested in science and engineering with an increase in the number of 'Apollo Era' scientists and engineers retiring and America is presented with a severe shortage of 'qualified' college graduates entering the work force to fill vacancies left by experienced personnel. How will this decrease in supply coupled with an increase in demand affect the United States' capability in space science and engineering?

NASA, Department of Defense, private space industry, and academe are all competing against numerous other businesses for a drastically declining number of properly educated individuals to fill their ranks. And, although aerospace has been the largest contributor to America's balance of trade for a number of years, international competition is quickly eroding our share of the commercial space 'pie'. Also, past national excitement has been

replaced by only occasional public support in an area that should be driving our country into the future as 'the leader'. These problems are serious but not irreversible.

Preliminary conclusions drawn from educational, demographic, and employment studies indicate a problem in America's ability to replace those individuals who originally produced the government and industrial production base which propelled this country into a position of leadership in space endeavors. One aspect of the problem stems from a reduced interest by U.S. students to devote their energy towards the more demanding math and science curriculums in high school, science and engineering in college, and follow-on master's and doctorate programs. "Today, 75 percent of the graduate students receiving financial support from university engineering departments are foreign nationals [Ref 4:pg. 27]." Fortunately, other agencies have seen the problem and are working through a variety of methods to improve the problem.

This thesis will consist of three major areas of concentration: America's aerospace program and how it is affected by student interest or the lack thereof in math and science; past and present programs devised to increase interest in these areas, and a potential program to entice America's youth into space related education and career paths.

The first part will delve into the supply and demand issues; America's lack of ability to adequately replace the growing number of senior scientists and engineers reaching retirement age with young, new American scientists and engineers, also touching on some of the economic issues involved with the loss of America's lead in the commercial space sector, and how the education problem is related. Although attempts have been underway for some time to curb the lack of interest in the more difficult science and engineering fields, the reports still show a decline in student interest. Why?

The second part will analyze various educational programs, both past and present, to define the best and worst of what has been tried and what is available now. Programs are available from NASA, private industry, and through numerous education groups.

The final part will be a detailed description of an educational program, entitled: AMERICA'S YOUTH: Our Future In Space, designed to entice high school age students to pursue increased knowledge concerning America's space program utilizing well known people and an IMAX<sup>®</sup> type film and promote the numerous space oriented education and career paths within the aerospace program with organizations such as NASA, Department of Defense, federal agencies, private industry, and colleges/universities. Included in the appendix will be A User's Guide which would allow an orator to work their way through AMERICA'S YOUTH: Our Future In Space.

## **II. AEROSPACE IN AMERICA: WILL IT BE LOST?**

### **A. BACKGROUND**

The Space Act of 1958 directs the National Aeronautics and Space Administration, (NASA) to:

1. Expand human knowledge of phenomena in the atmosphere and space.
2. Improve the usefulness, performance, speed, safety and efficiency of aeronautical and space vehicles.
3. Develop vehicles capable of carrying instruments, supplies, and living organisms through space.
4. Study the benefits to be gained from aeronautical and space activities.
5. Preserve the role of the United States as a leader in aeronautical and space work.
6. Cooperate with other nations in aeronautical and space work. [Ref. 5, pg. 3]

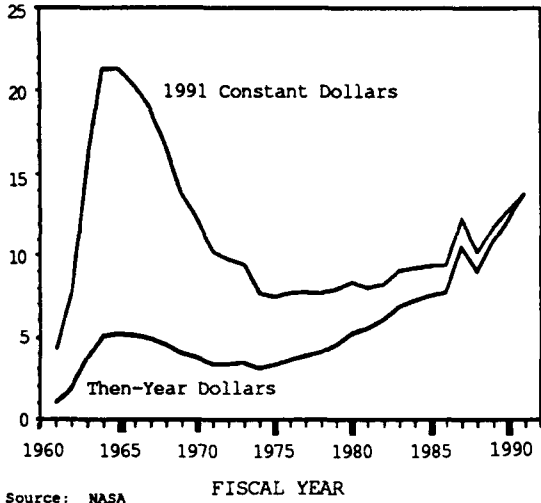
When most people think of achievements in space, they think of NASA and the goals described above. However, other agencies are working equally hard to obtain these same goals: the United States Department of Defense (DoD), numerous federal agencies, private industry, colleges and universities are all pursuing the difficult and expensive task of space development. Who receives the benefits from this hard work? All American's do. Who loses when these goals are not achieved? Again, all American's!

### **B. AMERICA'S CURRENT AEROSPACE PROGRAM**

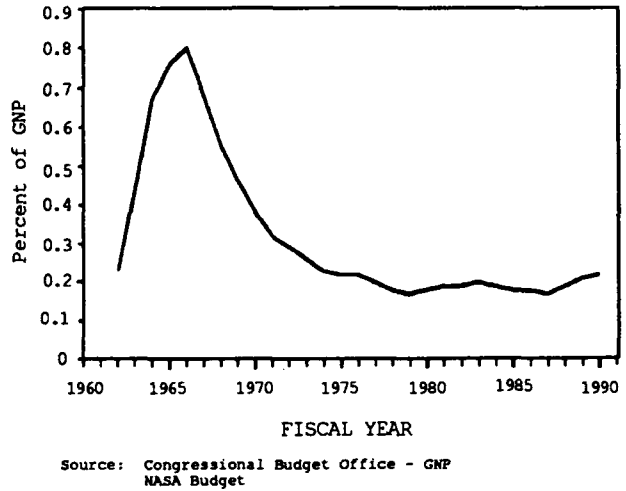
The aerospace program is one of America's leading industries providing positive influence of some kind for almost every citizen in our country on a daily basis. Also, through no other profession has mankind benefited by so much in so little time, slightly over 30 years to be exact. Considering the size of this expansive space program, one would think NASA, the leadership for America's efforts, would work with a major portion

of the U.S. Federal Budget. Unfortunately, they do not! Figure 2.1 [Ref.6:pg. 4-5] gives an historical perspective on how well NASA has faired during the budget battles since 1960. (All three Figures listed below are contained within the author's Figure 2.1.)

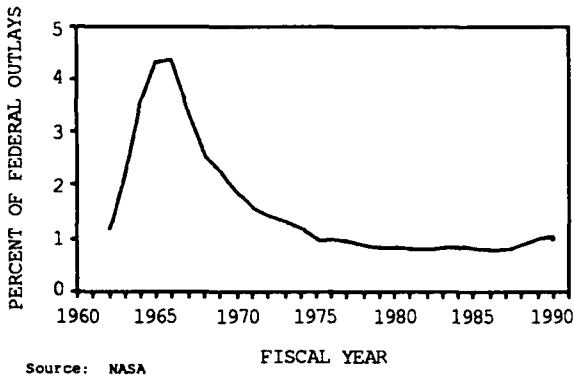
At its peak, during the Apollo years, America spent 0.8 percent of its gross national product on its civil space program (Figure 2 {Percent of GNP}). This level amounted to about 4.5 percent of federal spending at the time (Figure 3 {Percent of Federal Spending}) and, perhaps more importantly, about 6 percent of the discretionary portion of the federal budget (Figure 4 {Percent of Total Discretionary Federal Spending}). Today, we as a nation are spending about one-third of the Apollo peak spending as a portion of the GNP -- and the fraction of the increasingly pressured total discretionary budget has declined to 2.5 percent. [Ref. 6:pg. 4]



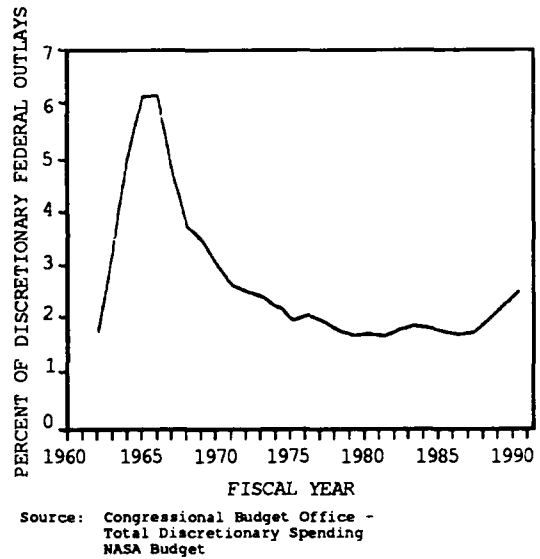
**Dollars**



**Percent of GNP**



**Percent of Federal Spending**



**Percent of Total Discretionary Federal Spending**

**Figure 2.1. NASA Budget Trends**

Who is NASA competing against for those scarce federal resources? Table 2.1 [Ref. 7:pg. 16] shows where and by whom the money has been spent since 1965. Even excluding NASA's 1965 budget, when they were in the middle of the Apollo program, they have still seen a 25 percent reduction in available funds since 1970. The only agency



to experience a loss in federal funds during the time period shown; yet, they still contribute tremendously to education, industry, health, defense, and America's economy.

**TABLE 2.1 COMPARISON OF FEDERAL AGENCY OUTLAYS**

Agency	1965	1970	1975	1980	1985	% Growth (85-65)	%
Agriculture	21.7	21.6	29.5	45.9	55.5	+156	
Commerce	1.3	2.0	2.0	4.1	2.1	+66	
Defense	152.9	206.1	163.1	172.9	245.4	+60	
Education	3.7	12.1	14.3	19.5	16.7	+354	
Energy	8.0	6.1	6.1	8.5	10.6	+32	
Health & Human Services	69.1	75.7	197.9	256.4	315.5	+356	
Housing & Urban Development	1.5	6.3	14.3	16.8	28.7	+1771	
Transportation	17.4	17.3	19.1	26.1	25.0	+44	
Environmental Protection Agency	.4	1.0	4.8	7.4	4.5	+974	
NASA	15.9	9.6	6.2	6.5	7.2	-54	
Total U.S. Government	368.9	502.8	631.4	780.0	946.3	+157	

Sources: Office of Management and Budget (FY 87) and Congressional Budget Office

Before going on, what exactly does "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. [Ref. 5:pg. 1]

Current technology allows air/spacecraft to pass freely between the boundaries. The most familiar example would be the space shuttle, But that is only one example. Why are the two terms tied together? One primary reason is NASA's beginning and how closely it was tied into the airline industry. For further information see: "Orders of Magnitude; a History of the NACA (National Advisory Committee for Aeronautics) and NASA", 1914-1990, NASA SP4406. Another reason is that much of the technology is transferable and the companies working in one field also specialize in the other. And, although recently NASA has become synonymous with America's space program the agency is still an

important leader in airplane development; a fact many Americans may not realize. Evidence of this lack of understanding came while working with a group of high school science students from San Diego, CA. 52 students were asked what work NASA did in the aeronautics arena. Not a single student knew of any NASA accomplishments towards one of America's most profitable industries.

### C. THE AEROSPACE INDUSTRY'S CONTRIBUTION TO AMERICAN'S PROSPERITY

Exactly how much and in what ways does the aerospace industry contribute to America's prosperity? *Aviation Week and Space Technology* reports the following figures. [Ref. 8:pg. 38-39, 67 and 145].

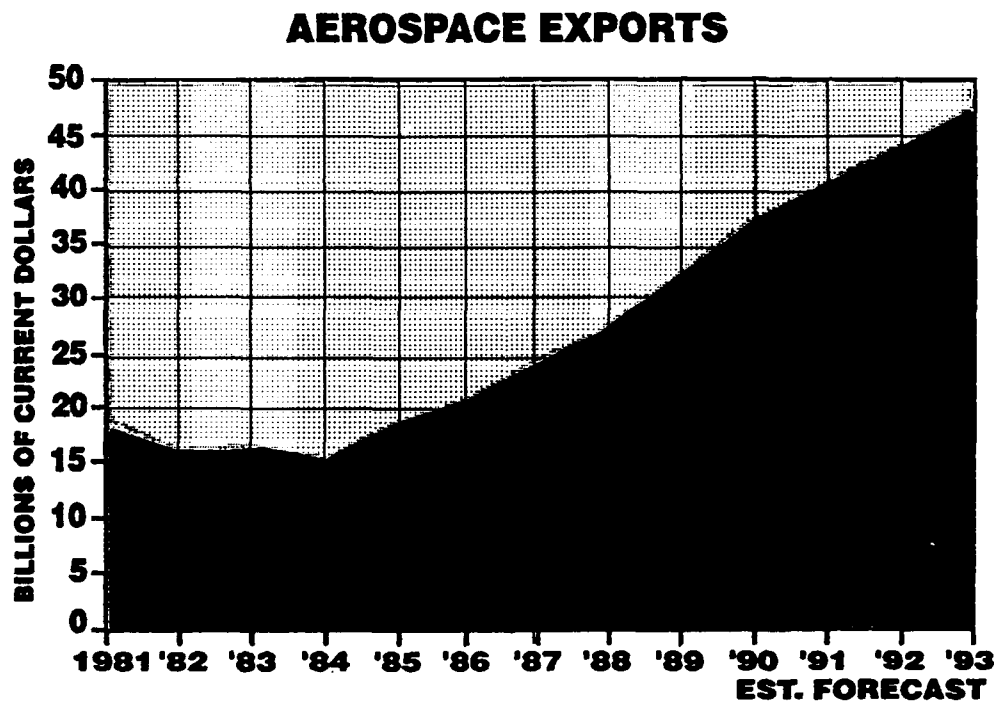


Figure 2.2. U.S. Aerospace Exports, 1980-1993

# SPACE

## Growth Trends: U.S. Space Sales, 1980-1993

U.S. space sales include complete space vehicles, systems, parts, components, services, engines and propulsion units, and research and development expenditures

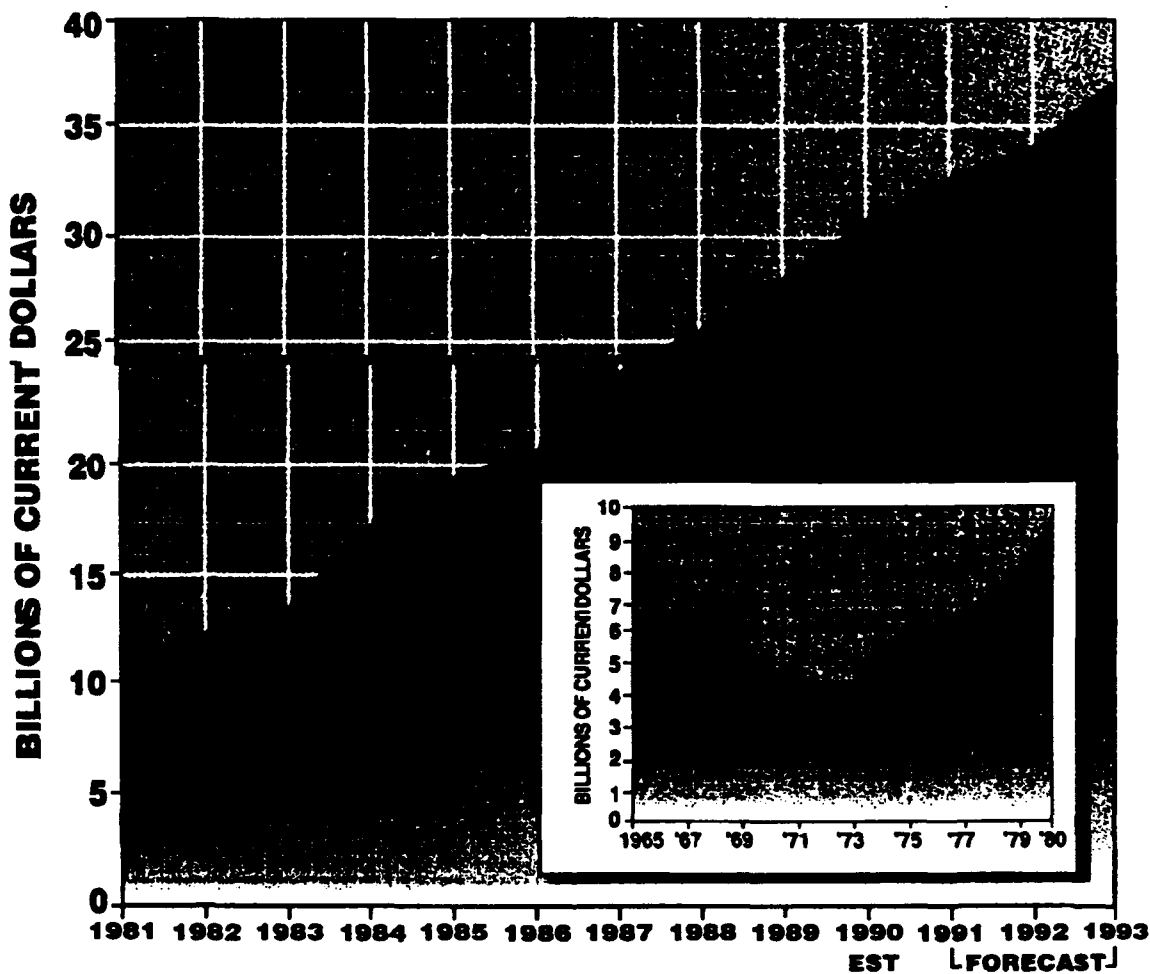


Figure 2.3. U.S. Space Sales, 1980-1993

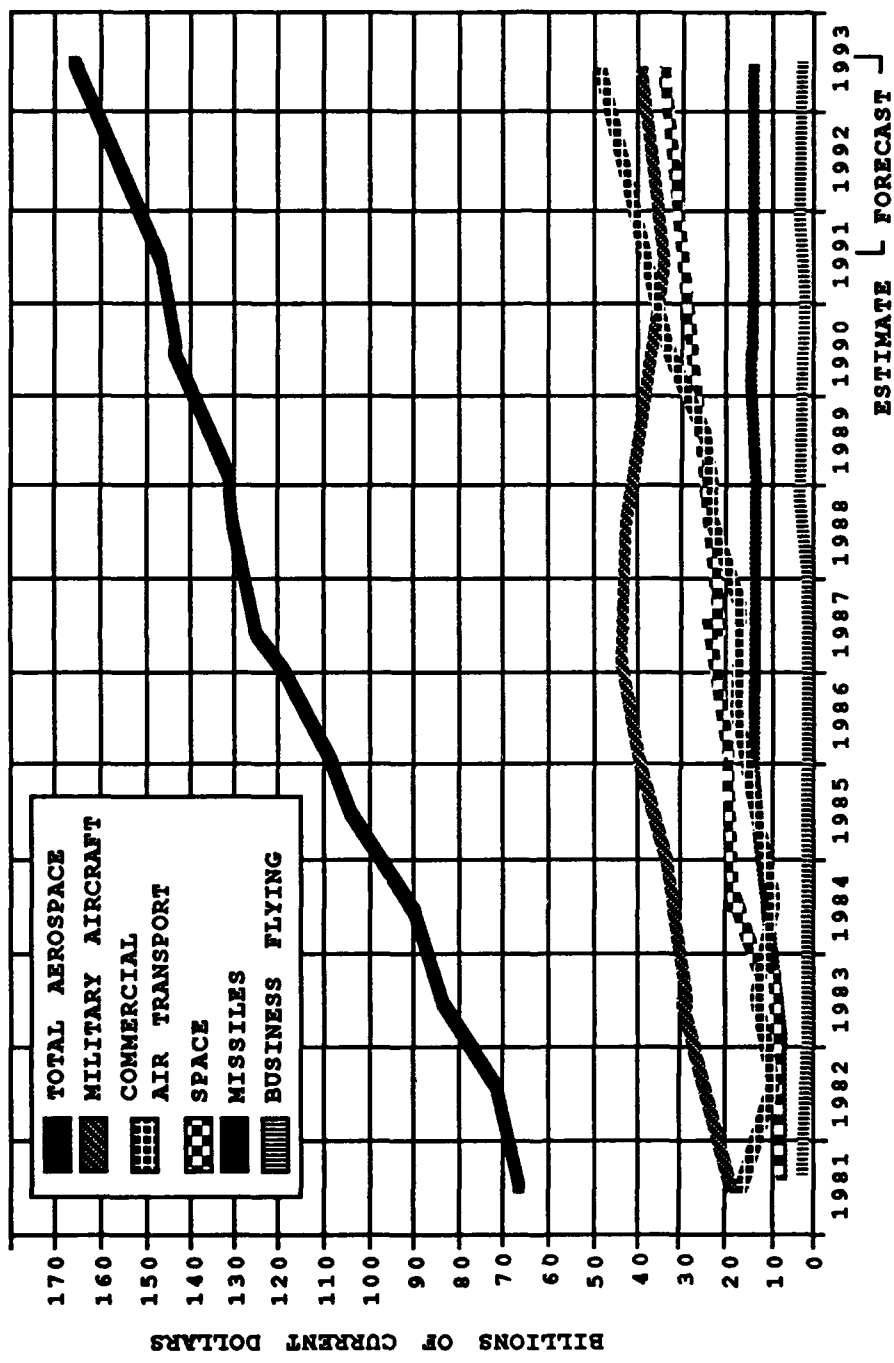


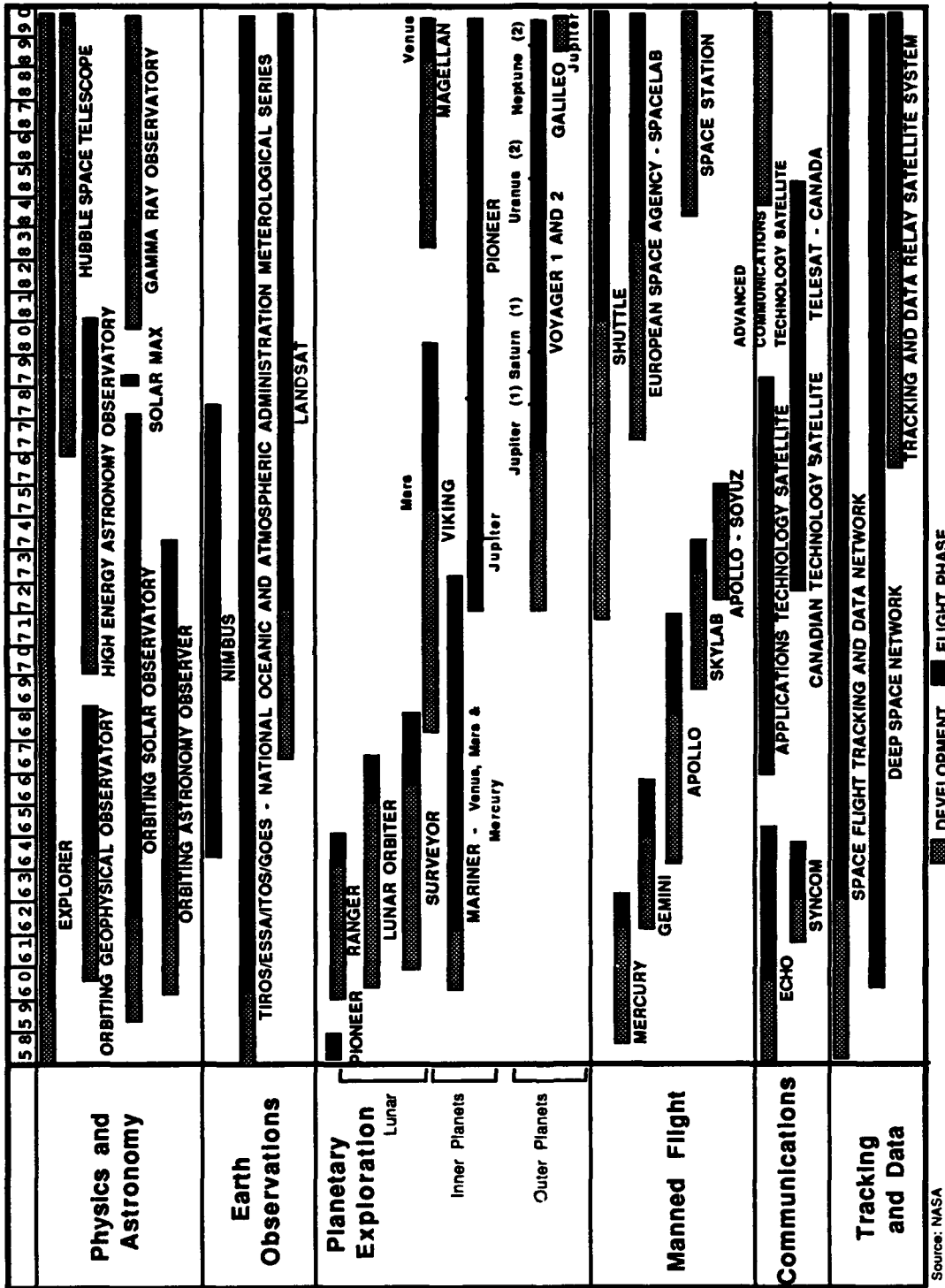
Figure 2.4. U.S. Growth Trends: U.S. Aerospace Industry, 1980-1993

Prosperity can be measured in more than just dollar terms, As of 1989, the United States, with an extensive series of unmanned probes, had successfully visited all of the planets in our solar system with the exception of Pluto. Table 2.2 and Figure 2.5 [Ref. 6:pg. 12] detail some of these achievements and their highlights. Table 2.2 lists specific achievements from American spacecraft that have greatly contributed to scientist and astronomer's knowledge of the Earth, our solar system and the universe.

**Table 2.2 AMERICA'S SOLAR SYSTEM EXPLORATION**

Spacecraft	Mission	Year	Achievement
Surveyor	Moon	1967	Landing
Mariner 6, 7, 9, 10	Mercury	1969-1975	Flybys / Pictures
Landsat	Earth	1972-	Imaging
Pioneer 10	Jupiter	1973	Flyby / Pictures
Pioneer 11	Jupiter/Saturn	1974-1979	Flyby / Pictures
Viking I, II	Mars	1976-1982	Landing / Orbiter
Pioneer	Venus	1978-1987	4 Probes / 3000 Orbits
Voyager I, II	Jupiter	1979	4 Moons Imaged
Voyager I, II	Saturn	1980-1981	8 Small Moons Discovered
Voyager II	Uranus	1986	10 New Moons Discovered
Voyager II	Neptune	1989	6 Moons/5 Rings Discovered
Magellan	Venus	1990-	Radar Images of Surface
Galileo	Jupiter	1996~	Orbit / Surface Probe

Figure 2.5 provides a look at the broader, civil space program.



Source: NASA

■ DEVELOPMENT ■ FLIGHT PHASE

Figure 2.5. Civil Space Program: Major Projects

These are just a few of the many exploration programs that have been conducted over the years by NASA.

Another major achievement came during the peak years of the Apollo program when:

NASA {in December of 1961} established the Sustaining University Program as a means of bringing academic institutions into full and equal partnership with Government and industry to reach the national goal of landing a man on the moon...Small colleges and universities were encouraged to participate, along with larger institutions. By 1970, when the program ended, NASA had supported studies of 5,000 scientists and engineers for doctoral degrees at a cost of more than \$100 million. Moreover, NASA had contributed \$42 million to construct new or additional research facilities on 31 campuses and had awarded multi-disciplinary research grants totaling \$74 million to 90 college and universities, which had participated in 190 projects. [Ref. 9:pg. 43-44]

Fortunately America is still benefitting from the dollars invested: American universities with international renown, doctoral holding industry and Government leaders, and top quality research and development facilities.

One of the questions that arises when discussing the NASA and military space budget is whether the money spent for space exploration and science could be better spent on programs such as AIDS research, caring for the homeless, and feeding the world's hungry. Fortunately, those individuals in positions of powers have realized the considerable benefits that can come from the extensive research and development conducted for the sake of "aerospace." Many of the humanitarian needs of our globe have already been helped by aerospace technology. Because of the rigors of space, numerous products have been created to perform flawlessly and with no hands-on repair by humans throughout the life of a spacecraft. Each new discovery enables the spacecraft to carry more weight, work better, and live longer; ideas which mankind also hopes to obtain. To assist the public in understanding some of the tremendous improvements in their lives stemming from aerospace research and development, NASA published reports in 1988 and 1989 entitled "Spinoff" [Ref. 10, 11] which go into detail describing the related technology transfer from aerospace to the marketplace. And although not all of the discoveries listed below have

directly touched the reader's life, many of them will. Some of the more interesting developments are listed in Table 2.3. The complete list holds approximately 30,000 items. (There is controversy concerning the exact origins of some of the "Spinoffs".)

**Table 2.3 MARKETPLACE DEVELOPMENTS AS A RESULT OF AEROSPACE RESEARCH AND DEVELOPMENT**

Advanced Wheelchair	Hearing Eye Glasses	Pool Purification
Aid for Visually Impaired	Heat Pipe System	Pollution Control Device
Anti-glare Filters	Image Processing	Portable Medical System
Apollo's Head Shield Fire Protection	Increased Power/Life Batteries	Radiation Blocking Lenses
Automatic Implanted Defibrillator	Insulin Delivery System	Robot Manipulators
Clean Room Apparel	Invisible Braces for Teeth	Self-injury Inhibitor
Composite Materials	Laboratory Tools	Software for Automotive Design
Deicing Aircraft Wings	Laser Technology	Solar Electricity
Digital Image Processing for Medical and Industry	Light Reflector	Space Age Archeology
Drug Research	Lightning Detection	Sports Training
Durable Bar Code Labels	Longer Lasting Lights	Surveying System
Environment Monitor	Lubricant Coating Process	Telescope Equipment-Space
Error-free Software	Manufacturing Aids	Thermal Video System
Explosive Joining	Marine Life Study	Thermoelectric Products
Farmland Survey	Metalized Films or Foils	Temperature Control Suit
Fishing Forecast	Modern Wind Mills	Temperature Pill
Fluid Flow Measurement	Natural Air Purification System	Universal Antidote
Foam Cushioning	Natural Wastewater Treatment	Water Filter
Forest Damage Assessment	Patient Monitoring	Windshear Prediction
Gas Analyzer	Physical Therapy Machines	

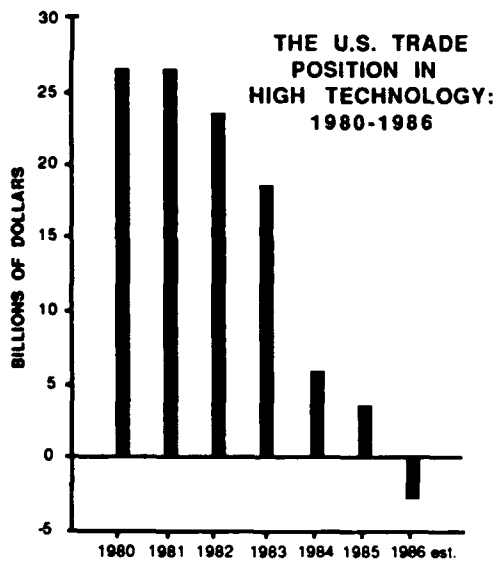
Not only do spinoffs help people's daily lives but they also tend to create new industries of their own. The best example would be the computer revolution and microminiaturization of everything from electronics to tools.

So far the wonders of America's space program have been discussed, but how long can they continue without greater budget support? Unfortunately, without Government and national support, the agency and industry that created such prosperity also stands to lose



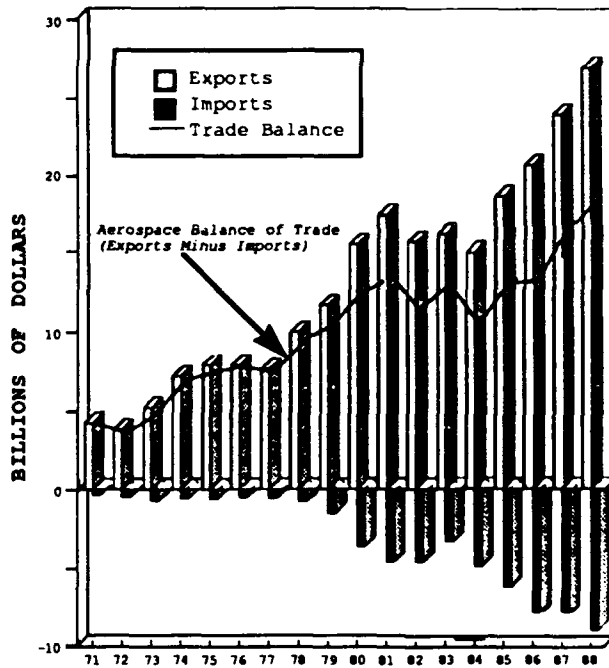
their dominance in the field they helped to create. Evidence of this decline can be seen in almost every facet of the space program. A 1987 report by the American Institute of Aeronautics and Astronautics, AIAA, confirms the potential loss.

The formerly healthy U.S. balance of trade in high technology products and services has been decaying sharply since 1980-1981 [see Figure 2.6A]. U.S. Trade Position in High Technology 1980-1986, and even the traditionally strong favorable balance in agricultural products declined from nearly 25 billion in 1981 to only 7.5 billion in 1986. Although the aerospace trade balance has remained positive during this period, see [Figure 2.6B [Ref 12:pg. 26]] foreign inroads, particularly in the still-small but rapidly growing space sector, are building alarmingly. Foreign governments provide substantial support of space activities not only in the Soviet Union but also in Europe, Japan, and China, with the clearly stated intent of developing the industrial capability needed to take advantage of growing space-related global market opportunities. [Ref. 7:pg. 9]



Source: Report to Joint Economic Committee, U.S. Congress, Oct. 1986

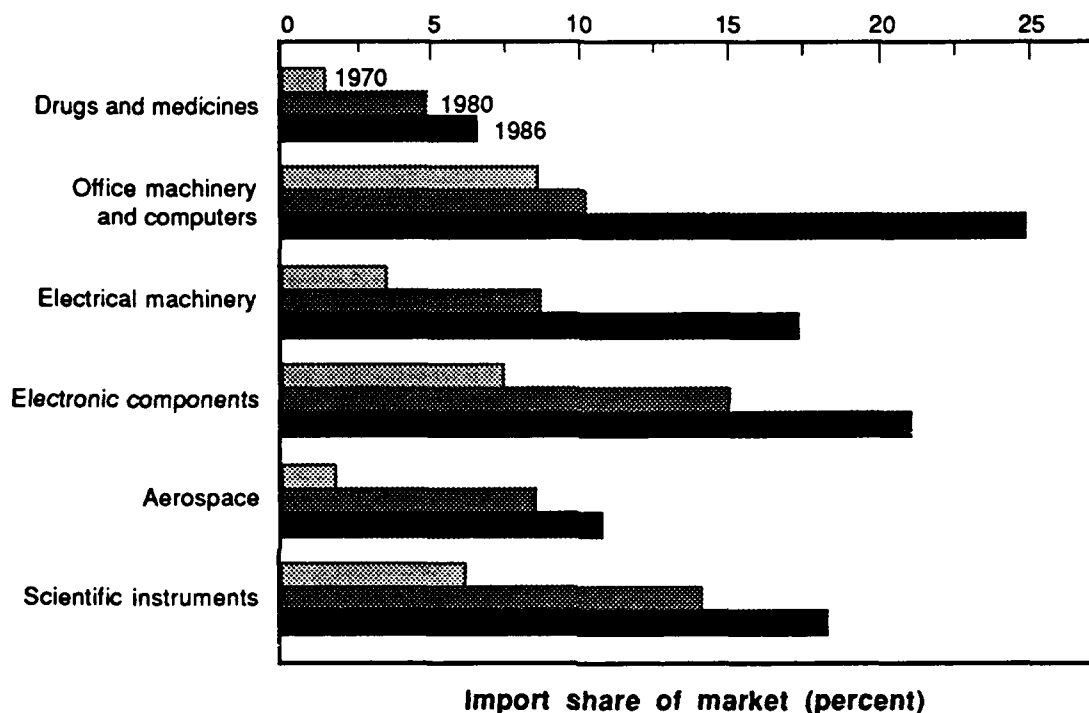
Figure 2.6A: U.S. Trade Position in High Technology



Source: U.S. Department of Commerce International Trade Administration

Figure 2.6B: Aerospace Imports, Exports, & Trade Balance

The loss of exports is only one side of the story. An increase in imports also speaks of a changing market structure. Figure 2.7 [Ref. 1:pg. 152] shows such an increase in foreign goods purchased in the United States with the associated loss of domestic goods purchased.



