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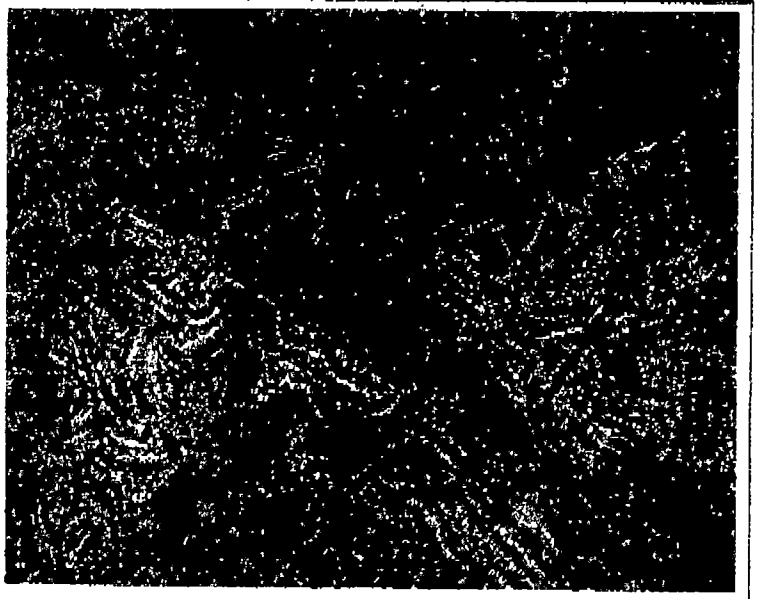
"We were close to maxed out on the number of aircraft we had there and could work effectively," Kendrick said. As it was, only two tankers at a time could make runs, due to the constrained area and the need to intermingle with the helicopters. However, he said, the CDF was able to fulfill all requests for aerial support from the city of Oakland.

The tanker fleet comprised mostly CDF S-2s, with a few other types from contract operators. The S-2s, which can haul 800 lb. of fire retardant, are Grumman piston-powered twins once used as carried-based antisubmarine warfare aircraft. One of the S-2s has been retrofitted with turboprop engines. Two CDF Bell UH-1 helicopters were used, along with a variety of other rotary-wing craft from private contractors. The Bells can haul 320 lb. of a water-based foam mixture.

The aerial activity over the fire scene was directed by a CDF fire-fighting specialist in an O-2—a military version of the Cessna 337 Skymaster—flown by a contract pilot. This team, coordinating with Oakland Approach Control, established ground contact, provided separations and generally "took control of the air over the incident," Kendrick said. "Oakland allowed us to do incursions into the TCA, with coordination by Approach Control," he said.

In addition to the intensity of the fire and the hilly terrain, the aerial activities were hampered by high winds, which "approached the limits of the aircraft," he said.

The heavy, dense smoke was also a problem. "You can't fly through it," Kendrick said. "You have to be able to see going in and coming out, and you have to have an escape route. You have to plan around the smoke."



Infrared imagery shows hundreds of homes burning in Oakland's Broadway Terrace, where Routes 24 and 13 intersect.

These conditions sometimes prevented pilots from dropping the 7,200-lb. load in the most effective manner—from about 100-150 ft. while flying at about 120 mph. After a drop, the tankers flew to the Sonoma County Airport—about 25 min. away—where they reloaded from a supply of retardant.

The helicopters were less affected by the wind conditions, and were able to maneuver into tighter spots and drop more accurately. However, their loads were much smaller, and the foam mixture they drop is considerably less effective than retardant, the CDF official said. The helicopters were reloading by dipping into lakes a few minutes away, and the ingredients to create foam were added while en route to the drop site.

Kendrick emphasized that while fire-fighting aircraft are highly visible, they rarely are able to extinguish major conflagrations by themselves. "We try to get in early and slow the advance until the ground forces get there," he said. "We are a holding action." □

French Order Launches Production of Canadair Turboprop-Powered Fire-Fighting Aircraft

BOSTON

The Canadair Group of Bombardier Inc. has formally signed a production of a turboprop version of its fire-fighting amphibious aircraft. The French government has ordered 12 of the new model, to be named the CL-415.

The $300-million (Canadian) contract, signed this month, allows production of the new CL-415 to begin next year with the first delivery expected to occur in 1994. Quebec also plans to acquire eight of the new production aircraft.

The CL-415 has fully powered flight controls, a new cockpit with electronic flight instrument systems and 15% more water capacity than its CL-215 piston-powered counterpart. One of the CL-415 turboprop-powered waterscoopers can drop 23,828 gal. of water on a fire during a 3-hr. mission, 41% more than a piston-powered version.

Canadair has been discussing the CL-415 with California officials in recent months. The turboprop version of the aircraft would be better suited to the hot-day flying conditions in California than the piston-powered CL-215. The waterbombers can scoop water from lakes, bays and even the ocean and make a bombing run on a fire every few minutes if a body of water is nearby. CL-215s have been used in North and South Carolina recently under leasing agreements.

Canadair also has a program to retrofit piston-model waterbombers with Pratt & Whitney Canada PW123AF engines. Spain has ordered 15 of the retrofit kits, and Quebec has two of its piston-powered models modified. Retrofitted aircraft are designated the CL-215T. □

Back To The Moon And Beyond...

"I am proposing a long-range, continuing commitment. First, for the coming decade—for the 1990's—Space Station Freedom—our critical next step in all our space endeavors. And next—for the new century—back to the Moon. Back to the future. And this time, back to stay. And then—a journey into tomorrow—a journey to another planet—a manned mission to Mars."
President George Bush
Air & Space Museum,
July 20, 1989

"I believe that before Apollo celebrates the 50th anniversary of its landing on the Moon—the American flag should be planted on Mars."
President George Bush
Texas A & I University,
May 11, 1990

"Our space program will help 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 communication, from medicine to metals, regaining and retaining America's high-tech competitive edge. It will create new technologies, new industries, and new jobs."
President George Bush

"Leadership is seizing bold opportunities—especially in uncertain times—and investing in the future."
NASA Administrator Richard Truly
Town Hall of Calif., March 7, 1990

"It's time to open up the final frontier. There can be no turning back. America's space program is what civilization needs to begin this journey, and to perfect the commitment to go beyond. Each time we go to the frontier and beyond, we bring back more than we hoped for. This time we have the chance to bring back more than we can imagine."
President George Bush
Texas A & I University,
May 11, 1990

"...Just as Jefferson sent Lewis and Clark to open the continent, our commitment to the Moon-Mars initiative will indeed open the Universe. It's the opportunity of a lifetime—and offers a lifetime of opportunity."
President George Bush
University of Tennessee, February 2, 1990

"Hard questions need answers based on hard data. The world does not have adequate environmental data now. And the only place it can get it is from space. Space offers the only true global perspective of our environmental system, with all its constituent parts. Space gives the world its best opportunity to understand how to preserve the beauty and bounty of our small planet for all generations to come."
NASA Administrator Richard Truly
Town Hall of Calif., March 7, 1990

"From the voyages of Columbus—to the Oregon Trail—to the journey to the Moon itself—history proves that we have never lost by pressing the limits of our frontiers."
President George Bush
Air & Space Museum,
July 20, 1989

"If the past indeed is prologue, American industry will transform the new aeronautics, space, and related technologies—that emerge from our programs—into

"...besides heading the Space Council, there's another Council that I chair—the Competitiveness Council. I believe the two are closely related and that space science and space exploration are crucial to our nation's technological and scientific development and economic competitiveness."
Vice President Dan Quayle
American Astronomical Society,
January 10, 1990

"Some say the space program should wait—that we should only go forward once the social problems of today are completely solved. But history proves that attitude is self-defeating... Many an American schoolkid has read the story of Columbus' doubters, and shook their heads in disbelief that these naysayers could have been so short-sighted. We must not let the schoolchildren of the future shake their heads at our behavior."
President George Bush
Marshall Space Flight Center,
June 20, 1990

"I believe that a great nation like ours, at the dawn of the 21st century, should explore space even if there were no tangible benefits on Earth. But of course there are... Environmental concerns are a top priority of peoples everywhere. Space can give us the means to understand the problems and devise solutions."
Vice President Dan Quayle
American Astronomical Society,
January 10, 1990

"Where are we going in space? We are going to build Space Station Freedom. We are going back to the Moon. We are going to Mars. And we are going to not only maintain, but also increase, the momentum of our magnificent space science program. All this is going to happen because American society needs the sense of purpose, American students need the inspiration, American business needs the new technology and the world needs the new knowledge. It is also going to happen because it is inevitable, and Americans are determined to be a part of it. We are a frontier people; this is the new frontier."
NASA Administrator Richard Truly
National Space Outlook Conference,
June 19, 1990

"NASA's budget is focused upon providing solutions to the problems we face in innovation, education and competitiveness."
NASA Administrator Richard Truly
Town Hall of Calif., March 7, 1990

"In the next century, space will be providing even more valuable products and services. New medicines and medical understanding from research and manufacturing in space could cure dreaded diseases and extend life. Material from the Moon could enable us to supply many of Earth's energy needs safely and cleanly from space. Space exploration could give us access to precious metals of various sorts—the equivalent of finding whole new continents on Earth."
Vice President Dan Quayle
American Institute of Aeronautics and Astronautics
May 1, 1990

space exploration initiative —I believe the most important spinoff of all because it has to do with kids. We believe it will inspire our children to do better in school. NASA's work—the space program, can inspire our children to achieve, especially in mathematics and science."

NASA Administrator Richard Truly
Down Town Assn., N.Y.C.,
June 9, 1990

each and every one of us."

NASA Associate Administrator
Arnold Aldrich
American Institute of Aeronautics and Astronautics
May 1, 1990

or my children, but a dream to be realized by future generations must begin with this generation. We cannot take the next giant leap for mankind tomorrow unless we take a single step today."

President George Bush
Air & Space Museum,
July 20, 1989

"Our goal is nothing less than to establish the United States as the preeminent space-faring nation."

President George Bush
Air & Space Museum
July 20, 1989

NASA

America's Space Program

An Investment in the Future

"And so as this century closes, it is in America's hands to help determine the kind of people, the kind of planet, we will become in the next. We will leave the Solar System and travel to the stars. Not only because it is democracy's dream, but because it is democracy's destiny."

"The recently launched Hubble Telescope might serve as a metaphor for a renewed spirit of basic exploration. But important for the understanding of the cosmos though it be, it is inadequate. A far better inspiration will be the manned missions to Mars and beyond—to which President Bush committed America on the 20th anniversary of man's reaching the Moon. These missions will involve more applied research. More importantly, they will symbolize directly what is at the heart of the American Romance: Man is meant to pioneer, to explore, to expand, to advance, to reach and exceed new frontiers. In this land of the Wright brothers and the Right Stuff, we must get beyond the policy equivalent of the fear of flying."

Office of Management and Budget Director Richard Darman Harvard University, May 1, 1990

"We expect yet another spinoff from the President's Space Exploration Initiative

"On the day that Benjamin Franklin flew his kite in a thunderstorm, did he foresee cities lit with electric lights, students and scientists using computers, and all the rest? Of course not. But the elements of discovery were in his hands, as they will be in the hands of Space Station Freedom astronauts."

NASA Administrator Richard Truly Town Hall of Calif., March 7, 1990

"Mars responds to a fundamental need in all of us. There is a human imperative to explore. People must explore because they are human beings with a desire to expand the scope of human experience. Exploration adds to our knowledge, satisfies our curiosity, and responds to our sense of adventure. We are going to Mars because we are alive, and because it reflects something very special inside each and every one of us."

"NASA is clearly not the Department of Education for the Federal Government. But let me tell you, in a sense NASA is all about education. We explore in our science programs. We invent and create in our technology programs and we stimulate, I believe, the very heart and soul of this country. NASA is an education agency because space is a stimulus and a magnet for learning."

Deputy NASA Administrator James R. Thompson Aviation Space Writers, April 21, 1990

"...in the coming century, first in space will mean first on Earth."

President George Bush University of Tennessee February 2, 1990

"In the decades ahead, we will follow the path of Pioneer 10. We will travel to neighboring stars, to new worlds, to discover the unknown. And it will not happen in my lifetime, and probably not during the lives of my children, but a dream

"James Michener was right when he told Congress: 'There are moments in history when challenges occur of such a compelling nature that to miss them is to miss the whole meaning of an epoch. Space is such a challenge,' he said."

President George Bush Air & Space Museum, July 20, 1989

"We are a nation of pioneers, and we love the challenge of the unknown."