Source: Science & Engineering Indicators--1989

Figure 2.7. Import Penetration of Certain U.S.High-Tech Markets: 1970, 1980, and 1986

From 1970 to 1986, only 16 short years, every category saw a significant increase. These changes range from 173% in the "Electronic components" to as high as 511% in the "aerospace arena." A changing export market could occur for any number of reasons, however, when combined with an increasing import market, one thing is for sure: America is no longer producing the best product for the best price.

## **D. CONTRIBUTING MEMBERS**

Who contributes to America's space program? The list is long and varied. Their numerous past, present, and future achievements and endeavors are contained within volumes of text and therefore, trying to compress them into this thesis would offer unfair treatment. However, throughout the text, a few of these organization's contributions are discussed to offer the reader an insight into their hard work. Exactly how extensive is American's current space program? The following are a few of the primary organizations working towards a strong U.S. space program.

### **1. NASA's Primary Locations**

NASA has several large research centers located around the United States, these are listed below. In addition, a considerable amount of NASA's research and development is contracted to outside organizations, both private industry and colleges/universities, from these central agencies.

Ames Research Center  
Moffett Field, CA

Jet Propulsion Laboratory  
Pasadena, CA

John F. Kennedy Space Center  
Kennedy Space Center, FL

Langley Research Center  
Hampton, VA

Lyndon B. Johnson Space Center  
Houston, TX

Stennis Space Center  
Stennis Space Center, MS

Goddard Space Flight Center  
Greenbelt, MD

Lewis Research Center  
Cleveland, OH

George C. Marshall Space Flight Center  
Huntsville, AL

## **2 . Launch Sites**

Although listed only as launch sites, these two facilities continue to contribute in many other areas of the space program. Both locations launch not only civil rockets but also work closely with and launch numerous military payloads, thereby contributing to the national defense as well as the civil space program.

Kennedy Space Center, FL

Vandenberg Air Force Base, CA

## **3 . Space Related Education**

Colleges and universities in 39 states and the District of Columbia offer degrees in at least one of the following: Aerospace/Aeronautical/Astronautical Engineering; Astronomy, Astrophysics; and Planetary Science.

NASA currently has selected 21 "Space Grant College/Consortia," which include close to 100 colleges and universities, to receive grants for research and development and provide fellowships to undergraduate and graduate students.

Teacher Resource Centers are located at all of the NASA regional sites listed below, plus 22 other regional centers located around the country.

## **4 . Non-profit Organizations**

Below are three non-profit organizations which have and continue to work toward improving the national space program; they receive contracts both from NASA and numerous federal space related agencies.

U.S. Space Foundation  
Colorado Springs, CO.

The RAND Corporation  
Santa Monica, CA.

The Aerospace Corporation  
Los Angeles, CA

## **5 . Military Organizations**

The military space organization does not operate in the same manner as NASA's, primarily due to the difference in their objectives. Both organizations do, however, a considerable amount of joint work in the space arena. Technological achievements from one often help the other which allows for cooperative working arrangements under most conditions.

All three services, Navy, Air Force, and Army, utilize and continue research in space hardware/software. The Air Force maintains the lead in spending and the Navy in use of the available information. The below listed military space centers are involved in numerous small and large contracts with outside agencies for procurement of space hardware. Through work from these contracts the private sector as well as colleges and universities maintain their knowledge and research equipment at the leading edge of technology.

U.S. Space Command  
Colorado Springs, CO

### *a. Naval*

Naval Research Laboratory  
Washington, DC

Naval Space Command  
Dahlgren, VA

Fleet Surveillance Support Command  
Chesapeake, VA

Naval Satellite Operations Center  
Point Mugu, CA

Naval Space Surveillance Center  
Dahlgren, VA

***b. Air Force***

U.S. Air Force Command  
Colorado Springs, CO

1st, 2nd, and 3rd Space Wings  
Colorado Springs, CO

Space and Warning Systems Center  
Colorado Springs, CO

Western Space and Missile Center  
Vandenberg AFB, CA

9th Space Division  
Patrick AFB, FL

Eastern Space and Missile Center  
Patrick AFB, FL

***c. Army***

U.S. Army Space Command  
Peterson AFB, Co

Army Space Command - CONUS  
Washington, DC

Army Space Command - Europe  
Vaihingen, Germany

Army Space Command - Pacific  
Wheeler AFB, HI

**6. Astronaut Program**

The astronaut program is an important part of NASA's overall achievements. Astronauts afford the public a chance to feel a part of the national space program at the same time offering valuable research into the life science aspects of manned space travel. But, from where do the astronauts come? Although their backgrounds are becoming more

diverse, for a number of years the primary source was the military. The figures listed below offer a glimpse into the selection of past astronauts. An important consideration for aspiring astronauts, this point will also be addressed during the seminar, future space endeavors will rely less on the piloted aspect and more on the research investigator. The Soviet space manned space station is proof of this idea. The following information on the astronaut program came from NASA presentation overheads.

***a. Graduates***

U.S. Naval Academy - 31  
U.S. Air Force Academy - 18  
U.S. Naval Postgraduate School - 14  
U.S. Military Academy - 11  
U.S. Air Force Institute of Technology - 8

***b. Military Service Selection History/Current:***

U.S. Air Force - 59/28  
U.S. Navy - 43/17  
U.S. Marine Corps - 14/8  
U.S. Army - 8/6  
U.S. Coast Guard - 1/1

**7. Private Industry**

Numerous companies are hard at work in the aerospace industry. Some are only concerned with the aeronautical or space aspect where others are capable of operating within both arenas. All of these corporations have something in common: helping maintain the United States lead in the aerospace field. These companies will be heavily influenced by the availability of future scientists and engineers. Therefore it is to their benefit to cooperate whenever possible with educational programs designed around improving interest in aerospace careers.

The following is a sample of larger companies with 1989 or 1990 Revenues. (Figures are listed in millions and are compiled from 1989 and 1990 corporation annual reports.) Revenue for individual aerospace related divisions are listed first with annual corporate totals following.

<u>General Electric Co.</u>	
Aerospace	\$ 5,614
Aircraft Engines	7,558
Total	\$48,414
<u>McDonnell Douglas</u>	
Combat Aircraft	\$ 5,830
Transport Aircraft	5,812
Missiles, Space, and Electronic System	3,188
Total	\$16,255
<u>Rockwell International</u>	
Electronics	\$ 5,003
Aerospace	3,781
Total	\$12,379
<u>Honeywell</u>	
Space & Aviation	\$2,004
Total	\$6,059
<u>Martin Marietta</u>	
Astronautics	\$2,754
Electronic & Missiles	2,117
Total	\$5,796
<u>Loral Corporation</u>	
Total	\$1,274

Total Revenues (exclusively aerospace related) for only seven of the numerous American aerospace companies comes to: **\$47.142 Billion**, over 3 times NASA's annual budget. This is just a small portion of what America stands to lose if it allows competition and the lack of foresight to reduce the nations capabilities.

#### **E. COMPETITORS**

The middle '80's witnessed a series of events which seriously eroded the U.S. dominance in commercial space launches. A poor decision to "put all of their eggs in one



basket" by relying on only the Space Shuttle to launch both Government and commercial payloads proved disastrous when the unthinkable occurred: Challenger exploded after liftoff and NASA failed to achieve its goal of a single, inexpensive, reusable launch platform. These two events combined to bring America's space program to a standstill. While the Government forced NASA and the American people to agonize for almost two years over what had always been a dangerous profession, the rest of the world took advantage of a tremendous gap in a growing need for commercial launch vehicles. AIAA reported that by 1987 Ariespace had launched or was committed to launch approximately 40% of the free world's geostationary-orbit satellites (because geostationary orbits are one of the highest, 36000 km (19000 nm), they require the largest and also the most expensive launch vehicles to place them in proper orbit); U.S. launchers carried or were schedule to carry the remaining 60%. By 1991, those figures had reversed; Ariespace held 60% of the commercial launch market and the United States only 40%. Only ten years earlier, America's commercial space industry was providing **all** of the free world's launch requirements. How do these changes equate into lost revenue for the U.S.?

Ariespace's backlog stands at 35 payloads, representing an orderbook value of 15.4 billion French francs (about \$2.75 billion) and approximately four years of Ariane launches. [Ref. 13:pg. 27]

In other words, they are contracted for an amount equal to 20% of NASA's annual budget (\$14 Billion, 1990).

What other strong competitors does the United States have? The USSR stands as number two in terms of space program expenditures. Their strongest attribute is their available fleet of launch vehicles: they possess the greatest variety (Figure 2.8) and the most experience in terms of actual number launches (Figure 2.9). [Ref. 14: pg. 61]

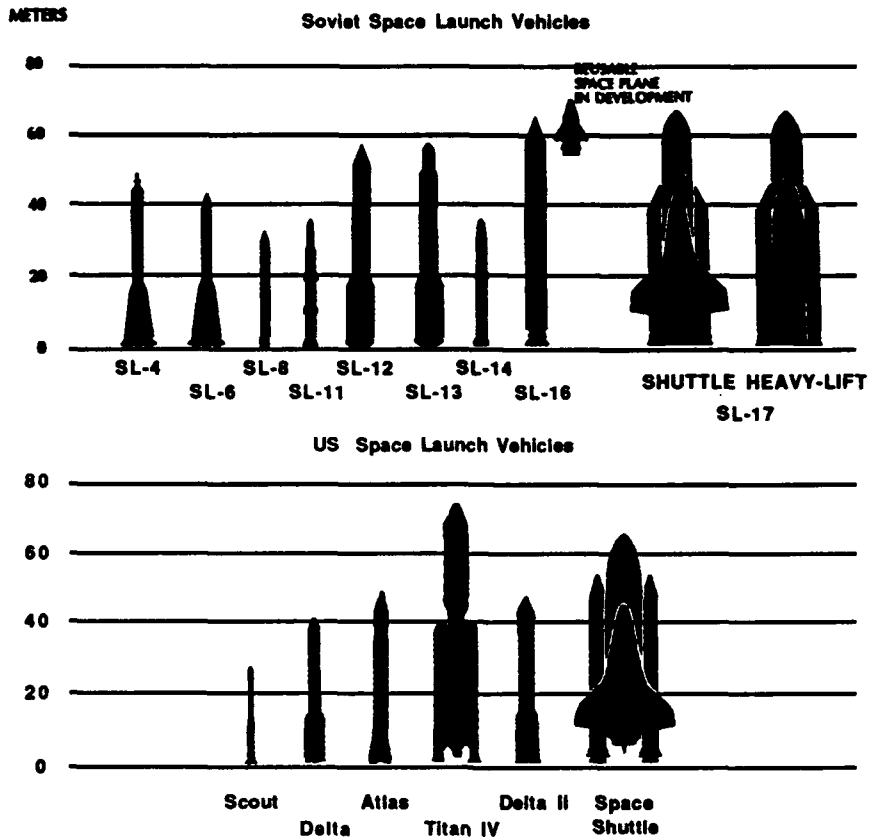


Figure 2.8. Soviet/U.S. Space Launch Vehicles

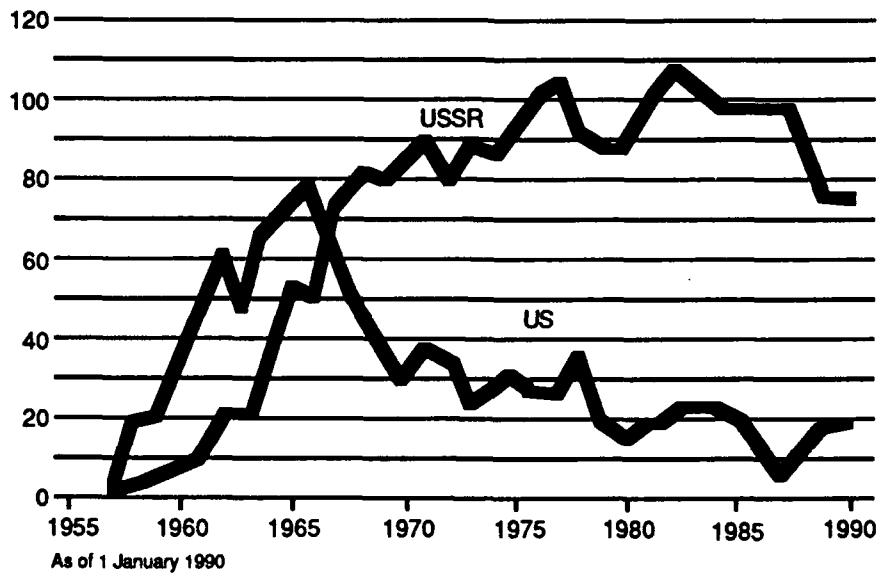


Figure 2.9. Soviet and U.S. Space Launches 1957-1990

Due primarily to economic necessities, the Soviets are aggressively pursuing customers to purchase their commercial launch vehicles in order to obtain western currency. Because of their already existing, extensive launch complex and Government support, they are able to offer inexpensive flights. If it were not for the United States Government's resistance to technology transfer for national security reasons, the Russians could possibly dominate the commercial satellite launch business, thereby excluding American companies from a very profitable business.

Arianespace and the USSR have already been described as strong competitors. In what other direction should the United States look? China spends \$3 billion per year on space and their government is developing and aggressively marketing several commercial launch vehicles. Although the Japanese spend less on their space budget, \$1.2 billion in 1990 [Ref. 15:pg. 12-16] and have experienced difficulty developing a launch vehicle, if they attack the space industry as aggressively as they did the computer industry, they will soon be selling satellites and launch services to the United States. In 1987:

Norman Augustine, Chairman of both the semiconductor task force of the Defense Science Board and the Martin Marietta Corporation, reported to Secretary of Defense Caspar Weinberger and confirmed what the bid had seemed to symbolize {Fujitsu, a Japanese company, bid for Fairchild Semiconductor, a major U.S. firm}. Augustine stated bluntly the central dilemma facing the United States: The U.S. semiconductor industry was rapidly going the way of the television and automobile industries as it staggered under relentless pressure from Japan (see figure 2.1 {Figure 2.10A}). Under present circumstances, this industry cannot compete with the Japanese in commercial markets. This situation has enormous national security implications: twenty-one absolutely critical U.S. military systems contain chips available only from foreign, mainly Japanese, sources. More important development momentum is also with the Japanese....Moreover, the Japanese are displacing not only the U.S. semiconductor industry but also the critically important equipment and materials manufacturers who supply it. Because advances in semiconductor technology are closely linked to equipment and materials capabilities, the decline of these suppliers means that the United States is not only suffering production losses (see figure 2.2 {Figure 2.10B}); it is actually losing the ability to stay at the leading edge and is becoming dependent on Japan for the technology critical for its entire defense strategy. [Ref. 16:pg. 27-28]

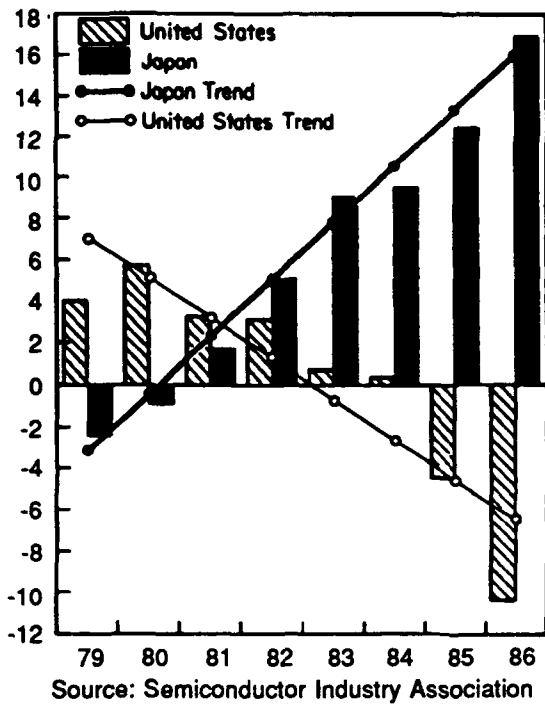


Figure 2.10A: Cumulative Change in World Semiconductor Market Share Since 1978 (Percentage points)

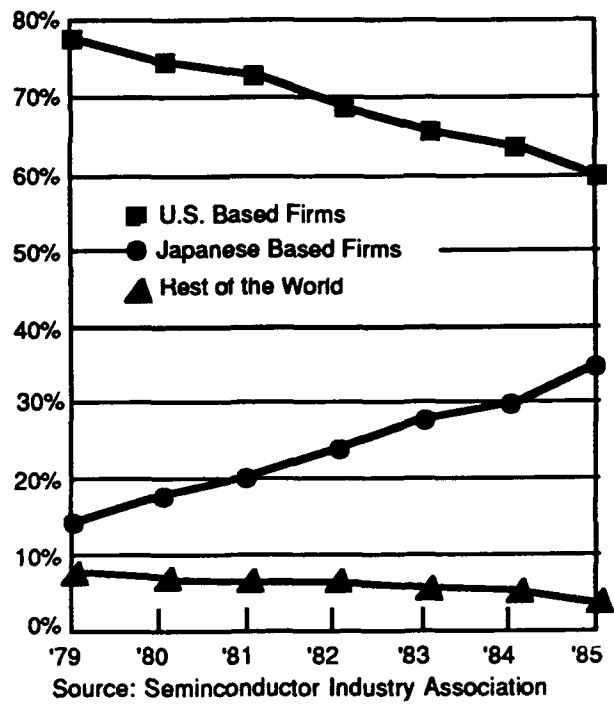


Figure 2.10 B: Semiconductor Manufacturing Equipment World Market Share (Percentage of World Shipments)

The intent of reporting these facts is not to imply that competition will ruin America's strong space program. On the contrary, competition in other industries has induced the producers to streamline their operations thereby providing better and less expensive service to the customer. Unfortunately, in the past, the United States has allowed competition to erode its position as the world's leading manufacturer of heavy industry: ships, steel, and automobiles; and high technology: semiconductors, computers, and home entertainment products. As reported in numerous economic journals, America's economic strength is relying more and more upon a service oriented industry. How far will making hamburgers, producing movies, and offering legal advice take our country in time of national need?

## **F. EDUCATING AMERICA'S FUTURE**

America must begin working harder to maintain its lead in the aerospace arena into and through the next century or risk losing the one industry that has been the largest contributor to America's balance of trade for the last decade. Profitable exports are only one reason why the United States must maintain a leadership role; helping our youth understand and control the complex issues of tomorrow requires colleges and universities capable of educating the students of today in the most advance technological areas. Aerospace is the technology of tomorrow! But, first American students must find renewed interest and motivation towards the more difficult aerospace education and careers. It will take a great deal of research and development by the private sector, the military, and NASA to ward off the intense international competition that is already underway in the aerospace industry.

The desire and pride of being the best and producing the best no matter how hard an individual needed to work was an integral part of America's heritage. How much of this has been lost on the youth of today? And, how is the country giving up its inherited wealth from the Apollo era? The first place to look is in America's education system. With the combined effect of the post-World War II GI Bill and the nation's sudden interest in the space race, American colleges and universities saw a surge in the number of individuals pursuing technical degrees. Their efforts did not stop at just the Bachelor's Degrees but fortunately continued on into the Master's and Doctoral Degrees. Colleges and universities became one of the places where fast-paced aerospace research and development was taking shape. Military, civil, and private laboratories being the others. The sudden surge in federal and private funding created numerous state-of-the-art laboratories and R&D facilities. How did these events help America's colleges?

Historically, student enrollment increases when research and scholarship funding becomes easier to obtain. Also, with new discoveries, the universities receive greater

prestige which in its own way attracts new students. State-of-the-art equipment and facilities, plentiful research and development funding, international renown, and breakthrough-technological discoveries created an atmosphere capable of drawing the highest quality professors and greater numbers of students and thereby increased tuition, all of which proved extremely beneficial for America's college/university system. Another added advantage of the space race atmosphere was the direct and immediate application of a university's discoveries towards a national objective.

America proved what its colleges and universities, civil service programs, military, and private industry were capable of when in only eleven years they went from dreaming of spaceflight to actually having a man step on the moon. Fortunately, when America needed new ideas and creative thinkers, the nation was capable of providing highly educated and motivated individuals who were not after the fast, big buck but were willing to work long hours just to see the fulfillment of their nation's dreams. Could America produce such a cadre of young scientists and engineers from within its own ranks today? The following facts seem to say no:

**1. Fact 1**

"During the 1980's, 10 million school-age youth dropped out of high school before graduation; most of them faced bleak employment prospects in the years ahead. Another 28 million completed high school and began to sort themselves into educational programs and career paths." [Ref. 17:pg. iv] (That equates to a 25% drop out rate, most of which will be incapable of understanding the more complex issues facing American voters today.)

## **2 . Fact 2**

May 9th, 1989, Commerce Secretary Mosbacher put it this way:

Illiteracy, dropout rates, underachievement; all these cost business and society dearly. Dropouts alone cost our society in wasted human potential, lost taxes and wages and public assistance, over \$240 billion annually. And business must spend over \$30 billion every year to train and retrain employees. [Ref. 12:pg. 3]

## **3 . Fact 3**

According to the Director of Public Relations for the Air Force Academy:

"Only 2 percent of U.S. high school graduates in 1988 had taken courses needed to qualify for entry consideration by the Air Force Academy..."[Ref. 12:pg. 22].

## **4 . Fact 4**

The Aerospace Industries Association reports:

...for aeronautical and astronautical engineering, non-U.S. citizens represented 38 percent of graduate enrollment and over 50 percent of doctoral candidates in 1986. Few of these students can take jobs in the United States because of visa and national security requirements. [Ref. 12:pg. 32]

What would happen with even fewer young people? The number of applicants qualified to fill the needs of all the organizations desperately trying to hire them would decrease. Unfortunately, fewer students is exactly what is happening as can be seen by the following demographic studies, Figure 2.11. [Ref. 17:pg. 20-21, 25]

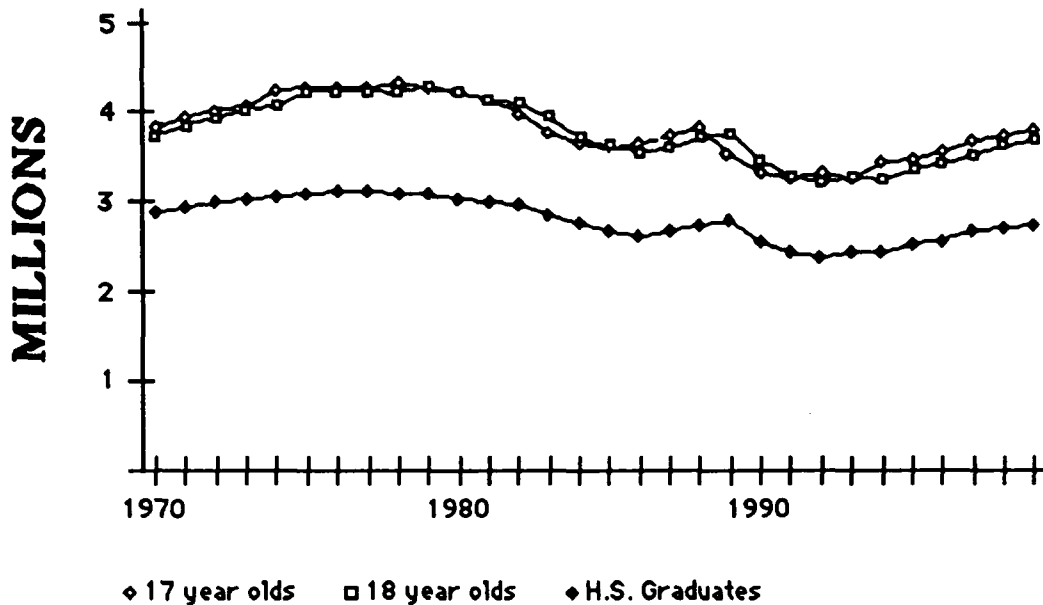


Figure 2.11. 17-18 Year Olds and High School Graduates  
From 1970 Through the Year 2000

1990 through 1993 show the lowest numbers over the thirty years. Something to keep in mind when analyzing these facts is the four or five years it will take a high school graduate to complete college and become productive in the work force. How capable are these graduating students which will be entering college and/or a university then business, Government, and/or military service? Are they capable of maintaining America's prosperity and of following the footsteps of the giants from the successful "Apollo era"?

### 5. SAT Results Decline

First, how well are students scoring on the Scholastic Aptitude Test, SAT, which is offered nationally as a measure of a college bound individual's capabilities? Figure 2.12 portrays an alarming trend in three different sectors of American society: a drop in the math SAT scores of (1) U.S. Naval Academy graduates, (2) DoD civilian engineers/scientists, and (3) national average for male college bound senior high school students. (SAT scores



are a generally accepted ranking method for college bound students, however, information concerning student make-up is not usually discussed and might possibly affect the analysis of the data.)

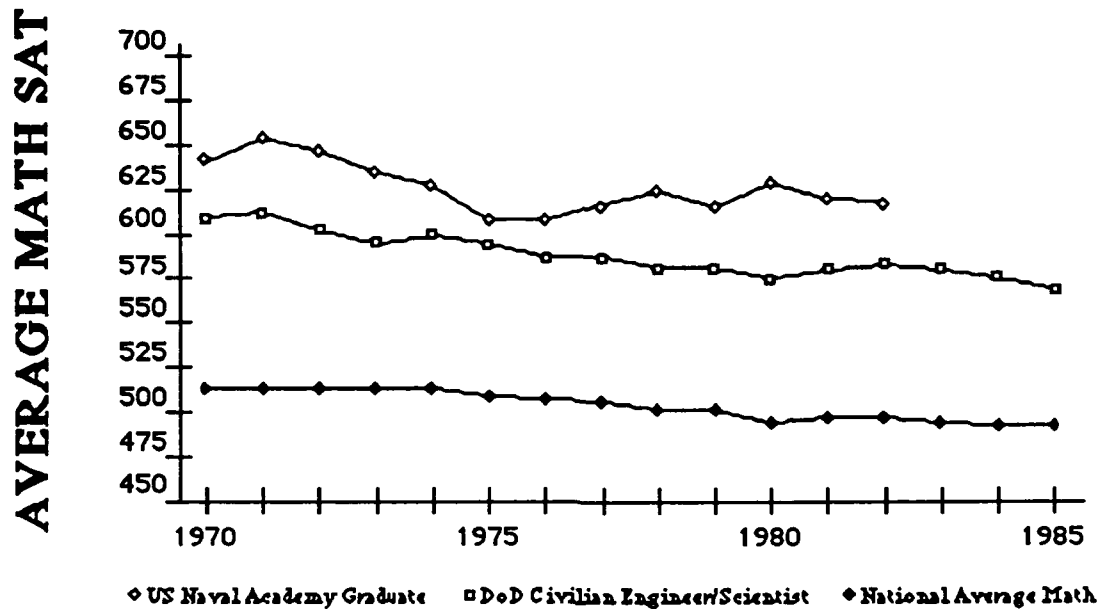


Figure 2.12. Scholastic Aptitude Test, SAT Results, Math

## 6. American Versus Foreign Students

Second, how well do American students, living in a country with the highest gross national product, GNP, rate against students from countries around the world in terms of their high school math and science education? See Figures 2.13 [Ref. 1:pg. 29-31], 2.14 [Ref. 12:pg. 19], and 2.15 [Ref 18:pg. 19].

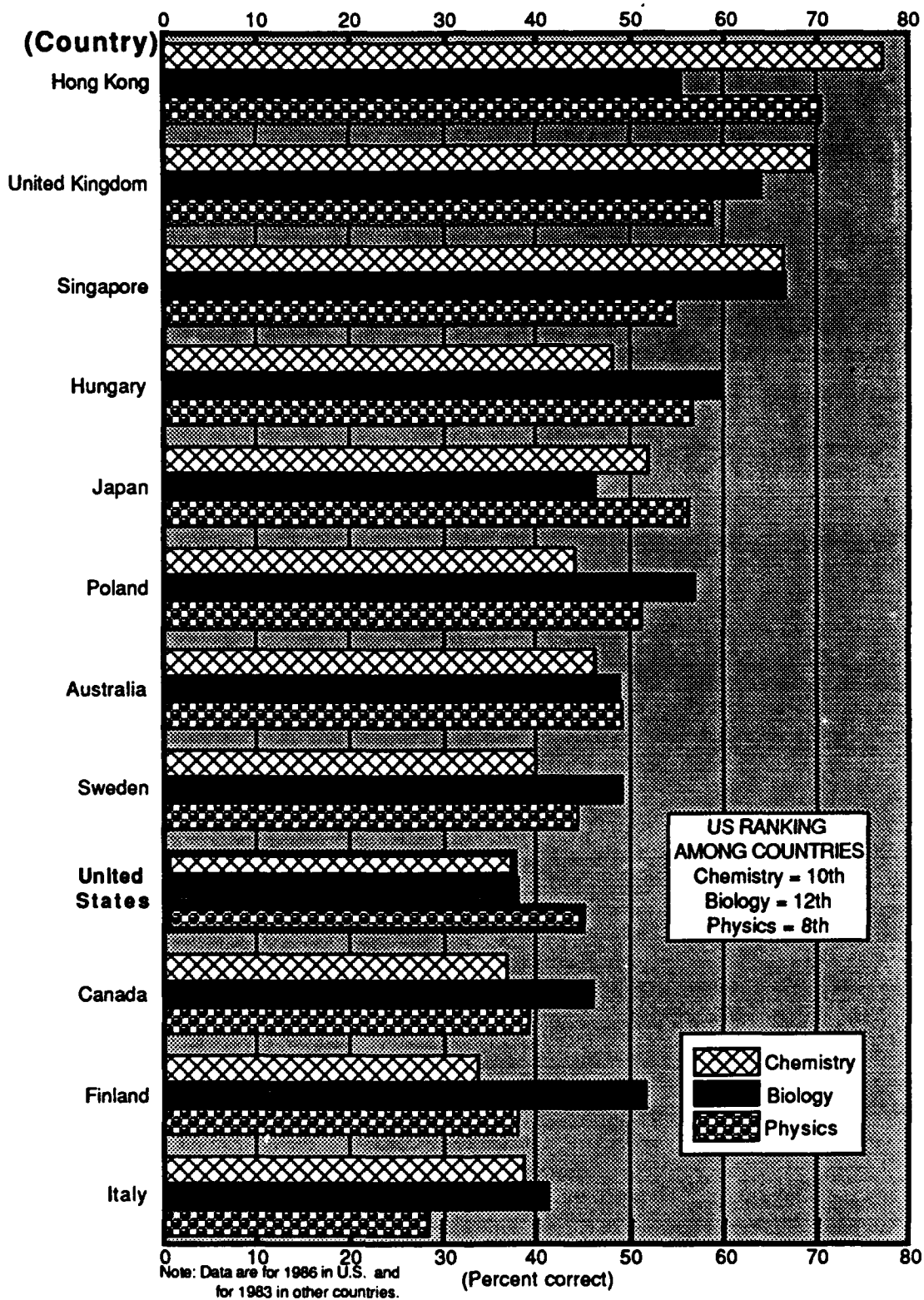
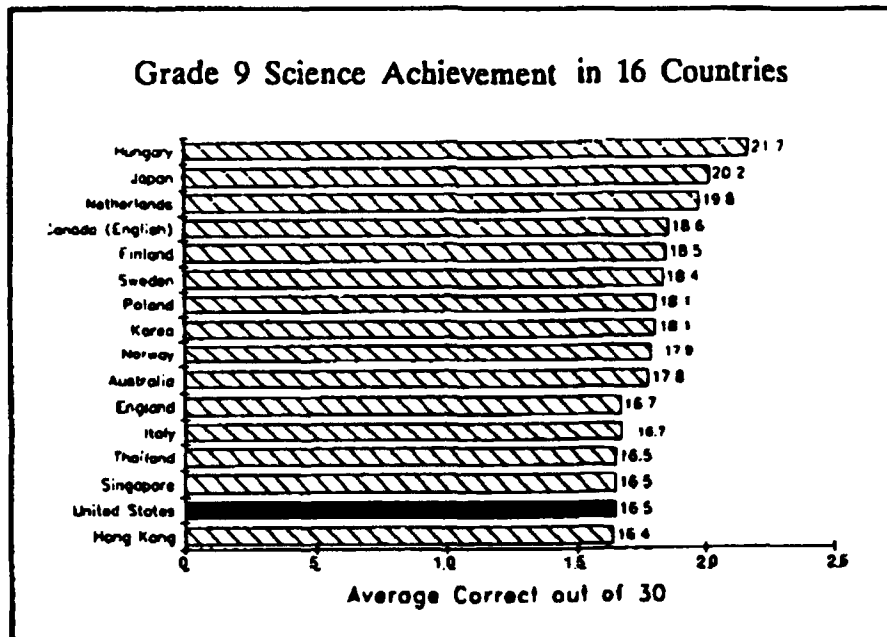
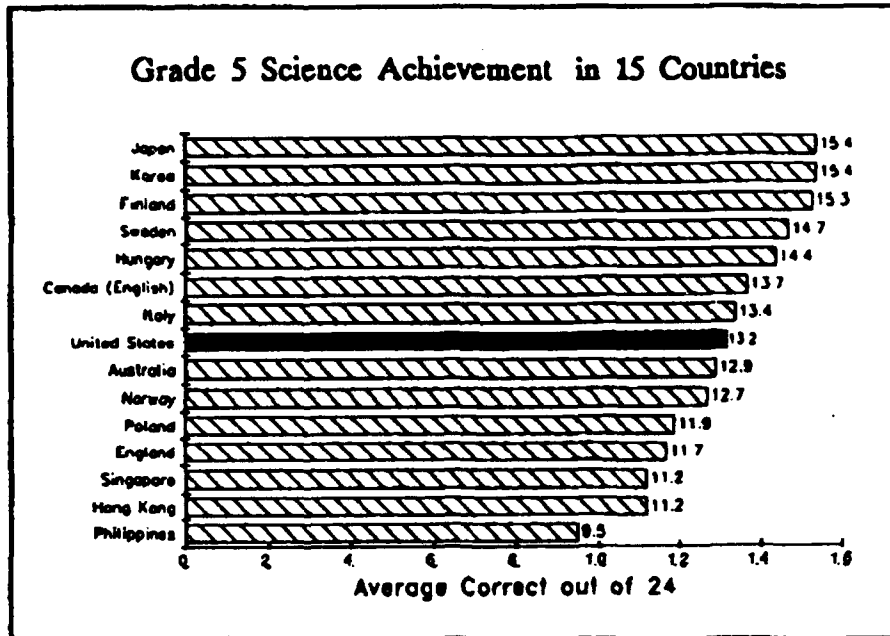
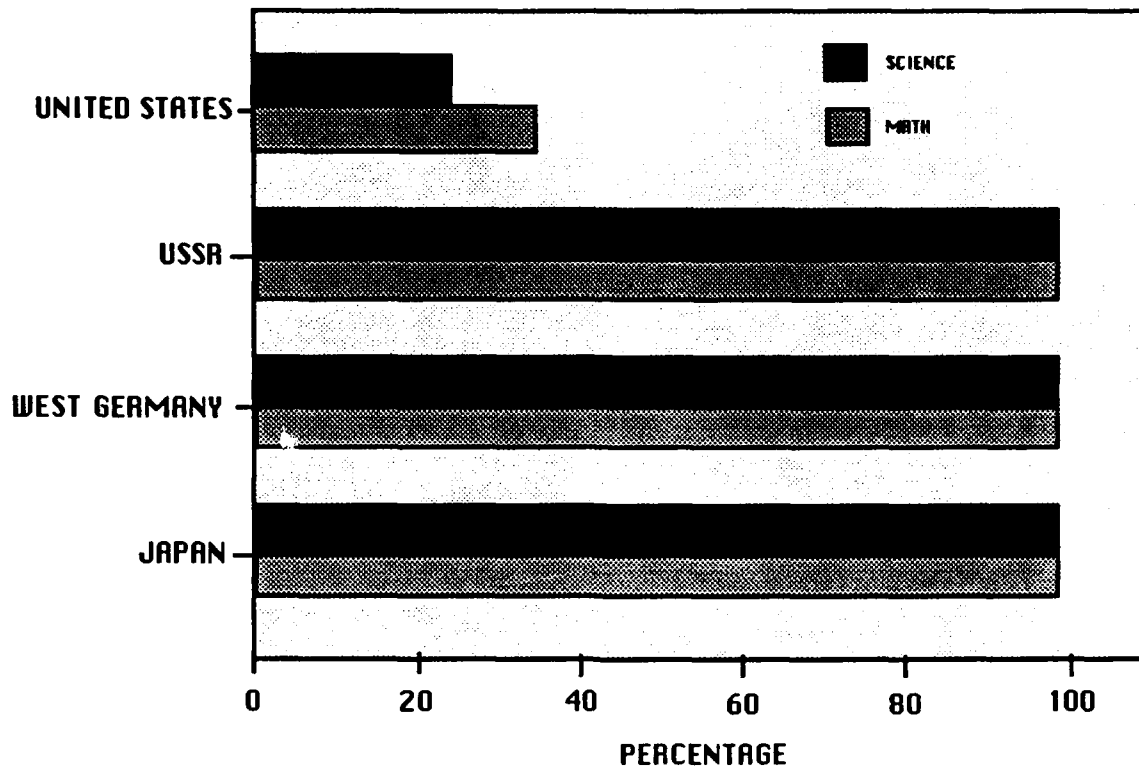


Figure 2.13. Mean Science Scores In Final Year of High School, by Country



Source: National Science Foundation,  
Reprinted with Permission from Council on Research and Technology

Figure 2.14. Competitors Out Distance U.S. Students



Note: While all students study mathematics and science (at least one course) each year in the upper secondary school in Japan, West Germany and the U.S.S.R., the most recent NAEP data (1983) indicate 84% of U.S. students do not take physics, 65% do not take chemistry, 62% do not take Algebra II, 48% do not take geometry and 23% do not take biology.

Source: National Center of Educational Statistics, *High School and Beyond*, Washington, DC; National Center for Educational Statistics, April, 1981 and *A Challenge for American Precollege Education: Scientific Literacy in Japan, China, the Germanies and the Soviet Union*, edited by Margrete Klein and F. James Rutherford, New York: The Macmillan Company (in press).

Figure 2.15. Percentage of High School Students Taking 3 Years of Science and Mathematics

Has America become lazy? Although math and science are not usually favorite subjects among many young students, they are basic building blocks necessary in understanding many of today's everyday machines and conveniences in addition to being imperative when working in the aerospace field. Without a strong comprehension of these subjects, how will American students maintain the United States' strong position in the future world aerospace market?

## **7. Educating Future Generations**

Third, the students of today will also become the instructors of tomorrow, and to be qualified, Graduate and Doctoral degrees are necessary. If today's students do not prepare themselves properly how well will they be able to teach the next generation?

Graduate and Doctoral programs are another alarming indicator of America's inability to continue as a leader in the aerospace field into the next century. Figure 2.16A and 2.16B [Ref. 1:pg. 10, 55] show a broad spectrum of science/engineer related subjects in which foreign nationals have shown a greater willingness to work hard for the many years required to achieve Master and Doctoral Degrees.

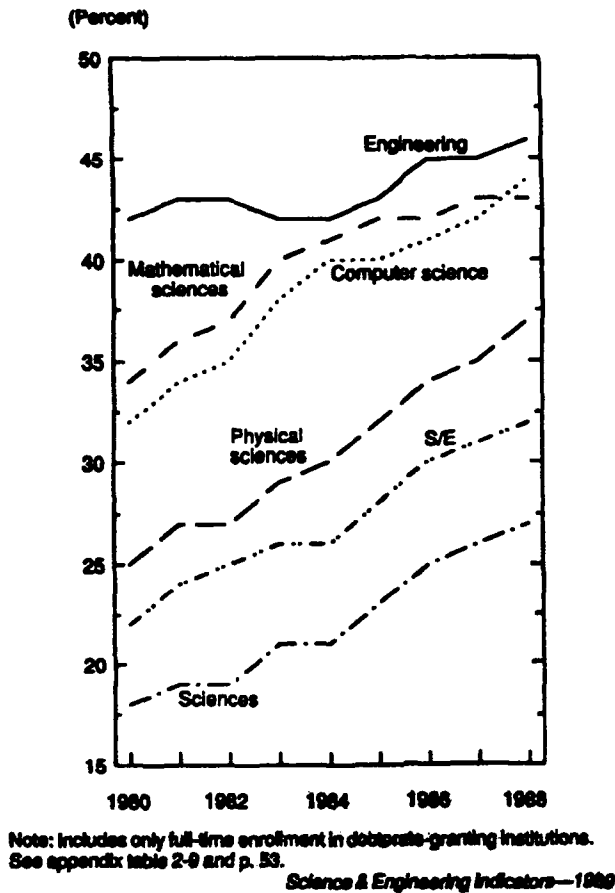


Figure 2.16A: Foreign Enrollment in S/E Graduate Programs: 1980-88

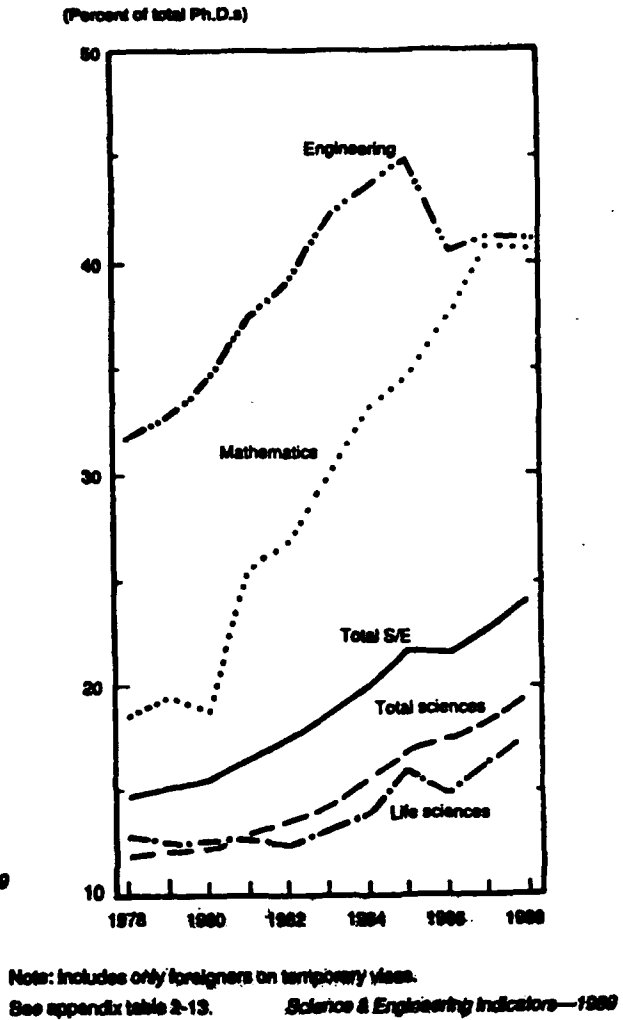


Figure 2.16B: S/E Ph.D.s Awarded to Foreigners: 1978-1988

The reputation of American colleges and universities appears to have drawn a considerable number of the world's students. This is both a boon and a burden. Greater numbers of students bring in more finances and prestige, however, when those students return to their respective countries, they take with them knowledge of U.S. technology that might otherwise have benefitted American companies.

## **8. An Aging Fleet**

Finally, with fewer American students interested in pursuing the more difficult engineering and science careers, there will be fewer professionals to replace the dedicated individuals that have been in the field since the aerospace program began. Personnel in private industry, NASA, military R&D facilities, university and college instruction are just a few of these important people. Since the beginning of the "Apollo era", only thirty three years ago, many of the individuals that made significant contributions to the program have already retired or are getting very close to retirement.

The National Science Foundation reports that 40 percent of all aeronautical and astronautical engineers were over 50 years of age in 1986, an increase of 23 percent from 1976. [Ref. 12:pg. 30]

In 1987 only 29 percent of all scientists and engineers were under 40 years of age, with 34 percent being over 50 years of age. From 1977 to 1987 the older group saw a 31 percent jump. [Ref 1:pg. 59] With the experienced work force leaving and an unenthusiastic work force following who will be the creators of America's space exploration initiative in the twenty first century?

## **G. A BRIGHT FUTURE**

With these last four mentioned areas of concern, is it possible for America to recover? If more positive influence is not attempted soon, the United States will never again be in position as the number one spacefaring nation. Is something being done? Most definitely!

The facts and figures throughout this chapter were provided to give the reader a clear understanding of (1) how extensive America's space program is, (2) the benefits associated with aerospace technology, industry, and education and (3) the potential shortfalls associated with not continuing a strong national aerospace program. The goal of the last section was definitely not to portray only the doom and gloom perceived in the educational

system, but to bring to light some of the shortfalls so that the programs in the next chapter will have greater purpose and meaning. The next chapter will discuss many of the organizations already hard at work providing incentive for America's youth to become the next generation of aeronautical wizards.



### **III. SPACE RELATED EDUCATION PROGRAMS**

#### **A. WHAT TO LOOK FOR**

"AMERICA'S YOUTH: Our Future in Space" is not a unique concept in that it will offer students information regarding America's extensive aerospace program, show them how to become actively involved, and hopefully persuade them to pursue a life-long career. Many agencies and organizations are already providing much of the same information in their own special way. However, to provide the students with the best possible program, some analysis must be done on those programs that are now and have been operating for a number of years. The goal is to find the "best" or most unique portion of each program and also what similar mechanisms the various organizations used to provide long term student retention and interest towards their stated objectives. Although not all of the groups were specifically after aerospace education, their overall goals were still the same: increase student awareness of the importance of learning math and science and the numerous ways these subjects will be applied sometime in their future.

After talking to numerous experts in the field of education, one common theme was strongly emphasized by all: American societal values have changed towards the importance of working long, hard years to obtain one's goals, in this case: education. These changes can be seen through reduced family and peer pressure placed on today's students. So, to blame America's youth alone would be very wrong. And, to try and solve America's societal problems is beyond the scope of this work.

#### **B. WHAT'S OUT THERE TODAY**

Who else recognizes the facts presented in Chapter II? What is being done today to turn the tide? Fortunately, many organizations and societies across America are hard at

work attempting to help students find their way into and through the difficult science and engineering curriculums. President Bush, speaking to the 1990 graduates of Texas A&I University:

Last summer, in a speech commemorating the 20th anniversary of the Apollo Moon landing, I announced three major space policy objectives: First, to have Space Station freedom up before the century is out. Second, for the new century, a permanent lunar base: "Back to the moon, back to the future—and this time—back to stay." and Third, a manned expedition to Mars.

Together, these objectives form the cornerstone of my Administration's far-reaching plan for investing in America's future. Our space program will rekindle public interest in science and mathematics, and revitalize an area of our educational system that has become disturbingly weak. In fact, one of the education goals we announced in January is to make the United States first in math and science by the year 2000. But our space program will do more. It will revolutionize everything from computers to communications, from medicine to metals, regaining and retaining America's high-tech competitive edge. It will create new technologies, new industries, and new jobs. [Ref. 19:pg. 3]

Finally, America's President has given the country succinct guidelines to follow for its national space program. Hopefully, other branches of the Government will be as willing to launch the nation on this bold new adventure.

## **C. NASA PROGRAM REVIEW**

### **1. Organization**

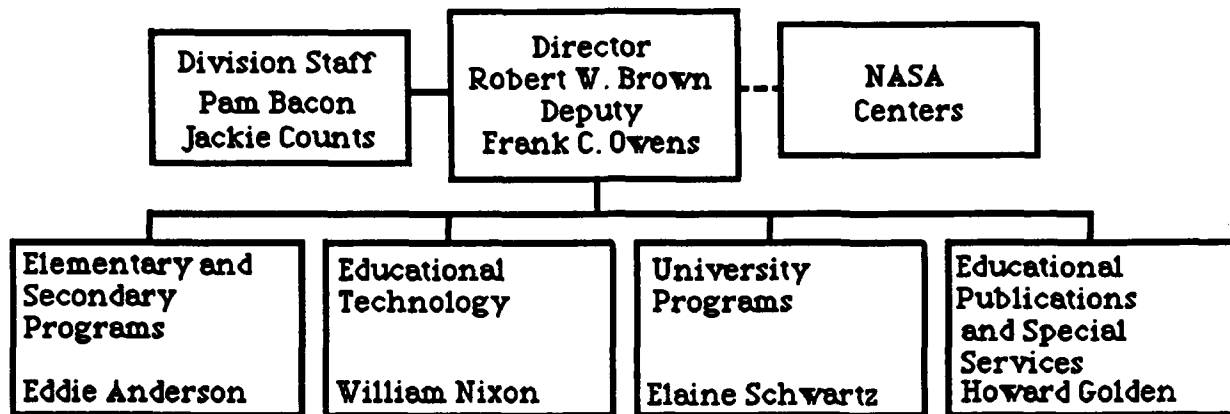
Without the students of today learning the fundamentals of math and science when they are young, how will they be able to understand the more complex global questions this nation will face in the future? Does America want an uneducated populace voting into law issues they do not even comprehend? By not motivating the young to work hard during school years, are we cheating them out of a prosperous future? The United States has been in a position to make world policy since World War II, and the author believes, a major portion of that capability came from the equal education of all of its citizens. Also the United States is relying too heavily upon past achievements and successes to maintain the same standard of living it enjoyed when it was in its prime years of profitable industry.

The size of the national debt speaks to this fact. Without strong new industry bringing back large quantities of profit, America will continue to slide further into a hole from which it will be incapable of recovering. Why must America wait for a national disaster, such as Pearl Harbor or the launch of Sputnik, to join together for a single-minded, national goal which will provide for long term well being and security of all of its citizens? Why not devote energy and money towards a single goal now!!

Two questions are implied: (1) where should the work begin (the previous chapter addressed this question), (2) where is the work taking place? The obvious place to begin looking for ongoing programs would be in the organizations and industry affected the most by the declining interest in the science and engineering fields. And there, the facts show the greatest achievements are being accomplished. NASA has the most extensive and well known educational programs currently working towards fostering future aerospace enthusiasts. However, there are also numerous other organizations and societies involved in the process, several of which will be listed later. For now, NASA will hold the stage, offering the reader an inside look into the many ways and areas they pursue the objectives stated below.

Because the Space Act mandates NASA to expand human knowledge of space, to arrange for participation in space endeavors by the scientific community, and to disseminate information to the widest practicable audiences, NASA can be said to be an "education agency." The use of space and space topics has long been known as a magnet for learning, and NASA hopes to assist the educational community in the use of this magnet through its educational programs. [Ref. 20:pg. 2]

Figure 3.1 depicts NASA's Educational Affairs Division, giving some idea of how extensive their work is in the field of aerospace education. [Ref. 20:pg. 20]



- Aerospace Education Services Program
- Community Involvement Program
- Educational Conferences
- Lunar Sample Education Program
- MATHCOUNTS
- Materials of Instruction
- Orbiter Naming Program
- NEWMAST
- NEWEST
- Publication Writing
- Student Research Assistance
- Teacher Resource Centers
- Teacher In-Service Programs
- Adopt-A-School
- SEEDS
- SSIP
- SHARP
- UCEP
- Teacher-In-Space Program
- Satellite Video-conferences
- Software Development
- Laser Videodisc
- Interactive Learning Program
- Spacelink (Info Access System)
- Telelectures
- Advanced Design
- Graduate Student Researchers Program
- Summer Faculty Fellowship
- Post-Doctoral Fellowships
- Space Grant College and Fellowship Program
- Publications Writing
- Editing
- Graphic Design
- Layout
- Printing (Quality Control)
- Distribution
- Publication Storage

Figure 3.1. Educational Affairs Division Office of External Relations

Although funding is not necessarily a criteria for a successful program, increased funding usually allows a greater number of participants and improved resources. And, the number of participants reached can be considered a grading criteria. Table 3.1 [Ref. 21:pg. 10] shows the approximate number of people NASA reaches each year and the money spent in the respective area.

**Table 3.1 AGENCY WIDE EDUCATIONAL PROGRAMS OVERVIEW  
FISCAL YEAR (FY) 1987 DATA**

Category	Programs	Participants	Expenditures
Elementary & Secondary	59	1.8 M	\$3.7 M
University*	37	1,500 students	\$51.6 M
Minority Outreach	30	1,500	\$9.1 M
Employment	19	2,189	N/A
Public Education	17	4.1 M	N/A
<b>Total</b>	<b>162</b>	<b>4.9 M</b>	<b>\$64.4 M</b>

\*62 Universities

To ensure the widest possible dissemination of information from NASA's educational system, each one of their regional centers, listed in Chapter II, is capable of providing almost any portion of the numerous programs, pamphlets, and projects they offer. In terms of overall effectiveness, NASA must be considered to have the most outstanding program. Their educational assets work for students and teachers of all ages, professionals, and even more importantly, the general public. Without enough voters interested or knowledgeable about America's space program future funding will continue to be unsure. What are some of the specific areas in which NASA's education division works? The following list includes many of NASA's major, current projects, thus giving the reader an appreciation of just how extensive their work in the field of education is today.

## **2. Elementary and Secondary Programs**

1. **NASA Education Workshop for Math and Science Teachers (NEWMAST):** teachers in grades 7-12, expense-paid workshop at NASA field center; FY 1989 - 4 centers, 100 teachers.
2. **NASA Education Workshops for Elementary School Teachers (NEWEST):** teachers in grades 1-6, expense-paid workshop at NASA field center; FY 1989 - 5 centers, 115 teachers.
3. **Teacher Workshops:** summer workshops at NASA field centers, elementary and secondary schools, and on college campuses; astronomy, aeronautics, life in space, principles of rocketry, Earth sciences, and remote sensing.
4. **Space Science Student Involvement Program (SSIP):** grades 6-12 create experiments, art, and newspaper articles. Several student experiments have actually been flown on the Space Shuttle.
5. **MATHCOUNTS:** annual math competition for grades 7 and 8.
6. **Science and Engineering Fairs:** competition is the culmination of more than 350 affiliated regional and state fairs.
7. **Community Involvement Program (CIP):** combines NASA's educational and public affairs resources in a community-wide program; FY 1989 - 75 class visits with 1,885 teachers and 114,125 students involved.
8. **Urban Community Enrichment Program (UCEP):** middle-school students in urban areas with high percentage of minorities utilize the Aerospace Education Services Program, AESP, (formerly Spacemobile). This program will be listed in greater detail later
9. **Summer High School Apprentice Research Program (SHARP):** underrepresented-minority students, grades 10-12 take part in an eight-week, paid apprenticeship, working directly with a NASA scientist or engineer; FY 1989 - 158 students.
10. **Teacher-in-Space Program:** 11,000 initial applicants for the Space Shuttle trip, 112 current Space Ambassadors.

## **3. University Programs**

1. **National Space Grant College and Fellowship Program:** expands NASA's research base by providing grants and fellowships to consortia, universities, institutes, laboratories, and other nonprofit research organizations; FY 1989 - \$.9 M, 21 universities/consortia, FY 1990 - \$6.7 M.
2. **Advanced Design Program:** students study advanced mission topics for NASA within context of fully accredited courses at their university; FY 1989 - 41 universities and 1,000 students, cost: \$1.5 M.

3. **Cooperative Education Program:** high school, college, and graduate students work at a field center while completing their education.
4. **Graduate Student Researchers Program (GSRP):** awards grants to graduate students whose research interests are compatible with NASA research programs. (Numerous students from the Naval Postgraduate School, Monterey, CA, have been awarded this grant from researchers at NASA Ames Research Center).
5. **Summer Faculty Fellowship Program:** allows faculty fellow the opportunity to use NASA field centers to perform research; 508 fellowships, 183 universities, 427 doctorates, 81 masters; FY 1988 - \$6.8 M, FY 1989 - \$7.0 M, FY 1990 - \$8.7 M.
6. **Resident Research Associateships Program:** allows postdoctoral scientists and engineers an opportunity to perform research at one of NASA's field centers; approximately 235 awards each year; FY 1989 - 259 participants, \$12.2 M.

#### **4. Educational Technology**

1. **Spacelink:** electronic information access system regarding NASA activities; FY 1989 saw 9,700 registered users and 37,200 total calls.
2. **Satellite Videoconferences:** educational programs offered to teachers across the country covering aerospace subjects; approximately 500 sites received in all 50 states.
3. **Aerospace Software Director:** 133 software packages from 76 different vendors/sources.

#### **5. Other Categories**

1. **Teacher Resource Centers (TRC), and Regional Teacher Resource Centers (RTRC):** located at one of the nine regional sites, and 21 locations around the country respectfully; information for educators, most is free; over 60,000 served annually.
2. **Central Operation of Resources for Educators (CORE):** centralized mail-order audiovisual library for educators, small fee for cost of the media.
3. **Space-exposed Experiment Developed for Students (SEEDS):** Long Duration Exposure Facility (LDEF) carried tomato seeds into space to study radiation exposure; 100,000 packets delivered to schools around the country.
4. **Lunar Sample:** 525 samples loaned reaching over 245,000 students.
5. **Naming the Orbiter:** 61,000 entry packets were requested, 6,150 projects received, 71,650 students involved.

#### **D. MEASURING EFFECTIVENESS**

The information above may appear extensive and lengthy but it is necessary to explain just how hard NASA has been working. NASA's educational division is the most well-rounded, balanced program offering information to numerous age groups and areas of American culture. This is one reason such a variety of their programs were listed in detail. Another important reason for selecting NASA was the amount of follow-up research that had been documented concerning the number of people they reach.

An optimal situation would be if each program could track every participant after they leave and until they finish their education even through doctoral studies. This would allow for a true Measure of Effectiveness (MOE). Questionnaires would be offered at the beginning of each program to determine student interest in math, science, and engineering education, and also aerospace careers. At various stages, preferably before college, during college, after college/pre-job selection, post-job hiring, and during masters and/or doctoral work, the students would be surveyed to determine how effective the particular program(s) was (were) in which they attended. Were they strongly influenced, slightly influence, or influenced not at all? Which portion helped them the most when making their college/career decision? If they were unaffected or lost interest, what changed their minds? These questions would allow educational officials to verify any contributions from their program in changing the figures of deteriorating student interest shown in Chapter II. Unfortunately, obtaining actual "numbers of students" affected or influenced over a long term period by even one program is difficult if not impossible. The study itself would take away valuable funds. It was determined, after extensive research, that studies similar to the ones described above either have not been done or are not well know. Of the ten educational programs or organizations contacted only one had completed an informal study



(no published report). However, one did plan on starting a follow-up program study to determine its effectiveness within the next year, but felt their study would not be complete for at least two years.

Through telephone interviews and literature research an evaluation of four programs was done to determine methods of approach, student involvement, and unique characteristics. Although MOE studies were not available for any of the four, each individual interviewed offered some personal opinion or experience regarding the respective program's effectiveness.

## **E. EDUCATIONAL PROGRAM REVIEW**

### **1. Spacemobile**

The first program that will be discussed before moving on to other organizations, will be NASA's Spacemobile, or under its new title, AESP.

(AESP) is the Educational Affairs Division's premier outreach program. AESP specialists, all former teachers themselves, reach millions of students each year. They cross the country from September to June each year, assisting schools so students and teachers can see firsthand what NASA is all about. The program has received such enthusiastic response that today {1989} AESP specialist have 26 {1991 - 30} vans on the road during the school year. [Ref. 22:pg. 7]

Dr. Kenneth E. Wiggins, Director of Aerospace Education Services Program, and Head, Department of Aviation and Space Education at Oklahoma State University is contracted through NASA's Elementary and Secondary Programs Branch to coordinate and operate all 30 vans and 30 professional and 15 support personnel currently working for the AESP. A short history of the program states that at 30 years consecutive running, it is one of the longest, if not the longest, running federal program of its kind still in existence.

Unfortunately, too many Government programs operate only as long as the originating individual is around to ensure their creation keeps going. Many have proven to be short lived. This one has not. Its four key points are;

1. free to schools and universities
2. works toward improving science and math skills from kindergarten through graduate level by relating them to aerospace
3. relays NASA's current aerospace programs and work being conducted in its many R&D facilities, and
4. provides students and teachers a summer workshop at schools, colleges, and universities.

By using actual aerospace "spinoffs" and research and development, AESP's primary goal is to prove to students how many ways aerospace can actually be applied to the "real world."

Each Spacemobile visit includes one of NASA's trained professionals.

The visit begins with an assembly, {approximately 50 minutes} at which the AESP specialist introduces students to NASA and, using models and exhibits, explains contributions NASA has made to aerospace. Because all of AESP specialists are former teachers, they are adept in involving large audiences {from less than 100 to over 1500}, often using humor to create a relaxed and pleasant atmosphere. The students are encouraged to ask questions and the specialist often uses volunteers from the audience to help in demonstrations.

After the assembly, the AESP specialist spends the rest of the day visiting individual classrooms, as requested by the school, and expanding on information introduced during the assembly. Most students want to know more about what it's like to live in space, so specialists often show footage taken about past Space Shuttle missions. The specialist may also demonstrate new technologies, such as laser videodisc systems or Spacelink... The specialist also talks to teachers and answers questions about additional resources. [Ref. 22:pg. 7-8]

Another aspect of the program is the four satellite broadcasts, two and one half hours in length, done each year to over 200 school districts in the United States, Canada, and Mexico. The system is designed to be interactive, allowing students to call in and talk live to scientists, researchers, and astronauts.

With only 26 vans and specialists in 1989, they reached: 619,000 elementary students, 237,000 junior high students, 156,000 senior high school students, and 28,750 teachers, for a total of 1,040,750 people. [Ref. 21:pg. 12-13] By 1991, with 30 vans and specialists, the numbers had increased to over 2 million each year. If advanced bookings were a Measure of Effectiveness, then this program would be rated as one of the best. Currently, AESP is running at two years advanced booking. With more vans, they could reach even a greater number of people. Dr. Wiggins was recently given some very positive feedback for this program when two current astronauts explained their motivation to become astronauts came when in their childhood they were exposed to the world of NASA by one of the early Spacemobiles.

## **2. Space Camp®**

The second program to be discussed will be the United States SPACE CAMP® located in Huntsville, AL, at the U.S. Space & Rocket Center.

The U.S. Space & Rocket Center, which established the U.S. SPACE CAMP® in 1982, is America's largest showcase of space technology and is widely noted for its "learning by doing" exhibits related to astronaut training and rocket technology... The attraction includes America's only full-scale Space Shuttle model, the Apollo 16 command module spacecraft returned from lunar orbit and the full-scale model of Skylab. Also featured are rockets developed in Huntsville that launched America's first satellite; the first astronaut into space, Alan Shepard; seven crews of Apollo astronauts to the Moon; and Space Shuttles.

The Spacedome Theater has a 67-foot domed screen and state-of-the-art sound system...Astronauts narrate "The Blue Planet," the new Omnimax feature filmed by several crews in orbit... [Ref. 3:pg. 25]

Darlene Perry, Aerospace Education Supervisor for SPACE CAMP, provided her insights into the unique program offered in Huntsville, AL. (There are also camps located at Kennedy Space Center, Cape Canaveral, FL, Kitakyushu, Japan, and Euro-SPACE CAMP will open in Belgium during 1991.) U.S. Space & Rocket Center and SPACE CAMP were the culmination of Dr. Wernher von Braun's dreams, an internationally respected,

American rocket scientist, of having realistic space hardware available for the public to see and feel, thereby providing them with a better understanding of the wonders their space program was creating. SPACE CAMP, specifically, was created to offer students an alternative to the numerous sports camps available, the second part of Dr. von Braun's dream. The primary goal is to motivate students towards working hard in math and science by offering them a chance to experience and operate first-hand actual space missions and hardware. When combined, U.S. Space & Rocket Center and SPACE CAMP cover quite a mix: students, teachers, and actual "touch and feel" hardware for the public.

There are a total of nine different programs offered from February through December. Table 3.2 [Ref. 23:pg. 19] below provides costs of each session so the reader may judge the expense compared to other types of instructional programs. Scholarships are available for those individuals that apply. Approximately 300 scholarships per year are awarded.

**Table 3.2 SPACE CAMP TUITION**

Program	Days	Feb.-May	June-Aug.	Sept.-Dec.
<b>Youth Sessions</b>				
SPACE CAMP-AL	5	\$450	\$550	\$425
SPACE CAMP-FL	5	450	550	425
SPACE ACADEMY Level I	5	400	600	475
A VIATION CHALLENGE (Both)	5	650	650	675
SPACE ACADEMY Level II	8	675	675	675
<b>Adult Sessions</b>				
Adult ACADEMY Level I	3	450	450	450
Adult A.V. CHALLENGE	3	500	500	500
Adult ACADEMY Level II	8	675	675	675
TEACHER'S LEVEL I	5	625	625	625
TEACHING THE FUTURE	5	750	750	750

Tuitions are subject to change without notice.

Each camp provides something unique to its participants while all offer the same **SPACE CAMP** theme. One similarity between all of the programs is the graduation and awarding of a diploma, thus notifying each participant of the importance of their individual accomplishment.

1. **SPACE CAMP**, grades 4-8: space history; rocketry; Shuttle mission simulation; astronaut training; aerospace careers; and an IMAX film; 1 counselor to 12 team members.
2. **SPACE ACADEMY Level I**, grades 7-9: review space history; Shuttle mission training, simulation, team experiment, and operation; 1 counselor to 20 students.
3. **SPACE ACADEMY Level II**, grades 10-12: authentic astronaut training; numerous shuttle simulation missions with longest being 16 hours aboard; 1 counselor to 8 students.
4. **AVIATION CHALLENGE**, grade 7-12: classroom aviation training; survival skills; aviation simulators; career guidance.
5. **Adult ACADEMY LEVEL I**: space history; astronaut training simulation; Shuttle mission simulation.
6. **Adult ACADEMY LEVEL II**: adult version of **SPACE ACADEMY Level II** for students.
7. **Adult AV. CHALLENGE**: adult version of **AVIATION CHALLENGE** for students.
8. **TEACHERS LEVEL I**: "Hands-on space science applications and intensive astronaut training."
9. **TEACHING THE FUTURE**: extensive aerospace lectures; three semester hours of graduate credit; aerospace history; IMAX® film; Shuttle mission simulator.

Approximately 800 participants per week and over 20,000 per year keep the instructional staff extremely busy. **SPACE CAMP** recently (early 1991) recorded their 100,000th person through the training program since it began in 1982. Another part of their whole approach is the newsletter describing changes and current events which is used

to maintain the flow of information to their graduates and help the staff in follow-up reports. Although limited, SPACE CAMP does have some statistics concerning their effectiveness:

- Approximately 30 percent of advanced participants have previously attended a program.
- Some 91 percent of trainees report a greater interest in science and technology after attending Space Camp.
- Sixty-five percent of trainees report actually taking additional math or science courses after attending Space Camp.
- More than one-third of the trainees are female. [Ref. 23, pg. 25]

### **3. Visions of Exploration**

The fourth program to be discussed is USA Today's VISIONS OF EXPLORATION: Past, Present, Future, done in partnership with NASA. Development of and guidance through VISIONS OF EXPLORATION include a highly qualified consortium: National Science Teachers Association, International Reading Association, National Association of Elementary School Principals, National Council for the Social Studies and National Council of Teacher of Mathematics as well as representatives from the National Geographic Society, National Air and Space Museum, 4-H Youth Development and the Mathematical Sciences Education Board. However, unlike the previous three programs that have been reviewed VISIONS OF EXPLORATION has not had the test of time in which to prove or disapprove its effectiveness. The pilot program was completed December of 1990. A finished product became available for other-than-test school systems for the first time during the final spring months of the 1991 school year. The real, full-year school test will begin during the 1991-1992 session at elementary and junior high schools across America.