Vice President Dan Quayle General Dynamics Facility, San Diego, July 18, 1989

"It's (Mission to Planet Earth) an effort of such magnitude, it dwarfs everything in the past—a worldwide study of the complex interactions between land, sea, ice and air—as well as between the Earth and the Sun . . . Initiatives like these mark a critical investment in America's future. They will help protect the environment, fuel an educational renaissance, and hone America's competitive edge."

President George Bush Texas A & I University, May 11, 1990

"Space offers the only true global perspective of our environmental system, with all its constituent parts. Space gives the world its best opportunity to understand how to preserve the beauty and bounty of our small planet for all generations to come."

NASA Administrator Richard Truly Town Hall of Calif., March 7, 1990

Texas A & I University,
May 11, 1990

products and processes that will capture world markets. It has happened in the past: it can happen again."
NASA Administrator Richard Truly
Town Hall of Calif., March 7, 1990

A Vision For The Future. . .

STATEMENT OF

RICHARD H. TRULY
ADMINISTRATOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BEFORE THE

SUBCOMMITTEE ON VA-HUD-INDEPENDENT AGENCIES

COMMITTEE ON APPROPRIATIONS
U. S. SENATE

June 28, 1990

Madam Chair and distinguished members of the Subcommittee:

I am pleased to have the opportunity to testify before you on the importance of mathematics and science education in America. NASA supports a strong education program which seeks to kindle students' instinctive interests in airplanes, spacecraft, astronauts, and space exploration to draw them into the disciplines of mathematics, science and technology.

I am especially pleased by the presence and testimony during the first Panel of two close colleagues -- Dr. Allan Bromley, the Assistant to the President for Science and Technology; and Dr. Erich Bloch, Director of the National Science Foundation. Although personal circumstances prevented Admiral Watkins, Secretary of Energy; and Dr. Ted Sanders, Under Secretary, U.S. Department of Education, from appearing today, they have sent very able people to represent them.

Each of our agencies has a vested interest in and national responsibility for improving mathematics, science, and technology education. Individually, our agencies' education programs reflect our special missions, specialized workforces and unique facilities. Collectively, we are using several promising mechanisms to work together. An extremely important collaborative mechanism entails NASA membership on the Education and Human Resources Committee under the Federal Coordinating Council for Science, Engineering and Technology (FCCSET), sponsored by the Office of Science and Technology Policy. Another includes a recently negotiated Memorandum of Understanding on Science and Mathematics Education between NASA

and the Department of Energy. We also consult with the National Science Foundation and the Department of Education on a number of science and math education areas.

At no time in our history has education been so prominent on the national agenda. The statistics that mark the education problem in this country have been talked and written about over and over. But quoting statistics won't make the problem go away. Statistics won't open our children's eyes to the excitement of math, science, and technology. We will need to take action to stimulate and implement educational reform.

Our country urgently needs a continuing supply of young scientists, engineers, and technicians to keep our nation economically and technologically competitive. The compelling national education goals set by the President and the Governors require that we develop more innovative educational outreach strategies, while retaining our proven educational programs. We cannot simply continue to do what we have always done, because that has proven not to be good enough.

I am tempted to tell you about NASA's exciting portfolio of education programs coordinated through the Educational Affairs Division of our External Relations Office and in concert with our nine field centers. This comprehensive array of educational programs parallels the diverse nature of our aeronautics, space science, and exploration programs. Our education budget is not large, but the unique aerospace content of our education programs provides great popular appeal. This and the participation in our programs by the professional education community makes our programs stand tall among all of the Federal agencies that conduct science and education outreach programs.

I would like to focus my remarks today on the educational policy changes that I have initiated to strengthen NASA's education program and on the new education outreach programs that have been started during my Administration.

Refocussed Education Policies

I have made several policy changes to improve the design and execution of our NASA Educational Affairs Program. The first change has been to clarify the mission of our external education program. The new mission statement directs NASA to conduct and promote aerospace education programs and activities, from elementary school through graduate school, in order to assist and inspire more of today's students to prepare themselves for careers in science, engineering, and technology.

NASA's educational strategy, in order to achieve this goal, is comprised of three elements designed: 1) to capture student

interest in science, mathematics, and technology at an early age; 2) to channel more students into science, engineering and technology career paths; and 3) to enhance the knowledge, skills, and experiences of precollege teachers, college and university faculty, and other educators.

NASA's educational strategy is closely aligned with the six national educational goals the President and the Governors have established for the nation. While we will address all of the President's goals, NASA is structured to make the greatest contribution to four. Those four goals concern increasing the high school graduation rate; enhancing student achievement and citizenship; making U.S. students first in science and mathematics achievement; and advancing adult literacy and lifelong learning .

To ensure a close coupling of NASA's activities with the President's goals, I have designated the Director of our Educational Affairs Division to be a member of the White House Education Summit Follow-up Committee.

In pursuing our educational programs, NASA leverages its aeronautics, space science and applications research programs to yield a wide range of activities, experiences and materials for use in the educational community. We deliver these educational resources to the community through a variety of ways. We have a small unique team of aerospace education specialists who conduct classroom and assembly lectures and give demonstrations. We develop supplementary curriculum materials and administer national student competitions. We provide fellowships and internships. We conduct and participate in educational conferences and conventions. We offer urban community education enrichment programs. We maintain computer data bases on aerospace education. And we conduct satellite video broadcasts to teachers around the country.

I have established NASA's educational programs as a separate line item, beginning in the FY 1990 NASA budget. Listed under the title of Academic Programs, this additional measure elevates and identifies education as one of NASA priorities. Our FY 1991 budget request for education is $50.1 million, representing an increase of 35 percent over the current $37.0 million program level.

Recently we began a process to update and convert NASA's existing Five-Year Educational Affairs Plan into a ten-year plan. In this way, the plan will correspond to the time frame of President's national education goals for the 1990-2000 decade. In addition to maintaining the three elements of NASA's fundamental educational strategy, this more comprehensive plan, entitled Science and Technology Literacy

for the 21st Century (STL-21) will also include the following guidelines:

* We will emphasize educational programs and projects that leverage our resources by having a multiplier effect on the target groups we seek to reach.

* We will substantially increase the number of underrepresented minorities, women, and handicapped participants in all of our educational programs.

* We will target all students, rather than just the traditional 5 percent who are highly motivated toward science and technical careers.

* We will use and promote increased application of educational technologies to deliver aerospace education programs. Among such programs are live and recorded lessons from the astronauts on appropriate Space Shuttle missions; satellite video broadcasts; expanded use of NASA Select for educational broadcasts; computer access information systems; laser disc technology; and educational software development.

* We will form additional partnerships with other Federal agencies, private industry, foundations and other organizations to coordinate educational resources.

New Outreach Initiatives

NASA's educational programs have one principal goal -- to increase the number of scientists, engineers and technicians available to contribute primarily to the civilian aerospace workforce, and secondarily, to other workforce segments of our economy. But to meet this goal, we need to have a comprehensive educational outreach program, from the elementary level through university level. The three elements of NASA's educational strategy have guided the development and evaluation of all NASA education programs. First, we know that students become interested in science, math and technology at an early age. Conversely, they can be "turned off" at an early age. Therefore, it is important to me that NASA has a broad outreach program to capture a student's interest in science, mathematics and technology at the elementary and middle school levels by using aeronautics and space as a vehicle of excitement. Second, once we have captured that interest, it is important to have a broad and diverse set of informal educational experiences that channel secondary and university students into science and engineering career paths. Third, it is not enough to have a comprehensive program only for students. We must leverage our resources and help our teachers and university faculty enhance and update their knowledge, skills and

experiences, thus providing a significant multiplier effect on their students.

Early in my tenure, I asked my staff to analyze our existing educational programs in light of the three elements of NASA's educational strategy just discussed -- capture, channel, and enhance. I challenged them to look for new ways to use NASA's exciting missions, unique talents of our staff and our unique facilities to determine how we could do more to help alleviate this national crisis in education. I would like to share with you some specific steps we are taking in this regard. And I would like to emphasize that I am providing only highlights of our programs in these three areas. In total, NASA is conducting over 150 separate educational programs; I am describing only a few.

Capture Student Interest in Science, Math and Technology at an Early Age

The Space Exposed Experiment Developed for Students project (SEEDS) is an example of one of our unique educational activities designed to stimulate student interest in science, mathematics and technology. This cooperative project between NASA and the Park Seed Company involved distributing to teachers some 12 million Rutgers tomato seeds that were returned to Earth after having been in orbit on NASA's Long Duration Exposure Facility (LDEF) for over five years. The space seeds, along with a set of control seeds and a Teachers' Guide, has enabled students to compare the seeds for germination time and rates, seedling vigor, phototropic responses and fruit products. More advanced students are performing chromosome and population genetics studies. Through this project, students are learning how to design their own experiments, test hypotheses, collect and classify data, make decisions, and report results. Since April of 1990, we have distributed over 100,000 space tomato seeds kits to elementary and high school teachers in every state.

By bringing together the talents of astronomy mission managers, the Space Shuttle astronaut crew of STS-35, and our educational staff, we are piloting a new approach of teaching live lessons from space. Our pilot effort will be applying the science of the Astro-I observatory to a topic taught at the middle school level -- the electromagnetic spectrum. This pilot effort involves teaching a lesson on the spectrum to students assembled at the Goddard Space Flight Center and the Marshall Space Flight Center. The educational lesson taught from the Columbia will be edited into an educational video tape that will be supported by a teacher's guide, slide set and poster so that the educational value can be shared in classrooms throughout the nation for years to come. More importantly, this pilot program forms the basis of a new working group I

have established to systematically develop educational plans related to specific NASA missions for the 1990's.

My view is that we must concentrate more and more on younger and younger people. It is not too early in kindergarten and even before to have programs to teach parents to do simple things to make their children receptive to the excitement of math, science, and technology. We talk a lot about the brilliance of some of our university students and the achievements of some of our high performers. At the same time, we cannot afford to lose the attention of the majority of our American youngsters where math and science are concerned.

Channel More Students into Science and Engineering Career Paths

Improved education for minorities, women and the handicapped will increase the availability of scientists and engineers for future programs and thus will prove to be one of the real solutions to the nation's educational competitiveness problem. The demographics of the work force is changing and if we cannot excite more young Black, Hispanic and female children about math and science, then we are not going to have adequate manpower to be competitive in the international arena. In this respect, NASA has initiated an innovative government/private sector program called the National Scholars Program (NSP) which I cited in my November 1989 report to the Congressionally mandated Task Force on Women, Minorities, and the Handicapped in Science and Technology.

The goal of NSP is to have all relevant Federal agencies and various private sector organizations fund a series of programs at the high school level through the graduate school level that would result in the production of more underrepresented minority science and engineering Ph.D's. NASA and the U.S. Department of Energy, through our Memorandum of Agreement, are getting the program started by folding into NSP many of our existing programs.

We are adding a new component to our highly successful Space Science Student Involvement Program (SSIP). Each year, over 1,000 junior high and high school students participate in a national competition by submitting proposed experiments that theoretically can be tested, for example, on a Space Station, in the wind tunnel at the NASA Langley Research Facility or the microgravity research facility at the NASA Lewis Research Center. The new component of the competition will involve research proposals for supercomputers and result in awarding Super Computer Internships at our Ames Research Center.

Another effort to influence the career paths of more students is our collaboration with the American Association for Counseling and Development (AACD). School guidance counselors

give students critical assistance in understanding the variety of careers available and in choosing the necessary courses to those career paths. Recently we convened an exploratory meeting with the AACD to look for ways to work together, including the development of new student materials concerning technical careers.

As we anticipate the increasing demands on our future science and engineering workforce, we have become even more sensitive to the important role of technicians, many of whom receive their education through community colleges. We have also come to appreciate that community colleges enroll a significant proportion of the nation's 12 million students in higher education, and that these institutions enroll approximately 40% of all minority students in higher education. Consequently, we have begun to examine ways in which our education programs, both external and internal, can work more closely with community colleges. We already have good experience with one model for this approach -- Kennedy Space Center's working relationship with Brevard Community College in Cocoa Beach, Florida.

Last year we carried out Phase I of the National Space Grant College and Fellowship Program. A major emphasis of this program is to provide both undergraduate and graduate fellowships to the 21 designated Space Grant Universities/Consortia with emphasis on recruiting women and underrepresented minorities. This new effort significantly increases NASA's existing fellowship programs to channel more students into the science and engineering pipeline.

Enhance the Knowledge Skills and Experience of Teachers and University Faculty

Reaching out to enhance, encourage and strengthen teacher skills is the third part of our strategy. It is a key element because it is where NASA has the best opportunity to leverage its resources and to ensure sustained change.

Recently we announced a new effort to infuse the theme of aeronautics and space into the training of teachers enrolled at colleges of education. Experience gained during this pilot program will provide us valuable information that may be useful to a broader set of colleges and universities in the future. The Learning About Science and Engineering Research (LASER) mobile teacher resource center was developed at the NASA Marshall Space Flight Center as a prototype NASA-industry partnership project. LASER brings NASA educational materials (e.g. teachers' guides, videotapes, software, slides, etc.) to those teachers not currently served by our existing teacher resource center network.

NASA is fortunate to have unique facilities to carry out its mission. NASA Select, our internal satellite video communications system, ties together all NASA Centers to provide communication in support of Space Shuttle missions and other NASA activities. While its primary purpose is mission support, this valuable resource can be used for education over extended periods. The footprint of our satellite system reaches all 50 states and is currently received by many cable TV systems as well as by those schools that have ground receiving stations. Soon, we will begin to utilize segments of the non-mission time on NASA Select for broadcasting existing educational and informational video tapes directly to teachers throughout our nation.

Our astronauts are seen as heroes and heroines by our nation's youth and their teachers. When visiting schools, astronauts can be excellent role models for children and adults alike as they relate their experiences and training. To use this resource strategically, I have created a new position for an educational specialist to work collaboratively with the Astronaut Corps at the NASA Johnson Space Center to seek out educational activities that enhance the training of teachers, capture student interest, and channel more students into the science and engineering pipeline.

One final example: we have begun work on defining a "Classroom of the Future." NASA, in its unique position at the forefront of many technology areas, is seeking to identify, define and develop a classroom that will take advantage of the latest technologies and learning strategies in using aerospace concepts in the teaching of science, math and technology. It is our intent to demonstrate this concept and to encourage its features be replicated by other classrooms around the country.

Conclusion

In closing, let me say that our nation must stop reacting to educational problems with short-term solutions. We must and can prepare long term strategies. Today, scientists and engineers comprise only 4% of American workers, but projections are that more will be needed in the future and it is obvious that their specialized and scarce skills are vital to our national welfare. Furthermore, all young people from kindergarten through high schools should also be exposed to mathematics, science and technology even if they do not pursue careers in these areas.

We have no choice but to provide this knowledge if we, as a nation, and our students, as citizens and job-holders, are to participate effectively in our world. I can assure you that NASA can be counted on to do our very best to help alleviate the national education crisis. We intend to be a reliable

partner in helping to implement the national education goals. We will continue to use our unique resources to conduct our aerospace education programs that capture student interest in science, mathematics and technology at an early age; channel more students into these career fields; and increase the knowledge, skills, and experiences of precollege teachers, college and university faculty and others.

Thank you.

"Engineers: Turning Ideas Into Reality"

National Engineers Week® February 16-22, 1992

By Admiral Richard H. Truly
NASA Administrator

Five hundred years ago, Columbus ventured into the unknown to seek a new route to the Indies. He discovered instead a new frontier with enormous potential for challenge, opportunity and expansion. Similarly, the exploration of space presents an endless frontier, bounded only by our knowledge and imagination.

In the past 87 years—a mere instant in the history of intelligent humanity—we have progressed from the sands of Kitty Hawk to the dusty plains of the Moon; from Robert Goddard's 4-second flight of a rocket 65 years ago to the passage of our Pioneer and Voyager spacecraft beyond the planets into the void of deep space. And just 10 years ago, the most versatile flying machine ever invented—the Space Shuttle—made its first thunderous ascent into space. Two days later this reusable aircraft was piloted—without engines—through the burning reentry into the atmosphere.

These monumental technological feats and discoveries are but a precursor of what is to come. This country is on the verge of a great new adventure—we will build Space Station Freedom, return to the Moon, and venture on to Mars. And, American students who enter the science, math, and technology pipeline, are the generation who will transform this idea into reality—they will be the first colonists of the Moon and the first Martians.

Man's desire to explore stems from our curiosity and desire to learn about our surroundings, to challenge the unknown, and to find what is to be found. Like Benjamin Franklin, Madame Curie, Benjamin Banneker, and Albert Einstein, we have been intrigued by the idea of making discoveries that may lead to important breakthroughs—in energy, medicine, transportation or materials.

Expanding our presence in space sets the stage for discovery. Across the decades, we have witnessed a revolution in discoveries and technological advances. Satellites have allowed global communications. Microelectronics, including information processing, was made possible by miniaturization driven by space programs. Military intelligence gathering has helped prevent nuclear war for a generation. More than 30,000 products and processes have been created to simplify and improve our quality of life. And a revolution of knowledge of our home planet, solar system, and the universe beyond affords us a new global perspective on our own precious planet.

One can only imagine the technologies which will allow humans to live permanently in space, build an outpost on the Moon, and explore Mars. To expand the frontiers of scientific knowledge will require our most powerful computer—the human mind. New technologies will emerge such as artificial intelligence, virtual reality, advanced robotics, ultra high-strength and high-temperature resistant materials, supercomputers, wireless power transmission, and many others. And, I expect that over the next quarter century of space exploration we will certainly experience a major unexpected breakthrough. Certainly, Benjamin Franklin did not envision New York City lit up at night or our digitized society when he flew a kite in a thunderstorm.

And finally, as we explore the solar system and expand human presence to other worlds, we will continually search for other life. Suppose some night we receive the dim remnants of a far away signal that is unmistakably not random, but intelligent? Fear would certainly grip some, while others would feel elation. Our sense of common humanity would be heightened and perhaps our earthly conflicts would seem trivial. Undoubtedly, mankind's curiosity would drive us to become eavesdroppers, decoding conversations of another civilization, to understand such things as what they are like, how they combat disease, and what traditions they hold dear.

Throughout mankind's existence, more than anything else, curiosity impelled us over the next hill, across the next river, across the ocean, then into the atmosphere, and now, into space. Soon, it will drive us to the next planet, then to its moons, and then on to the next and the next.

How fitting that during International Space Year 1992, nations around the world will cooperate in endeavors of exploration and discovery on the greatest frontier of all—the endless frontier of space. Twenty-nine national space agencies, ten affiliated international organizations, and the United Nations, have adopted the theme: Mission to Planet Earth.

One important emphasis of ISY 1992 is science education. I encourage you to join the wide variety of public and educational activities that will take place throughout the year to promote a new era of global cooperation in space. In 1492, 500 years ago, Columbus discovered the new world. To my mind, linking the discovery of the new world to international cooperation in the endless frontier of space during 1992 could not be more appropriate.

(Administrator Truly has been an active participant in National Engineers Week. He is an engineer.)

AIAA-92-1687
Space Education in the Context of U.S. Government Multiagency Efforts on Science and Mathematics Education

M. G. Finarelli, R. W. Brown and F. C. Owens
NASA-Headquarters
Washington, DC

AIAA Space Programs and Technologies Conference
March 24-27, 1992 / Huntsville, AL

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AIAA-92-1687

SPACE EDUCATION IN THE CONTEXT OF U.S. GOVERNMENT MULTIAGENCY EFFORTS IN SCIENCE AND MATHEMATICS EDUCATION

AIAA SPACE PROGRAMS AND
TECHNOLOGIES CONFERENCE
MARCH 24-27, 1992

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Abstract

This paper presents the status of an unprecedented multiagency endeavor to involve U.S. Federal agencies in the attainment of National Education Goals for the 1990s. The program was initiated after a 1989 summit conference of the President of the United States and the Nation's Governors, which led to the establishment of six National Education Goals. The Education and Human Resources Committee of the Federal Coordinating Council for Science, Engineering and Technology (FCCSET) is ensuring that Federal technical agencies' education programs are focused effectively on implementing the President's education goals by the year 2000. In April 1991, the President further emphasized the National Education Goals by introducing *America 2000* as an implementation strategy.

Within FCCSET, Federal program implementation priorities were derived from the National Education Goals. Following this initial step, program reviews were linked to the budget process in a crosscutting analysis that has provided an unprecedented level of understanding about total U.S. Government expenditures on education.

This paper originally presented at the 42nd IAF Congress in Montreal, Canada, and updated for the 1992 Spring AIAA Space Programs and Technology Conference, particularly emphasizes the educational activities of the National Aeronautics and Space Administration, which is one of 16 Federal agencies on FCCSET. NASA's is a prototype education program to achieve excellence in science and mathematics in the coming generations of Americans. NASA's Education Mission is to utilize NASA's inspiring mission, its unique facilities, and its specialized workforce to conduct, and to leverage externally conducted, science, mathematics, and technology education programs and activities. These efforts are directed toward helping to meet the National Education Goals and ensuring a sufficient talent pool to preserve NASA and U.S. leadership in aeronautics, space science, and technology.

This mission is implemented through two broad objectives:

1) Precollege Level: To use NASA's mission to demonstrate the integrated applications of science, mathematics, technology, and related subject matter by expanding curricula and instructional opportunities for teachers and students.
2) Collegiate Level: To support, through educational programs featuring active participation in NASA research, undergraduate and graduate student incentives and opportunities, and faculty preparation and enhancement.

NASA's strategy to achieve its education mission has three main elements: 1) to *capture* children's interest in mathematics, science, and technology at an early age; 2) to *channel* those students into mathematics, science, and technology career paths; and 3) to *enhance* the science, mathematics, and technology knowledge, skills, and experiences of teachers and faculty at all levels.

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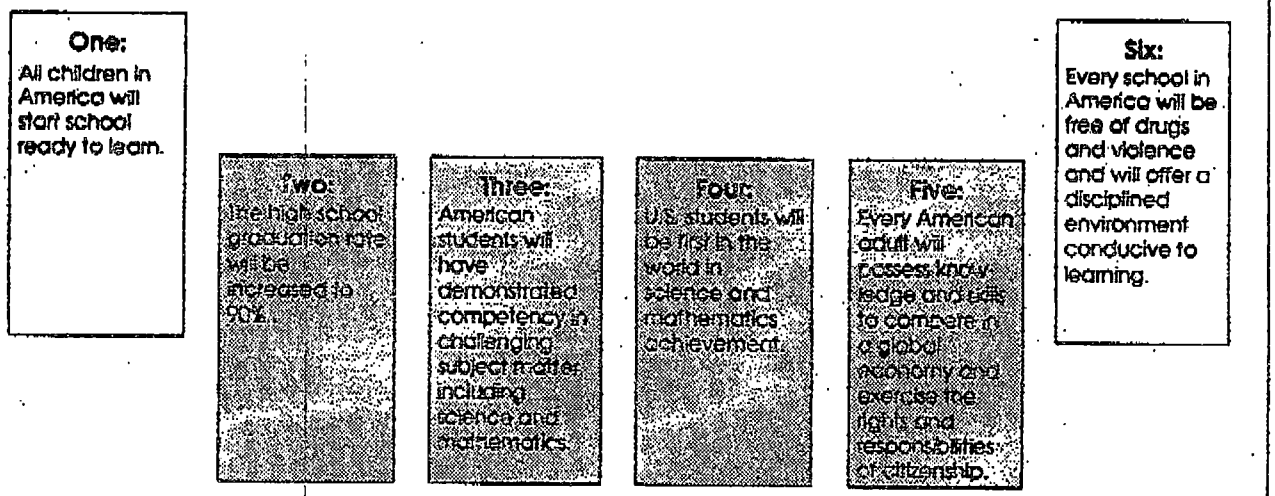
Figure 1. National Goals for U.S. Education by the Year 2000



The Challenge

A quiet crisis has been developing in American education for the past two decades. American student achievement is alarming compared to that of other nations. Particularly alarming is the lack of achievement in science and mathematics education as evidenced by:

- Declines in American student performance relative to international peers,
- Inadequate preparation and lack of current scientific knowledge among American teachers,
- Insufficient numbers of students pursuing education and training to fill critical scientific and technical jobs,
- Underrepresentation of women, minorities, and persons with disabilities in science courses and careers,
- Low levels of scientific literacy among the American public.

To be able to compete in the world markets of the 21st century, innovative and imaginative reform of America's educational system is needed.

This crisis in American education led President Bush to hold an Education Summit in 1989 with all U.S. State Governors in Charlottesville, Virginia. As a result, six national goals were developed for improving education in the United States by the year 2000. Figure 1 shows the National Education Goals, highlighting the four that are related to science and mathematics education.

Federal Involvement in Education

Education in America is a partnership effort involving Federal, State and local governments; educators and parents; business and industry; professional associations; and community-based organizations. The Federal Government, as a user and patron of a large segment of the Nation's scientific and technical workforce, has a direct stake in the quality of mathematics and science education.