Michelle Wickham of USA Today's Education Initiatives Department offered her insight into the history, goals, and unique aspects of VISIONS OF EXPLORATION. A

pilot program was conducted utilizing four school districts with nearly 6000 students in elementary and middle schools around the country, all located relatively close to a NASA center. The four were: Los Angeles Unified School District, Houston Independent School District, Orange County (FL) Public Schools, and Cleveland area schools. Surveys were completed by faculty members after working with the program and as many of the problems as possible were corrected before the finished product became available.

From USA Today's advertisement brochure:

This exciting project motivates students to learn about the explorers of the past and the present in order to discover the qualities within themselves to become explorers in the future. VISIONS OF EXPLORATION: Past, Present, Future targets grades 3 through 8. The curriculum focuses on science, math, technology, and social studies; but expression is encourage in all the disciplines, including reading, career education, music, and art. Today's students, more than those of the any former generation, need to be able to locate, comprehend, and use information to be better prepared to live in an age when technology multiplies and changes information daily. VISIONS OF EXPLORATION: Past, Present, Future goals:

- \*Rekindle students' interest in science and space exploration.
- \*Encourage students to explore the areas of science, social studies, and math.
- \*Allow students to use technology in practical applications.
- \*Identify role models for young people and help them set realistic goals for their dreams.
- \*Help students identify science-related career paths.
- \*Teach basic skills and offer opportunities for practicing those skills within a realistic environment.
- \*Teach clear thinking and decision making.
- \*Establish lifelong habits of reading, sound decision making, and social participation.
- \*Involve the students, school, family, and community in an active celebration of education. [Ref. 24:inset]

When compared to other educational programs, one aspect that really stands out is the VISIONS OF EXPLORATION use of USA Today daily newspapers to assist with lesson plans. Students, while reading about current events, will discover how to tie together present day, national and international, goals and problems with historical ones. What could be better than a history textbook that is updated on a daily basis? An

elementary school principal expressed to Ms. Wickham his affirmation of using newspapers to teach when he explained, "By the time our kindergartners are in high school facts about the GULF WAR will just be getting into their textbooks."

Ms. Wickham felt the best part of the VISIONS program was its open ended curriculum or "no straight answers." The idea was for the students to "create - dream - imagine." However, she did acknowledge the extra burden placed upon the teachers when introducing a more essay style of learning and testing as opposed to a right versus wrong style. By incorporating space, cooperative learning, (student groups), and the many aspects of learning, (science, social studies, math, music, and art), as shown in the brochure, she expressed her confidence in VISIONS ability to motivate students, not just for the duration of the program, but for their entire educational process. And, since long term motivation of students towards higher achievement has been a common goal expressed by all of the previous programs, VISIONS OF EXPLORATION: Past, Present, and Future, can truly be ranked with the many other successful programs in its ability to find new and innovative ways to pursue a most necessary national goal.

#### **F. EDUCATIONAL PROGRAM ANALYSIS**

The primary objective in reviewing NASA's education program, AESP (Spacemobile), SPACE CAMP, and VISIONS OF EXPLORATION was to discover the best and possibly worst traits, the unique aspects, and the successful and unsuccessful methods of each. By discovering what worked for the above listed programs and eliminating what did not, it was felt AMERICA'S YOUTH; Our Future In Space program would provide students with the proper building blocks for a long term commitment to America's space program.



## **1. The Best**

**NASA** — covers almost every conceivable tactic for reaching students, teachers, parents, and the public.

**AESP** — takes a free program to the students and teachers providing for many who would otherwise never receive space education.

**SPACE CAMP** — offers education, interaction, and hands-on time for one whole week making it very hard to forget.

**VISIONS OF EXPLORATION** — combines space and exploration, thereby generating futuristic thought, with everyday classroom session.

## **2. The Unique**

**NASA** — draws from its national resources all across the country such as the space and research centers, also, being the chief controller of America's space program, can draw upon numerous experts and utilize actual hardware to inspire students.

**AESP** — reaches students all across the country, even those far removed from NASA's main centers.

**SPACE CAMP** — provides an opportunity and a place to learn about and use current space technology for students interested in excelling in something besides sports.

**VISIONS OF EXPLORATION** — although new, this program has convinced administrators, school boards, and teachers all across America to use a common theme in educating their students which will leave a long lasting impression on America's future leaders and explorers.

## **G. CONCLUSION**

Defining the best, unique, and successful portions of each program was not difficult. However, finding the antithesis proved impossible. Of the ten people interviewed

concerning American educational programs, only two expressed any hint that the combined efforts of the numerous programs were not working. Unfortunately, the facts alone prove the worsening condition. Even with approximately 300 different programs striving to change student opinion and inject a motivation to work harder at learning the difficult math and science subjects, America's youth continue to express less interest and motivation. Chapter II has the facts to prove this. But what if the programs discussed here did not exist? How much worse would America's loss be? Helen Marie Hoffman, from the National Science Teachers Association, expressed the feeling of "swimming up stream" with funding decreasing availability to the students. Her program alone saw a decrease from 200 down to 40 students.

As stated earlier, changing societal values is beyond the scope of this thesis. However, many of the individuals involved with education programs interviewed expressed the same opinion: America's societal values no longer enforce working hard, especially in the area of education, towards achieving one's goals. The emphasis has shifted to less strenuous goals. Therefore, a common idea that should be and has been stressed in any educational program is the benefits of exceptional effort and obtaining higher education.

Another common thought from those interviewed was the inability of primary, secondary, and college education to properly prepare American students for the future hard work necessary to allow them to compete against other nations. Part of the problem was placed upon the primary teachers and their lack of education and understanding of math and science subjects. And also, the secondary teachers are trying to teach all of the students as if they were "rocket scientists" instead of providing some type of "science for poets," or in other words, physics, chemistry and math that is interesting and enjoyable enough so that all of the students can understand and learn, not just the potential college track students.

For more information on shortfalls and remedies to America's education needs, see "EDUCATING AMERICANS FOR THE 21st CENTURY:...", A report to the American People and the National Science Board by The National Science Board Commission on Precollege Education in Mathematics, Science and Technology, September 1983.

The difficulties lie in many sectors: student's desire, teacher's ability, parent's guidance, national objectives. No single program can hope to improve all of these areas, but by bringing together and analyzing the varied problems and solutions seen in America's education system, the author believes, AMERICA'S YOUTH: Our Future in Space, will provide the best possible space educational program for as many students as the program is able to reach.

## **IV. THE MOST DIFFICULT PART IS THE BEGINNING**

### **A. INTRODUCTION**

The process by which a plan is devised is often as important as the plan itself. With that in mind, this chapter will explain how the idea and design for the seminar came about and step through the seminar offering reasons for each portion of **AMERICA'S YOUTH: Our Future In Space**. For greater details on the actual operation of the entire seminar including instructions for the orator see Appendix E, A Users Guide.

### **B. DEVELOPING A PLAN**

Lack of interest in math, science, and engineering by American students, a smaller population of students, an experienced work force reaching retirement age, promoting the national space program and finally positively influencing American youth towards becoming scientists and engineers: these were the reasons behind developing a medium with which to reach a large number of students in an effective manor. The greatest need and therefore the greatest good for the national space program seemed to be in the area of promoting space science and engineering. **AMERICA'S YOUTH: Our Future in Space** is a program initially conceived to entice American students, in a one day session, to become those necessary space scientists and engineers. By offering them spectacular, life-like, film footage, Imax, well known guest speakers, useful college and job information, and an opportunity to converse with successful people from the student's home state it was felt that their long term career choices could be channeled towards pursuing the more difficult and longer courses of study which would enable them to become America's future space scientists and engineers. Difficulties arose when trying to create a short duration method of changing student's career goals and pushing them to want to work harder.

## **C. TESTING A PLAN**

### **1. Review**

During program development two events occurred which caused the overall goals of the seminar to change. First, after analyzing various educational programs and discussing the seminars goals with several educators it was determined that to create long term goal changes a program would need to be of an extended length of time utilizing multiple approaches. Therefore, in order to maintain a one day seminar a different set of program goals would be necessary for AMERICA'S YOUTH: Our Future In Space.

### **2. Pilot Test**

Second, while attempting to obtain better insight into the actual knowledge, abilities, and interests of current high school age students their responses to career questions were different enough than expected to warrant redefining the program goals. Further explanation of the results of the analysis to student responses will follow.

#### ***a. Vista High School, San Diego***

Classroom sessions were scheduled with three different high schools. The first was completed in October, 1990 at Vista High School, San Diego, California, with two separate physical science classes, each 50 minutes in length, composed of college track sophomores, juniors, and seniors. Appendix A contains the questions addressed to the students and their responses. Prior to talking with the students a predetermined supposition was that a considerable number of the students would have already selected careers such as lawyers and stock brokers to pursue. This hypothesis proved extremely incorrect. Their career choices proved much more varied than expected. From their answers to the question concerning career choice it was determined that the initial goals for the seminar needed to change. Instead of trying to completely rechannel the students interests into new directions and careers it was determined a more effective plan for a one

day seminar would be to use student's existing career goals and interests to offer a more general goal, careers in the space program, with detailed directions on how to go about achieving success. The long term objective would be to persuade the students to pursue higher education oriented around the space program instead of general job titles, i.e., space architect vice architect.

The primary objective of the first student session was to reacquaint the author with current high school student thoughts and at the same time find out how much that particular age group knew about the national space program. It turned out to be more successful than planned. Although the results were surprising, after discovering the mix of career choices the author was able to redefine, during these two sessions, many of the careers into ones that could be used in the space program. At the time, the method used was to explain how the college courses necessary for the degree that would provide the student with their career choice were also necessary for degrees that would provide them with space careers or jobs, i.e., an architect would take courses on what type of metals to use for strength in buildings or bridges (structural engineering), that same course would apply to someone designing a spacecraft or launch pad. In this manner the author was able to discover a new set of goals and at the same time test the new methodology. The first sessions were successful enough to become the first, interactive portion of the seminar.

***b. Monterey/Manitou Springs High Schools***

The next phase in testing the program came after the Mars Mission Design Project, Appendix D.3, was created. As stated earlier some type of interaction by the students was necessary to provide long lasting impressions. The Mars Mission scenario would allow the orator the chance to tie unrelated careers to space related careers and allow the students the opportunity to be creative and interactive, not just sit quietly and listen all day. The purpose of the test would be to:

- 1.) Determine student interest in the project.
- 2.) Provide the time required for an orator to complete the project.
- 3.) Obtain a wide mix of answers to assist in writing directions for the orator.
- 4.) Determine if the students would understand the handout, instructions.
- 5.) Decide if student career goals could be successfully blended into a space project.

Two schools were selected for test, Monterey High School, California, and Manitou Springs High School, Colorado. Both were accomplished in May, 1991, Monterey's session one week before Manitou's. Again, the students were all college track with the same mix of ages, two 50 minute classes at Monterey and three 50 minute classes at Manitou. None of the schools were selected for statistical purposes but were selected for accessibility. A handout, Appendix B, was given all of the students two days prior to the actual classroom session to allow them adequate time to read through and write their responses. For the Monterey session, because the students would not have the benefit of the first portion of the actual seminar the handout given to them included the questions and answers from Appendix A. Appendix A was not found to be beneficial and therefore was left out during the Manitou session. A portion of the answers from both sessions are combined into Appendix C; the answers selected for reprint were either the more interesting or applicable ones and were reproduced to provide the orator with a sample to study prior to presentation.

### *c. Pilot Test Complete*

Overall, the two test sessions proved extremely successful. The students were very interested in the project and had time been available would have spent it asking questions. During the first Monterey session time ran out using the first handout, so during the second session a portion of the questions was eliminated. Several other changes

were made between the Monterey and Manitou sessions, such as fewer questions, more variety in the questions, and easier to understand instructions. Approximately one hour is required to get through all of the questions. And, quite a few of the student's career goals could be applied to the space program. Unfortunately, only 50 minute sessions were available for test with approximately 25 students per class, therefore, several pilot programs encompassing the entire one day seminar would be recommended prior to beginning full operations around the country.

The remaining sections will define the plan, again, with some explanation of the decision process behind the development of the seminar.

#### **D. THE PLAN**

##### **1. Personnel**

AMERICA'S YOUTH: Our Future In Space was designed as a one day presentation to a mix of 250 total sophomore, junior and senior high school students living in the state in which the program is held. Personnel requirements include an orator and presentation staff, headquarters staff, and an advisory committee. With 50 states and only 52 weeks in a year one working week will be allotted to each state, this requirement will keep the presentation staff extremely mobile. Personnel, equipment and supplies will move between locations each week with presentation staff needing time to complete some preprogram preparations and set-up upon arrival. One possibility to reduce logistic difficulties would be to send an advance person (team) to the next location one week in advance. Once preparations were complete, the advance person (team) would move on leaving the actual operations to the presentation staff. The central headquarters staff will be kept extremely busy coordinating the continuously moving events. An advisory committee would be necessary in advance of the actual start-up of the program to be involved in creating student selection rules and criteria. Once the program begins the committee would



continue to assist with selection of students, locations, guest speakers, and panel members. However, the actual presentation and material used would be the sole responsibility of the orator.

## **2. AMERICA'S YOUTH: Our Future In Space**

### ***a. About the Program***

AMERICA'S YOUTH: Our Future In Space is broken into seven sections (see Appendix D for a list of events, sections, and breaks during the day). Each section will be separated by a break; lunch will either be catered or close to the auditorium to avoid any unnecessary lost time. The schedule for the program is not set and has not been tested during a pilot program therefore the orator might consider varying the order of some of the modules to determine the most desirable schedule. Responsibility rests with the orator to maintain the quality of the program. The morning hours will be the most active for the majority of the students and for several hours after lunch most of the students will be wound down, less responsive, and less attentive. With this in mind the orator should offer something in the afternoon at which they need not be very attentive, or present something that will keep the students so busy and active, falling asleep is impossible.

### ***b. Opening Section***

1. National Anthem
2. Guest Speaker
3. SPECTRAFILM
4. Explain Day

==Break==

The national anthem will open each session followed by the guest speaker. In order to increase the student's feeling of attending a very special program the guest speakers will be persons such as the U.S. President or Vice President, Congressman,

Senators, astronauts or well known movie stars. The selected individual will be requested to offer encouragement and incentive to the students concerning future space careers. A 45-50 minute film entitled SPECTRAFILM will be next. SPECTRAFILM is designed to excite and stimulate the students by giving them a realistic view of what the astronauts see while in space, current and future space projects, and areas of their lives affected by space spinoffs. SPECTRAFILM is an IMAX quality film using a bigger than life theme to increase the overall effect of the film's ideas. The reason for using an IMAX type film is the realism and grandeur associated with watching a 55 foot screen; shuttle astronauts have said viewing *The Dream Is Alive* is the closest thing there is to actually being in space. The guest speaker and film should be two of the strongest draws to the program, hopefully providing a long lasting impression for the students. At the completion of the film the orator will explain the days schedule, rules of behavior and finish by calling for a ten minute break. Following the break the more interactive portion of the program will begin.

*c. Begin Student Participation Section*

5. How Much Do You Already Know

==Break==

6. Mars Design Project I (Groups)

==Lunch==

7. Mars Design Project II (Assembly)

Following the break the students will be asked to answer questions presented by the orator. As discussed earlier the questions are from Appendix A. This portion of the seminar is designed to start the students thinking about what type of career they might wish to pursue. Examples are provided for the orator in case there are limited responses from

the audience. Although this section could take a considerable amount of time the orator must stay within the allotted time throughout to prevent missing items at the end of the day. A break follows Section 5.

One of the key elements within each of the successful education promotion programs analyzed in Chapter II, was some degree of practical experience or hands-on time. This next portion of the seminar is designed to use the students suggestions from the previous section to bring to light how their interests both for college majors and careers could be used in the space industry working for NASA, Department of Defense, private industry, or education—the four primary players in the American space program. During the break the students will have been instructed to find four other members of a group with which they will spend time in Section 6 (Mars Design Project I). After the break the students will reassemble in the auditorium with their respective groups and begin discussing the questions found in Appendix D.3. The small groups will allow the students time to hear ideas from their peers and also sound out some of their own ideas. Each student should write down individual ideas in the handout, waiting until the entire group is reassemble to write down other students suggestions.

At 1200 lunch will begin. It is expected during this time the groups will continue their discussion. Following lunch the students will return to the auditorium to begin Section 7 (Mars Design Project II). During Section 7 the orator will attempt to bring together student career interests with space related career possibilities using the design project as a catalyst. Combining these two items will not be evident to the students and will be highly dependent upon the expertise and enthusiasm of the orator. For greater detail on the discussion between the orator and the students see Appendix E. A break will separate the interactive portion of the seminar from the informative portion.

***d. Information Presentation***

**8. College/University Information**

**==Break==**

**9. Careers in Aerospace**

**==Break-snack==**

**10. Panel of experts**

**11. New Teachers (conclusion)**

Hopefully, all of the previous sections of the seminar will have excited the students towards the national space program. This next portion will introduce information which will help the students pursue a career somewhere in the field of American aerospace.

First, a questionnaire designed to assist the students in selecting the right college/university for themselves will be discussed. The major emphasis during the questionnaire discussion will be on convincing the students that the more work they put into college/university selection the greater the chances will be of getting their first choice and the best education. During the seminar emphasis will be placed upon colleges/universities which provide some type of aerospace related degrees within that state's location and also the military academies. A more nationally inclusive list of colleges and universities is provided in the student package along with a copy of college/university rankings.

Second, after thinking about which college/university the student wishes to attend the next portion of this section will offer information on aerospace related course and majors available. Slides will begin to be used to assist with visualization. Although the students are not expected to remember the exact titles it is hoped that by both hearing about and seeing pictures of the courses and majors they will retain much of what is presented.

Engineering will be used to introduce majors to the audience and a wide variety of courses will be explained. Time will dictate into how much detail the orator will be allowed to go.

Once the college/university and major is decided upon another serious concern for any student (and parent) will be funding available to pay for school. A data base of information concerning different scholarships and grants available in each state will be necessary before the seminar begins, with the understanding that the information will continue to change with time. Some information will be discussed during the seminar but due to the continuous changes associated with local and regional scholarships separate handouts will be made available afterwards which offer greater detail for those students interested. Once a data base is established it might be possible to include the scholarship information directly inside the student packets. A break will end this section.

The next logical step after finishing a discussion concerning obtaining a college degree is to consider where the degree might be applied in the working world. What might the students expect to find as a career with the degree they have so carefully selected and worked so hard to obtain? Four career areas will be presented: NASA, government agencies, Department of Defense, private industry, and education. In the student packet will be lists of NASA centers and private companies. For information concerning employment with the Department of Defense the students will be told to contact the local recruitment office. One other possibility available to students after obtaining a college degree is pursuing Master and Doctorate Degrees. Information on what is necessary for a master and doctorate degree will be lightly addressed so that students know something about the requirements necessary in obtaining these higher forms of education.

Most students will have a general idea concerning the type of college degree they are interested in pursuing. It is believed few of them understand fully what their degree entails, what courses will be required, and what type of job they might expect after

school. Providing this information now will help them determine if they are really interested in their original degree choice or if there are other possibilities for them. Something for the students of today to consider that will be discussed during the seminar is that future space travelers will not just be astronauts flying space shuttles. With the advent of the space station and Moon/Mars colonization programs, both of which require extended stays in space, flying the spacecraft from place to place will become less important. Soon, the emphasis will be on people capable of working and living in space. With the current Space Shuttle crew composed not only of shuttle pilots but also mission specialists, and payload specialists, the transformation can already be seen. The last break will begin at the end of the section, snacks will also be provided.

*e. Experience Talks*

To help the students combine the tremendous amount of information offered a panel of speakers will be presented to allow the students time to ask questions of people that have actually experienced the items discussed throughout the day. The speakers should be people to which the students can relate, in other words, local success stories or aerospace people that are well known for their abilities to address young people. Because this section is at the end of the day either extra time can be allotted or the speakers can be invited to stay afterwards and address more questions.

*f. New Teachers*

The conclusion to the seminar will be a request from the orator to the students. They will have received a great deal of valuable information during the day and should consider sharing as much of it as possible with their friends, teachers, and especially their parents. A newsletter will be sent to them quarterly to help continue the aerospace education and offer updated reports on colleges, scholarships, jobs, special events in the

space community and other related aerospace news. One last thing will be asked of the students and that is to fill out the opinion survey about the seminar, both the one in their student packets and any that might come to them in the mail in the future.

## **V. OPERATIONS AND LOGISTICS FOR THE SEMINAR**

### **A. INTRODUCTION**

This chapter will concentrate on two key elements: (1) logistic requirements to establish and continue AMERICA'S YOUTH: Our Future In Space, and (2) a more detailed explanation of various portions of the seminar contained throughout Chapter IV. Appendix E was written to be used by the orator or on-site organizer to actually conduct AMERICA'S YOUTH: Our Future In Space. This chapter will offer guidance to the organizing committee when establishing the entire program. As a pretrial design only major items were considered necessary to discuss within the guidelines of this thesis, and, although specific item costs were not considered in planning and developing the seminar, funding decisions were never far away. Some of the guidance for this chapter came from Eleni Kleamis and Julie Walker, both Meeting Managers working for American Institute of Aeronautics and Astronautics, (AIAA).

### **B. LOGISTICS**

#### **1. Sponsors**

What can be done without proper sponsorship? Funding must come from somewhere and it can and will make the difference between just an idea and an actual working program. Fortunately, once a program is operating and has proven its effectiveness, the chance of cancellation diminishes somewhat, although not completely. Therefore, what type of funding to pursue is one of the first major questions to be answered. The two choices are: sponsorship or student fees. Any other choice is a combination of these, but one specific direction must be determined. Of the major programs discussed, SPACE CAMP® was the only one in which the burden of cost was



placed primarily upon the individuals attending. AMERICA'S YOUTH: Our Future In Space will use a sponsorship method to fund at least the majority of the cost. A small fee will be assessed the individual participants to partially offset the cost and also teach those young kids the meaning of "there ain't no free lunch in life" (ha ha). (Just kidding, a little childish humor to break the monotony)

NASA's Education Affairs Division, a part of the Office of External Relations spends a major portion of the agency's available funds for public education. However, other divisions and centers from within NASA also participate and contribute through programs of their own. Of those programs reviewed in Chapter III, all were affiliated with NASA. Other organizations and agencies also contribute to both NASA's programs (see Figure 5.1 [Ref. 21:pg. 21]) and those outside of NASA's jurisdiction.

**Educational Partnerships**

American Society for Engineering Education	Astronaut Memorial Foundation
Challenger Center for Space Science Education	International Space University
Mathematics Sciences Education Board	National Air and Space Museum
National Council of Teachers of Mathematics	National Research Council
National Science Teachers Association	Triangle Coalition
National Society of Professional Engineers	US Space Foundation
Task Force on Women, Minorities and the Handicapped in Science and Technology	
Universities Space Research Association	US Space Camp
Young Astronaut Council	

Figure 5.1. NASA Educational Partnerships

In partnership with NASA, USA Today's VISIONS OF EXPLORATION: Past, Present, and Future, received sponsorship from McDonnell Douglas Foundation and the American Institute of Aeronautics and Astronautics, as well as direct support from the Advisor Team listed in Chapter III. U.S. SPACE CAMP, a non-profit organization, obtained direct support from a variety of organizations. Besides the U.S. Space & Rocket

Center, NASA-Marshall Space Flight Center in Alabama, and NASA-Kennedy Space Center in Florida, the following private companies are partners with SPACE CAMP: Coca Cola, USA; Rockwell International; United Technologies, McDonnell Douglas Foundation; Lockheed; Thiokol Corporation; Boeing; IBM Corporation; TRW; Martin Marietta; Teledyne Brown Engineering; Wyle Laboratories; BDM International, Inc.; GoldStar; Grumman; Apple; Delta, The Official Airlines of U.S. SPACE CAMP; Fuji; and Budget, car and truck rental (and other contributors not listed). [Ref. 23:pg. 2]

When pursuing funds for any program, an important consideration is: Who will benefit from the positive results obtained through the successful completion of the program? In the case of AMERICA'S YOUTH: Our Future In Space, those organizations and businesses listed above are only a few of the possible benefactors, and all would be likely candidates to pursue for sponsorship (Chapter II contains the name and address of federal agencies and numerous aerospace companies which might provide sponsorship). The National Science Foundation (NSF) with a 1990 budget of over \$2 billion, offers federal assistance

primarily by sponsoring scientific and engineering research and by supporting selected activities in science and engineering education. NSF does not itself conduct research. [Ref. 25:pg. vii]

AMERICA'S YOUTH: Our Future In Space falls under the category of Science and Engineering education, subheading: Materials Development, Research, and Informal Science Education; Informal Science Education or Instructional Materials Development. Point of contact at NSF is: Division of Materials Development, Research and Informal Science Education, National Science Foundation, Washington, DC 20550, (202) 357-7452. [Ref. 25:pg. 65]

So far the national level has been addressed. What about more local groups such as state and local Governments and agencies? Since a significant portion of the program is

designed around promoting state specific successful individuals, schools, and industry, each state would benefit from the program. Although the amount of support might not be at the same level as federal agencies or large corporations, local participation would help foster a stronger community acceptance of the overall theme, which is to promote national pride and drive enhancing America's space program and therefore its future success.

Sponsorship does not need to come from only a few supporters. The greater and more widespread the funding, the greater variety and detail can be used throughout the program. How will the sponsors funding be spent? This question and others pertaining to location logistics will be covered in the next section.

## **2. Location Logistics**

### ***a. Outline***

This section will describe the necessary details involved with in-state site and auditorium selection and associated requirements and then obtaining panel speakers from the local area or state. As described in Chapter IV, the program is designed to move from state to state concentrating on areas not closely associated with one of the NASA centers. (These areas receive a significant portion of existing attention due to the proximity to NASA facilities.)

### ***b. Site Location***

The actual location or city in which the seminar will be held will be dependent first and foremost upon whether an IMAX® quality film is obtained for the program.

IMAX and OMNIMAX® are the finest motion picture systems in the world. Images of unsurpassed size, clarity and impact, enhanced by a superb specially-designed six-track sound system, are projected onto giant rectangular screens, up to eight stories high. OMNIMAX projects onto large dome screens, often in planetariums and space theaters. The IMAX image is ten times larger than a conventional 35 mm frame and three times bigger than a standard 70mm frame. The sheer size of an

IMAX/OMNIMAX film frame, combined with the unique IMAX/OMNIMAX projection technology, is the key to the extraordinary sharpness and clarity of IMAX/OMNIMAX films. IMAX and OMNIMAX projectors are the most advanced, highest-precision and most powerful projectors ever built. [Ref. 26:pg. 1-2]

Two difficulties will arise from using IMAX films. First, the required screen size restricts the number of auditoriums that might be available around the country; they will generally be located only in large cities. Second, the projector is approximately one ton and the size of a subcompact car which increases the difficulty of transportation between sites. One alternative solution would be to schedule the seminars at existing IMAX equipped theater locations. The following is a partial list of the possible 33 U.S. theaters:

Baltimore:	Maryland Academy of Sciences
Boston:	Boston Museum of Science
Chicago:	Museum of Science & Industry
Cincinnati:	Museum Center at Union Terminal
Denver:	Museum of Natural History
Detroit:	Detroit Science Center
Ft. Worth:	Ft. Worth Museum of Science & Technology
Houston:	Museum of History & Science
Huntsville:	Alabama Space & Rocket Center
Hutchinson:	Kansas Cosmosphere & Space Center
Las Vegas:	Caesars Palace
Los Angeles:	California Museum of Science & Industry
Louisville:	Museum of History & Science
New York:	American Museum of Natural History
Philadelphia:	Franklin Institute Science Museum
Richmond:	Science Museum of Virginia
San Diego:	Reuben H. Fleet Space Theater & Science Center
Santa Clara:	Great America Show Operations
Seattle:	Pacific Science Center
Washington, DC:	National Air and Space Museum

Unfortunately, many states and regions do not have properly equipped theaters and others have several within the same vicinity. One of the goals of AMERICA'S YOUTH: Our Future In Space is to reach students in areas of the U.S. that are not easily accessible by NASA centers. Therefore, special accommodations would be necessary to allow presentations in the less populated states. For the purpose of this thesis, it will be assumed an IMAX or equivalent film has been procured, that the necessary equipment and

screen are available for transportation and that theaters are equally distributed among the states. However, if the cost and logistics of using an IMAX quality film become too restrictive a lower quality film can be used, unfortunately the effectiveness of the film portion of the seminar will be reduced. One advantage to using a standard film would be the increased number of locations available. For more information concerning the special requirements, see section SUPPLIES in this chapter. Because of the uncertainty of the type of film used, SPECTRAFILM will be a generic title used throughout this thesis when discussing the seminar film.

The primary considerations for location logistics are finding an adequate facility to house the special equipment required for an IMAX film and establishing a data base of individuals who came from each state to act as panel speakers. Once proper theater locations are determined the rest of the planning involves personal, on-site viewing, and negotiations. Information concerning planning and scheduling was obtained during an interview with Ms. Eleni Kleamis and Ms. Julie Walker, both Meeting Managers with American Institute of Aeronautics and Astronautics. AIAA utilizes a staff of only three people to coordinate 30 conventions per year, most of which remain in the same location from year to year. A considerable amount of the arrangements are handled for hotels, auditoriums, catering, and temporary personnel from the main office in Washington, DC. Nevertheless, Ms. Walker and Ms. Kleamis stated that a considerable amount of road work was required to complete most of the initial arrangements. They also recommended the following bits of advice when working on future locations:

1. Establish advance contract at least two or three years in advance, complete a follow-up planning meeting six months prior to the actual event.
2. Colleges and universities are easy to work with and often maintain most of the necessary equipment on-site. Also, due to the nature of AMERICA'S YOUTH, they may volunteer the facilities.

3. Convention Bureau's provide lists of temporary personnel, but ask for the same people to work if more than one day in length.

If travel is required by the students, accommodations will be their own responsibility. However, local transportation, hotel, and restaurant information would be provided in the application package. Special rates for transportation, overnight accommodations, and eating, should be sought where possible for all speakers and seminar personnel, including the students. This would not add much in the way of work.

### **3. Advertisement**

There are two parts to advertisement. The first is notification to the students that the seminar is coming to the area and the second is providing advertisement for existing program sponsors through various means. Once the state location has been determined, advance notices will be sent out asking for interested individuals or groups to request an application. Two of the qualities which are to make AMERICA'S YOUTH something special and unique for students to attend are the IMAX film and the guest speaker. Therefore, special guest speakers need to be booked far enough in advance that their names and titles can be used for the first notifications. The method of notification will generally be direct mailing to school administrations and districts, television and newspapers, notices in professional magazines to notify parents, and also NASA newsletters and related media methods.

Two extremely desirable candidates for guest speakers would be the U.S. President and Vice President. Request in writing with a desired time and location, keeping in mind that allowing several days on either side of the actual date will increase the chance

of success. Also, include a description of the program to be offered and the possible theme for their speech. Contact:

Ms. Katherine Super  
Director, Presidential Schedule  
White House  
Washington, DC 20500  
(202) 456-7560

Cecile Kremer  
Director, Vice Presidential Schedule  
White House  
Washington, DC 20500  
(202) 395-4245

Another possibility from the President and Vice President, is an endorsement letter from them for the program. Although the letter would not be nearly as effective as actually having them speak in person, it would provide an endorsement of the program throughout its life.

Congressmen and Senators can be reached by calling or writing the respective state's Public Affairs Office located at the state capital. To obtain astronauts for guest speakers, write or call:

NASA, Johnson Space Center  
Astronaut Scheduling Office  
Houston, TX 77058  
(713) 528-2802

Notice, application, and acceptance/denial for the seminar by the students, guest speakers, and panel speakers will require a central office staffed year round. Since follow-up data is sought, the student's name and address will be maintained in the data base. There will be more on the data base to follow.

After completion of the seminar, two items will be mailed to each student. First, a NEWSLETTER will be sent on a quarterly basis to keep the students interested in the aerospace program by providing at least the minimum following information.

1. Scholarship information
2. Summer jobs with NASA and DoD facilities, colleges, and universities, and aerospace firms.
3. New rankings of American colleges.

4. Job opportunities with NASA, DoD, aerospace companies, and colleges and universities.
5. Space related television programs.
6. Special space events, i.e., launches and astronomical observations.
7. Individual and team math and science competition and winners of completed competitions.
8. Other related space educational programs.

Second, a questionnaire will be sent to each student at various times through the years following their attendance to obtain relevant biographical data needed to determine the effectiveness of either this program or others attended. (SPACE CAMP also maintains contact with its past attendees by a newsletter, which provides a medium in which to obtain follow-up data.) Due to the nature of the printed material in this section, sponsorship by private companies should be possible by offering to use company logos on the newsletter and/or questionnaire.

#### **4. Supplies**

Supplies will range in importance and price from producing the film to providing pencils for student folders, but all will be necessary for successful completion of the program. Some of the supplies will need to be transported between sites, i.e., student folders, pencils, slides, while others will be located at the central office. Greater study will be required to determine all of the necessary equipment.

The largest expense will be the procurement of an IMAX quality film. Three options are available. First, utilize an existing film, there are more than 70 films in the IMAX/OMNIMAX film library. Second, combine various portions of existing films to produce the desired final product. Third, and the most expensive choice, produce a new film with AMERICA'S YOUTH in mind. From Julian Brown, Communications and Media Officer for IMAX Systems Corporation:



Film production costs are difficult to predict, but as a rough guideline, a film should be budgeted at \$100,000.00 (US funds) per finished minute. Thus a twenty-minute film would cost at least \$2 million to produce.

She also provided the following information for IMAX and two other film production companies:

Andrew Picard  
Imax Systems Corporation  
38 Isabella Street  
Toronto, Ontario, Canada, M4Y 1N1  
(416) 960-8509  
FAX (416) 960-8596

Greg MacGillivray  
MacGillivray Freeman Films  
P.O. Box 205  
South Laguna, CA 92677  
(714) 494-1055  
FAX (714) 494-2079

George Casey Graphic Films  
3341 Cahuenga Blvd.  
Hollywood, CA 90068  
(213) 851-4100  
FAX (213) 851-4103

The next major expense related to the film is the necessary motion picture equipment. Ms. Brown explained that normally, the theaters where the film is shown are already equipped with the right projector. She stated that a "road show" had never been discussed and therefore would be difficult to predict prices. She also suggested that utilizing existing, properly equipped theaters would be the least expensive method.