Education is also decentralized in America. Only about 6 percent of the total national spending for elementary and secondary education comes from Federal sources. Nonetheless, the Federal Government can play a leadership role by highlighting national problems, mobilizing national support, and funding programs that offer unique national solutions and leverage State, local and private sector investments.

In addition to Federal dollars, other Federal resources are used to stimulate educational improvement. The Nation's vast and broadly distributed network of Federal scientific laboratories, technical facilities, and expert personnel present a largely untapped potential. These facilities produce science- and mathematics-related information and materials. In addition, volunteer teaching outreach conducted by Federal employees and their contractors can have a major impact on rapidly improving the basic science knowledge of American teachers and students.

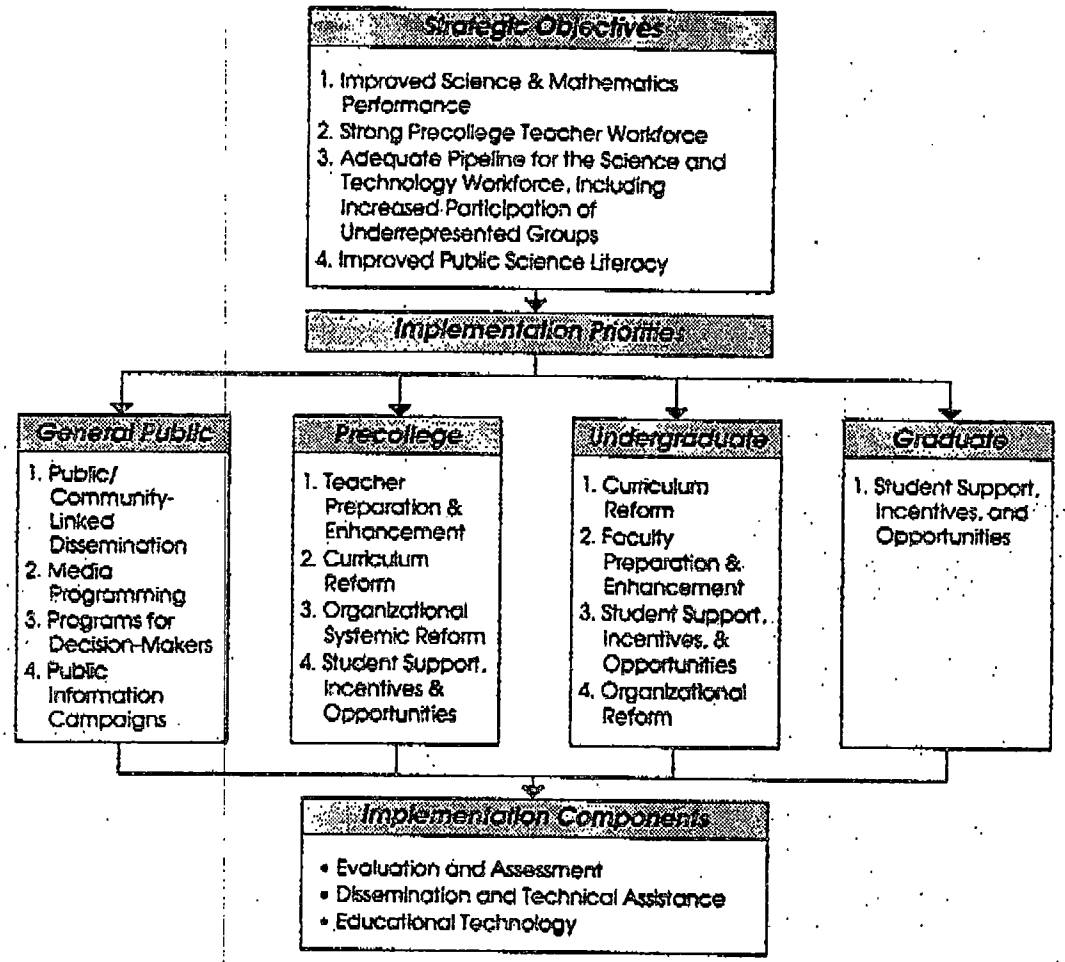
America 2000—The Strategy

In April 1991, President Bush introduced *America 2000*, a long-term Federal implementation strategy for the six ambitious National Education Goals. The strategy honors local control, relies on local initiative, affirms States and localities as the senior partners in paying for education and recognizes the private sector as a vital partner too. It has four components that will be pursued simultaneously:

- Better and more accountable schools;
- A New Generation of American Schools;
- A Nation of Students continuing to learn throughout life; and,
- Communities where learning can happen.

All 110,000 public and private schools nationally will be improved and made accountable for results. A new type of school will be created to meet the demands of a new century, with at least 535 coming into existence by 1996 and thousands by the decade's end. A Nation of Students will be created, with continual learning throughout life. And communities will become places where learning can happen. The Federal Government will set standards, highlight examples, contribute funds, and provide flexibility in exchange for accountability in the next nine years.

Figure 2: FY 1993 Federal Math/Science Education Priority Framework



FCCSET Role

The White House Office of Science and Technology Policy, part of the Executive Office of the President, is responsible for managing the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET), a body established to coordinate science, engineering, and technology issues across all agencies of the Federal Government. FCCSET comprises seven standing committees:

1) Committee on Earth and Environmental Sciences
2) Committee on Education and Human Resources
3) Committee on Food, Agricultural, and Forestry Research
4) Committee on Industry and Technology
5) Committee on International Science, Engineering and Technology
6) Committee on Life Sciences and Health
7) Committee on Physical, Mathematical, and Engineering Sciences.

This paper will discuss only one of the seven committees, the Committee on Education and Human Resources (CEHR), and its efforts at educational reform. This paper will also highlight NASA's educational programs implementing the National Education Goals and the *America 2000* educational strategy.

FCCSET Committee on Education and Human Resources

In May 1990, Dr. D. Allan Bromley, Director of the Office of Science and Technology Policy, Chairman of FCCSET convened the Committee on Education and Human Resources (CEHR) to look at the full range of science and mathematics education activities being conducted throughout the Federal Government. CEHR consists of key personnel working to facilitate educational objectives from 16 U.S. Government departments and agencies, 10 of which represent significant funding sources for science and mathematics education. The remaining six were those with potential resources to be developed. The purpose of the CEHR was to establish a unified Federal science, mathematics and technology education strategy to achieve the Federal portion of the National Education Goals effort.

During the spring of 1990, CEHR established four strategic objectives for improving mathematics and science education. These strategic objectives were derived from the National Education Goals. The CEHR next elaborated implementation priorities in all areas of education: precollege, undergraduate, graduate and general public education. Figure 2 notes the strategic framework designed by CEHR to address the three National Education Goals that specifically target achievement, competency and literacy in the sciences and mathematics. These are Goals 3, 4, and 5 as shown in Figure 1.

CEHR Budget Role

Following interagency agreement on strategic objectives and implementation priorities for the National Education Goals, CEHR proceeded to examine participating agencies' FY 1992 budget proposals for programs related to science and mathematics education.

The problems addressed in the President's National Education Goals and CEHR's objectives cut across the missions of many of CEHR's member Federal agencies. CEHR's recommendations, therefore, had the potential of ultimately revising budget priorities, eliminating unwarranted duplication, and sharing costs among agencies. CEHR's crosscutting budget analysis sought to improve the quality of individual agencies' budget proposals and of the President's FY 1992 budget recommendation to the United States Congress in the area of science and mathematics education.

The President's FY 1993 Budget proposes an increase of 11 percent over the FY 1992 enacted levels for these programs and a 44 percent increase over their FY 1990 enacted levels. In preparation for the FY 1993 budget submission, CEHR established programmatic and budgetary priorities for the continuation of existing programs and the initiation of new ones; systematically reviewed every program of every agency and established goals and milestones for each against which future progress could be measured; convened four program-based task forces to establish Government-wide program priorities and milestones in precollege, undergraduate, graduate and science literacy education; developed a new budget category—science literacy—to better emphasize and coordinate programs that reach a broader public; and encouraged agencies to assist with the implementation of *America 2000* reform efforts at the State and local levels.

The Future

The FCCSET/CEHR exercise developed strategic objectives and implementation priorities and led to the development of a budget for all U.S. Government agencies involved in science and mathematics education. This effort represents the first time the Federal Government had attempted to look comprehensively at this subject and led to a more improved, coordinated and integrated U.S. Government product.

The most important achievement of FCCSET-CEHR over the past year has been the maturing of the interagency process. Agency collaboration has advanced to the point where joint program activities are being recommended that capitalize on agency strengths. During this phase, the CEHR is concentrating on measuring the effectiveness of programs, refining goals and objectives, and coordinating efforts with other public entities and the private sector.

The follow-on CEHR program will set the reform of precollege education as the highest priority, with undergraduate and graduate reforms as priorities two and three, and public scientific literacy as priority four. To improve and restructure precollege education, the *America 2000* strategy proposes that new world-class standards for schools, teachers, and students in five core subjects, including mathematics and science, be enforced. To accomplish this, teachers will be trained in the latest technical and scientific knowledge. Hands-on activities will link curricula with the practical use of science in professions through contact with a valuable network of Federal experts and facilities.

It is also a CEHR priority, consistent with the *America 2000* strategy, that U.S. Government activities will increase the general public's knowledge and understanding of science and technology. In addition, by making sure that all programs reach out to better educate underrepresented groups such as women, minorities, and the disabled, the program will improve career awareness and educational levels of such individuals at all levels of society. It is hoped that successful programs will be replicated throughout the country and rated according to national standards.

NASA'S Role in FCCSET'S Educational Objectives

As one of the 10 agencies with significant funding resources for science, mathematics, and technology which is on the Committee on Education and Human Resources, the National Aeronautics and Space Administration (NASA), is responsible for the the United States' civil aerospace program, has had and will continue to have a major role in fostering American technological and scientific advancement.

NASA's Role

At present, virtually every science and engineering discipline is represented in NASA's 23,000 employees, 55 percent of whom are scientists and engineers and 68 percent of whom have college degrees. Furthermore, an additional 41,000 people, largely technical, work as private sector contractors on NASA projects.

In addition to conducting research and development on the world's most advanced aircraft and spacecraft, NASA conducts a coordinated program of basic and applied research in a wide variety of science and engineering areas. NASA is currently engaged in activities including human spaceflight, space operations, aeronautics and space technology development, space science, life science, and earth science and applications. Its ongoing mission includes charges to operate the Space Shuttle, explore the Solar System with robotic spacecraft, investigate the universe with Earth-orbiting telescopes, as well as to plan for future initiatives such as Space Station Freedom, Mission to Planet Earth and the Space Exploration Initiative. Maintaining an ongoing critical mass of highly trained professionals in science, engineering and other technical areas is critical to NASA's mission.

NASA's Educational Mandate

The National Aeronautics and Space Act of 1958 mandated that the first function of the agency would be fourfold:

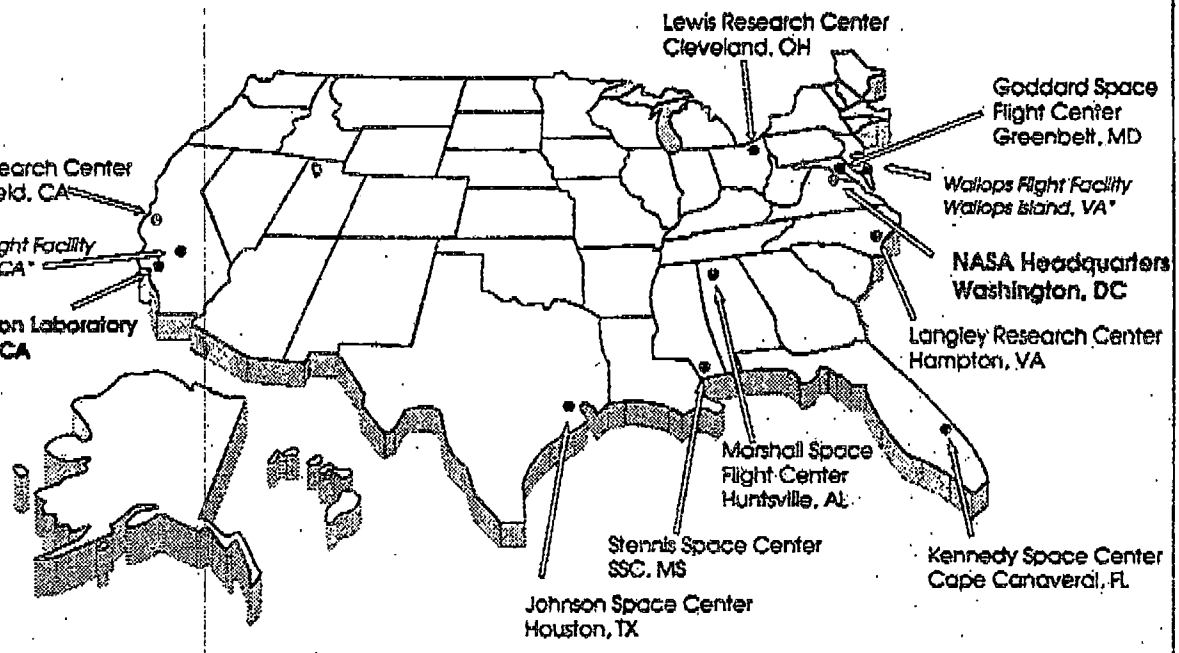
1) [Conduct activities that expand] human knowledge of phenomena in the atmosphere and space;
2) Arrange for participation by the scientific community in planning scientific measurements and observations;
3) Preserve the role of the U.S. as a leader in aeronautics, space science and technology;
4) Effectively utilize the scientific and engineering resources of the U.S.

NASA's educational mandate is derived from these components of the Space Act.

In pursuing its educational programs, NASA, through its Educational Affairs Program, draws on a team of highly skilled researchers at eight NASA Field Centers, the Jet Propulsion Laboratory, and two facilities under the Centers. All facilities have active educational outreach programs, serving students and teachers throughout the country (see Figure 3).

The NASA installations and facilities around the United States provide the agency with the expertise to conduct this outreach. The Lewis, Langley, and Ames Research Centers are leaders in aeronautics research, while the Jet

Figure 3. NASA Center Installations and Facilities Across the Country



*Wallops Flight Facility is under the direction of Goddard Space Flight Center;
Dryden Flight Facility is under the direction of Ames Research Center.

Propulsion Laboratory and Kennedy, Johnson, Goddard, Stennis, and Marshall Field Centers concentrate on space research and operations.

Expenditures for NASA's civil aerospace program in FY 1991 totaled $13.9 billion. For FY 1992, NASA's FCCSET-CEHR budget is $77.8 million for education programs, a 14 percent increase over FY 1991 funding.

NASA's 10-Year Education Affairs Plan

NASA is developing a 10-year Education Strategic Plan to take effect from 1993 to 2003, a period that essentially corresponds to the timeframe of the President's and Governors' National Education Goals and *America 2000*. The plan will anticipate requirements for future science, mathematics, and technology education and help to ensure that a skilled work force will be present to meet those requirements.

More than 160 NASA aerospace education programs and projects, from elementary through post graduate school, are currently in place. This network of programs will be expanded and refined in a manner that is consistent with the four FCCSET-CEHR strategic objectives of 1) improved science and mathematics performance, 2) strong precollege teacher work force, 3) adequate pipeline for science and technology work force, including increased participation of underrepresented groups, and 4) improved public science literacy.

In so doing, NASA will retain its fundamental three-part educational strategy that guides the design and implementation of all of its education programs. That strategy produces educational programs that *capture* student interest in science and mathematics at an early age; *channel* interest at the secondary, undergraduate, and graduate levels so that students pursue careers in science, engineering, and technology; and *enhance* the mathematics, science, and technological knowledge and teaching capabilities of teachers and faculties at all levels of education (see Figure 4).

NASA Offers Diverse Educational Opportunities

In pursuing its educational programs, NASA leverages its aeronautics, space science, and applications research programs to yield a wide range of activities, experiences, and materials for use in the educational community. Its educational resources are delivered in a wide variety of ways including classroom and assembly lectures and demonstrations, supplementary curriculum materials development, national student competition, fellowship and internship awards, urban community education enrichment programs, computer database management on aerospace education, satellite video broadcasts to teachers, and the Teacher Resource Center Network.

The following programs exemplify NASA's current initiatives to *capture* student interest, *channel* it into technical careers, and *enhance* faculty selected to achieve National Educational Goals.

NASA Programs to *Capture* Student Interest Early

Aerospace Education Services Program.

NASA employs approximately 35 aerospace education specialists who were formerly classroom science and mathematics teachers to visit schools from September through June each year to conduct student assemblies and classroom lectures. Driving a van called Spacemobile loaded with a wide variety of aerospace artifacts, these specialists, during the summer months, conduct teacher workshops at NASA Field

Centers and college and university campuses throughout the country. They develop aerospace curricula that enhance the teaching of science, mathematics, and technology. The program reaches more than a million students and approximately 20,000 teachers each year at a cost of $6 million. It has a 2- to 3-year waiting list of schools wishing to participate. This popular outreach program is being enhanced by increasing the number of Spacemobiles from 30 to 50 over the next several years to have at least one specialist assigned to each State in the Nation.

Space Science Student Involvement Program.

This program, jointly sponsored by NASA and the National Science Teachers Association, is a highly competitive national program that provides an avenue for middle and high school students to propose and theoretically test scientific and engineering experiments in facilities at NASA Field Centers. The program also includes Moon base mission and Space Station scenarios, space art projects, and journalism articles on aeronautics and space. During the 1990–91 school year, over 1,500 students across the nation directly participated in the program.

Space Classroom Assignment—The Stars.

This pilot program taught students at the middle school level about the electromagnetic spectrum. The lesson, taught by the shuttle crew of ASTRO-1, was edited into an educational videotape that is supported by a Teachers Guide, slide set, and a poster, so that the educational value can be shared in classrooms throughout the Nation.

NASA Programs to *Channel* Students into Science and Engineering Courses

Summer High School Apprenticeship Research Program.

This program is designed to encourage academically gifted, underrepresented minority students in grades 10 through 12 to explore professions related to science, mathematics and engineering. As paid apprentices for 8 weeks in the summer, each student works directly under the mentorship of a NASA Center scientist, engineer, or other technical specialist in a field that interests them. Approximately 225 students participate each year.

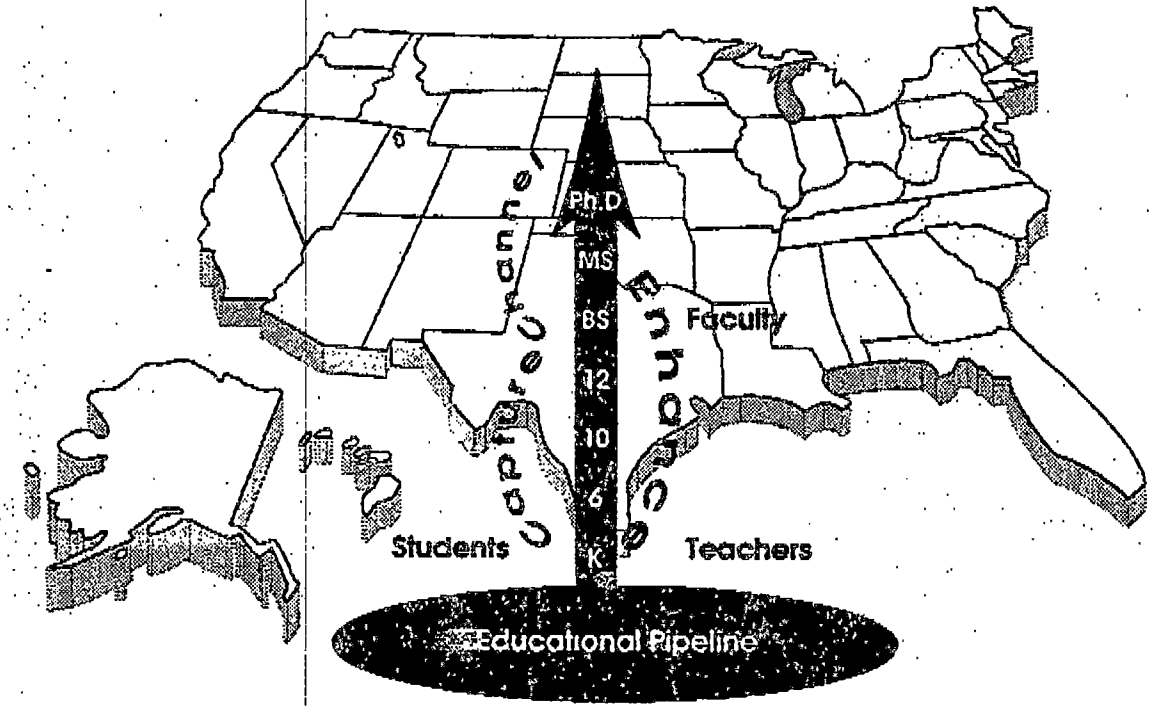
Baccalaureate Cooperative Training Program.

Students pursuing a bachelor's degree in aerospace, electrical, and other branches of engineering, or mathematics, and computer science at various colleges and universities, enroll in NASA's Baccalaureate Cooperative Training Program. A semester of college-level course work is alternated with a semester of full-time work experience at a NASA Field Center in this annual $7.4 million program. The approximately 1,800 annual graduates of this program make up 40 to 50 percent of NASA's engineering and science hiring each year.

Underrepresented Minority Internships

Approximately 16 awards have been made annually for the past 8 years to fund minority undergraduate and graduate students for degrees in science and engineering through

Figure 4. NASA's strategy to capture student interest, channel it into technical careers, and enhance faculty knowledge and skills to achieve national educational goals.



internships and interactions with role models and mentors at NASA Centers to supplement students' classroom work. This $5 million program has assisted 598 undergraduates, 10 graduate students, and 50 college and university faculty members.

Advanced Design Program.

Fourth year undergraduate engineering students, as part of their capstone course requirement, work on advanced mission topics of interest to NASA. Universities with accredited engineering programs submit design topics in the fields of space and aeronautics to the Universities Space Research Association, which manages the program for NASA. Now in its sixth year, the program fosters interdisciplinary projects and involved several hundred undergraduate students from 45 universities in 1991. Over the past four years, there has been increasing involvement from industry in this $1.6 million program which provides financial assistance and summer internships.

Graduate Student Researchers Program.

This NASA-wide program provides fellowships for graduate students to conduct thesis research at either a NASA Center or their home institutions. Currently, approximately 500 students are supported at a level of $22,000 for a year's fellowship. During the past decade, over 1,000 university students earned advanced degrees in aeronautics and space-related fields with this program.

Resident Research Associateships Program.

Managed for NASA by the National Research Council, this program gives post-doctoral fellows the opportunity to conduct research at NASA Field Centers. Senior one-year associateships are also awarded to those with a doctorate for more than 5 years, who have already made significant contributions in their fields.

National Space Grant College and Fellowship Program.

Authorized by Congress, the centerpiece of this program is State consortia, composed of colleges and universities, industry, and other organizations and institutions with an interest in aerospace education, research, and public service. Each consortium receives an annual grant for up to five years, a portion of which is targeted for fellowships for worthy undergraduate and graduate students. The remaining funds, which must be matched by funds from other sources, are used for research, education, public service (precollege outreach), and broadening and expanding existing capabilities in aerospace and related fields.

Community College Program.

As a new initiative, NASA has begun to focus more attention on community colleges as a valuable resource for supporting the Agency's goal to increase the number of science, mathematics, and technology majors. This initiative will also help NASA to increase its outreach to underrepresented minorities since approximately 40 percent of all minority students in higher education are enrolled in community colleges. In collaboration with the American Association for Counseling and Development, NASA is currently developing new student materials on technical careers to work closely with community colleges to educate technicians for the next century. The Kennedy Space Center has taken the lead in developing a model for this approach with Brevard Community College in Cocoa Beach, Florida.

National Scholars Program.

A new program concept entitled the NASA Scholars Program (NSP) is in the first phase of development. Serving as an "umbrella" for all of NASA's underrepresented minority programs, NSP is designed to build up to the education of 320 PhDs in science and engineering annually, by the year 2002. The program concept has six major components: a precollege feeder system; undergraduate NSP; graduate NSP; NSP reserve pools; and a computerized clearinghouse that will aid in identifying, selecting, tracking and monitoring NSP students. This will consequently also result in a larger number of B.A. and M.S. degrees. NASA will initially start the program with the U.S. Department of Energy through a Memorandum of Agreement, which will fold many existing minority efforts into the program.

NASA Programs to *Enhance* Teachers and Faculty

Educational Technology.

NASA operates *Spacelink*, a computer "bulletin board" that allows individuals to log on and receive news about current NASA programs, along with historical and astronaut data, lesson plans, educational publications, and classroom activities. Satellite video-conferences are conducted four times a year to teachers across the country. In addition, laser videodisc technology is used by NASA education specialists to help teachers develop interactive lesson plans on space-related topics and to familiarize teachers with materials available at NASA Teacher Resource Centers. NASA Select, the internal television satellite communications system, ties together all NASA Centers to provide communication during missions and activities. Reaching all 50 States as well as many cable systems and schools with ground receiving stations, it has started to use nonmission time to broadcast existing educational and informational videotapes to teachers throughout the Nation.