Numerous photograph slides will be utilized to adequately portray different portions of the program. Appendix E explains at what time during the seminar each type of slide would be utilized. A general list would include photographs of:

1. Artist renditions of and/or actual Mars mission hardware, Mars surface pictures from the Viking spacecraft, and any other pictures that might help explain the Mars Design Project.
2. Various types of engineers doing typical jobs in a normal working environment.

3. Depictions of students or professionals engaged in work exemplifying college majors and courses.
4. NASA regional centers, launch sites, and research and development facilities.
5. Department of Defense Centers
6. Private Industry (sponsor) locations in-state and around the country.

A considerable number of slides will be moved to each location as reserve, allowing the orator some flexibility in the program structure.

### **5. Data Base**

A considerable amount of data will be processed during the operation of the program. The basics are: sponsors and possible sponsors; college and university information; scholarship and funding information; job opportunities, NASA, DoD, academe, and industry points of contact; student information, guest and panel speaker information; state site information - auditorium, hotels, restaurants, convention bureau; and finally, spinoffs. Most of this information will be maintained at the central office, however, some of the data will be sent for use at each new site. Considerable manhours will be required to build the necessary data base, specifically: obtain and update scholarship availability, college and university addresses, and panel speakers from each state. Input, storage, and processing of all necessary data will require extensive computer resources. Manhours and computer resources must be considered in the overall program cost.

### **6. Student Folders**

Student folders will be provided to every student that attends the seminar. Cost for the folders will be approximately \$8/packet which includes removable sleeves and 4 dividers with printed material. Advertisement for sponsors can best be done utilizing the student folders. The contents of the folders are discussed in Appendix E and a copy can be found in Appendix D.

## **C. CONCLUSION**

To produce the seminar more research would be required in several of the areas previously described. The most important ones would include: transportation, data base, staff, orators, film production, speakers, and student interest. Of all those listed student interest is the most important. The whole program was devised with the students in mind. If it is not exciting to them then the seminar is not operating properly.

## VI. CONCLUSION

The reports are in and studies have shown over and over again that America is facing a declining science and engineering community. This thesis proposes an active method to do something about the problem. **AMERICA'S YOUTH: Our Future In Space** is not designed to fix all of the problems or offer all of the information; instead, by inspiring the students with the wonders of space it is believed they can overcome the obstacles and prepare themselves properly for a career in America's space program. Reaching out to young people with exciting information they understand will guide them towards a path of stronger academic pursuits, enhanced awareness of national space goals, and active participation in America's space exploration. The long term effects will benefit the students as well as our country. The United States needs to offer its young people a chance for adventure in space NOW!

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## **APPENDIX OUTLINE**

**Appendix A** San Diego High School Questionnaire and Answers

**Appendix B** Monterey Questionnaire

**Appendix C** Monterey/Manitou Questionnaire Answers

**Appendix D** STUDENT PACKAGE AMERICA'S YOUTH: Our Future In Space

1. Schedule (outline)
2. Student Questionnaire
3. Mars Mission Project Handout
4. College/University Choice Questionnaire
5. College/University Rankings
6. College/University Choices
7. NASA Field Centers
8. Aerospace Companies

**Appendix E** A User's Guide for AMERICA'S YOUTH: Our Future In Space

## APPENDIX A

### SAN DIEGO HIGH SCHOOL QUESTIONNAIRE AND ANSWERS

#### VISTA HIGH SCHOOL, SAN DIEGO, CA

Two science classes with a mix of sophomore, junior, and senior students were asked the following questions during separate fifty minute sessions. These are their responses.

1. How many of you are planning to go to college? 52

2. What type of job or career are you interested in after college or high school?

Answers:	Drafting	Pilot	Accountant
	Teacher	Musician	Fire Fighter
	Psychologist	Doctor	Infantry
	Architect	Pro Sports	Lawyer
	Interior Design	Fashion Design	

3. What courses in colleges would you need to take in order to get one of the jobs listed?

Answers:	Math	Engineering	Teaching
	Anatomy	Merchandizing	Business
	History	Computers	Special Arts
	Calculus	Physics	Chemistry
	Athletics	Medicine	Child Psychology

4. When you hear the word NASA, what comes to mind?

Answers:	Shuttle	Hubble Telescope	Satellites
	Launch/Design	Search for E.T.	Astronomy
	Space Sation	Voyager	Scientific Experiments
	Moon/Mars Mission		

5. National Aeronautics and Space Administration, NASA, what do they do with Aeronautics?

Answers: None of the students were aware of any work NASA did with aeronautics.

6. How does the military use space?

Answers:	Star Wars	Spy Satellites	Communication
	Nuclear Detection	Weather	



7. How do private companies use space?

Answer: They were unaware of private company use of space.

8. What would motivate students like yourselves to take a space related job?

Answer:      Good Pay                      Work Environment              Job Availability  
                  Chance to Travel              Benefits                      Variety  
                  Location\*

\*1/2 of the students were interested in working near home. The other half wished to travel to a new place.

9. What type of college degree would you need to get one of the space related jobs we have discussed?

Answers:      Chemistry                      Math                      Architecture  
                  Astronomy                      Computers                      Engineer  
                  Aeronautics                      Science Technology              Mechanical Engineer

## APPENDIX B

### MONTEREY QUESTIONNAIRE

Student Survey

5-10-91

The following questions were presented to a high school science class similar to yours, they were attending Vista High School, in San Diego. Their answers follow each question. Please read and answer for yourself each question before reading their ideas, then, see if your answers come close to any of theirs (you do not need to write anything down during this portion). Upon completing this section continue to the next entitled: "Where is Mars Anyway?". Write your answers to as many of the questions as possible. Do not worry if you cannot answer very many of the questions by yourself. There will be a class discussion with other students which will help you complete any unanswered portions. Please bring this handout to class.

#### STUDENT QUESTIONS AND ANSWERS

1.) How many of you are planning to go to college?

Ans.) Most of the students wanted to go to college.

2.) What type of job or career are you interested in after college or high school?

Ans.)	Drafting	Pilot	Accountant	Teacher
	Musician	Fire Fighter	Psychologist	Doctor
	Infantry	Architect	Pro Sports	Lawyer
	Interior Designer	Fashion Designer		

3.) What courses in college would you need to take in order to get one of the jobs listed?

Ans.)	Math	Engineering	Teaching	Anatomy
	Merchandizing	Business	History	Computers
	Special Arts	Calculus	Physics	Chemistry
	Athletics	Medicine	Child Psychology	

4.) When you hear the word NASA, what comes to mind?

Ans.)	Shuttle	Hubble Telescope	Satellites
	Launch/Design	Search for E.T.	Astronomy
	Space Station	Voyager	Scientific Experiments
	Moon/ Mars Mission		

5.) National Aeronautics and Space Administration, NASA, what do they do with Aeronautics?

Ans.) None of the students were aware of any work NASA did with aeronautics.

6.) How does the military use space?

Ans.)	Star Wars	Spy Satellites	Communication
	Nuclear Detection	Weather	

7.) How do private companies use space?

Ans.) They were unaware of any private company use of space.

8.) What would motivate students like yourselves to take a space related job?

Ans.)	Good Pay	Work Environment	Job Availability
	Chance to travel	Benefits	Variety
	Location*		

\*1/2 of the student were interested in working near home, the other half wished to travel to new places to work.

9.) What type of college degree would you need to get one of the space related jobs we have discussed?

Ans.)	Chemistry	Math	Architecture
	Astronomy	Computers	Engineer
	Aeronautics	Science Technology	Mechanical Engineer

#### WHERE IS MARS ANYWAY?

1.) Are you interested in college? \_\_\_\_\_ (Yes or No)

2.) Where would you like to go? \_\_\_\_\_.

3.) What majors or fields of study are you interested in applying for?

\_\_\_\_\_, \_\_\_\_\_.

4.) What type of job would you like after school/college? \_\_\_\_\_.

5.) Could you get a job working for NASA with your degree? \_\_\_\_\_ (Yes or No)

6.) What type of work would you do for NASA?

\_\_\_\_\_.

Now let us begin:

Because of changing conditions on Earth, your group **must** be sent to Mars to start the first colony. Together, in class, we will create and design a plan to (1) get 50 students, from your school, to Mars, (2) start a colony, and (3) survive using only what you bring and what is on the planet. This is very similar to what the Pilgrims did upon setting out for America and what the settlers did when they left the safety of their eastern homes for the possible riches on the west coast. Each one of you holds some of the knowledge that is required to successfully accomplish this task. Assume you have graduated from college with the degree of your choice and you are already working at the job you selected above, together, you can all make it to the Red Planet. Try to determine during which part, 1, 2, and/or 3, you will be of greatest help. This worksheet will step you through some of the important questions that must be answered, however, there is room to add ideas of your own.

- 7.) Would you be willing to go to Mars? \_\_\_\_\_ (Yes or No)
- 8.) If you knew you might not be able to return to Earth would you still wish to go?  
\_\_\_\_\_ (Yes or No)
- 9.) Do you think the job you listed above will help with this project? \_\_\_\_\_ (Yes or No)
- 10.) Can you think of any other jobs, other than those listed on the first page, that might be necessary? (example: Scientist) \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

**STEP ONE:** The first part will be designing the two spacecraft required to get everyone to Mars. You will be living and working inside these spacecraft, each one is about the size of two school buses put together, for the 6 months of travel required to get to Mars and then on the surface until permanent buildings are completed. Unfortunately, weight is very important, so you may not bring everything you want, only essential items.

1.A.1) What are some of the jobs you think would need to be done before leaving Earth? (example: Decide where on Mars would be the best place to establish the colony; are there enough of the right raw materials on Mars to provide water, oxygen, and food, produce buildings, and produce computer parts.)

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1.A.2) Who would be the most important people to have working on the first stage of the trip which includes initial planning on Earth until arrival at Mars? Use job descriptions or titles.

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After each assignment write down the job descriptions of as many people as you think would be necessary to complete the work. The same job may fit more than one assignment.

1.B.1) Designing the spacecraft, similar to designing a house. (example: Engineer)

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1.B.2) Providing food, water, and oxygen to breathe until food can be grown on the planet.

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1.B.3) Creating recreational activities both in the form of exercise and entertainment for the trip.

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1.B.4) Navigating the spacecraft 171 million kilometers (92.4 million miles or approximately 333 trips to the moon) at 11 km/sec (63,700 mph).

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1.C.1) There are two methods for providing food, the first is to bring frozen, packaged food for the entire trip and seeds to begin farming once on Mars, the second is to grow most of what is required on board the spacecraft. There are advantages and disadvantages to both methods. Select from either A or B below which method you think is best:

\_\_\_\_\_ A: Using frozen, packaged food requires considerably less handling area, energy, and weight and also presents a greater variety. However, it does not provide the enjoyment of freshness associated with garden grown food.

\_\_\_\_\_ B: Garden plants can be used to filter air, water, and waste and still provide fresh food. Unfortunately, this method would use up space and weight that might otherwise be used for machinery or personal items.

1.C.2) Several personal items are listed below, write down the weight in pounds of each item you would like to bring, you may also add other suggestions to the list. The total weight of all items combined cannot be more than 110 lbs (50 kg).

_____ clothes	_____ books	_____ personal hygiene supplies
_____ games	_____ photos	_____ music
_____ plants	_____	_____

**STEP TWO:** Once established in an orbit around Mars the most dangerous portion will begin. Getting all of the equipment and people safely to the surface involves numerous risks, primarily while landing the spacecraft with all of the people aboard. The next major portion will entail establishing the base which will require a great deal of spacesuit time outside the safety of the spacecraft. Something to consider once on the Martian surface, gravity is only one third as strong as on Earth. Which means, if you weigh 150 pounds on Earth while on Mars you will only weigh 50 pounds. Consider some of the problems/advantages a lower gravity would present.

2.A.1) Who would be the most important people to have working on the second stage of the trip, which, includes initial touchdown on Mars until water and oxygen production facilities are complete? Use job descriptions or titles.

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After each assignment write down the job descriptions of as many people as you think would be necessary to complete the work. The same job may fit more than one assignment.

2.B.1) Setting up food production facilities (farms). (example: Chemist)

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2.B.2) Designing and constructing permanent buildings.

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2.B.3) Providing medical treatment and advice when dealing with the effects of lower gravity.

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2.B.4) Constructing a mining operation to provide raw material for everything from cement to oxygen.

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2.B.5) Providing recreation, entertainment, and education for everyone.

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2.C.1) Rank the following in the order of which you think they should be built.

- |  |   |
|--|---|
| _____ Communication Center             | _____ Living Quarters                     |
| _____ Sleeping Quarters                | _____ Food Preparation Facility (kitchen) |
| _____ Water Production Facility        | _____ Entertainment Center                |
| _____ Food Production Facility (farms) | _____ Oxygen Production Facility          |
| _____ Exercise Center                  |   |

**STEP THREE:** After the initial construction has been completed and people have settled down to a routine and become accustomed to living in the Martian environment long term planning must begin to ensure room for families to expand.

3.A.1) Who would be the most important people to have working on the third stage of the trip, which, includes all work after creating the initial base until a permanent self-sufficient colony is established? Use job descriptions or titles.

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3.B.1) Without an atmosphere like Earth's the surface of Mars gets very cold, there is a risk of meteors hitting at any time, and dust storms can build that encompass the entire planet. All of these things combine to make the surface a difficult place to live. Construction underground is much slower than on the surface, requires considerably more energy, and is very dangerous for the workers. Should future construction be done underground to provide protection against the harsh surface environment or should time be spent creating above ground buildings that will provide a safe place to work and play? Please explain which method you prefer and why.

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3.B.2) Producing air requires complex, dangerous machinery and is very expensive, but everyone needs it to survive. Since all buildings are connected everyone shares the same air. Should each person be charged for air or should it be free? If free, how will the workers be paid for what they provide?

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3.B.3) Eventually, families will form and children will be born which will change many of the living requirements. One building for eating, one for sleeping and another one for recreation would use less construction material and would be easier to build than individual family units. Since everyone shares the same eating, sleeping, and recreation facilities fewer tunnels are required. However, there is very little privacy for anyone. Should time, material, and effort be expended to construct individual living areas for families? Explain advantages and disadvantages of your choice.

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3.B.4) It is costly and dangerous to continue expansion of the colony even for the new families of the people presently living on Mars. If the Earthling request to send more people to Mars should they be allowed to send them to your colony which might exhaust your supplies before they are regenerated or should they begin their own colonies starting the same way your group did?

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## APPENDIX C

### MONTEREY/MANITOU QUESTIONNAIRE ANSWERS

#### WHERE IS MARS ANYWAY?

1. Are you interested in college? 55

2. Where would you like to go?

Harvard	Stanford	New York University
San Diego State	U.C. Davis	U.C. Santa Barbara
U.C. Sacramento	U.C. Berkeley	Fresno State
U.S. Naval Academy	U.S. Air Force Academy	San Jose State
Spain	U.C. Los Angeles	U.C. San Diego
Otis Parsons	U. of Colorado	U. of Texas
Georgia Tech.	Long Island	U. of Southern California

3. What majors or fields of study are you interested in applying for?

English	Theater Arts	Communication	Math
Business	Biological Sciences	Physics	Medicine
Law	Engineer	Public Relations	Military
Nursing	Music	Sciences	Architect
Oceanography	Computer Science	Film Industry	Animal Care Tech.
Psychiatry	Art	Design	Physics
English	Psychology	Fine Arts	Biology
Chemistry	Athletics	Aeronautics	Dentist

4. What type of job would you like after school/college?

Directing	Civil Engineer	Science related	Doctor
Real Estate	Astrophysicist	Business Manager	Public Relations
Register Nurse	Pilot	Scientist	Engineer
Oceanography	Computer Progr.	Animal Care Tech.	Interior Design
Accountant	Art Professor	Biological Scientist	Zoologist
Piloting	Football	Architect	Lawyer
Fighter Pilot	Dentist		

5. Could you get a job working for NASA with your degree? 40-y, 28-n, 3 undecided

6. What type of work would you do for NASA?

Engineering; Astronaut; Astronaut preparation; Experiments in vacuum, low gravity; Supervise space program; Astronaut training; Scientist; Research; Programming computers; Management; Pilot; Administration; Biology, chemistry; Design shuttles.

7. Would you be willing to go to Mars? 59-y, 12-n, 2-unk
8. If you knew you might not be able to return to Earth, would you still wish to go?  
37-y, 31-n, 3-unk
9. Do you think the job you listed above will help with this project? 45-y, 20-n, 1-unk
10. Can you think of any other jobs, other than those listed in the first page, that might be necessary? (example: Scientist)

Farmer	Ecologist	Economist	Zoologist
Meteorologist	Engineer	Geologist	Computer Scientist
Priest	Envir. Science	Microbiologist	Astronomer
Navy SEALs*	Architect	Cook	Pilot
Biologist	Scientist	Commander	Nutritionist
Athlete	Agriculture	Breeding	Doctor
Physicist	Athletics	Construction	Chemical Eng.
Environmentalist	Business	Religion	Chemist
Interior Design	Nuclear Personnel	Solar Engineer	Botanist
Leader	Landscaper	Mechanic	Comm. Spec.
Cook	Recreation Mgr.	Electrical Eng.	Mechanical Eng.

\*For security, reconnaissance, and general protection.

### STEP ONE

- 1.A.1 What are some of the jobs you think would need to be done before leaving Earth? (example: Decide where on Mars would be the best place to establish the colony; are there enough of the right raw materials on Mars to provide water, oxygen, and food, produce buildings, and produce computer parts.)
  1. Meteorologist, rock and mineral specialist, land, food, medicine, cleanliness, games exercises.
  2. Satellite communication to keep track of all events
  3. Calculate weather conditions; what type of energy supply; where to land, food, water; clean environment; activities, games.
  4. Before starting, a 2-3 manned spacecraft must be sent to calculate the above questions accurately, so that the life of the 50 colonists is not wasted.
  5. Astronomers to decide if Mars is capable of sustaining life. Doctors to determine which of the applicants is in the best physical condition.
  6. Research about the other living organisms that may be on Mars. Research about the atmosphere and possible effects.

7. How much can we afford to bring on the spacecraft. Could we send replenishments on separate missions. Test people to make sure than can held a confined, crowded area for 6 months.
  8. Setting some rules, deciding on what the first things they are going to do when they land.
  9. Research a place to build, material that is need to be brought along. Training on how to work things, packing, practice liftoffs, designing buildings.
- 1.A.2 Who would be the most important people to have working on the first stage of the trip which includes initial planning on Earth until arrival at Mars? Use job description titles.

Engineer	Geologist	Builders	Designers
Leader	Doctors	Biologist	Pilot
Physicist	Scientist	Mars experts	Computer Specialist
Architect	Communication	Astronomer	Nutritionist
Astronauts	Aeronautical Eng.	Planners	Navigator
Mechanic	Space Engineers	Psychologist	Interior Designers
Biochemist	Landscaper	Farmers	Construction Worker
Government	Recreation person	Cook	Electrical Eng.

People to establish rules and purposes of going.

After each assignment, write down the job descriptions of as many people as you think would be necessary to complete the work. The same job may fit more than one assignment.

1.B.1 Designing the spacecraft, similar to designing a house. (example: Engineer)

Builders	Architects	Carpenters	Plumber
Interior Decorator	Engineer	NASA Shuttle Designers	
Interior Designers	Jet Propulsion Eng.	Structural Architect	Physicist
Aeronautical Eng.	Test Crew	Psychologist	Space Eng.
Supplier	Designer	Mars Specialist	Drafter

1.B.2 Providing food, water, and oxygen to breathe until food can be grown on the planet.

Biochemist	Farmer	Nutritionist	Cook
Scientist	Physicist	Geologist	Biologist
Statisticians	Health Experts	Microbiologist	Gardener
Chemist	Dietician	Agriculturalist	Governments
Doctor	Replenishment Ship	Botanist	Engineer

1.B.3 Creating recreational activities both in the form of exercise and entertainment for the trip.

Sports Director	Musician	Artist	Computer Scientist
Pro Sports	Athlete	Social Director	Architect
Actor	Comedian	Athletic Director	Priest
Physical Education	Medicine	Planners	Doctor
Drill Instructor	Gymnast	Computer Games	

1.B.4 Navigating the spacecraft 171 million kilometers (92.4 million miles or approximately 33 trips to the moon) at 11 km/sec (63,700 mph).

Astronaut	Pilots	Navigator	Astronomer
Scientist	Computer Operators	Physicist	Engineer
Aircraft Eng.	Mission Specialist	Computer Engineer	

1.C.1 There are two methods for providing food. The first is to bring frozen, packaged food for the entire trip and seeds to begin farming once on Mars, the second is to grow most of what is required on board the spacecraft. There are advantages and disadvantages to both methods. Select from either A or B below which method you think is best:

Frozen Food: 43

Fresh Food: 27

A. Using frozen, package food requires considerably less handling area, energy, and weight and also presents a greater variety. However, it does not provide the enjoyment of freshness associated with garden grown food.

B. Garden plants can be used to filter air, water, and waste and still provide fresh food. Unfortunately, this method would use up space and weight that might otherwise be used for machinery or personal items.

1.C.2 Several personal items are listed below. Write down the weight in pounds of each item you would like to bring. You may also add other suggestions to the list. The total weight of all items combined cannot be more than 110 lbs. (50 kg).

**Minimum - Average - Maximum**

clothes	books	games	photos	music	plants	misc.*	pers. hygiene
10-42-70	0-15-47	0-13-30	0-5-20	0-5-18	0-12-50	0-8-40	0-3-30

\*Candy, Rechargeable batteries, Videos on laser disk (10 lbs), Pets

## STEP TWO:

- 2.A.1. Who would be the most important people to have working on the second stage of the trip, which, includes initial touchdown on Mars until water and oxygen production facilities are complete? Use job descriptions or titles.

Botanist	Farmer	Engineer	Geologist
Miners	Chemist	Architect	Biologist
Scientist	Astronaut	Drafter	Doctor
Biochemist	Pilot	Navigator	Agriculturalist
Construction Crew	Zoologist	Architect	Cryogenics
Recreation Director			

Experienced astronauts who have worked in spacesuits and trained for exactly what they have to do before leaving earth.

- 2.B.1 Setting up food production facilities (farms). (Example: Chemist)

Farmer	Botanist	Zoologist	Vet
Hydroponics Spec.	Scientist	Nutritionist	Agriculturalist
Pharmacist	Chemist	Biochemist	Biologist
Geologist	Laborer	Meteorologist	Engineer
Chemical Eng.	Exterior Design	Electrical Eng.	Builder

- 2.B.2 Designing and constructing permanent buildings.

Drafter	Architect	Plumber	Carpenter
Interior Design	Electrical Eng.	Developer	Envir. Scientist
Engineer	Electrician	Meteorologist	Mathematician
Physiologist	Builder	Civil Engineer	

- 2.B.3 Providing medical treatment and advice when dealing with the effects of lower gravity.

Physicist	Scientist	Doctor	Psychologist
Vet	Pharmacist	Musician	Nurses
Chemist	Biologist		

- 2.B.4 Construction a mining operation to provide raw material for everything from cement to oxygen.

Miners	Engineer	Chemist	Scientist
Geologist	Architect	Mining Eng.	Civil Engineer

- 2.B.5 Providing recreation, entertainment, and education for everyone.

Teacher	Parks	Musician	Architect
Films	Artist	Comedian	Athlete
Recreation Director			

- 2.C.1 Rank the following in the order of which you think they should be built. (See Table C.1)

**Table C.1 STUDENT RANKING OF FACILITY CONSTRUCTION ORDER**

Order in which the students felt the facility should be built.  
(Numbers below indicate total students selecting a particular order.)

	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Commun. Center	7	5	6	13	14	12	12	1	1
Living Quarters	4	5	2	10	13	19	15	1	0
Sleeping Quarters	1	2	3	11	15	14	21	2	1
Food Prep. Facility	0	1	1	14	13	22	14	4	0
Water Prod. Facility	4	39	24	4	1	2	0	0	0
Entertainment Center	0	0	0	1	2	0	11	20	44
Food Prod. Facility	6	11	35	12	9	1	1	1	0
Oxygen Prod. Facility	52	11	3	5	1	0	1	0	0
Exercise Center	0	0	0	1	2	2	2	39	23

### STEP THREE:

3.A.1 Who would be the most important people to have working on the third stage of the trip which includes all work after creating the initial base until a permanent self-sufficient colony is established? Use job descriptions or titles.

Unselfish politicians	Telecommunication specialist	Chemist
Meteorologist	Engineer	Agriculturalist
Community Planner	Teacher	Nurses
Architect	Mathematician	Biologist
Psychologist	Planner	Lawyer
Athletes	Musician	Builder
Farmer	Politician	Civil Engineer
		Constr. Crew

3.B.1 Without an atmosphere like Earth's, the surface of Mars gets very cold. There is a risk of meteors hitting at any time, and dust storms can build that encompass the entire planet. All of these things combine to make the surface a difficult place to live. Construction underground is much slower than on the surface, requires considerably more energy, and is very dangerous for the workers. Should future construction be done underground to provide protection against the harsh surface environment or should time be spent creating above ground buildings that will provide a safe place to work and play? Please explain which method you prefer and why.

Underground: 40

Surface: 22

1. On surface. The disadvantages of below surface construction are more than on surface. Not only construction, but artificial light uses energy.
2. No, because we can live in shielded buildings with heating and glass windows.
3. Living quarters, food preparation, all survival facilities, and air production underground; farming on the surface.
4. Underground buildings are better since the Martian surface is much different. The life facilities should be safe. The further research can be done later.
5. Should be partially underground as this would provide a secure and permanent base for rebuilding after an accident and for expansion. This could be accomplished by colonizing mines that have been used up.
6. Above ground. The buildings can be insulated from the cold and built strong enough to withstand dust storms. The chance of a meteor hitting the buildings is infinitesimally small. It is easier to build above ground and you would have a better view.

3.B.2 Producing air requires complex, dangerous machinery and is very expensive, but everyone needs it to survive. Since all buildings are connected, everyone shares the same air. Should each person be charged for air or should it be free? If free, how will the workers be paid for what they provide?

Money: 40

No Money: 28



1. It should be free. The workers should not expect pay because everybody will be involved in providing one necessity or another in the beginning stages.
2. Free air, because everyone uses the same amount and it is part of a communal effort
3. It should be with a reasonable price so that less waste is produced and some financial problems are solved.
4. It should be paid for as a water or electrical utility is paid for.
5. No, I think that it should be the ideal communist environment. Everyone should share everything. One person should not have more of anything than another. If the Mars people did not return to Earth, there would be no reason for money since it is something that they would not need on Mars.
6. Plants make air for free.

3.B.3 Eventually, families will form and children will be born, which will change many of the living requirements. One building for eating, one for sleeping and another one for recreation would use less construction material and would be easier to build than individual family units. Since everyone shares the same eating, sleeping, and recreation facilities fewer tunnels are required. However, there is very little privacy for anyone. Should time, material, and effort be expended to construct individual living areas for families? Explain advantages and disadvantage of your choice.

Single Family Units: 38

Communal Units: 28

1. Yes. If you had one large building for each, that would eventually have to be enlarged because of population increase anyway. If you had separate areas, you could add more for new families.
2. Yes, there should be individual living areas for families. There would be a substantial amount of extra privacy and there would actually be a chance for these colonist to live a somewhat normal life.
3. Yes, because this is important for human psychology. It will need more research and more money but for long term, this should also be thought.

3.B.4 It is costly and dangerous to continue expansion of the colony, even for the new families of the people presently living on Mars. If the Earthlings request to send more people to Mars, should they be allowed to send them to your colony which might exhaust your supplies before they are regenerated, or should they begin their own colonies starting the same way your group did?

Join Group: 35

Start Separately: 31

1. Everyone should be in the same colony. This would put the two forces together and they would have a better chance at thriving. The new group of colonists should bring enough new materials to provide for them, and more to help the existing colony.

2. These people should come to the original colony. The extra people would help construct the extra needed facilities. The destiny of the human race is to unite, not divide.
4. Remain self-sufficient for awhile nearby, then connect to the other colony.
5. A few sent to your colony to learn how it works and then sent to build a new colony.

**APPENDIX D**

**STUDENT  
PACKAGE**

**AMERICA'S YOUTH:  
Our Future In Space**

## SCHEDULE

8:00 a.m.	National Anthem (SPECTRAFILM)	
8:10 a.m.	Guest Speaker	(Name)
8:40 a.m.	SPECTRAFILM	(Name)
9:30 a.m.	Explanation of Day	
9:45 a.m.	Break	
9:55 a.m.	How Much Do You Already Know?	
11:15 a.m.	Break	
11:25 a.m.	Design Project I (Groups)	
12:00 a.m.	Lunch	
12:45 p.m.	Design Project II (Assembly)	
14:00 p.m.	Break	
14:10 p.m.	College/University Information	
15:00 p.m.	Break	
15:10 p.m.	Careers in Aerospace	
16:00 p.m.	Break – Snack	
16:10 p.m.	Panel of Experts (Question & Answer Period)	
17:30 p.m.	New Teachers	
17:45 p.m.	Completion	

## STUDENT QUESTIONNAIRE

1. Are you planning to go to college? (Yes or No)

2. Where would you like to go to college?

\_\_\_\_\_

3. What type of job or career are you interested in after college or high school?

\_\_\_\_\_

4. What type of major or degree would you need to get a space related job?

\_\_\_\_\_

5. What courses in college would you need to take to get one of the jobs listed above?

\_\_\_\_\_

6. When you hear the word NASA, what comes to mind?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

7. What does NASA do with Aeronautics?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

8. How does the military use space?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

9. How do private companies use space?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## INSTRUCTIONS

Please write your answers to as many of the questions as possible. Do not worry if you cannot complete all of the questions by yourself. There will be a group discussion to explain in greater detail the entire handout and to answer any questions you might have. Please leave this first page at the door when you leave.

### WHERE IS MARS ANYWAY?

- 1.) Are you interested in college? (Yes or No)
- 2.) Where would you like to go? \_\_\_\_\_, \_\_\_\_\_
- 3.) What majors or fields of study are you interested in apply for?  
\_\_\_\_\_
- 4.) What type of job would you like after school/college? \_\_\_\_\_
- 5.) Could you get a job working for NASA with your degree? (Yes or No)
- 6.) What type of work would you do for NASA? \_\_\_\_\_

#### Now let us begin:

The Earth is rapidly becoming overcrowded and more and more people are getting the desire to find a new place to get away, start fresh, and/or do something adventurous. Therefore, you and a group of 50 people will be sent to Mars to do experimental work on starting the first colony. The survival of other explorers depends upon your success. Already, in your small groups, you have begun to brainstorm the essential ideas necessary to safely carry out this task. Together, we will discuss the important questions needed to (1) get everyone from Earth to Mars, (2) start a colony, and (3) survive and prosper using only what you bring and what is on the planet. This scenario is very similar to what the Pilgrims did upon setting out for America, and many years later when American settlers left the safety of their eastern homes for the possible riches of the west coast. Each one of you holds some of the knowledge that is required to successfully accomplish this task. To help with the discussion, assume you have already graduated from the first college you listed on the "STUDENT QUESTIONNAIRE," and have been working at your first job or career choice. Together, we will make it to the Red Planet.

- 7.) Would you be willing to go to Mars? (Yes or No)
- 8.) If you knew you might not be able to return to Earth, would you still wish to go? (Yes or No)
- 9.) With your job listed above would you be selected to work on the Mars Mission Project? (Yes or No)

---

## STEP ONE:

### EARTH TO MARS

Things to consider: 25 people in a spacecraft about the size of ten school buses.  
Living and working inside the spacecraft for at least 6 months.  
Zero gravity environment, everyone and everything will be free floating.  
Weight is very important, bring only essential or valuable items.

1.A.1.) What decisions must be made even before you leave Earth? (example: What type of plants/animals to bring; where to land the spacecraft.)

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1.A.2.) Would you prefer nuclear power or solar power? Nuclear power provides considerable more energy than does solar power; a great deal of energy will be required to begin construction once you are on Mars. Solar power requires less space and weight is less dangerous. Select A or B below and tell why you prefer one and not the other.

A.) Nuclear: \_\_\_\_\_

---

B.) Solar: \_\_\_\_\_

---

After each job assignment below, write down the job descriptions of as many people you think would be necessary to complete the work. The same job may fit more than one assignment.

1.B.1.) Designing the spacecraft, similar to designing a house. (example: Engineer)

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---

1.B.2.) Providing food, water, and oxygen to breathe until construction is completed on the planet. \_\_\_\_\_

---

1.B.3.) Creating recreational activities both in the form of exercise and entertainment for the trip. \_\_\_\_\_

---

---

1.B.4.) Navigating the spacecraft 171 million kilometers (92.4 million miles or approximately 333 trips to the moon) at 11 km/sec (63,700 mph).

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1.C.1.) There are two methods for providing food. The first is to bring frozen, packaged food for the entire trip, and seeds to begin farming once on Mars; the second is to grow most of what is required on board the spacecraft. Select from A or B the method which you prefer.

\_\_\_A: Using frozen, packaged food requires considerably less handling area, energy, and weight and also presents a greater variety. However, it does not provide the enjoyment of freshness associated with garden grown food.

\_\_\_B: Garden plants can be used to filter air, water, and waste and still provide fresh food. Unfortunately, this method would use up space and weight that might otherwise be used for machinery or personal items.

1.C.2.) Several personal items are listed below, write down the weight in pounds of each item you would like to bring; you may also add other suggestions to the list. The total weight of all items combined cannot be more than 110 lbs. (50 kg). (example: one full laundry basket weighs 20 lbs., 10 medium size books weigh 12 lbs.)

- |             |            |                               |
|-------------|------------|-------------------------------|
| ___ clothes | ___ books  | ___ personal hygiene supplies |
| ___ games   | ___ photos | ___ music                     |
| ___ plants  | ___ misc.  | ___                           |

---

## STEP TWO:

### First Year on Mars

Things to consider: Mars has 1/2 the diameter of Earth and only 1/3 the gravity.  
150 pounds on Earth will feel like 50 pounds on Mars.  
There is not enough oxygen in the air to breath, and the temperature is usually below freezing, so all outside activity will require spacesuits.  
Supplies will be getting low after landing.  
The soil is rich with minerals and there is ice at the poles.

2.A.1.) Rank the following in the order of which you think they should be built.

- |                                      |   |
|--------------------------------------|---|
| ___ Communication Center             | ___ Living Quarters                     |
| ___ Sleeping Quarters                | ___ Food Preparation Facility (kitchen) |
| ___ Water Production Facility        | ___ Entertainment Center                |
| ___ Exercise Center                  | ___ Oxygen Production Facility          |
| ___ Food Production Facility (farms) |   |



After each assignment write down the job descriptions of as many people as you think would be necessary to complete the work. The same job may fit more than one assignment.

2.B.1.) Setting up food production facilities (farms). (example: Chemist)

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2.B.2.) Designing and constructing permanent buildings.

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2.B.3.) Providing medical treatment, advice and counseling. (example: Musician to keep people calm.)

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### STEP THREE:

#### After the First Year on Mars

Things to consider: Food, water, and oxygen production facilities are now working.  
You must establish a long term plan for expansion.  
What type of government will be created?  
How much control will Earth have in your affairs?

3.A.1.) Without an atmosphere like Earth's the surface of Mars gets very cold, receives a great deal of harmful radiation from space, and runs the risk of being hit by meteors. Dust storms can build until they encompass the entire planet. Construction underground is much slower than on the surface, requires considerable more energy, and is very dangerous for the workers, but provides greater protection from the harsh surface conditions. Should future construction be done underground to provide protection against the harsh surface environment or should time be spent designing and building above ground to provide a safe place to work and play? Please explain which method you prefer and why.

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---

3.A.2.) Should you have money to buy things such as food, air, water, and entertainment (new clothes, movies): Or, should everyone receive all of these items free? Without money, if a job is more dangerous than other jobs, why should the workers take the risk? Please write down which you prefer; money or no money, and any problems or solutions you might have.

---

---

---

3.A.3.) After families have formed and your numbers begin to increase, should private dwellings be constructed for each family; or should there be one building for eating, one for recreation, and one for sleeping? Less time and material would be required for single purpose buildings, but there would be very little privacy. Explain advantages and disadvantages of your choice.

---

---

---

3.A.4.) It is costly and dangerous to continue expansion of the colony even for the new families of the people presently living on Mars. Food, air, and water production can just barely meet your needs now. If the Earthlings request to send more people to Mars, should they be allowed to join your group, or should they begin their own colonies starting the same way your group did?

---

---

---

3.B.1.) Do you think the job you listed at the beginning will help with this project now? (Yes or No)

## COLLEGE/UNIVERSITY CHOICE QUESTIONNAIRE

1. What majors or degrees am I most interested in obtaining? (Write down at least three.) \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_.

2. Where can I go to get good information about different colleges and universities?

(Place an X in the Box after each has been complete.)

- |   |   |                                    |
|---|---|------------------------------------|
| <input type="checkbox"/> Counselor          | <input type="checkbox"/> Parents                              | <input type="checkbox"/> Teachers  |
| <input type="checkbox"/> Professional       | <input type="checkbox"/> Library                              | <input type="checkbox"/> Magazines |
| <input type="checkbox"/> College/University | <input type="checkbox"/> Professional Organizations/Societies |                                    |

3. Which are the best schools available that offer the degrees I am interested in acquiring?

(List at least three. And, do not let monetary problems restrict early choices.)

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

4. Where would I like to go to college?

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

5. How much and from where is financial aid available for each choice? (Some scholarships can be used at almost any college/university.)

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

FINAL COLLEGE/UNIVERSITY CHOICES

Name \_\_\_\_\_  
Location/address \_\_\_\_\_  
Tuition/Cost \_\_\_\_\_  
Degrees Offered \_\_\_\_\_  
Ranking \_\_\_\_\_  
Sources of Information \_\_\_\_\_  
Scholarships \_\_\_\_\_  
Advantages \_\_\_\_\_  
Disadvantages \_\_\_\_\_

Name \_\_\_\_\_  
Location/address \_\_\_\_\_  
Tuition/Cost \_\_\_\_\_  
Degrees Offered \_\_\_\_\_  
Ranking \_\_\_\_\_  
Sources of Information \_\_\_\_\_  
Scholarships \_\_\_\_\_  
Advantages \_\_\_\_\_  
Disadvantages \_\_\_\_\_

Name \_\_\_\_\_  
Location/address \_\_\_\_\_  
Tuition/Cost \_\_\_\_\_  
Degrees Offered \_\_\_\_\_  
Ranking \_\_\_\_\_  
Sources of Information \_\_\_\_\_  
Scholarships \_\_\_\_\_  
Advantages \_\_\_\_\_  
Disadvantages \_\_\_\_\_

Name \_\_\_\_\_  
Location/address \_\_\_\_\_  
Tuition/Cost \_\_\_\_\_  
Degrees Offered \_\_\_\_\_  
Ranking \_\_\_\_\_  
Sources of Information \_\_\_\_\_  
Scholarships \_\_\_\_\_  
Advantages \_\_\_\_\_  
Disadvantages \_\_\_\_\_

Name \_\_\_\_\_  
Location/address \_\_\_\_\_  
Tuition/Cost \_\_\_\_\_  
Degrees Offered \_\_\_\_\_  
Ranking \_\_\_\_\_  
Sources of Information \_\_\_\_\_  
Scholarships \_\_\_\_\_  
Advantages \_\_\_\_\_  
Disadvantages \_\_\_\_\_

## College/University Rankings

BEST ENGINEERING SCHOOLS											
	REPUTATION	RESEARCH ACTIVITY	RESEARCH DOLLARS	RESEARCH PER FACULTY	RESEARCH PER STUDENT	RESEARCH PER FULL-TIME FACULTY	RESEARCH PER FULL-TIME STUDENT	RESEARCH PER FULL-TIME FACULTY STUDENT	RESEARCH PER FULL-TIME FACULTY STUDENT	RESEARCH PER FULL-TIME FACULTY STUDENT	RESEARCH PER FULL-TIME FACULTY STUDENT
1 Massachusetts Institute of Technology	100.0	1	1	11	3	2	2,228	3.7/1	27.7	84.7	
2 Stanford University, Calif.	96.7	2	4	30	1	1	2,452	4.4/1	43.2	66.6	
3 University of Illinois @ Urbana	83.7	4	6	44	4	3	2,072	2.9/1	30.1	76.3	
4 California Institute of Technology	78.3	5	5	7	9	14	464	4.3/1	16.2	23.0	
5 University of California @ Berkeley	77.4	3	7	19	11	4	1,443	2.5/1	27.5	46.0	
6 University of Michigan	77.2	6	8	21	10	5	1,085	2.3/1	37.7	50.6	
7 Cornell University	76.8	7	9	23	12	6	1,262	2.2/1	19.4	33.0	
8 University of Wisconsin @ Madison	75.2	8	10	25	13	7	1,175	2.1/1	23.0	37.2	
9 University of Texas @ Austin	74.8	9	11	27	14	8	1,093	2.0/1	30.5	39.7	
10 Purdue University, Ind.	67.9	10	12	29	15	9	1,062	1.9/1	45.9	33.5	
11 Texas A&M University	67.0	11	13	31	16	10	1,833	1.7/1	52.9	45.1	
12 Rensselaer Polytechnic University, N.Y.	66.2	12	14	33	17	11	1,026	2.2/1	51.2	27.0	
13 Georgia Institute of Technology	65.2	13	15	35	18	12	1,673	2.2/1	53.5	29.2	
14 University of Wisconsin @ Madison	65.2	14	16	37	19	13	1,093	2.4/1	39.6	35.4	
15 University of California @ Los Angeles	64.0	15	17	39	20	14	1,001	4.0/1	36.0	28.1	
16 University of California @ Berkeley	63.3	16	18	41	21	15	1,062	3.0/1	26.1	21.8	
17 Pennsylvania State University	61.5	17	19	43	22	16	1,507	1.5/1	24.4	44.0	
18 Northwestern University	61.2	18	20	45	23	17	722	3.0/1	23.3	14.5	
19 Ohio State University	60.7	19	21	47	24	18	1,007	1.4/1	24.1	37.2	
20 Columbia University, N.Y.	59.0	20	22	49	25	19	894	3.1/1	57.8	22.7	
21 Virginia Polytechnic Institute	57.6	21	23	51	26	20	1,200	1.5/1	41.2	27.3	
22 Rice University, Tex.	57.2	22	24	53	27	21	348	3.0/1	17.4	10.2	
23 University of Maryland	55.7	23	25	55	28	22	1,301	2.0/1	34.1	21.3	
24 University of Washington	55.7	24	26	57	29	23	1,451	2.4/1	44.1	24.6	

How to read the table: Numbers that appear in the attribute columns represent a school's ranking for that criterion relative to all schools in the same discipline. Schools having the same number were tied in the rankings for that particular attribute. Acceptance rates are for the M.S. and Ph.D. students who entered last fall. Research dollars represents funding from outside sources obtained during the 1988-89 school year. Ratio of full-time Ph.D. students to full-time faculty is for the current school year. Total enrollment is fall, 1988, full- and part-time M.S. and Ph.D. students.

Source: U.S. News & World Report

BEST ENGINEERING SCHOOLS BY DEPARTMENT		
<b>AEROSPACE</b> 1 Massachusetts Institute of Technology 2 California Institute of Technology 3 Stanford University, California 4 Purdue University, Indiana 5 University of Michigan	<b>COMPUTER</b> 1 Massachusetts Institute of Technology 2 Stanford University, California 3 University of Illinois @ Urbana 4 University of California @ Berkeley 5 Carnegie Mellon University, Pennsylvania	<b>MATERIALS &amp; METALLURGICAL</b> 1 Massachusetts Institute of Technology 2 University of Illinois @ Urbana 3 University of California @ Berkeley 4 Stanford University, California 5 Northwestern University, Illinois
<b>BIO-MEDICAL</b> 1 Massachusetts Institute of Technology 2 Stanford University, California 3 University of California @ Berkeley 4 University of Michigan 5 University of Wisconsin @ Madison	<b>ELECTRO-ELECTRONIC</b> 1 Massachusetts Institute of Technology 2 Stanford University, California 3 University of Illinois @ Urbana 4 University of California @ Berkeley 5 University of Michigan	<b>MECHANICAL</b> 1 Massachusetts Institute of Technology 2 Stanford University, California 3 University of California @ Berkeley 4 University of Illinois @ Urbana 5 Purdue University, Indiana
<b>CHEMICAL</b> 1 Massachusetts Institute of Technology 2 University of California @ Berkeley 3 University of Minnesota 4 University of Illinois @ Urbana 5 University of Wisconsin @ Madison	<b>ENVIRONMENTAL</b> 1 Stanford University, California 2 University of California @ Berkeley 3 University of Illinois @ Urbana 4 University of Michigan 5 University of Texas @ Austin	<b>NUCLEAR</b> 1 Massachusetts Institute of Technology 2 University of Michigan 3 University of California @ Berkeley 4 University of Illinois @ Urbana 5 Texas A&M University
<b>CIVIL</b> 1 Massachusetts Institute of Technology 2 Stanford University, California 3 University of California @ Berkeley 4 University of Michigan 5 University of Wisconsin @ Madison	<b>INDUSTRIAL</b> 1 Massachusetts Institute of Technology 2 Stanford University, California 3 University of California @ Berkeley 4 University of Illinois @ Urbana 5 University of Michigan	<b>PETROLEUM</b> 1 University of Texas @ Austin 2 Texas A&M University 3 Stanford University, California 4 Louisiana State University 5 University of Oklahoma

Source: U.S. News & World Report

Note: See U.S. News & World Report, October 15, 1990 for several articles on "America's Best Colleges" [Ref 27:pg. 19].

## COLLEGE/UNIVERSITY CHOICES

Key to Degrees: A = Associate B = Bachelor's M = Master' D = Doctorate W = Work Beyond Doctorate

=====  
**AEROSPACE/  
 AERONAUTICAL/  
 ASTRONAUTICAL  
 ENGINEERING**  
 =====

### ALABAMA

Auburn University: B,M,D  
 Auburn, AL 36849  
 (205) 826-4000

Community College of the Air  
 Force: A  
 Maxwell Air Force Base, AL  
 36112  
 (205) 727-8011

Tuskegee University; B  
 Tuskegee, AL 36088  
 (205) 727-8011

University of Alabama in  
 Huntsville: B,M,D  
 Huntsville, AL 35899  
 (205) 895-6120

University of Alabama:  
 B,M,D,  
 Tuscaloosa, AL 354001  
 (205) 348-6010

### ARIZONA

Arizona State University;  
 B,M,D  
 Tempe, AZ 86301  
 (602) 965-3255

Embry-Riddle Aeronautical  
 University:  
 Prescott Campus; B  
 Prescott, AZ 86301  
 (602) 778-4130

University of Arizona; B,M,D  
 Tucson, AZ 85721  
 (602) 621-3237

### CALIFORNIA

Azusa Pacific University; B  
 Azusa, CA 91702  
 (818) 969-3434

California Institute of  
 Technology; B,M,D,W  
 Pasadena, CA 91125  
 (818) 356-6811

California Polytechnic State  
 University: San Luis Obispo: B  
 San Luis Obispo, CA 93407  
 (805) 546-0111

California State Polytechnic  
 University: Pomona; B  
 Pomona, CA 91768

Merced College  
 Merced, CA 95348  
 (209) 384-6000

Northrop University; B,M  
 Los Angeles, CA 90045  
 (213) 337-4413

San Bernardino Valley College;  
 A  
 San Bernardino, CA 92410  
 (714) 888-6511

San Diego State University;  
 B,M  
 San Diego, CA 92182  
 (619) 594-5200

San Jose State University; B  
 San Jose, CA 95192  
 (408) 924-1000

Southwestern College; A  
 Chula Vista, CA 92010  
 (619) 421-6700

Stanford University; M,D  
 Stanford, CA 94305  
 (415) 723-2300

University of California Davis;  
 B,M  
 Davis, CA 95616  
 (916) 752-1011

Los Angeles; B,M,D  
 Los Angeles, CA 90024  
 (213) 825-4321

University of Southern  
 California; B,M,D  
 Los Angeles, CA 90089  
 (213)743-2311

West Coast University; M  
 440 Shatto Place  
 Los Angeles, CA 90020  
 (213) 487-4433

### COLORADO

United States Air Force  
 Academy; B  
 Colorado, Springs, CO 80840  
 (303) 472-1818

University of Colorado at  
 Boulder; B,M,D  
 Boulder, CO 80309  
 (303) 492-0111

### CONNECTICUT

University of Connecticut;  
 M,D  
 Storrs, CT 06269  
 (203) 486-2000

### DISTRICT OF COLUMBIA

George Washington  
 University; M,D  
 Washington, D.C. 20052  
 (202) 994-1000

### FLORIDA

Embry-Riddle Aeronautical  
 University; B,M  
 Daytona Beach, FL 32014  
 (904) 239-6000

Florida Institute of  
 Technology; B  
 Melbourne, FL 32901  
 (407) 768-8000

University of Central Florida;  
 B  
 Orlando, FL 32816  
 (407) 275-2000

University of Florida; B,M,D  
Gainesville, FL 32611  
(904) 392-3261

#### GEORGIA

Georgia Institute of  
Technology; B,M,D  
Atlanta, GA 30332  
(404) 894-4154

Mercer University; B  
Macon, GA 31207  
(912) 744-2700

Middle Georgia College; A  
Cochran, GA 31014

#### ILLINOIS

Illinois Institute of  
Technology; B  
3300 South Federal Street  
Chicago, IL 60616  
(312) 567-3025

Parks College of St. Louis  
University; B  
Cahokia, IL 62206  
(618) 337-7500

Richland Community College;  
A  
100 North Water Street  
Decatur IL 62523

University of Illinois at  
Urbana-Champaign; B,M,D  
Urbana, IL 61801  
(217) 333-1000

#### INDIANA

Purdue University; B,M,D,W  
West Lafayette, IN 47907  
(317) 494-1776

St. Joseph's College; B  
Rensselaer, IN 47978  
(219) 866-7111

Tri-State University; B  
Angola, IN 46703  
(219) 665-3141

University of Notre Dame;  
B,M,D  
Notre Dame, IN 46556  
(219) 239-5000

#### IOWA

Iowa State University of  
Science and Technology;  
B,M,D  
Ames, IA 50011  
(515) 294-5836

#### KANSAS

Coffeyville Community  
College; A  
11th and Willow  
Coffeyville, KS 67337  
(316) 251-7700

University of Kansas; B,M,D  
Lawrence, KS 66043  
(913) 864-3911

Wichita State University; B,M  
Wichita, KS 67208  
(316) 689-3085

#### MARYLAND

Howard Community  
College; A  
Little Patuxent Parkway  
Columbia, MD 21044

United States Naval  
Academy; B  
Annapolis, MD 21402  
(301) 267-6100

University of Maryland  
Baltimore County; M,D  
5401 Wilkens Avenue  
Catonsville, MD 21228  
(301) 455-2291

College Park; B,M,D  
College Park, MD 20742  
(301) 454-5550

#### MASSACHUSETTS

Boston University; B,M  
Commonwealth Avenue  
Boston, MA 02215  
(617) 353-2000

Eastern Nazarene College; B  
Wollaston Park  
Quincy, MA 0270  
(617) 773-6350

Massachusetts Institute of  
Technology; B,M,D,W  
Cambridge, MA 02139  
(617) 253-4791

Northeastern University; B  
Boston, MA 02115  
(617) 437-2200

Simmons College; B  
300 The Fenway  
Boston, MA 02115  
(617) 738-2000

Stonehill College; B  
North Easton, MA 02356  
(617) 238-1081

Worcester Polytechnic  
Institute; B  
Worcester, MA 01609  
(508) 831-5000

#### MICHIGAN

University of Michigan;  
B,M,D  
Ann Arbor, MI 48019  
(313) 764-7433

Western Michigan  
University; B  
Kalamazoo, MI 49009  
(616) 383-1950

#### MINNESOTA

University of Minnesota;  
Twin Cities; B,M,D  
Minneapolis, MN 55455  
(612) 373-2144

#### MISSISSIPPI

Mississippi State University;  
B,M  
Mississippi State, MS 39762  
(601) 325-2224

#### MISSOURI

St Louis University; B,M,D  
221 North Grand Blvd.  
St. Louis, MO 63103  
(314) 658-2500

University of Missouri;  
Columbia; B,M,D  
Columbia, MO 65201  
(314) 882-2121

Rolla; B,M,D  
Rolla, MO 65401  
(314) 341-4164

#### NEW JERSEY

Princeton University, B,M,D  
Princeton, NJ 08544  
(609) 452-3060

Rutgers-The State University  
of New Jersey; New Brunswick  
Graduate Campus; M,D  
New Brunswick, NJ 08903  
(201) 932-3770

#### NEW YORK

City University of New York:  
City College; B  
Covenant Avenue &  
West 138 Street  
New York, NY 10031  
(212) 690-6977

Columbia University, School  
of Engineering and Applied  
Science, M,D,W  
Broadway & West 116 Street  
New York, NY 10027  
(212) 280-2521

Cornell University; M,D  
Ithaca, NY 48103  
(607) 256-1000

Dowling College; B  
Oakdale, NY 11769  
(516) 589-6100

New York Institute of  
Technology; B  
Old Westbury, NY 11568

Polytechnic University;  
Brooklyn; B,M,D  
333 Jay Street  
Brooklyn, NY 11201  
(212) 643-2150

Long Island Campus; B  
Rt. 110  
Farmingdale, NY 11735

Rensselaer Polytechnic  
Institute, B,M,D  
Troy, NY 12181  
(518) 270-6216

State University of New York  
at Buffalo; B,M,D  
1300 Elmwood Ave  
Buffalo, NY 14222  
(716) 878-5511

Syracuse University, B,M,D  
Syracuse, NY 13210  
(315) 423-3611

United States Military  
Academy; B  
West Point, NY 10996  
(914) 938-4041

University of Rochester, M,D  
Rochester, NY 14627  
(716) 275-3221

#### NORTH CAROLINA

North Carolina State  
University; B  
Raleigh, NC 27650  
(919) 737-2434

St. Augustine's College; B  
Raleigh, NC 27611  
(919) 828-4451

#### OHIO

Air Force Institute of  
Technology; M,D  
Wright-Patterson  
Air Force Base  
Dayton, OH 45433

Case Western Reserve  
University; B,M,D  
University Circle  
Cleveland, OH 44106  
(216) 368-4450

Ohio State University;  
Columbus Campus; B,M,D  
Columbus, OH 43210  
(614) 422-3980

University of Cincinnati;  
B,M,D  
Cincinnati, OH 45221  
(513) 475-3427

University of Dayton, M,D  
300 College Park Avenue  
Dayton, OH 45469  
(513) 229-4411

#### OKLAHOMA

Oklahoma State University; B  
Stillwater, OK 74078  
(405) 624-6384

Southeastern Oklahoma State  
University; B  
Durant, OK 74701  
(405) 924-0121 ext. 381

University of Oklahoma  
B,M,D  
Norman, OK 73019  
(405) 325-2251

#### PENNSYLVANIA

Penn State University Park  
Campus; B,M,D  
University Park, PA 16802  
(814) 865-4700

#### TENNESSEE

Middle Tennessee State  
University; B  
Murfreesboro, TN 37132  
(615) 898-5555

Motlow State Community  
College; A  
Tullahoma, TN 37388

Tennessee State University; B  
Nashville, TN 37203  
(615) 320-3131

University of Tennessee;  
Knoxville; B, M,D  
Knoxville, TN 37996  
(615) 974-2591

#### TEXAS

Rice University; M,D  
6100 South Main  
Houston, TX 77251  
(713) 527-4036

Texas A&M University; B,M,D  
College Station, TX 77843  
(713) 845-1031

University of Texas  
Arlington; B,M,D  
Arlington, TX 76019  
(817) 273-3401



Austin; B,M,D  
Austin, TX 78712  
(512) 471-1711

#### VIRGINIA

Mountain Empire Community  
College; A  
Drawer 700  
Big Stone Gap, VA 24219

University of Virginia, B,M,D  
Box 3728  
University Station  
Charlottesville, VA 22903  
(804) 924-7751

Virginia Polytechnic Institute  
and State University; B,M,D  
Blacksburg, VA 24061  
(703) 961-6267

#### WASHINGTON

Evergreen State College; B  
Olympia, WA 98505  
(206) 866-6000

University of Washington;  
B,M,D  
1400 Northeast Campus Way  
Seattle, WA 98195  
(206) 543-9686

#### WEST VIRGINIA

West Virginia University;  
B,M,D  
Morgantown, WV 26506  
(304) 293-0111

=====  
**AERONAUTICAL  
TECHNOLOGY**  
=====

#### ALABAMA

Community College of the Air  
Force; A  
Maxwell AFB, AL 36112

Patrick Henry State Junior  
College; A  
Monroeville, AL 36460  
(205) 575-3156

Wallace State Community  
College at Hanceville; A  
Hanceville, AL 35077  
(205) 352-6403

#### ARIZONA

Arizona State University; B,M  
Tempe, AZ 85287  
(602) 965-3255

#### CALIFORNIA

Bakersfield College; A  
Bakersfield, CA 93305  
(805) 395-4011

Chaffey College; A  
Rancho Cucamonga, CA  
91701  
(714) 987-1737

College of the Redwoods; A  
Eureka, CA 95501  
(707) 433-8411

Cyprus College; A  
Cypress, CA 90630  
(714) 826-2220

Kings River Community  
College; A  
Reedley, CA 93654  
(209) 638-3641

Merced College; A  
Merced, CA 95348  
(209) 384-6000

MiraCosta College; A  
Oceanside, CA 92056  
(619) 757-2121

Mount San Antonio  
College; A  
Walnut, CA 91789  
(714) 594-5611

Northrop University; A,B  
Los Angeles, CA 90045  
(213)337-4413

Ohlone College; A  
Fremont, CA 94539  
(415) 659-6000

Orange Coast College; A  
Costa Mesa, CA 92628  
(714) 432-0202

Sacramento City College; A  
Sacramento, CA 95822  
(916) 449-7111

San Bernardino Valley  
College; A  
San Bernardino, CA 92410  
(714) 888-6511

San Diego Miramar College; A  
San Diego, CA 92126  
(619) 693-6800

Santa Rosa Junior College; A  
Santa Rosa, CA 95401  
(707) 527-4011

Shasta College; A  
Redding, CA 96099  
(916) 225-4600

Solano Community College; A  
Suisun City, CA 94585  
(707) 864-7000

Southwestern College; A  
Chula Vista, CA 92010  
(619) 421-6700

West Los Angeles College; A  
Culver City, CA 90230  
(213) 836-7100

#### COLORADO

Aims Community College; A  
Greeley, CO 80632  
(303) 330-8008

Colorado Northwestern  
Community College; A  
Rangley, CO 81648  
(303) 774-1160

#### CONNECTICUT

Quinebaug Valley Community  
College; A  
Danielson, CT 06239  
(203) 774-1160

Thames Valley State Technical  
College; A  
Norwich, CT 06360  
(203) 886-0177

**DELAWARE**

Delaware Technical and  
Community College: Terry  
Campus; A  
1832 North duPont Parkway  
Dover, DE 19901  
(302) 736-5321

**DISTRICT OF COLUMBIA**

University of the District of  
Columbia; A  
4200 Connecticut Ave., NW  
Washington, DC 20008  
(202) 282-7300

**FLORIDA**

Broward Community College;  
A  
Fort Lauderdale, FL 33301  
(305) 761-7465

Embry-Riddle Aeronautical  
University; A,B  
Daytona Beach, FL 32014  
(904) 239-6000

Gulf Coast Community  
College; A  
Panama City, FL 32401  
(904) 769-1551

Manatee Community College;  
A  
Bradenton, FL 34207  
(813) 755-1511

Miami-Dade Community  
College; A  
Miami, FL 33132  
(305) 347-3221

**GEORGIA**

Clayton State College; A  
P.O. Box 285  
Morrow, GA 30260

**HAWAII**

University of Hawaii; Honolulu  
Community  
College; A  
Honolulu, HI 96822  
(808) 948-8207

**ILLINOIS**

City Colleges of Chicago;  
Richard J. Daley College; A  
3939 West 79th Street  
Chicago, IL 60652

Lewis University; A,B  
Route 53  
Romeoville, IL 60441  
(815) 838-0500

Moody Bible Institute; B  
820 North La Salle Drive  
Chicago, IL 60610

Parks College of St. Louis  
University; A,B  
Cahokia, IL 62206  
(618) 337-7500

Rock Valley College; A  
Rockford, IL 61101

Southern Illinois University at  
Carbondale; A  
Carbondale, IL 62901  
(618) 453-2121

**INDIANA**

Indiana State University; A,B  
Terre Haute, IN 47809  
(812) 232-6311

Purdue University; A,B  
West Lafayette, IN 47907  
(317) 494-1776

Vincennes University; A  
1002 North First Street  
Vincennes, IN 47591  
(812) 882-3350

**KANSAS**

Central College; A  
McPherson, KS 67460  
(316) 241-0723

Hesston College; A  
Box 3000  
Hesston, KS 67062  
(800) 835-2026

Johnson County Community  
College; A  
12345 College Blvd.  
Overland Park, KS 66210

**LOUISIANA**

Delgado Community  
College; A  
615 City Park Avenue  
New Orleans, LA 70119

Nicholls States University; A  
Thibodaux, LA 70310  
(504) 446-8111

**MARYLAND**

Frederick Community  
College; A  
Frederick, MD 21701

Howard Community  
College; A  
Little Patuxent Parkway  
Columbia, MD 21044

**MASSACHUSETTS**

North Shore Community  
College; A  
3 Essex Street  
Beverly, MA 01915

Roxbury Community  
College; A  
Roxbury, MA 02119

Wentworth Institute of  
Technology; A  
550 Huntington Avenue  
Boston, MA 0215  
(617) 442-9010

**MICHIGAN**

Andrews University; A  
Berrien Springs, MI 49104  
(616) 471-7771

Charles Stewart Mott  
Community College; A  
1401 East Court Street  
Flint, MI 48503

Ferris State University; A  
Big Rapids, MI 49307  
(616) 796-9971

Jackson Community  
College; A  
Jackson, MI 49201

Kirtland Community  
College; A  
Roscommon, MI 48653

Lansing Community College;  
A  
419 North Capitol  
Lansing, MI 48914

Macomb Community  
College; A  
Mt. Clemens, MI 48044

Southwestern Michigan  
College; A  
Cherry Grove Road  
Dowagiac, MI 49047

Wayne County Community  
College; A  
4612 Woodward Avenue  
Detroit, MI 48201

Western Michigan  
University; B  
Kalamazoo, MI 49008  
(616) 383-1950

#### MISSISSIPPI

East Mississippi Junior  
College; A  
Scooba, MS 39358  
(601) 476-2111

Hinds Community College; A  
Raymond, MS 39154  
(601) 857-5261

#### MISSOURI

Calvary Bible College; A  
Kansas City, MO 64147

Central Missouri State  
University; A,B  
Warrensburg, MO 64093  
(816) 429-4111

St. Louis University; A  
221 North Grand Blvd.  
St. Louis, MO 63103  
(314) 658-2500

#### NEW HAMPSHIRE

Daniel Webster College; A  
University Drive  
Nashua, NH 03063  
(603) 883-3556

#### NEW YORK

State University of New York  
College of Technology at  
Farmingdale; A  
Farmingdale, NY 11735  
(516) 420-2000

#### NORTH CAROLINA

Guilford Technical Community  
College; A  
5800 Friendly Avenue  
Guilford, College, NC 27401  
(919) 292-5511

Wayne Community College; A  
P.O. Box 8002  
Goldsboro, NC 27530

#### OHIO

Bowling Green State  
University; B  
Bowling Green, OH 43403  
(419) 372-2086

Cincinnati Technical College;  
A  
570 East Leffels Lane  
P.O. Box 570  
Springfield, OH 45501

Cuyahoga Community College:  
Western Campus; a  
11000 Pleasant Valley Road  
Parma, OH 44130

Ohio University; A  
Athens, OH 45701  
(614) 594-5174

#### OREGON

Lane Community College; A  
Eugene, OR 97405

#### PENNSYLVANIA

Community College of  
Allegheny County; A  
Monroeville, PA 15146

#### SOUTH CAROLINA

Florence-Darlington Technical  
College; A  
P.O. Box 8000  
Florence, SC 29501

#### TENNESSEE

Motlow State Community  
College; A  
Tullahoma, TN 37388

#### TEXAS

Central Texas College; A  
U.S. Highway 190 West  
Killeen, TX 76541  
(817) 526-1211

El Paso Community College; A  
P.O. Box 20500  
El Paso, TX 79998

Lee College; A  
Baytown, TX 77520

LeTourneau College; A,B  
Longview, TX 75607  
(214) 753-0231

Mountain View College, A  
Dallas, TX 75202

Tarrant County Junior College;  
A  
1400 The Electric Service Bldg.  
Fort Worth, TX 76102

Texarkana College; A  
Texarkana, TX 75501

Texas State Technical Institute;  
Waco; A  
Waco, TX 76705  
(817) 799-3611

#### UTAH

Dixie College; A  
225 South 700 East St.  
George, UT 84770

Utah State University  
Logan, UT 84322  
(901) 750-1000

#### VIRGINIA

Northern Virginia Community  
College; A  
8333 Little River Turnpike  
Annandale, VA 22003

Tidewater Community  
College; A  
Portsmouth, VA 23703

**WASHINGTON**

Big Bend Community  
College; A  
28th and Chanute  
Moses Lake, WA 98837

Everett Community College; A  
801 Wetmore Avenue  
Everett, WA 98201

Green River Community  
College; A  
Auburn, WA 98002

South Seattle Community  
College; A  
6000 16th Avenue SW  
Seattle WA 98106

Spokane Community College;  
A  
North 1810 Greene Street  
Spokane, WA 99207

Yakima Valley Community  
College; A  
P.O. Box 1647  
Yakima, WA 98907  
(509) 575-2612

=====  
**ASTRONOMY**  
=====  
**ALABAMA**

Alabama Agricultural and  
Mechanical University; B  
Normal, AL 35762

**CALIFORNIA**

California Institute of  
Technology; B,M,D,W  
Pasadena, CA 91125  
(818) 356-6811

Chabot College; A  
Hayward, CA 94545  
(415) 786-6600

El Camino College; A  
Torrance, CA 90506  
(213) 532-3670

Fullerton College; A  
Fullerton, CA 92634  
(714) 992-7000

Modesto Junior College; A  
Modesto, CA 96350  
(209) 575-6498

Nappa Valley College; A  
Nappa, CA 94558  
(707) 253-3095

Ohlone College, A  
Fremont, CA 94539  
(415) 659-6000

Pomona College; B  
Claremont, CA 91711  
(714) 621-8000

Saddleback College; A  
28000 Marguerite Parkway  
Mission Viejo, CA 92692  
(714) 582-4500

San Bernardino Valley College;  
A  
San Bernardino, CA 92410  
(714) 888-6511

San Diego State University;  
B,M  
San Diego, CA 92182  
(619) 594-5200

San Francisco State  
University; B  
San Francisco, CA 94132  
(415) 338-1111

Santa Monica College; A  
Santa Monica, CA 90405  
(213) 450-5150

Scripps College; B  
Claremont, CA 91711  
(714) 621-8000

Southwestern College; A  
Chula Vista, CA 92010  
(619) 421-6700

University of California;  
Berkeley; B,M,D  
Berkeley, CA 94720  
(415) 642-6000

Los Angeles; B,M,D  
Los Angeles, CA 90024  
(213) 825-4321

Santa Cruz; M,D  
Santa Cruz, CA 95064  
(408) 429-0111

University of Southern  
California; B,  
Los Angeles, CA 90089  
(213)743-2311

**CONNECTICUT**

Wesleyan University; B,M  
Middletown, CT 06457  
(203) 347-9411

Western Connecticut State  
University; B  
Danbury, CT 06810  
(203) 797-4347

Yale University; B,M,D  
New Haven, CT 06520  
(203) 432-4771

**DISTRICT OF COLUMBIA**

Howard University; B  
2400 6th Street, NW  
Washington, DC 20059  
(202) 636-6100

**FLORIDA**

Daytona Beach Community  
College; A  
Daytona Beach, FL 32015  
(904) 255-8131

University of Florida; B,M,D  
Gainesville, FL 32611  
(904) 392-3261

**GEORGIA**

University of Georgia; B  
Athens, GA 30602  
(404) 453-5187

Valdosta State college; B  
Valdosta, GA 31601  
(912) 247-3233

**HAWAII**

University of Hawaii at  
Manoa, M,D  
2530 Dole Street, C-200  
Honolulu, HI 96822  
(808) 948-8111