Innovative Education Programs.

A wide range of education programs use aeronautics and space themes to motivate students to learn science, mathematics, and technology.

Summer Faculty Fellowship Program.

NASA, in cooperation with the American Society for Engineering Education (ASEE), awards summer fellowships to engineering and/or science educators. The program furthers the professional knowledge of engineering and science faculty, stimulates an exchange of ideas between university faculty and NASA scientists and engineers, and contributes to ongoing research at NASA facilities. Approximately 200 participants receive a stipend and spend 10 or 11 weeks working at a NASA Field Center on aeronautics of space research. Specific research varies from Center to Center and is supplemented with enrichment activities such as short courses, workshops, or seminars.

Targeted Outreach Programs.

This is a focused effort to draw more underrepresented minority youth into the scientific and engineering work force from elementary through college. These programs range from technological updates for teachers to special enrichment and career orientation programs for students. Through 12 different grants, these programs directly affect 5,639 students each year, along with 110 teachers, who reach

another 3,300 students indirectly. NASA provides approximately 70 percent of the funding, with the rest coming from community organizations and the private sector.

Astronaut Corps Educational Specialist Position Created.

This new aerospace education position was filled at the NASA Johnson Space Center to enable the astronauts to provide shuttle mission related educational products to enhance teacher training, capture student interest, and channel more students into science and engineering.

Classroom of the Future.

NASA, in its unique position at the forefront of many technological areas, is seeking to identify, define, and develop a classroom that will take advantage of the latest technologies and learning strategies to teach aerospace concepts. The pilot classroom can then be replicated throughout the country.

Educational Partnerships

In addition to the above programs, many of NASA's educational endeavors are undertaken in partnership with a variety of organizations varying from the Council of Chief State School Officers to the Young Astronaut Council. There are 26 current partnerships with such national organizations. One example of such a program is NASA's partnership with the Challenger Center for Space Science Education. Under a Congressionally established trust fund, NASA supports the Challenger Center for Space Science Education, a nonprofit organization working to develop curriculum materials for use in the classroom. The Center also conducts workshops and other programs that enhance teachers' knowledge and skills in teaching science, mathematics, and technology. A national faculty of more than 100 highly skilled teachers run these programs.

Conclusion

The FCCSET CEHR has played a most significant role in seeking American excellence in science and mathematics—an outgrowth of the President's National Education Goals set in 1989 and the *America 2000* education strategy established in 1991. CEHR developed strategic objectives and implementation priorities for Federal Government science and mathematics education activities. It is also undertaking a comprehensive evaluation of existing Federal science and mathematics educational activities. In concentrating on the effectiveness of all agency programs, CEHR will be examining training programs, looking at public science literacy issues, and establishing effective linkages with State and local, private sector, and other non-Federal mathematics and science education reform efforts. Throughout CEHR's activities runs an effort to develop meaningful Federal budgets for science and mathematics education which coordinate and integrate all agencies' activities. Throughout the CEHR all relevant Federal agencies will be developing partnerships with cohesive and coordinated strategies to ensure that as a Nation we will be combining resources effectively to combat the educational problems facing the United States.

In all of these efforts, NASA will continue to be an active member of the FCCSET-CEHR team to help implement the National Education Goals with the thrusts of *America 2000*. NASA will accomplish this by using NASA's unique resources of exciting aerospace missions, a highly technical workforce, and its unique facilities to develop the scientists, engineers, and technicians for the Nation's future.

Bibliography

1. Bromley, D. Allan, Testimony before the Appropriations Subcommittee on Veterans Affairs, Housing and Urban Development, and Independent Agencies, U.S. Senate, "Mathematics and Science Education in the President's FY 1992 Budget," Executive Office of the President, Office of Science and Technology Policy, Washington, D.C. (April 23, 1991).

2. Brown, Robert W., Speech before the Annual Breakfast for Educators, Indiana University, Indianapolis, Indiana, "Science and Technology Literacy for the 21st Century (STL-21)" (November 1, 1990).

3. Bush, George. *America 2000: An Educational Strategy*, Department of Education, Washington, D.C. (April 1991).

4. FCCSET Committee on Education and Human Resources. *By the Year 2000: First in the World*, Executive Office of the President, Office of Science and Technology Policy, Washington, D.C. (February 1991).

5. FCCSET Committee on Education and Human Resources. *By the Year 2000: First in the World, Budget Summary*, Executive Office of the President, Office of Science and Technology, Washington, D.C. (February 1991).

COMMENCEMENT ADDRESS

New Community College of Baltimore
Baltimore, MD

June 9, 1991

Dr. Robert W. Brown, Director
Educational Affairs Division
Office of External Relations
National Aeronautics and Space Administration
Washington, DC 20546

COMMENCEMENT ADDRESS

New Community College of Baltimore
Baltimore, MD

June 9, 1991

INTRODUCTION

What a beautiful morning and glorious day to celebrate your academic accomplishments. Thank you Dr. Tschechtelin, and the faculty of the New Community College of Baltimore for inviting me to speak on this proud occasion. I am delighted to be here.

Here, as well as across the country, community colleges represent more diversity by race, gender, ethnicity, and age than any other of our society's educational institutions. In a society still troubled by social division, tensions, and inequities, graduates of community colleges enter higher education and the workforce with the advantages of a multicultural perspective that can serve them well.

I believe that community colleges represent one of America's best chances to rescue our under-utilized human resources.

A commencement address is usually delivered by someone who commenced a long time ago, and I am no exception. I am a part of that "Grey Beard" generation that was born well before 1947. We were born before penicillin, polio shots,

frozen food, and contact lenses; before there were credit cards, dishwashers, clothes dryers, and before humans walked on the Moon.

Before 1945, we had never heard of FM radios, tape decks, word processors, yogurt, McDonalds, ... or of men wearing earrings.

In our time, closets were for clothes; Bunnies were small rabbits, and rabbits were not Volkwagons.

For us, timesharing meant togetherness, not computers or condos. A chip meant a piece of wood. Hardware meant hardware, and software was not even a word.

Grass was mowed, Coke was a cold drink, and pot was something you cooked in.

But I did not come here to romance about the past. Rather, I come with great admiration for the philosophy of the New Community College of Baltimore that acknowledges the traditions of the past, honors the present, but educates for the future. Your theme, "Start Tomorrow Today" is especially appropriate for this commencement.

The concept of education for the future is no stranger to us in NASA. I wish there were time enough to tell you about the nearly $70 million a year that we spend on external aerospace science, math, and technology education

programs for students and teachers, from elementary through post graduate school.

I wish there were time enough to tell you how education for the future has created a NASA-lead workforce that in the past two years has:

-- executed 16 consecutively successful Space Shuttle launches, including the current space life sciences mission;

-- sent the spacecraft Magellan to Venus and radar mapped over 80% of that hot greenhouse planet that used to be like our Earth;

-- sent Galileo on its 6 year journey to probe the planet Jupiter; and

-- sent the spacecraft Ulysses on its way to study the poles of the Sun, to obtain a fuller understanding of the Star on which all of life we know, depends.

I wish there were time to tell you about NASA's nearly 2000 Black scientists, engineers, technicians and administrators who perform critical roles in constructing our aeronautics and space future. They include Col. Charles Bolden, who piloted the Shuttle that launched the Hubble Space Telescope that, in spite of its cataracts, is producing some excellent science.

I wish I had time to tell you how aeronautics and space research and development benefits our every day life, here on this Planet.

But we will have to talk about these things at another time and another place.

However, when you leave the campus today, and begin to chart your course for the future, there are two ideas I would like for you to carry away in your memory bank.

The first is the importance of lifelong learning. And the second is the importance of responsible risk-taking in the learning process.

Life Long Learning

When we speak of lifelong learning, we are referring to the future by definition. Preparing for the future is usually perceived as an inspirational concept that is hard to argue with. But the fact is, in education, the future is often a hard concept to sell. The President of Michigan State University, John Biaggio, sadly concludes that we are limiting ourselves to the present 1990's, let alone the 21st. century. He observes that "now" is God.

One hears students and parents asking about "immediate payoffs," as if compliance with the requirements of the

current job market is the reason for higher education. Even in the research universities, we hear about the immediate payoff prospects of certain research functions, as if science is supposed to guarantee imminent marketable technologies in order to be deemed worth.

We seem to have forgotten that colleges and universities exist to educate a student for that last job, not merely train a student for the first one. In a world where instant gratification reigns, training becomes more attractive than education; technology becomes more enticing than science. And we sell out the future myopically, buying into the present. We make a virtue of this temporary paralysis by claiming we live in a bottom-line world where today is all that counts. Some even mistakenly call this "accountability."

Education is more than classes, homework, final exams, and degrees that represent the sum total of credit hours earned over several years. Education should be a lifelong endeavor.

The writer Robert Heinlein said, "learning isn't a means to an end; it is the end itself." If you continue to learn you continue to grow. The possibilities are endless.

Make the world your classroom. Learn from every job and every person that you meet. Squeeze everything you can out of every opportunity. Never refuse a chance to learn something new.

The advice that I remember best on learning is stated in the title of one of John Gardner's books: It says, "What I Can Learn After I Know It All."

One of the reasons I'm so impressed by the student body of the New Community College of Baltimore is because many of you have already embraced the concept of lifelong learning. You have overcome obstacles not encountered by most students at traditional four-year schools. The majority of you attended school part-time, juggling classes, families, and careers. Your presence here today is a testimonial to the rewards of hard work, perseverance, and dedication to learning.

Taking Responsible Risks

Responsible risk taking is a characteristic of successful lifetime learners. In order to get anything out of life really worthwhile, you have to go as far as you possibly can, and then go one step further.

Progress always involves risk. You cannot steal second base and keep your foot on first.

Certain risks are necessary and appropriate for our growth and self-realization. The word risk recognizes that not all ventures succeed. Even on those occasions there can be positive learning experiences. For the most part, we humans grow when we face the consequences of our behavior.

Mistakes are a natural part of life. We can learn by experimenting. Mistakes and failures can be important parts of our learning process. Thomas Edison tried over 9,000 kinds of filament before he found one that would work in a light bulb. Walt Disney went bankrupt five times before he built Disneyland. If we can accept our setbacks, we can continue to risk, learn, and move on with excitement and satisfaction.

Closing

If our nation is to continue to advance technologically, economically, and achieve its democratic ideal of fairness and social equity, we must have a continuing stream of educated citizens who pursue and create the future, with a zeal for lifelong learning and responsible risk-taking.

Your education at the New Community College of Baltimore has provided not only the tools for continued academic success, but also the key to personal growth and self-realization. I applaud your perseverance and dedication to your goals.

Keep learning, keep risking, and keep reaching for your dreams.

Thank you.

Office of Policy Coordination and International Relations

NASA Headquarters
Washington, DC 20546

FAX Message To : GARY GERSHOWITZ **Date :** JAN 16 1992

FAX From : John D. Schumacher

FAX Phone No. : (202) 755-3741

Office Phone No. : (202) 453-8305

Total Pages Including Lead : 32

MESSAGE :

Gary:

Further to our conversation of today, attached please find:

(1) America's Space Program--a compendium of quotes by the President and other senior Government officials regarding space, many of which contain education as a theme;

(2) Statement of the NASA Administrator regarding mathematics and science education to the VA-HUD-Independent Agencies Subcommittee of the Senate Committee on Appropriations;

(3) NASA Administrator's article, "Engineers: Turning Ideas Into Reality;"

(4) AIAA article by several NASA Headquarters officials entitled, "Space Education in the Context of U.S. Government Multiagency Efforts on Science and Mathematics Education;" and

(5) Commencement Address by the Director of NASA's Educational Affairs Division, which discusses space as an inspiration for America's youth to strive for excellence.

If you have any questions or require any further information, please call me at (202) 453-8305.