**ILLINOIS**

Northwestern University;  
B,M,D  
633 Clark Street  
Evanston, IL 60201  
(312) 492-7456

University of Chicago, B,M,D  
Chicago, IL 50537  
(312) 753-1234

University of Illinois at  
Urbana-Champaign; B,M,D  
Urbana, IL 61801  
(217) 333-1000

**INDIANA**

Earlham College; B  
Richmond, IN 47374  
(317) 962-6561

Indiana University  
Bloomington, B,M,D,  
Bloomington, IN 47405  
(812) 335-0661

**IOWA**

Drake University; B  
Des Moines, IA 50311  
(515) 271-3182

University of Iowa; B,M  
Iowa City, IA 52242  
(319) 353-3976

**KANSAS**

Benedictine College; B  
Atchison, KS 66002  
(913) 367-5340

University of Kansas: B  
Lawrence, KS 66043  
(913) 864-3911

**LOUISIANA**

Louisiana State University  
and Agricultural and  
Mechanical College; B  
Baton Rouge, LA 70803  
(504) 388-1686

**MARYLAND**

Howard Community College; A  
Little Patuxent Parkway  
Columbia, MD 21044

Johns Hopkins University;  
B,D  
Baltimore, MD 21218  
(301) 338-8171

University of Maryland:  
College Park; B,M,D  
College Park, MD 20742  
(301) 454-5550

**MASSACHUSETTS**

Amherst College, B  
Amherst, MA 01002  
(413) 542-2328

Boston University; B,M,D  
Commonwealth Avenue  
Boston, MA 02215  
(617) 353-2000

Hampshire College; B  
Amherst, MA 01002  
(413) 549-4600

Harvard and Radcliffe Colleges;  
B  
Cambridge, MA 02138  
(617) 495-1551

Massachusetts Institute of  
Technology, B,M,D,W  
Cambridge, MA 02139  
(617) 253-4791

Mount Holyoke College; B  
South Hadley, MA 01075  
(617) 538-2000

Smith College; B  
Northampton, MA 01063  
(413) 584-2700

Tufts University; B  
Medford, MA 02155  
(617) 628-0990

University of Massachusetts at  
Amherst; B,M,D  
Amherst, MA 01003  
(413) 545-0222

Wellesley College; B  
Wellesley, MA 02181  
(617) 235-0320

**MICHIGAN**

University of Michigan;  
B,M,D  
Ann Arbor, MI 48109  
(313) 764-7433

Wayne State University; B  
5980 Cass Avenue  
Detroit, MI 48202  
(313) 577-3577

**MINNESOTA**

Mankato State University; B  
Mankato, MN 56001  
(800) 722-0544

University of Minnesota;  
Twin Cities; M  
Minneapolis, MN 55455  
(612) 373-2144

**MONTANA**

Montana State University; B  
Bozeman, MT 59717  
(406) 994-2452

**NEBRASKA**

University of Nebraska-  
Lincoln; B,M,D  
Lincoln, NE 68508  
(402) 472-3601

**NEW MEXICO**

New Mexico State University;  
M,D  
Las Cruces, NM 88003  
(505) 646-3121

**NEW YORK**

Colgate University; B  
Hamilton, NY 13345  
(315) 824-1000

Columbia University;  
Columbia College; B  
Broadway & West 116 Street  
New York, NY 10027  
(212) 280-2521

Cornell University; M,D  
Ithaca, NY 48103  
(607) 256-1000

State University of New York at  
Stony Brook; B  
Stony Brook, NY 11794  
(516) 246-5126

University of Rochester; D,W  
Rochester, NY 14627  
(716) 275-3221

Vassar College; B  
Poughkeepsie, NY 12601  
(914) 452-7000

#### **NORTH CAROLINA**

University of North Carolina at  
Chapel Hill; B,M,D  
Chapel Hill, NC 27514

#### **OHIO**

Case Western Reserve  
University; B,M,D  
University Circle  
Cleveland, OH 44106  
(216) 368-4450

Mount Union College; B  
Alliance, OH 44601  
(216) 821-5320

Ohio State University;  
Columbus Campus; B,M,D  
Columbus, OH 43210  
(614) 422-3980

Ohio Wesleyan University; B  
Delaware, OH 43015  
(614) 369-4431

Otterbein College; B  
Westerville, OH 43081  
(614) 890-3000

University of Akron; B  
302 East Buchtel Avenue  
Akron, OH 44325  
(216) 375-7100

University of Toledo; D  
Toledo, OH 43606  
(419) 537-2696

Youngstown State University;  
B  
Youngstown, OH 44555  
(216) 742-3150

#### **OKLAHOMA**

University of Oklahoma; B  
Norman, OK 73019  
(405) 325-2251

#### **PENNSYLVANIA**

Bryn Mawr College; B  
Bryn Mawr, PA 19010  
(215) 645-5152

Haverford College; B  
Haverford, PA 19041  
(215) 896-1000

Lycoming College; B  
Williamsport, PA 17701  
(717) 326-1951

Penn State University Park  
Campus; B,M,D  
University Park, PA 16802  
(814) 865-4700

Swarthmore College; B  
Swarthmore, PA 19081  
(215) 447-7300

University of Pennsylvania;  
B,M,D  
Philadelphia, PA 19104  
(215) 243-7507

University of Pittsburgh;  
B,M,D  
4200 Fifth Avenue  
Pittsburgh, PA 15260  
(412) 624-4141

Villanova University; B  
Villanova, PA 19085  
(215) 645-4000

#### **RHODE ISLAND**

Brown University; B  
79 Waterman Street  
Providence, RI 02912  
(401) 863-2378

#### **TENNESSEE**

Vanderbilt University; B,M  
Nashville, TN 37212  
(615) 322-2561

#### **TEXAS**

Austin Community College; A  
P.O. Box 2285  
Austin, TX 78768

Rice University; M,D  
6100 South Main  
Houston, TX 77251  
(713) 527-4036

San Antonio College; A  
San Antonio, TX 78284

Texas Christian University; B  
2800 University Drive  
Fort Worth, TX 76129  
(817) 921-7490

University of Texas at Austin;  
B,M,D  
Austin, TX 78712

Western Texas College; A  
Snyder, TX 79549  
(915) 573-8511

#### **VERMONT**

Bennington College; B  
Marlboro College; B  
Marlboro, VT 05344  
(802) 257-4333

#### **VIRGINIA**

University of Virginia; B,M,D  
Box 3728 University Station  
Charlottesville, VA 22903  
(804) 924-7751

#### **WASHINGTON**

Lower Columbia College; A  
Longview, WA 98632

University of Washington;  
B,M,D  
1400 Northeast Campus Way  
Seattle, WA 98195  
(206) 543-9686

Western Washington  
University; B  
Bellingham, WA 98225  
(206) 676-3000

Whitman College; B  
Walla Walla, WA 99362  
(509) 527-5176

**WISCONSIN**

University of Wisconsin;  
Madison, M,D  
140 Peterson Building  
750 University Avenue  
Madison, WI 54408

**WYOMING**

University of Wyoming; B  
Laramie, WY 82070  
(307) 766-5160

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**ASTROPHYSICS**

=====

**ALABAMA**

Auburn University; M,D  
Auburn, AL 36849  
(205) 826-4000

**ALASKA**

University of Alaska  
Fairbanks; M,D  
Fairbanks, AS 99775  
(907) 474-7112

**CALIFORNIA**

San Francisco State University;  
B  
San Francisco, CA 94132  
(415) 338-1111

University of California;  
Santa Cruz, M,D  
Santa Cruz, CA 95064  
(408) 429-0111

**COLORADO**

University of Colorado at  
Boulder; D  
Boulder, CO 80309  
(303) 492-0111

**CONNECTICUT**

Wesleyan University; B,M,D  
Middletown, CT 06457  
(203) 347-9411

**DISTRICT OF COLUMBIA**

Howard University; D  
2400 6th Street, NW  
Washington, DC 20059  
(202) 636-6100

**GEORGIA**

Georgia State University; D  
University Plaza  
Atlanta, GA 3-3-3  
(404) 658-2000

**ILLINOIS**

Northwestern University; B  
622 Clark Street  
Evanston, IL 60201  
(312) 492-7456

University of Chicago; B,M,D  
Chicago, IL 60637  
(312) 753-1234

**INDIANA**

Indiana University  
Bloomington; D  
Bloomington, IN 47405  
(812) 335-0661

Purdue University; M  
West Lafayette, IN 47907  
(317) 494-1776

**IOWA**

Iowa State University of  
Science and Technology; M,D  
Ames, IO 50011  
(515) 294-5836

**MASSACHUSETTS**

Boston University; B  
Commonwealth Avenue  
Boston, MA 02215  
(617) 353-2000

Massachusetts Institute of  
Technology; B,M,D,W  
Cambridge, MA 02139  
(617) 253-4791

Tufts University; M,D  
Medford, MA 02155  
(617) 628-0990

Williams College; B  
Williamstown, MA 01267  
(413) 597-2211

**MICHIGAN**

Michigan State University; B  
East Lansing, MI 48824  
(517) 355-8332

**MINNESOTA**

University of Minnesota;  
Twin Cities; B,D  
Minneapolis, MN 55455  
(612) 337-2144

**MONTANA**

Montana State University; B  
Bozeman, MT 59717  
(406) 994-2452

**NEW JERSEY**

Princeton University; B,D  
Princeton, NJ 08544  
(609) 452-3060

**NEW MEXICO**

New Mexico Institute of  
Mining and Technology;  
B,M,D  
Socorro, NM 87801  
(505) 835-5424

University of New Mexico; B  
Albuquerque, NM 87131  
(505) 277-0111

**NEW YORK**

City of New York; Brooklyn  
College; B  
Bedford Avenue & Avenue H  
New York, NY 11210  
(212) 78-05485

Colgate University; B  
Hamilton, NY 13346  
(315) 824-1000

Columbia University;  
Columbia College; B  
Broadway & West 116 Street  
New York, NY 10027  
(212) 280-2521

Cornell University; M,D  
Ithaca, NY 48103  
(607) 256-1000

United State Military Academy;  
B  
West Point, NY 10996  
(914) 938-4041

#### OHIO

University of Akron; B  
302 East Buchtel Avenue  
Akron, OH 44325  
(216) 375-7100

#### OKLAHOMA

University of Oklahoma; B  
Norman, OK 73019  
(415) 325-2251

#### OREGON

University of Oregon; M,D  
Eugen, OR 97403  
(503) 686-3201

#### PENNSYLVANIA

University of Pennsylvania;  
M,D  
Philadelphia, PA 19104  
(215) 243-7507

#### RHODE ISLAND

Brown University; B  
79 Waterman Street  
Providence, RI 02912  
(401) 863-2378

#### VERMONT

Bennington College; B  
Bennington, VT 05201  
(802) 442-5401

Marlboro College, B  
Marlboro, VT 05334  
(802) 257-4333

#### VIRGINIA

University of Virginia; B  
Box 3728 University Station  
Charlottesville, VA 22903  
(804) 924-7751

#### WISCONSIN

University of Wisconsin;  
Madison; B  
140 Peterson Building  
750 University Avenue  
Madison, WI 54408  
(608) 262-3961

#### WYOMING

University of Wyoming; B  
Laramie, WY 82070  
(307) 766-5160

=====  
**PLANETARY  
SCIENCE**  
=====

#### ARIZONA

University of Arizona; M,D  
Tuscon, AZ 85721  
(602) 621-3237

#### CALIFORNIA

California Institute of  
Technology; B,D  
Pasadena, CA 91125  
(818) 356-6811

#### COLORADO

University of Colorado at  
Boulder; M,D  
Boulder, CO 80309  
(303) 492-0111

#### FLORIDA

Florida Institute of  
Technology; B,M  
Melbourne, FL 32901  
(407) 768-8000

#### MARYLAND

Johns Hopkins University;  
B,M,D  
Baltimore, MD 21218  
(301) 338-8171

#### MASSACHUSETTS

Massachusetts Institute of  
Technology; B,M,D  
Cambridge, MA 02139  
(617) 253-4791

#### MONTANA

Montana State University; B  
Bozeman, MT 59717  
(406) 994-2452

#### TEXAS

Tyler Junior College, A  
P.O. Box 9020  
Tyler, TX 75711

#### VIRGINIA

University of Virginia; M  
Box 3728 University Station  
Charlottesville, VA 22903  
(804) 924-7751

#### WASHINGTON

Eastern Washington  
University; B  
Chaney, WA 99004  
(509) 359-2397



## NASA FIELD CENTERS

Ames Research Center  
Moffett Field, CA 94035  
*Aerodynamics, supercomputers, flight simulators, human factors. Includes Dryden Flight Research Facility at Edwards AFB*

Goddard Space Flight Center  
Greenbelt, MD 20771  
*Spacecraft tracking, climate research, communications, Hubble Space Telescope*

Jet Propulsion Laboratory  
4800 Oak Grove Drive  
Pasadena, CA 91109  
*Operated for NASA by Cal Tech. Primary center for planetary exploration, and NASA's Deep Space Network*

Lyndon B. Johnson Space Center  
Houston, TX 77058  
*Mission control for shuttle flights and space station. Responsible for astronaut selection, payloads and experiments*

John F. Kennedy Space Center  
Kennedy Space Center, FL 32899  
*Assembly, checkout and launch of space shuttle*

Langley Research Center  
Hampton, VA 13665  
*Aerodynamics, wind tunnel testing, flight displays, software development*

Lewis Research Center  
Cleveland, OH 44135  
*Aerospace propulsion and power systems*

George C. Marshall Space Flight Center  
Huntsville, AL 35812  
*Design and development of space transportation systems, space station Freedom*

Space Telescope Science Institute  
Johns Hopkins Homewood Campus  
Baltimore, MD 21218  
*Operated for NASA by Association of Universities for Research in Astronomy. Plans and conducts HubbleSpace Telescope operations*

Stennis Space Center  
Stennis Space Center, MS 39529  
*Rocket engine testing, oceanographic and environmental research*

## AEROSPACE COMPANIES

Aerjet General  
P.O. Box 1322  
Sacramento, CA 95813  
*Rocket motors, advanced  
propulsion concepts*

Allied-Signal Aerospace  
Company  
(Includes AiResearch, Garrett  
Fluid Systems and Bendix Field  
Engineering)  
2525 W. 190th Street  
Torrance, CA 90509  
*Tracking, communications,  
space shuttle operations*

American Rocket Company  
(AMROC)  
847 Flynn Road  
Camarillo, CA 93010  
*Private launch vehicle and  
payload services*

Arianespace  
Attn: Jacque Weschine  
Boulevard de L'Europe  
BP 177 Evry  
9100 France  
*Builds and markets Ariane  
booster; facilities in France and  
Kourou, French Guiana*

ARINC Research Corporation  
Attn: Professional Staffing  
Dept. 393  
4410 E. Fountain Blvd. #100  
Colorado Springs, CO 80916  
*Systems engineering satellite  
tracking and control*

Atlantic Research Corporation  
1375 Piccard Drive  
Rockville, MD 20850  
*Small rocket motors defense  
systems, NASA support  
contractor*

Ball Aerospace Systems Group  
Human Resources  
Dept. 53775  
P.O. Box 1062  
Boulder, CO 80306  
*Major subcontractor to NASA,  
DoD*

Battelle Columbus Laboratories  
505 King Ave.  
Columbus, OH 43201  
*Research and development,  
operates advanced materials  
center for NASA*

Boeing Employment Center,  
MS 31-13  
P.O. Box 2707  
Seattle, WA 98124  
*Aerospace & Electronics  
Company is space station  
contractor; military space  
supplier*

CAE-Link Corporation  
2224 Bay Area Blvd.  
Houston, TX 77058  
*Aerospace flight simulators*

ECE Instruments  
955 Overland Court  
San Dimas, CA 91773  
*Pressure and vibration sensors*

Communications Satellite  
Corporation (COMSAT)  
850 L'Enfant Plaza, S.W.  
Washington, DC 20024  
*Manages satellite  
telecommunications network*

Computer Sciences  
Corporation  
2100 East Grand Ave.  
El Segundo, CA 90245  
*Computer systems technology,  
software development for  
NASA and other government  
agencies*

CONATEC, Inc.  
P.O. Box 171  
Glendale, MD 20769  
*Private suborbital Launch  
vehicle services*

Contel ASC  
1801 Research Blvd.  
Rockville, MD 20850  
*Operates Tracking and Data  
Relay Satellite System  
(TDRSS) for NASA*

EOSAT  
4300 Forbes Blvd.  
Lanham, MD 20706  
*Markets LANDSAT data*

E-Prime Aerospace Corporation  
P.O. Box 792  
Titusville, FL 32781  
*Private launch vehicle and  
payload services*

E-Systems, Inc.  
Attn: Staffing  
P.O. Box 1056  
Greenville, TX 75401  
*Electronics for FLTSATCOM,  
MILSTAR, NAVSTAR*

External Tanks Corporation  
(ETCO)  
1877 Broadway  
Boulder, CO 80302  
*Proposes use of shuttle external  
tanks as orbiting research  
platforms*

Fairchild Space Company  
20301 Century Blvd.  
Germantown, MD 20874  
*Defense, NASA subcontractor*

Ford Aerospace  
Space Systems Division  
MS D-03  
3825 Fabian Way  
Palo Alto, CA 94303  
*Space station power systems,  
spacecraft electro-optical  
systems*

GE Aerospace  
Employee Relations  
Dept NTB  
P.O. Box 800  
Princeton, NJ 08543  
*Designs and manufactures  
satellites, space station truss*

General Dynamics  
Space Systems Division  
MS 21-7143-FF  
P.O. Box 85990  
San Diego, CA 92138  
*Builds Atlas-Centaur launch  
vehicle, space station power  
system*

Geostar Corporation  
1001 22nd Street, N.W.  
Washington, DC 20036  
*Owner-operation of Global  
Positioning System satellite  
message relay and locator  
system*

Global Outpost, Inc.  
6836 Deer Run Drive  
Alexandria, VA 22306  
*Proposes use of shuttle external  
tanks as orbiting research  
platforms*

Grumman Corporation  
111 Stewart Ave.  
Bethpage, NY 11714  
*Built lunar module,  
subcontractor for Orbital  
Maneuvering Vehicle*

GTE Spacenet Corporation  
1700 Old Meadow Rd.  
McLean, VA 22102  
*Owner-operator of  
communications satellite  
network*

Harris Corporation  
Electronic Systems Sector  
P.O. Box 37  
Melbourne, FL 32902  
*Space station subcontractor,  
flight simulators, ground  
support communications  
systems at Kennedy Space  
Center*

Hercules Aerospace Co.  
Attn: Human Resources  
P.O. Box 89  
Magna, UT 84044  
*Rocket motors and associated  
electronics, aerospace  
composite materials*

Honeywell, Inc.  
Space Systems Group  
Attn: Staffing  
13350 U.S. Hwy 195  
Clearwater, FL 33516  
*Computers and electronics,  
satellite systems*

Horizon Aerospace  
18333 Egret Bay Blvd. #300  
Houston, TX 77058  
*Payload planning and program  
development*

Hughes  
Space and Communications  
Group  
Bldg. F40, Mail Stop T371  
Los Angeles, CA 90009  
*Communications satellites and  
electronics*

Inmarsat  
Attn: Engineering and Process  
Recruitment  
PA Consulting Group  
Hyde Park House  
60a Knightsbridge  
London SW1X 7LE  
UNITED KINGDOM  
*International Maritime  
Satellite organization*

IBM  
Federal Systems Division  
Oswego, NY 13827  
*Information systems and  
management*

Instrumentation Technology  
Associates, Inc.  
99 Great Valley Pkwy.  
Malvern, PA 19335  
*Engineering services, payload  
integration for shuttle  
"Getaway Special" canisters,  
Hitchhiker and middeck lockers*

Kaman Aerospace Corporation  
Old Windsor Rd.  
Bloomfield, CT 06002  
Attn: Employment Office  
*Mostly defense and rotorcraft  
work; some space contracts*

Lockheed Missiles & Space Co.  
Attn: Employment  
P.O. Box 3504  
Sunnyvale, CA 94088  
*Space Station, shuttle  
components, shuttle  
processing*

## **APPENDIX E.**

### **A USER'S GUIDE AMERICA'S YOUTH: Our Future In Space**

#### **A. EXPLANATION**

This instructional packet will narrate a one day seminar which is designed for an assembly setting to be presented to approximately 250 high school age students. Although age of the students is not essential, the concentration will be on sophomores, juniors, and seniors. An orator with experience in aerospace, knowledge concerning how NASA, DoD, federal agencies, private industry, and academe work together, and an understanding of a variety of possible aerospace careers would, by following the guidelines set within, be able to present this program in its entirety. A sense of humor mixed with enthusiasm and a strong desire to persuade young students that America's aerospace program desperately needs their future help, would be essential for the orator. Since this individual will be primarily working alone, this person must be accustomed to addressing large audiences. A recommended staff of 3-5 permanent people will also be necessary in order to help with set-up, registration, monitoring, trouble-shooting, and clean-up.

#### **B. PROGRAM**

Doors will open for arrival and check-in 45 minutes prior to the beginning of the seminar, juice and fruit will be available for consumption only in the reception area. Upon arrival, the students will check-in to receive their badges, seating assignment, and folders (contents will be described in greater detail later). Check-in registration will provide total number of attendees and no-shows, also adding allowance time for last minute changes. Assembly room doors will close promptly at 8:00 a.m. However, at least one registration table and person will remain until 8:30. Late arrivals will be informed they must wait until

the movie begins to enter and find their respective seat. Students will be working in groups of five during the seminar and therefore group members should be seated close to one another to allow faster recognition and group assembly.

### **Instruction to the Orator:**

#### **1. Opener**

At 8:00 a.m., without an introduction, SPECTRAFILM will begin the seminar with the National Anthem playing while showing the flag in the background of well known locations around the United States. The majority of the pictures would be space related. Because some of the students may be unsure if they should stand the orator will lead the assembly in standing.

#### **2. Guest Speaker**

Upon completion of National Anthem , the orator will go to the podium and begin the program by introducing the key speaker. The key speaker will offer his/her opening remarks, 20-30 minutes in length. Subject matter will be oriented towards encouraging students to search for space related college majors and careers, willingness to devote extra effort and time towards math and science studies, and for each student to promote to friends and family the beneficial attributes of a strong national space program, which are all things that they will learn about during the remainder of the day.

The importance of obtaining high publicity individuals for key speakers; i.e., the President, Vice President, Congressmen, Senators, astronauts, or possibly well respected movie stars cannot be emphasized enough. To obtain maximum results from the seminar, the students must feel they are receiving special treatment or viewing something very few others will witness. The intended aim will be to leave a long lasting impression, something which each student can fall back on for incentive when deciding upon future careers.

### **3 . SPECTRAFILM**

The remainder of the film is a realistic view of what the astronauts see while in space, current and future space projects, and numerous ways space related spinoffs, such as those discussed in Chapter II, affect peoples' lives. SPECTRAFILM is 45-50 minutes long and is used to provide the key theme for the rest of the day.

### **4 . Explain Day**

Prior to the first break, the orator will instruct the students to take out the "Schedule" from within the student packets. How will the rest of the day be structured? What can the students expect from the remaining time? These are the type of questions that will be answered. The orator will review the general schedule included in the packet to delineate times and events, see Appendix D. Next, review rules of behavior to eliminate questionable action, i.e., where, when, and if smoking is allowed; where and when food and beverages will be consumed; bathroom breaks; how and when students might ask questions. These points may seem trivial, but if not presented, will definitely lead to problems.

Providing a preview of the day allows each student a chance to put the day in a personal frame of reference; when will the topics of most interest be presented, how long will each event be, and when will the next break occur. After a proper presentation, the students will understand the days events and therefore, have some feeling of control. By keeping the listed events general, the element of surprise will not be lost for later events. (general terms of description will be used in the schedule (see Appendix D).

The first ten minute break will begin now.

### **5 . How Much Do You Already Know?**

Since each seminar will be reorganized to enhance the qualities of the particular state in which it is being held, the orator will need to be acquainted with certain facts

relevant to the state in which the seminar is being held. Many of the students will hold some loyalty towards the "home state"; the presentation's emphasis will be directed with this in mind. In order to provide an example of what is desired, California will be used as the location of the first seminar. This section will consist of the orator asking questions of the audience in order to begin directing the general thought process towards what college and career interest each student has. The orator, or more likely an assistant, will type response into a computer which will then be magnified on the film screen for the entire audience to view.

**Prompt:** Before beginning this section, direct the students to remove the "STUDENT QUESTIONNAIRE" pamphlet (see Appendix D) and pencil from the folder; also, explain that each student will wish to write down individual or interesting group answers to the following questions.

*a. Student Questionnaire*

After each question, in the script and in this text, a list of possible and recommended suggestion will be available for the orator in case the audience provides limited response.

Although one of the criteria for attendance is a desire to pursue a college education, the opening question for this portion will be:

**Orator:** 1. "How many of you would like to go to college?"

**Prompt:** Enter an approximate percentage of positive responses and also state that amount.

**Orator:** 2. "Where would you like to go to college?"

**Prompt:** Instruct the students to raise a hand and then wait until called upon to avoid shouting contests. Continue to remind the students to write down answers in the respective space provided on the pamphlet. Enter approximately 15-18 choices. If there are limited or

no responses, begin by suggesting some possible state colleges/universities which will be standing by on a list to use as prompts, preferably ones with some type of aerospace applicable degree. If none of the service academies are mentioned ask the audience if anyone is interested in attending one or has started to apply.

California College Choices to suggest:

Loyola Marymount U. (LA)  
Northrup U. (Inglewood)  
U. of California (Berkeley, Davis, LA)  
California Institute of Technology (Pasadena)  
California Polytechnic State U. (San Luis Obispo)  
San Jose State  
Stanford U.  
San Diego State  
USC (LA)

**Orator:** 3. "What type of job or career are you interested in after college or high school?"

**Prompt:** Again, write down student ideas.

This list will be almost endless so the orator will try and supply general job descriptions as opposed to specific ones, i.e., doctor instead of brain surgeon, or musician vice rock star. The orator should also begin directing the students thoughts towards space related ideas, suggesting the following as a minimum: doctor, scientist, musician, athlete. By generalizing the ideas, other students will find jobs that can be related to career choices close to their own. Because of the title of the seminar and the type of students interested in applying, many will already have some interest in space related fields and thus will reply with space oriented jobs.

**Prompt:** 15-18 jobs should be sufficient to cover a broad mix of possibilities. Maintain each group of answers so that a relationship can begin to form between the various lists. A list of answers received during the pilot program plus any unique or surprising answers that occur during any seminar will be maintained; review prior to the beginning of each new session. Surprise answers are easier to explain and rationalize if they are not really surprises.



Job or Career

Musician  
Teacher  
Pilot  
Drafter  
Doctor  
Helicopter Pilot  
Teacher  
Fire Fighter  
Fashion Design

Infantry  
Interior Design  
Psychologist  
Musician  
Lawyer  
Architect  
Accountant  
Sports

**Orator:** 4. "What type of major or degree would be necessary to get a (emphasize) SPACE RELATED JOB?"

**Prompt:** This list offers specific names that might be looked for when applying for or attending college.

Space Related College Majors

Chemistry  
Architecture  
Computers  
Mechanical Engineer

Math  
Astronomy  
Engineer  
Aeronautics

**Orator:** 5. "What type of courses would you take to get one of the degrees listed or any one of the jobs listed?"

**Prompt:** When writing down the student's ideas keep in mind they will be unfamiliar with college level course titles. Some assistance may be rendered to properly classify unknown courses. This would be a good time to begin directing the students into thinking about how a particular job interest might relate to a space career. For instance, Chemistry would be necessary for a fire fighter to understand classifications of fires or for a rocket propulsion expert to create new fuels. Biology could be applied towards work as a regular doctor or a space Lift Scientist. Both of these courses would be beneficial in a space career.

### College Courses

Math  
Merchandising  
Anatomy  
History  
Computers  
Child Development  
Physics  
Athletics  
History

Engineering  
Teaching courses  
Business  
Special Arts  
Child Psychology  
Calculus  
Chemistry  
Medicine  
Criminology

**Orator:** 6. "How many students know what NASA stands for?", "When you think of NASA, what comes to mind?" or "What are some of NASA's past achievements, present and future projects?"

### NASA Projects

Shuttle  
Satellites  
SETI  
Moon  
Scientific Experiments  
Astronomy

Hubble Telescope  
Launch/Design  
Space Station  
Mars  
Aeronautics  
Voyager

**Orator:** 7. "How many know of any work NASA does on airplane development?"

Out of the two high school classes asked the second question, none knew of any work done by NASA. Therefore, it is assumed very few of the seminar participants will be aware of any work done by NASA on airplane Research and Development.

**Prompt:** Explain that National Aeronautics and Space Administration, NASA, works both on aeronautical as well as space research and development and that the origins of NASA can be traced back to when airplanes were the most advanced machines of the times. Because of their experience with experimental high speed advanced technology craft, the scientists, engineers and research and development installations with experience in aeronautics were perfect candidates when work began on America's space program.

**Orator:** 8. "Can you name some of the ways the military uses of space?"

### Military in Space

Weather  
Nuclear Detection  
Communication

Spy Satellites  
Star Wars  
Navigation

**Orator:** 9. "How do private companies contribute to America's space program?"

Again, from questioning two high school classes, none of the students had any suggestions or ideas concerning private industry.

### Private Industry

Navigation  
Television  
Space Hardware Construction

Telephone  
Banking

**Prompt:** All of the above mentioned lists should be written down and presented so that they are available for the students to see and make comparisons. This section will take approximately one hour.

### **6. Mars Design Project I (Group)**

**Prompt:** Before releasing the group for the second break, explain how the next session will work. First, each individual will have been assigned into a group of five; all five will be closely seated. During the break, students should find the other members of the group. Second, upon completion of the break, pick up the "student folder" and meet with the respective group somewhere in the auditorium. Third, write answers for the questions on the first page and then begin discussing the "Mars Mission" handout. There will be a series of fill in the blank and multiple choice questions that the students should attempt to answer individually. Instruct the students during this session to write down only their own ideas. Students may include ideas from the discussion after all of the students are reassembled. Finally, upon completion of group discussion time, reassemble in the originally assigned seats to begin a discussion and offer further explanation of the handout beginning with **STEP ONE.**

The second ten minute break will begin now.

## **7. Mars Design Project II (Assembly)**

**Prompt:** Once reassembled, start to discuss and explain in greater detail the "MARS MISSION." The first page of general questions will not be discussed. The students will be asked to leave the first page after the seminar, but they may keep the rest of the Mars Design project handout.. The remaining portion of the handout will be broken into three sections: Earth to Mars, Initial Buildup of Mars Colony, Long Term Mars Colonization.

There are several goals for this section: first, allow the students to have fun while being creative, encourage them to think of new ideas and not just repeat things they have heard from television or other adults. Second, attempt to tie together student's career choices offered in the morning session with space oriented careers. This goal is extremely important; it is what the seminar was designed to do. Many of the students will be unaware of how many different types of jobs are actually available and how their current choices might be applied.

This is an area where the experience of the orator will be most critical. His/her expertise and enthusiasm will have a significant effect on the overall success of the program. If and when the orator loses interest in the goals of the seminar, it will be time to find a new orator.

**Prompt:** One example to use for multiple career choices would be describing how someone interested in interior design might help create the interior of the spacecraft. Texture, color, and functionality will be extremely important for an enjoyable space voyage because of the long trip times, the large number of people, and the close quarters. Some of the people working on this type of work are called Human Factors Engineers. Another good example would be many of the medical professions. Doctors and nurses will definitely be necessary but also, medical technicians would be useful as crewmembers or in the preparations stages.

Overheads are available to assist with this section, however, creative computer graphics might also be used to provide visualization on a large screen. Students responses will be written down on the overheads for everyone to see. The slide presentation will also begin during this portion of the seminar. Combining visual effects with a creative exercise will hopefully provide a longer last impression.

**Prompt:** The last three questions from the first page of the handout will be addressed to the students as a lead into the design project. Begin with the first overhead (Where Is Mars Anyway?) now.

**Orator:** 1. "How many of you would be willing to go on this first trip to Mars?"

**Prompt:** Determine a count as best as possible and announce that number.

**Orator:** "If the design of your particular spacecraft, because it would land on Mar's surface and become your home, would not allow anyone to fly back to Earth how many of you would still be willing to go, knowing there was no return trip to Earth?"

**Prompt:** Determine a count as best as possible and announce the number.

**Orator:** "One final question before we begin the Mission to Mars. Considering the job you selected in question four, on page one: How many of you think you would be selected to work on the Mars Mission?"

**Prompt:** Start with the following explanation and the second overhead (STEP ONE: - 1.A.2).

**Orator:** "The Earth is rapidly becoming overcrowded and more and more people are getting the desire to find a new place to get away, start fresh, and/or do something adventurous. Therefore, you and a group of 50 people will be sent to Mars to do experimental work on starting the first colony. The survival of other explorers depends upon your success. Already, in your small groups, you have begun to brainstorm the essential ideas necessary to safely carry out this task. Together, we will discuss the

important questions needed to (1) get everyone from Earth to Mars, (2) start a colony, and (3) survive and prosper using only what you bring and what is on the planet. This scenario is very similar to what the Pilgrims did upon setting out for America, and many years later when American settlers left the safety of their eastern homes for the possible riches of the west coast. Each one of you holds some of the knowledge that is required to successfully accomplish this task. To help with the discussion, assume you have already graduated from the first college you listed on the "STUDENT QUESTIONNAIRE," and have been working at your first job or career choice. Together, we will make it to the Red Planet."

**a. STEP ONE: *Earth to Mars***

"Step One of the Mars Design Project will be designing the spacecraft required to get all 50 people to Mars. You will be living and working inside these spacecraft for the 6 months of travel required to get to Mars and then on the surface until permanent buildings are completed. Two spacecraft, each about the size of ten school buses, will hold 25 people. Because space travel is not like the movies where everyone walks normally, but instead, like what you may have seen from the Space Shuttle, you will be living in zero gravity during the entire voyage to Mars. You and everything will be free-floating. One important advantage to this is the ability to use all four walls, no ceiling or floor to worry about. Weight is very important so you may not bring everything you want, only essential items."

**Orator:** 1.A.1) "What decisions must be made even before you leave Earth? (example: What type of plants/animals to bring; where to land the spacecraft.)"

**Prompt:** Additional examples: Decide where on Mars would be the best place to establish the colony; are there enough of the right raw materials on Mars to provide water, oxygen, and food, produce buildings, and produce computer parts.