NASA

The Space Station Is Losing Friends

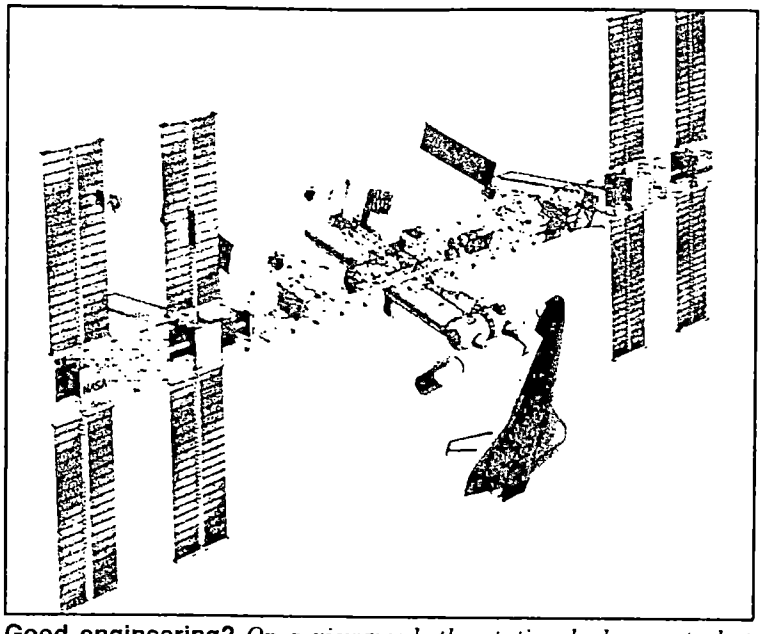
Even ardent space enthusiasts are low on patience: the ungainly structure NASA wants to build seems too big, too bureaucratic, and too risky. Is it time to start over?

WITH ITS ESTIMATED COST NOW standing at some $37 billion, and its purpose as a "permanently manned" orbital laboratory still as vaguely defined as ever, NASA's proposed space station *Freedom* is no stranger to political controversy. Lately, however, the proposal has begun to draw some scathing reviews for its alleged technical shortcomings as well: "The work that's been done to date is crap," says one particularly frustrated space station insider, who asked not to be quoted by name. "It's not even good engineering."

While other critics aren't quite so vehement on the subject, there is nonetheless a widespread perception in the space community that the space station program is rapidly sinking of its own weight. Increasingly, even the space enthusiasts who would like to see it used as a stepping stone to the moon and Mars won't support it. Take Thomas Paine, administrator of NASA during the Apollo moon landings, chairman of the 1986 National Commission on Space, and now a member of a White House committee on the goals and purposes of the space program: "The current space station program is no longer endorsed by most scientists," he declared in a 9 September letter to Martin Marietta chief Norman Augustine, who chairs the committee, "and is delaying, not advancing, the President's goals [for the exploration of the moon and Mars]."

Like many of the other critics that *Science* interviewed for this article, Paine thinks NASA would be far better off if it scrapped its current plan and found some simpler, cheaper, more evolutionary approach to working in space.

What bothers these critics is not just that the station will have to be launched in at least 28 separate payloads aboard the notoriously balky space shuttle, nor that it will have to be assembled and maintained in orbit by astronauts making hundreds of sorties per year in clumsy spacesuits—an issue that only became a top priority at NASA last spring after it was revealed in the *New York Times*. Nor, for that matter, are the critics concerned so much about technical flaws that might turn up in this piece or that piece of the station.



NASA

Good engineering? *On a viewgraph the station looks great—but there's no way to test it before launch.*

Instead, say the critics, their concern is with the totality of the station: what's going to happen when all the individual systems are finally assembled in orbit. The space station is going to be so big, so complex, and such an enormous leap beyond anything ever done before in space that nasty surprises are almost inevitable, they say. With no space station experience other than the long-fallen Skylab, last visited in 1974, NASA is trying to jump straight to a football field–sized facility that will reliably support human habitation for 30 years—with little chance for the engineers to experiment and learn along the way. "[The space station] has no period as a child. It immediately becomes an adult," says John McElroy, a former deputy director of NASA's Goddard Space Flight Center and now dean of engineering at the University of Texas in Arlington.

Worse yet, say the skeptics, there seems to be no feasible way to assemble and test the station on the ground before launch. Its first end-to-end test will be in orbit—an approach that is all too reminiscent of the fiasco of the fuzzy-eyed Hubble Space Telescope. Former Air Force Secretary and NASA Advisory Council chairman John McLucas put it bluntly: "What can't be tested, can't be trusted."

NASA officials, for their part, stoutly maintain that their space station design is the *right* design. "Early on in the decade we looked at more than a dozen structures" before settling on this one, says William Raney, special assistant to NASA's space station program manager Richard Kohrs. Moreover, he says, the basic design concept has been reviewed and endorsed many times since then by outside groups such as the National Research Council.

"Right" or not, however, the current space station design is now headed for its most thoroughgoing technical examination ever. Starting in November and continuing until the end of December, NASA's own space station design team is planning to conduct the first station-wide "preliminary design review," in which they finally get to put all the subsystems designs together and look for overall problems. Whether the official report will actually admit to any serious problems remains to be seen. But space station insiders speaking to *Science* off the record have pointed out several examples of the "Great Leap Forward" approach that they find worrisome.

■ **Vibrations in the truss.** The truss is the backbone of the station, the 120-meter spar that anchors the four crew modules in the center and that carries the 75-kilowatt solar panels out at the ends. It will be a fairly rigid object, being made as a latticework of stiff, graphite-epoxy rods. But nothing is ever perfectly rigid. The truss can therefore be expected to twist and oscillate in any number of subtle ways, all the while transferring potentially dangerous vibrations into the modules, the solar arrays, and anything else attached to it. So what will happen when the station's 90-minute orbit carries it from

the nightside of the earth to the dayside and the sunlit portion of the structure suddenly starts heating up and expanding ever so slightly? Then there's atmospheric drag, not a trivial matter for something as large as the station orbiting at the relatively low altitude of 400 kilometers: what kind of forces will drag exert on the truss and the sail-like solar arrays? And what kind of vibrations will be set up in the structure when drag brings the station into lower orbit, as it will, and the crew has to fire the built-in thrusters to regain altitude?

Since there is no way to reproduce the free-floating environment of space on the ground, the only way to answer such questions is to simulate the station on computers. Very large computers. And since the station will actually have to be assembled in at least 28 stages, with each partial structure flying on its own for a time, that analysis will have to be repeated at least 28 times.

Of course, there's nothing wrong with computer simulations in principle. The problem is that in this case, there's no way to know for sure how accurate the simulations might be because there's no way to test them against reality. No one has ever built a graphite-epoxy structure in space that's remotely the size of this one. Moreover, it's worth remembering that the Hubblespace telescope, quite aside from its optical problems, is plagued by a "jitter" in its solar arrays that all the elaborate analyses done before launch failed to identify.

■ **Thermal control.** Space is often thought of as cold. But in fact, the space station modules are going to be accumulating quite a bit of heat from experimental equipment, people, and sunlight. The trick will be to get rid of it.

The designers' current plan for thermal management calls for air-conditioners and heat exchangers inside the modules to dump the excess heat into pipes full of water, which will then circulate out of the modules and transfer the heat to a second set of pipes carrying a mixture of liquid and gaseous ammonia—a fluid that happens to be extremely efficient at moving heat around, but so toxic that no one wants it anywhere near the crew compartments. This second set of pipes will circulate the ammonia through a pair of fins out on the truss, where the heat will be radiated into space.

The ammonia system is a good example of off-the-shelf design, say those familiar with the program, since a similar thermal management system has long been used on the shuttle. But therein lies the problem. The shuttle system is not only an order of magnitude smaller than what's being proposed for the station, but it can be flushed out and refurbished if necessary every time the shuttle

Engineers Stymied by Chaos

Engineers at the working level of NASA's space station project say they would feel a lot better about their ability to make the station function properly if they thought that the agency's management structure were capable of dealing with large-scale issues coherently. Experience, however, suggests otherwise.

For example, says one project insider speaking off the record, "You can't point to X and say that's a bad design decision, because project managers don't even know what the design *is*." It keeps changing. In the years since the basic configuration was first laid out in the mid-1980s, budgetary reality and the post-Challenger limits on shuttle capacity have forced the station through several major redesigns and a host of minor ones. At any given time there may be dozens of change orders for engineers to keep track of—a situation that might as well have been created to help things fall through the cracks.

Take the issue of weight. The target weight for the completed station is 512,000 pounds, a figure dictated by constraints on the flight rate and lifting capacity of the shuttle. But this summer, when the station team finally started adding up the weight of all the individual pieces, in preparation for the preliminary design review the station is to undergo in November, the answer came up some 150,000 pounds over that target—enough to require at least another four shuttle trips. The result has been a fierce effort to "scrub" the design, to find everything that can be left off or pared down to save weight. The effort has been so fierce, in fact, that some engineers are beginning to wonder if this weight-loss regimen isn't beginning to compromise safety, reliability, and performance.

Exacerbating the chaos of constant retrofitting is the overweight structure of space station management: "The space station is a nightmarishly large, complex project," explains a station engineer, "not because it has to be, but because of history and politics." Former NASA administrator James M. Beggs, who started lobbying for a space station almost as soon as he was nominated for the post in 1981, has freely admitted that the project was largely intended to give the agency's research centers something to do after they got the space shuttle flying. After President Reagan endorsed the station in 1984, the project was accordingly divided among four major centers (Johnson, Marshall, Goddard, and Lewis), each of which then subcontracted most of the actual work to an aerospace company. The estimated cost of the station immediately began to soar. And by 1986, intercenter bickering had fragmented and stalled the project so badly that NASA headquarters was forced to add a whole new layer of centralized authority: the space station management office in the Washington, D.C., suburb of Reston, Virginia.

But then the Reston office developed its own instability. Managers deputized from the field centers would come in, stay a year or two, and go back home. Few of them have wanted to make a permanent move and pay Washington-area housing prices.

One consequence: Reston is only just now putting together an overall "verification" plan for the space station—the schedule laying out precisely how all the components and subsystems of the station will be tested or simulated before launch to make sure they work as required. Verification is hardly a new concern. Engineers working at the individual subsystem level have been thinking and worrying about it for years. Last year, a National Research Council panel singled verification out as a critical unresolved issue for the station as a whole.* And just this past summer, NASA's own space station advisory committee delivered a stinging critique of the central management's "continuing weakness" and underfunding of this area: "The baseline Verification Plan for Space Station requires considerable corrective action to correct significant deficiencies," wrote the panel, chaired by Martin Marietta president Tom Young.

In fairness, of course, Young's panel also said that the program's new station verification plan does look promising. Moreover, even some of the more skeptical insiders admit that NASA's leadership is trying hard to get issues such as weight and verification under control. But then, says one, the agency has already spent 6 years and $4 billion on this project. "It's amazing to me that the program got this far without understanding issues like weight and testing," he says. "They're only seriously addressing them now." ■ M.M.W.

* "Space Station Engineering Design Issues" (National Academy Press, Washington, D.C., 1989).

comes back to the ground. The space station version will have to operate 24 hours a day for 30 years, with no chance of having the station brought into drydock for an overhaul.

What makes this especially worrisome is that ammonia is not only toxic but corrosive, with a nasty habit of eating into valves and seals. So how are the astronauts going to do on-orbit maintenance if and when the system springs a leak? A careful design might eliminate that problem—but then, careful design was also supposed to eliminate the possibility of hydrogen leaks in the shuttle. Or what happens if the ammonia starts seeping into the water loop, and from there into the modules themselves? At 400 kilometers up, there's no stepping out for a breath of fresh air.

Thomas Paine Associates

Eyes on Mars. *The space station is delaying solar system exploration, says former NASA chief Paine.*

■ **On-orbit housekeeping.** The current design calls for the crew to occupy four modules on the station: one habitat module built by NASA for sleeping, eating, and relaxation; and one laboratory module apiece from NASA, Japan, and the European Space Agency. According to the mockups built so far, these modules will be bright, spacious, and engineered with painstaking attention to such "human factors" as comfort, ease, and privacy. But they are also supposed to remain in space for 30 years. So, even leaving aside the possibility of ammonia leaks, how is the crew supposed to prevent all the thousands of nooks and crannies from accumulating dirt, molds, bacteria, and ever increasing levels of subtle toxins? Imagine a submarine that's been continuously at sea since 1960, says one project engineer, and you'll know what those modules will be like after awhile.

The lesson of all this is not that such problems can't be solved, say project engineers, nor that NASA should never try anything new in space. It's that, when the agency does try something new, it should walk before it runs. After all, the Apollo 11 moon landing in 1969 was a Great Leap Forward, too—but it was preceded by nearly a decade of experimentation in the Mercury and Gemini programs and in Apollos 1 through 10.

This argument seems to be resonating with a good many critics of the station—including a surprising number of NASA veterans and other space afficianados who make no secret of their enthusiasm for President Bush's year-old "Space Exploration Initiative" for exploring the moon and Mars. On 19 September, for example, at a meeting on space station alternatives convened by a nationwide space interest group known as the Planetary Society, participants heard alternative plans discussed by such figures as Buzz Aldrin, the second man to walk on the moon; Maxime Faget, one of NASA's chief engineers on Mercury, Gemini, Apollo, and the shuttle; and Owen Garriott, a crew member on both Skylab and the shuttle. And shortly before that, on 9 September, members of the Augustine committee on the future of space exploration heard yet another alternative plan from Paine.