**Orator:** 1.A.2.) "Nuclear power or solar power? Which would you prefer to use on the Martian surface? Nuclear power provides considerable more energy than does solar power. It can also be constructed on Earth which means its energy will be available without the delays required to construct solar panels. Nuclear radiation and waste can be dangerous and nuclear power plants are much heavier than solar panels. Solar power on the other hand is cheaper to design and build, is easy to maintain, lightweight, and there is unlimited sunlight during daylight hours. However, many acres of solar panels would be necessary to provide an equal amount of nuclear generated electricity, and heavy, expensive batteries would be required for nighttime."

**Prompt:** Ask for a show of hands for both choices and a few of the reasons why the students selected one over the other.

**Prompt:** The third overhead (1.B.1 - 1.B.4) will go on now.

**Orator:** "We will now try to determine some of the different types of job descriptions necessary to complete the following assignments. The same job may fit more than one task. Also try to find ways your particular career might help to accomplish each assignment."

**Prompt:** Refer back to student suggestions from earlier in the program and explain how some of their ideas might be used in an unexpected ways. During the questions only offer examples if the student suggestions are not close to what might be expected.

**Orator:** 1.B.1) "Designing the spacecraft will be similar to designing a house or a building."

**Prompt:** Example: engineer, interior designer.

**Orator:** 1.B.2) "Providing food, water, and oxygen to breathe until food can be grown on the planet."

**Prompt:** Example: chemist, botanist, biologist.

**Orator:** 1.B.3) "Creating recreational activities both in the form of exercise and entertainment for the trip."

**Prompt:** Example: psychologist, computer scientist, musician.

**Orator:** 1.B.4) Navigating the spacecraft 171 million kilometers (92.4 million miles or approximately 333 trips to the moon) at 11 km/sec (63,700 mph).

**Prompt:** Example: pilot, navigator, astronomer.

**Prompt:** The fourth overhead (1.C.1 - STEP TWO) now.

**Orator:** 1.C.1) "There are two methods for providing food: frozen or fresh. Due to limited space and weight one or the other must be selected but not both. Packaged food requires considerably less handling area, energy, and weight than fresh food (soil and water to grow fresh food), it also presents a greater variety. It does not provide the enjoyment of fresh garden grown food. Garden plants can be used to filter air, water, and waste and still provide fresh food. Unfortunately, this method would use up space and weight that might otherwise be used for machinery or personal items. Seeds would be available to begin plant growth once on the surface."

**Prompt:** One of the possible questions that will come up will be about the use or need for live animals to provide food on Mars. Ask the students how they would handle a cow floating through their spacecraft. Available time will determine into how much detail to go concerning this and other good ideas provided by the students.

**Orator:** 1.C.2) "Several personal items are listed below, write down the weight in pounds of each item you would like to bring, you may also add other suggestions to the list. The total weight of all items combined cannot be more than 110 lbs (50 kg)".

**Prompt:** Read each of the items from the list below and provide personal examples for each. Consider for books: ask how many students would be willing to read their books only from a computer screen or if they would prefer holding books in their hands. From



the students one definite response when asked if there is anything else they would like to add to the list will be 'candy'. The author, when making the list, missed that essential item. Suggested weights are provided below.

_60_ clothes	_24_ books	_10_ personal hygiene supplies
_4_ games	_4_ photos	_4_ music
_2_ plants	_____	_2_ misc.

**b. STEP TWO: First Year on Mars**

**Orator:** "Congratulations, you all made the right decisions and are now successfully on your way to Mars."

"Once established in an orbit around Mars the most dangerous portion will begin. Getting all of the equipment and people safely to the surface involves numerous risks, primarily while landing the spacecraft with all of the people aboard. The next major portion will entail establishing the base which will require a great deal of spacesuit time outside the safety of the spacecraft. Something to consider once on the Martian surface, gravity is only one third as strong as on Earth. Which means, if you weigh 150 pounds on Earth while on Mars you will only weigh 50 pounds. Consider some of the problems/advantages a lower gravity would present. The soil is rich in mineral necessary to produce items you will all need eventually, including water and oxygen. There is also ice at the poles which can be processed to provide plenty of water."

**Prompt:** The fifth overhead (2.A.1 - 2.B.3) now.

**Orator:** 2.A.1) "Rank the following in the order of which you think they should be built."

**Prompt:** Call out each item and determine a consensus for the ranking.

- |                                      |   |
|--------------------------------------|---|
| ___ Communication Center             | ___ Living Quarters                     |
| ___ Sleeping Quarters                | ___ Food Preparation Facility (kitchen) |
| ___ Water Production Facility        | ___ Entertainment Center                |
| ___ Food Production Facility (farms) | ___ Oxygen Production Facility          |
| ___ Exercise Center                  |   |

**Orator:** "We will again try to determine some of the different types of job descriptions necessary to complete the following assignments. The same job may fit more than one task. Also remember to try and find ways your particular career might help to accomplish each assignment."

**Prompt:** This section would be the best one to skip if available time begins to get run out.

**Orator:** 2.B.1) "Setting up food production facilities (farms)."

**Prompt:** Example: chemist, farmer, zoologist.

**Orator:** 2.B.2) "Designing and constructing permanent buildings."

**Prompt:** Example: electrician, drafter, interior designer.

**Orator:** 2.B.3) "Providing medical treatment, advice, and counseling when dealing with the effects of lower gravity and confined spaces."

**Prompt:** Example: doctor, psychologist, nurse, musician. Consider priest or minister if this ideas is not suggested.

**Prompt:** The sixth overhead (STEP THREE: - 3.A.3 ) now.

**c. STEP THREE: After the First Year on Mars**

**Orator:** "Again, congratulations, consider your hard work a complete success. Now let's begin the final portion. After the initial construction has been completed and people

have settled down to a routine and become accustomed to living in the Martian environment long term planning must begin to ensure room for families to expand. Food, water, and oxygen production facilities are now working. To provide plans for long term expansion you must decide things such as what type of government if any you wish to have. How much control over your lives will Earth have? They did provide you with transportation and all the equipment you now possess and they also continue to send you resupply vessels. Here are some other things to consider."

**Orator:** 3.A.1) "Without an atmosphere like Earth's the surface of Mars gets very cold, receives heavy doses of harmful radiation, and there is a risk of meteors hitting at any time. Dust storms can build that encompass the entire planet. All of these things combine to make the surface a difficult place to live. Unfortunately, construction underground is much slower than on the surface, requires considerably more energy, and is very dangerous for the workers. Should future construction be done underground to provide more than adequate protection against the harsh surface environment or should time be spent creating above ground buildings that will provide a safe place to work and play?"

**Prompt:** Consensus will determine which method the group selects.

**Orator:** 3.A.2) "Should you have money to buy things such as food, air, water, and entertainment (new clothes, movies): Or, should everyone receive all of these items free? Without money, if a job is more dangerous than other jobs, why should the workers take the risk?"

**Prompt:** Example: "Consider: producing air requires complex, dangerous machinery and is very expensive, but everyone needs it to survive. Since all buildings are connected everyone shares the same air. Should each person be charged for air or should it be free? If free, how will the workers be paid for what they provide?"

**Orator:** 3.A.3) "Eventually, families will form and children will be born which will change many of the living requirements. One building for eating, one for sleeping and another one for recreation would use less construction material and would be easier to build than individual family units. Since everyone shares the same eating, sleeping, and recreation facilities fewer tunnels would be required. However, there is very little privacy for anyone. Should time, material, and effort be expended to construct individual living areas for families?"

**Prompt:** Ask the student to decide between having money or not having money.

**Prompt:** The seventh overhead (3.A.4 - 3.B.1) now.

**Orator:** 3.A.4) "It is costly and dangerous to continue expansion of the colony even for the new families of the people presently living on Mars. Food, water, and oxygen production facilities are at their maximum now. If the Earthlings request to send more people to Mars should they be allowed to send them to your colony which might exhaust your supplies before they are regenerated or should they begin their own colonies starting the same way your group did?"

**Prompt:** Try to determine their decision from the responses received.

**Orator:** 3.B.1.) "Considering the job choice you wrote down for question number four on page one how many of you think you would be selected to work on the Mars Mission now?"

**Prompt:** Maintain a record of this last count to help determine how effective this portion of the program has been.

The following pages contain the overheads which will be used for this section.

# **Where Is Mars Anyway?**

## **A Trip to Mars**

**How Many To Mars?**

**How Many With No Return to Earth?**

**With Your Job Will You be Selected to Help With This  
Project?**

-----  
**STEP ONE:**

**Earth to Mars**

Things to consider:

25 people in each spacecraft about the size of ten school buses.

Live and work inside the spacecraft for at least 6 months.

Zero gravity environment, everything will be free-floating.

Weight is very important, bring only essential or valuable items.

1.A.1) What decisions must be made even before you leave Earth?  
(example: What type of plants/animals to bring; where to land the  
spacecraft.)

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1.A.2) Nuclear Power: Excess power; Built on Earth; Ready to use on  
Mars; Very heavy; Dangerous; Nuclear waste

Solar Power: Cheap; Easy to maintain; Lightweight;  
Unlimited fuel; Limited Power; Long  
construction time; Batteries required

Nuclear? \_\_\_\_\_.

Solar? \_\_\_\_\_.

1.B.1) Designing the spacecraft, similar to designing a house. (example: Engineer)

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

1.B.2) Providing food, water, and oxygen to breathe until construction is completed on the planet.

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

1.B.3) Creating recreational activities both in the form of exercise and entertainment for the trip.

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

1.B.4) Navigating the spacecraft 171 million kilometers (92.4 million miles or approximately 333 trips to the moon) at 11 km/sec (63,700 mph).

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

1.C.1) Food production: Frozen or Fresh?

\_\_\_\_\_ A: Using frozen, packaged food requires considerably less handling area, energy, and weight and also presents a greater variety. However, it does not provide the enjoyment of freshness associated with garden grown food.

\_\_\_\_\_ B: Garden plants can be used to filter air, water, and waste and still provide fresh food. Unfortunately, this method would use up space and weight that might otherwise be used for machinery or personal items.

1.C.2) Personal items:

_____ clothes	_____ books	_____ personal hygiene supplies
_____ games	_____ photos	_____ music
_____ plants	_____ misc.	_____

-----  
**STEP TWO:**

**First Year on Mars**

Things to consider:

Mars has 1/2 the diameter of Earth and only 1/3 the gravity.

All outside activity will require spacesuits.

Supplies will be getting low after landing.

The soil is rich with minerals and there is ice at the poles.



2.A.1) Rank the following in the order of which you think they should be built.

- |                                 |                                  |
|---------------------------------|----------------------------------|
| _____ Communication Center      | _____ Living Quarters            |
| _____ Sleeping Quarters         | _____ Food Preparation Facility  |
| _____ Water Production Facility | _____ Entertainment Center       |
| _____ Exercise Center           | _____ Oxygen Production Facility |
| _____ Food Production Facility  |                                  |

2.B.1) Setting up food production facilities (farms). (example: Chemist)

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

2.B.2) Designing and constructing permanent buildings.

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

2.B.3) Providing medical treatment, advice and counseling.

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

-----  
**STEP THREE:**

**After the First Year on Mars**

Things to consider:

Food, water, and oxygen production facilities are now working.

You must establish a long term plan for expansion.

What type of government will be created?

How much control will Earth have in your affairs?

3.A.1) Surface construction: Surface very cold; Heavy dosage of harmful radiation; Meteor strikes; Tremendous dust storms----Less energy required; Safer; Windows to see outside.

Underground construction: Slow building; More energy;

Dangerous for workers----Less building material; Abundant protection.

Surface construction? \_\_\_\_\_ Underground Construction? \_\_\_\_\_

3.A.2) Should you use money?

3.A.3) Single purpose buildings or private homes?

3.A.4) Should new Earthlings join your group, putting your people at risk, or start their own colony?

3.B.1.) How many think they would be selected with their career selection now? \_\_\_\_\_

## **8. College/University Information**

### ***a. Explanation***

**Prompt:** In the previous sections of the seminar, students were given the opportunity to combine personal interests with possible space careers. This portion of the seminar will introduce information concerning (1) description of actual college courses and majors, (2) which colleges and universities offer courses and majors in areas that might be advantageous when pursuing an aerospace career (3) scholarships available and/or ways to find out about scholarships, and (4) after receiving a degree, the job opportunities available in a variety of aerospace fields. The colleges and jobs "emphasized" in this portion of the seminar will change depending upon which state the seminar is held. (California will be used to provide an example of the information content that would be presented at each seminar. Education and job opportunities from around the country will also be offered since many students have expressed interest in travel for both college and/or careers.)

### ***b. Begin College/University Selection Process Section***

**Prompt:** The "COLLEGE/UNIVERSITY CHOICE QUESTIONNAIRE" in Appendix D will be used for this section to assist the students in defining what their interests are concerning majors and colleges/universities.

**Prompt:**

1. Students should write answers to the questions in the "COLLEGE/UNIVERSITY CHOICE QUESTIONNAIRE" when discussed during the seminar.
2. Three necessary choices: (1) What majors are of the most interest, (2) Where would the student like to attend, i.e., local, in-state, or nationally, and (3) Which colleges are practical or possible, i.e., a high school senior with a B average will probably not be accepted to MIT's mechanical engineering program.
3. Most students change majors several times before graduation, so look for several majors of interest at the same college.
4. Graduating with one particular degree does not restrict the individual from pursuing other job opportunities. Careers can be made up of a variety of work experiences.

5. When first making college selections, students should not restrict themselves by worrying about too high of costs. Methods of obtaining scholarships will be discussed during this presentation to help those needing financial assistance.
6. The order in which the questions appear is not necessarily how everyone should rank its importance.

**Orator:**

1. "What majors or degrees am I most interested in obtaining? Select at least three."

**Prompt:**

- a. Each student should search for colleges or universities which have several of the top choices.
- b. Because numerous majors and degrees will be presented later, students' choices may change.
- c. Each individual should find the right order in which to rank the questions. For some, location may be very important, others may feel the school with the best reputation in a particular field is the most important thing to consider. But all of the questions should be answered to some degree to give the student a fair chance.

**Orator:**

2. "Where can I go to get good information about different colleges and university?"

**Prompt:**

- a. Attempt to contact as many sources as possible and write down ideas from each.
- b. High School counselors will normally have the most current information.
- c. Parents, teachers, and/or professionals working in the field are good sources of information.
- d. Write or call college and university Admissions Offices. Several addresses are listed in the "student folders."
- e. Related books which are designed for students, counselors, and parents.

"LIMITLESS HORIZONS: Careers in Aerospace" by Mary H. Lewis, Washington, DC, Academic Affairs Division, National Aeronautics and Space Administration, 1980

"SPACE CAREERS" by Charles Sheffield and Carol Rosin, New York: Quill, 1984. There is a list of 210 "Suggestions for Colleges" including addresses from all 50 states, Washington, DC, and Puerto Rico, pages 64-71.

"The ASTRONAUT Training Book for KIDS," by Kim Long, Dutton: LODESTAR BOOKS, 1990.

**Orator:**

3. "Which are the best schools available that offer the degrees I am interested in acquiring?"

**Prompt:**

- a. Do not let monetary problems restrict early choices. Scholarships are available for students willing to pursue them.
- b. The places to look for information on this subject are the same as for majors and degrees. Although, magazines will probably have the most current rankings of colleges/universities.
- c. Even if a college/university is not "ranked" as one of the best, the student can still receive the best possible education for themselves from a lower ranked school. Rankings should be considered as subjective and not the gospel truth.
- d. Numerous considerations will determine how each student personally ranks their choices of colleges/universities.

**Orator:**

- e. "In your packet is a one page example of the type of magazine article you might find interesting. Please refer to *U.S. NEWS & WORLD REPORT*, March 19, 1990 for complete information on the survey."

**Prompt:**

- f. Also, included on the same page is "see *U.S. NEWS & WORLD REPORTS*, October 15, 1990 for several articles on "America's Best Colleges."

**Orator:**

4. "Where would I like to go to college?"

**Prompt:**

- a. If the student definitely does/does not wish to travel, numerous choices can be eliminated.
- b. Out-of-state college, university searching is more difficult than looking for a local school.
- c. Out-of-state tuition is generally higher.

- d. In each of your packets, you will find a page entitled "COLLEGE/UNIVERSITY CHOICES." [Ref. 28:pg. 4-14]

**Prompt:**

**COLLEGE/UNIVERSITY CHOICES**

Stanford University, Stanford, CA 94305

Aeronautical, Chemical, Civil, Electrical and Mechanical Engineer; Astronomy

California Institute of Technology, Pasadena, CA 91109

Aeronautical and Chemical Engineer; Engineering & Applied Science

University of California at Berkeley, Berkeley, CA 94720

Chemical, Civil, Electrical, Mechanical, and Material Science Engineer; Naval Architect.

University of Southern California, Los Angeles, CA 90007

Chemical, Civil, Electrical, Mechanical, and Aerospace Engineer

San Diego State University, San Diego, CA 92115

Civil, Electrical, Mechanical, and Aerospace Engineer

Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139

Aeronautical, Chemical, Civil, and Mechanical Engineer; Astronomy, Computer Science & Engineering; Electrical Science & Engineering; Material Science & Engineering, Naval Architect

Purdue University, West Lafayette, IN 47907

Aeronautical, Chemical, Civil Electrical, Mechanical, and Nuclear Engineer; Astronomy, Metallurgical Engineer

United States Naval Academy, Annapolis, MD 21402

Electrical, Mechanical, Systems, and Aerospace Engineer; Naval Architect

United States Air Force Academy, USAF Academy, CO 80840

Aeronautical and Civil Engineer; Engineering Mechanics; Engineering Science

United States Military Academy, West Point, NY 10096

Does not list their degrees in a similar manner.

United States Coast Guard Academy, New London, CT 06320

Civil and Electrical Engineer

**Orator:**

5. "What type of financial aid is available?"

**Prompt:**

- a. Again, the list of possible sources is the same as for majors and degrees.

- b. "Scholarships, loans, grants-in-aid, fellowships, work-study programs, part-time jobs and cooperative education programs are available to qualified students. [Ref. 1:pg. 71]
- c. One additional place to pursue scholarship information is from students' parents employers. Most of the larger aerospace firms offer employee's children scholarships.
- d. Many scholarships will go only to those that are willing to vigorously pursue the funding. Every applicant is trying to convince the scholarship granting authority that they are the most qualified and deserving individual to receive the scarce and valuable funds. Trying several times, in some cases, may be all it takes to succeed.

**Prompt:** The rest of the handout is for the students to complete at a later time. Recommend the students review the questionnaire every six months to see how the information or their choices have changed. And, one of the most important things to stress throughout this section is: Preparation is the best way to get the college of their choice. In other words, working hard and taking enough math and science courses in high school will get them ready for the challenges of college. The "COLLEGE/UNIVERSITY CHOICE QUESTIONNAIRE" will be put away in preparation for the next section.

*c. What Are College Majors/Courses and College Majors/Degrees?*

**Prompt:** This section of the seminar will introduce a variety of college majors or degrees that would apply towards an aerospace career. The best approach will be to offer information on numerous known majors/degrees that are currently being applied in the aerospace field. A series of slides will be used to elaborate on each type of major/degree. By adding several of the student responses from module two (audience response time) the idea that almost any major can be applied towards the aerospace field will be reinforced.

**Prompt:**

1. Remind the students that deciding on a specific major/degree does not have to be done before deciding at which colleges to apply.
2. Many students do not actually select their majors until the second year of college and most students change majors/degrees at least three times before graduation.
3. Having several choices will help with college/university selection.



4. The most important thing for each student to determine is what they do best, what they enjoy doing the most, and what direction they wish to direct their career.

Since engineering is the second largest profession in the United States, discussion will begin with descriptions of some of the engineering choices available to students.

**Orator:** "How many people think they know what an engineer is or does? See if this definition is close to what you thought of as an engineer."

**Prompt:**

=Slide= [Slides will be used during this section to offer visual stimulation]

**Orator:**

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... Some engineering activities associated with work in the aerospace industry are:

1. Design aircraft and spacecraft to meet aerodynamic specification.
2. Planning the layout of experimental wind tunnels.
3. Designing mechanical, electrical or electronic equipment or instrumentation.
4. Calculating the effects of heat, radiation and pressure on the structure of satellites or interplanetary probes. [Ref. 5:pg. 46-47]

**Orator:** "From the definition, you can see that "engineer" is rather a broad term. What are some of the specific types of engineers that would apply towards a space career? Here are some examples."

**Prompt:**

=Slides=

**Prompt:**

1. **Aeronautical Engineer:** works with aircraft inside Earth's atmosphere. Ex. Airplanes, wind tunnels.

2. **Aeronautical Engineer:** works with spacecraft, missiles, and other items related to flight in space. Ex. Space Shuttle, rockets.
3. **Biomedical Engineer:** combines medicine with hardware design. Ex. Spacesuits, toilets/showers
4. **Ceramic Engineer:** works with non-metal material production. Ex. ceramic tiles for the Space Shuttle
5. **Chemical Engineer:** works with chemical and physical properties of material to produce better spacecraft components. Ex. water recycling, rocket fuel.
6. **Electrical Engineer:** works with computers, computer chips and wiring diagrams. Ex. computer control for rockets, communication.
7. **Mechanical Engineer:** works with steel, aluminum, plastic, and other material. Design entire structures. Ex. launch pad, Space Station structure.
8. **Nuclear Engineer:** works with safe production of nuclear energy. Ex. nuclear powered spacecraft, moon base power system.
9. **Systems Engineer:** combines the creations of the other engineers into single integrated products. Ex. robots, Space colony.

**Orator:** "What is available for students interested in other types of space careers?"

**Prompt:** The same type of discussion/slide presentation will be used to introduce this next group of majors/degrees. Also, this portion will lend itself well to introducing student choices. The following list is just an example of some of the possible student responses.

The orator will need to coordinate during the breaks which of these will be used for each seminar since each group will have different suggestions.

**Prompt:**

==Slide==

- |                     |                            |
|---------------------|----------------------------|
| 1. Mathematician    | 8. Chemist                 |
| 2. Statistician     | 9. Life Sciences           |
| 3. Physics          | 10. Biochemist             |
| 4. Computer Science | 11. Biophysicist           |
| 5. Human Factors    | 12. Microbiologist         |
| 6. Geologist        | 13. Administration Science |
| 7. Astronomy        | 14. Medicine.              |

#### ***d. What Are College Courses?***

A slide presentation similar to the one used in introducing majors/degrees will be used for college courses. The main objective of this section will be to acquaint students with college courses they can expect to see while pursuing an aerospace related major/degree. And the second objective will be to help tie together how different courses can be used for more than one type of major.

Students will understand the makeup of courses with similar titles to those experience in high school, i.e., calculus, physics, and chemistry, but will be unfamiliar with many of the other college course titles, i.e., differential equations, polymer chemistry statics, dynamics, and electromagnetic theory.

**Orator:** "How many of you have some idea about the type of classes you will be taking when you get to college? This section will be spent going over some of your choices. Ask if you have any specific questions."

**Prompt:**

1. Almost all colleges require a minimum number and type of standard courses, i.e., history, English, and math, the more engineering oriented majors will require greater amounts of math, science, and computers.
2. There is a great difference between the college catalog description of a course and what it really is. This is where the expertise of the orator will be most important, transforming college technical terms to understandable high school language.
3. Creativity with slides will also make understanding the complex explanations from the catalogs easier for high school students to comprehend, and more importantly, remember until they get to college.

**Prompt:** The list of possible courses to be covered is almost without end, therefore some research will be necessary during a pilot program to determine which titles explain the greatest amount to students. The following are only a few examples:

1. **Fluid Dynamics:** Basic physical laws to fluid systems, fluid statistics, dimensional analysis, viscous and compressible flow, normal and oblique shocks.

2. **Aerodynamics:** Inviscid, incompressible, and compressible flow over airfoils, wings and bodies.
3. **Astrodynamics:** An intermediate course in orbit mechanics. Topics include orbit determination, time and position in the orbit, orbit maneuvers, perturbations, rendezvous and docking. Emphasis is on the design and use of structural FORTRAN computer programs to solve real-world astrodynamics problems.
4. **Human Factors Engineering: Concepts and Theory:** History, principles, and guidelines of human factors as they impact the design of objects, places, and environments used by people. Emphasizes understanding the capabilities and limitations of humans as an integral part of human-machine systems and the translation of this knowledge into engineering principles and specifications.
5. **Dynamics:** Analysis of three dimensional motion of particles and rigid bodies. Kinematics include absolute and relative motion. Kinetics including force-mass-acceleration, work-energy, and impulse momentum. Vector solution methods are emphasized.
6. **Probability and Statistics:** Introduction to statistics, including data acquisition, measures of effectiveness, probability axioms, frequency distributions, sampling techniques, random variables, statistical inferences, confidence intervals, hypothesis testing, goodness-of-fit tests, reliability, regression and correlation analysis.
7. **Aerospace Physiology:** Physiological stresses associated with the aerospace environment. Emphasizes physiological mechanisms, environmental problems, and solutions that provide crew protection in aerospace operations. Temperature and pressure changes with altitude, respiratory and circulatory physiology, hypoxia and hyperventilation, pressurization and decompression, accelerative forces, high sustained G's and weightlessness, crash dynamics and restraint systems, physiological limitations of escape systems, sensory physiology, and human factors.

*e. How to Pay for College?*

1. **Scholarships.** Although SCHOLARSHIPS is the title for this section, funding for college/university education can come from a variety of sources: "Scholarships, loans, grants-in-aid, fellowships, work-study programs, part-time jobs, and cooperative education programs are available for qualified (and motivated) students." [Ref 5:pg. 71] This section which includes COLLEGE QUESTIONNAIRE also speaks of pursuing funding for each of the colleges/universities of interest to the students. Unfortunately, there are not any books available listing the various sources for students to search for scholarships, primarily because the fund sources and qualification rules change

on a regular basis or are different from region to region even within the same parent organization or society. Dan Koonz of the Junior Engineering Technical Society, JETS, states that several companies had attempted to put together an organized publication in which to offer students a complete guide to scholarship across America, none of them were successful. The motivation of each student will be the driving factor when it comes to how much funding is acquired for college. However, to assist the students this section will list some of the known sources to research further on their own.

**Prompt:**

1. National Science Foundation. For information contact: Forms and publications, National Science Foundation, Washington DC 20550, (202) 357-7861. [Ref. 25:inside cover page]
2. American Institute of Aeronautics and Astronautics, AIAA. For information contact: AIAA Director of Student Programs, 370 L'Enfant Promenade, S.W., Washington, DC 20024-2518. Must be a member to receive most publications.
3. Local U.S. military recruitment offices will have current information regarding all of the service academies and/or ROTC programs. The service academies offer complete scholarship programs whereas the ROTC programs may only offer partial funding.

Prior to the pilot program and each seminar, state scholarship programs would be researched. However, it is beyond the scope of this thesis to do so now.

## **9. Careers and Aerospace**

This section will offer the students a place to go after their college experience. Four areas will be described: (1) NASA, (2) DoD, federal agencies, (3) private industry, and (4) college/universities. If the student possesses some idea of where in the professional world they wish to work, the job of college and major selection becomes much easier. Slides will be used extensively through this section in order to offer the students a long lasting picture of where they will fit the best.

One of the primary goals of the seminar is not only to persuade students to pursue the harder math, science, and engineering subjects and majors, but also, to help find a place

in the aerospace community for their career goals. If they do not find a "typical" aerospace career, hopefully, from this seminar they will find how and where their particular interest can be used.

**Prompt:** For further information:

1. "CAREERS IN SPACE": An Educational & Career Guide For America's Space Program, *FINAL FRONTIER: The Magazine of Space Exploration*. 2400 Foshay Tower, Minneapolis, MN 55402, (612) 332-3001.
2. "Careers in Aerospace: WITHIN YOUR LIFETIME," a publication of the American Institute of Aeronautics and Astronautics, 370 L'Enfant Promenade, SW. Washington, DC 20024-2518.

*a. NASA*

**Prompt:**

1. Currently, astronauts are the most famous and well known of America's aerospace related individuals. Biographical data will be used on several of the 1990 astronaut selectees to acquaint the students with successful paths. Figure E.1, E.2 [Ref. 29:pg. 2-5] are examples of what will be given the students.
2. Included will be several figures with education and statistical information regarding the astronaut program.
3. For more information regarding the astronaut program, write to: NASA, Johnson Space Center, Astronaut Selection Office, ATTN: AHX, Houston, TX 77058.

### Selected 1990 Astronaut Candidates

**NAME:** Daniel W. Bursch, LCDR, USN, Mission Specialist  
**BIRTHPLACE/DATE:** July 25, 1957 - Bristol, PA  
**EDUCATION:** Vestal Senior High School, Vestal, NY  
BS, Physics, U.S. Naval Academy, 1979  
**CURRENT POSITION:** Student, U.S. Naval Postgraduate School

**NAME:** Leroy Chiao, Ph.D., Mission Specialist  
**BIRTHPLACE/DATE:** August 23, 1960 - Milwaukee, WI  
**EDUCATION:** Monte Vista High, Danville, CA  
BS, Chemical Engineering, U. of Cal. - Berkeley, 1983  
MS, Chemical Engineering, U. of Cal. - Santa Barbara, 1985  
Ph.D., Chemical Engineering, U. of Cal. - Santa Barbara,  
1987  
**CURRENT POSITION:** Research Engineer  
Lawrence Livermore National Laboratory  
Lawrence, CA

**NAME:** Eileen M. Collins, Maj., USAF, Pilot  
**BIRTHPLACE/DATE:** November 19, 1956 - Elmira, NY  
**EDUCATION:** BA, Math, Syracuse University, 1978  
MS, Operations Research, Stanford University, 1986  
MA, Space Systems Management, Webster University, 1989  
**CURRENT POSITION:** Student  
USAF Test Pilot School  
Edward AFB, CA

Figure E.1. Astronaut Biography Overhead

## Basic Qualification Requirements

### MISSION SPECIALIST

- \*Qualifying Bachelor's Degree in Engineering, Science, or Math
- \*Three years of related experience or equivalent
  - Master's Degree substitutes of 1 year of experience
  - Ph.D. substitutes for 3 years of experience
- \*U.S. Citizenship

### PILOT

- \*Qualifying Bachelor's Degree in Engineering, Science, or Math
- \*1,000 hours pilot-in-command time in jet aircraft
- \*U.S. Citizenship

### NASA ASTRONAUTS ON BOARD BY CURRENT AFFILIATION - JANUARY 1991

#### TOTAL

USAF		USN		USMC		ARMY		USCG		MILITARY		CIVILIAN		TOTAL	
MS	PLT	MS	PLT	MS	PLT	MS	PLT	MS	PLT	MS	PLT	MS	PLT	MS	PLT
8	20	6	11	2	6	6	0	1	0	23	37	37	6	60	43
	27		17		8		6		1		60		43		103

Figure E.2. Astronaut Qualifications Overhead



4. A slide presentation will help depict the different types of careers available at the many NASA sites.
5. Each primary NASA location and specialty at that site will be discussed. See Figure E.3. [Ref. 28:pg. 14]

Ames Research Center  
Moffett Field, CA 94035  
Aerodynamics, supercomputers,  
flight simulators, human factors.  
Includes Dryden Flight Research  
Factory at Edwards AFB

Figure E.3. NASA Field Centers

**Prompt:**

*b. Department of Defense*

6. The major players in the military space command structure are listed in Chapter II.
7. There are also several DOD operated research and development facilities located around the country; two of which are the Defense Advanced Research Projects Agency, DARPA, and Langley Research Center, U.S. Air Force Base. However, the list does not include many of the DOD research laboratories. These would need to be included when actually presenting the seminar.
8. The "Aeronautics and Space Report of the President, 1987 Activities," NASA, Washington DC, 1989 [use current edition], offers in great detail which of the other Government agencies are working in space and where. Department of Commerce, Department of Energy, Department of Interior, Department of Agriculture, Federal Communications Commission, Department of Transportation, National Science Foundation, Environmental Protection Agency, Smithsonian Institution, Department of State, Arms Control And Disarmament Agency, United States Information Agency.

**Prompt:**

*c. Private Industry*

9. Several publications have been listed which describe the many organizations and businesses where an aerospace career may begin.
10. A list of some of the various aerospace firms is enclosed in the student packets. Figure E.4 will be displayed to the students. [Ref. 28:pg. 13]

Aerojet General  
P.O. Box 1322  
Sacramento, CA 95813  
Rocket motors, advanced propulsion concept

Figure E.4. College/University Teaching/Research Staff

**Prompt:**

*d. Teachers*

11. Many people forget how important America's teaching profession is to the country's aerospace industry. Without highly qualified instructors at all levels of education, the United States would be incapable of producing the caliber of professionals that control the Government and private industry of today.
12. Although pay is not always as high as working in the private sector, there is a great deal of satisfaction from the teaching profession. Almost any teacher will tell the students the same thing.
13. A majority of the best research and development for the aerospace industry is done at colleges and universities across the country, thereby, providing two services at the same time: educating students while furthering technology.

**Prompt:**

*e. Masters and Doctoral Degrees*

14. Explain the procedures for obtaining a masters and doctoral degree.
15. Explain the many advantages and benefits from having a Masters and Doctoral Degree. The facts from the astronaut selection could be used again.

**Prompt:**

**10. Panel of Experts**

1. Introduce the panel of speakers, generally three to five. It will be composed of NASA, DOD, and private industry individuals, astronauts, and/or professionals.
2. The speakers, when ever possible, will be from the state in which the seminar is located. This will help the students associate with someone who has become successful from their own state.
3. This will be a question/answer period in which the students might ask experienced professionals about the aerospace field.

4. Request students to stand when asking questions.
5. Repeat all questions so that everyone in the audience knows which question is being answered.
6. Control the time so that enough is left over for the movie and conclusion.

**Prompt:**

**11. New Teachers (Conclusion)**

1. Each one of the students is now a teacher. They have numerous pamphlets that can be taken back to school and copied for friends, fellow students, and even more importantly, counselors.
2. Fill out the evaluation soon after getting home. Their responses will help make the seminar even better for future students.
3. Try to keep in touch through the NEWSLETTER by sending in a change of address when and if they move. The NEWSLETTER will contain updated information concerning new publications which might be of interest, new development in the aerospace field, college/university rankings when available, scholarships or other funding, and job opportunities.
4. Questionnaires will be sent periodically for a number of years to obtain information on how effective the seminar, the newsletter, and other aerospace educational programs have been in influencing the students to pursue aerospace careers.

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