The specific details of these suggestions varied considerably. But their philosophy was basically the same: break the space station up into smaller, simpler, more self-contained components. One piece might be an orbital fuel depot for deep space probes, for example, while another might be a "man-tended" module full of automated materials science experiments, which would be visited and serviced by space shuttle astronauts only once or twice per year. The European Space Agency already has such a module under development, as does Faget's own start-up company, the Houston-based Space Industries (*Science*, 21 April 1989, p. 282). But in any case, say the critics, NASA should build up its capabilities step by step, so that it can learn as it goes, and so that mistakes and surprises won't be so devastating. And most important, the agency should get something up there quickly, so that it can start getting some real work done in space and so that the country can see something happening.

Without some such restructuring, says Caltech planetary scientist Bruce Murray, president of the Planetary Society and a former director of NASA's Jet Propulsion Laboratory, "a progressively less interesting, more costly, and more delayed U.S. space station program will become irrelevant to the United States...[and] there will be no future space program for the United States of importance."

When confronted with such suggestions, NASA officials quickly point to the serious political obstacles that prevent any real changes to the space station program. For one thing, they say, the agency is now enmeshed in a web of international agreements with Japan and the European Space Agency for their laboratory modules, and with Canada, which will provide a remotely controlled manipulator arm for servicing the station. In this country, moreover, the agency is embedded in a web of legal agreements with its space station contractors.

Nevertheless, the looming deficit may soon force NASA to take a more evolutionary course with the space station. Desperate to meet its deficit reduction targets, the Senate's VA–HUD–Independent Agencies subcommittee recently hacked out $864 million from NASA's $2.451-billion space station budget request; if that cut is upheld in conference with the House, NASA's 1991 space station budget will actually be lower than it was in fiscal 1990. With NASA itself estimating that the completed station will cost some $37 billion by the year 2000—a figure that includes not just hardware, but salaries, facility costs, and launch expenses—it's clear that something has to give.

William Lenoir, the astronaut who is now NASA's associate administrator for both the shuttle and space station programs, admitted as much in recent testimony before House space authorization subcommittee under Representative William Nelson (D–FL): If space station budgets are kept as tight as they now seem to be, said Lenoir, "We would have to go into what I would call architectural redesign"—a major rethinking of the space station.

Another strong push for change could come from the Augustine commission, created by the White House's National Space Council to reexamine the U.S. space program's overall direction and fundamental assumptions. The commission is scheduled to report on 15 December. And members say the space station question is clearly one they cannot ignore.

"If the Space Station Program is in good shape, our independent committee should establish this fact and endorse it," wrote Paine in a 9 September letter to Augustine. "If not, we must say so and recommend timely action."

■ M. MITCHELL WALDROP

Vice President for Space

Having helped to persuade President Bush to endorse an expanded U.S. space exploration program, Dan Quayle and his Space Council will have to flesh out Bush's goals.

BY DAVID C. MORRISON

Never mind the excited wave of expectation that swept over space buffs in recent weeks. Superficial appearances to the contrary, President Bush did not launch a dramatic, Apollo-style drive for a permanent return to the Moon and a voyage to Mars in his July 20 speech marking the 20th anniversary of the U.S. landing on the Moon.

He did, of course, assert that manned missions to those bodies were national objectives. But the National Aeronautics and Space Administration (NASA) has already sponsored two studies since 1986 citing the Moon and Mars as aim points for the civil space program. And the Reagan Administration's 1988 directive on national space policy laid out as an "over-all goal ... to expand human presence and activity beyond Earth orbit into the solar system."

There is, clearly, a world of difference between President Kennedy's straightforward imperative 28 years ago that "this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth" and Bush's far less specific assertion that "there's little question that in the 21st century, humans will again leave their home planet for voyages of discovery and exploration." The only hard commitment that Bush set for the 30th anniversary of the Apollo 11 moon walk, in fact, was "to have Space Station *Freedom* up there, operational and under way."

Lacking a firm schedule, much less a fierce national determination to best the Soviet Union in a space race—both of which drove Kennedy's initiative to fruition—Bush's interplanetary plans will not necessarily become anything more than an indefinitely deferred desire.

Bush's message that "we are committed to human expansion into the solar system" said John M. Logsdon, director of George Washington University's Space Policy Institute, "is already national policy, set last year. What this means for the 1990s is building a space station and providing the means for living and working in space, and then, in the 21st century, moving out. None of that costs you much money beside what you've already committed yourself to—completing the space station and working on some transportation."

Richard A. Bloom

Vice President Dan Quayle
Space program success could help rehabilitate his image.

At the same time, there is a subtle but potentially significant shift in emphasis between the Reagan Administration's vague nods at visiting our planetary neighbors and Bush's comparatively more emphatic call to action. If nothing else, this President's vision for space is at least headed in the direction of consuming a lot more money, even though NASA is having a hard time financing the projects to which it is already committed.

The key job of fleshing out the vision that Bush described in his speech will fall to his new National Space Council, which he called upon to determine "specifically what's needed for the next round of exploration, the necessary money, manpower and material ..., and develop realistic timetables."

The spark plug of the council—whose formal membership includes the heads of almost every Cabinet department—is its chairman, Vice President Dan Quayle. And Quayle—who is, in part, staking the rehabilitation of a political image badly muddied in last year's ugly campaign on his success in spurring this venture—is nothing if not bullish on space.

"The bottom line is, what kind of political support can we garner in the country?" Quayle asked in an interview shortly before Bush's speech. "That is why personally, I err on the side of boldness. Because I can't see, as chairman of the Space Council, being able to garner the political support that is necessary if you don't. Then, when the American people understand and are with you on this, it makes it far more difficult to sort of change directions, even though you have a change of Administration." *(For excerpts from the Quayle interview, see box, p. 1912.)*

TAKING THE LEAD

Rep. Bill Nelson, D-Fla., who chairs the Science, Space and Technology Subcommittee on Space Science and Applications and has written a book urging an international mission to Mars, is, in turn, bullish on Quayle and the Space Council.

John Eisele

New NASA administrator Richard H. Truly
The council saved the National Aerospace Plane program.

"I give credit to the Vice President," Nelson said. "I think he has taken this particular job very seriously, and, I think, in the process he is enjoying his role as chairman of this council. He is making a point to get himself informed about space."

Quayle was circumspect in describing precisely what advice he had urged on Bush. But the information that leaked from Quayle's zealous briefings on space exploration options to a group of aerospace executives on July 6 and to senior members of Congress's space oversight panels a week later did much to inflate expectations of what Bush would actually announce on July 20.

Some officials, in fact, were miffed at what they viewed as Quayle's enthusiastic free-lancing on the issue. "This is being written up as a Space Council initiative, but you'll find that federal agencies sitting on the council have not been consulted on this," said a Senate source who had received complaints on that count. "This is not really a Space Council initiative," he said, "it is a Dan Quayle initiative."

Rep. Robert A. Roe, D-N.J., chairman of the Science, Space and Technology Committee, attended Quayle's July 13 briefing to Members of Congress. "It was very effective and very substantive," Roe said. Three options were sketched out: establishing a science colony on the Moon as a base camp on the way to Mars—the direction in which Bush ended up pointing—bypassing the Moon and flying directly to Mars or simply expanding robotic exploration of space.

"It was basically a vigorous program that they were talking about," Roe added. "But there is no fait accompli; nothing has been finalized."

But what could be finalized at this point, with some weighty budgetary questions looming over space policy like a swollen harvest moon? Indeed, the surliest bond that must be slipped if we are to rove the solar system is not the Earth's gravity, but that fiscal black hole, the federal budget deficit.

For all the hoopla over space this summer, the House voted, on the very day of Bush's speech, to whack $1 billion out of NASA's $13.3 billion fiscal 1990 request. That cut included $395 million taken from the $2 billion requested for the space station, which is an essential stepping stone to the Moon and Mars. That bodes poorly for a redoubling of NASA's budget by the turn of the century, which the Congressional Budget Office estimates would be needed to pave the route to interplanetary space.

"Any new goal, in whatever year, is going to require the adequate resources to do it," NASA administrator Richard H. Truly emphasized during his inaugural press conference on July 13. "We have a NASA that can be built upon to take up major new challenges," he said. "But, I can tell you this, today's NASA can't do it. We have been through several years of very marginal funding, we have a lot on our plate, and to take on new challenges would require buttressing up the facilities and the people to do the job."

It is now up to the National Space Council to devise a plan that is stirring enough to persuade the public and Congress to come up with the tax dollars to pay for it. The public may prove hard to convince: In a new poll by the Gallup Organization Inc., only 27 per cent of respondents believe that space spending should increase, and only 51 per cent view having an American as the first man on Mars as a meaningful goal.

Absent new taxes, prying the money loose from Congress is not likely to prove any easier. "Let's get our feet back on Earth, Mr. President," House Budget Committee chairman Leon E. Panetta, D-Calif., challenged Bush caustically after his speech. "How are you going to pay for it? You can't go to Mars on a credit card. This trip will have to be pay-as-you-go."

EARLY TEST

In January 1986, the space shuttle *Challenger* blew up over Florida. President Reagan's Senior Interagency Group (Space), or SIG Space, took until August to recommend financing of a replacement. SIG Space was already the subject of much criticism, and that delay was the final straw for its critics. "Those of us who understood anything about space knew that we had to have a replacement orbiter, and yet it took the White House eight months to make a decision about a replacement orbiter," Rep. Nelson recalled. "That was because decisions were being made by indecision." *(See box, p. 1914.)*

Congress, in response, freighted the fiscal 1987 NASA authorization bill with a measure recommended that year by the National Commission on Space to establish a National Space Council and mandate its duties and membership. Reagan vetoed the bill, saying that it would interfere with his "discretion and flexibility in organizing and managing the executive office" and create "additional and unnecessary bureaucracy." NASA, for the first time since its creation three decades earlier, went without an authorization bill.

The next year, Congress tried again, only to pull Space Council language out of the bill at the last minute in the face of renewed veto threats.

Last year proved to be a different story. During a campaign stop at the Marshall Space Flight Center in Alabama the previous October, then-Vice President Bush pledged that if elected President, he would establish a National Space Council "in order to develop a comprehensive strategy for space." Early in the year, Nelson staged field hearings on the issue in both Iowa and New Hampshire, with the result that both parties' candidates climbed on board the space council bandwagon early on.

Nevertheless, when House conferees

Quayle: 'Err on the Side of Boldness'

On July 14, Vice President Dan Quayle met with reporters from *National Journal* and seven other media outlets over lunch in his Old Executive Office Building suite to discuss his work as chairman of the National Space Council. Here are excerpts from that interview.

On his political and personal commitment to the space issue
This is clearly a priority of mine. The President created the Space Council and placed me in charge of it, and it is an issue and an idea that will be around for a long time. I've invested a lot of my personal time, [and] I'd say I'm investing some of my personal capital in the space endeavor.

On having and selling a bold vision for space
It's very difficult to balance your dream world and things we'd really like to do with fiscal reality. But you cannot sit there and just say, "Oh, by the way, we'd like to do a thing like go back to the Moon and go to Mars and have a commitment to manned exploration beyond the robotics and the space station." You can't just sort of put that in a speech and make it on a rhetorical basis. You've got to believe it. You may get the cart ahead of the horse, and the rhetoric may be a bit ahead of where some of the fiscal realities have set in. But if you do it in the reverse way, then you're going to have this constant ebbing of commitment to space.... Personally, I err on the side of boldness, because I don't think you can get that sustained commitment without being bold and stating your goals and saying, "This is what we need to do."

Richard A. Bloom

The Vice President on the space program
Space "is clearly a priority of mine."

On his relations with Congress
I'll be very active [with Congress]. It's very important that we have Congress involved, because they have a lot of very good ideas. Some of the people sitting at that table have been far more involved and really are as knowledgeable—more knowledgeable—than I am about space. And some of them have even been there before.

On space commercialization
The private sector has sat on the sidelines because they questioned the government's commitment to space. They look at the bottom line, they look at the dollars. That's why I met with a number of chief executive officers in the business community [at a July 6 briefing, so they would know] that there is a new interest in space and that I would be coordinating that.

On recent reports that the Space Council would propose financing civil space with defense dollars
That is not in my thinking, not in the Space Council's thinking. I'm sure that there's some folks probably on Capitol Hill who would say, "Okay, we're for Quayle and what you guys want to do, so let's just slide it over to defense." At Defense, they were one of the first people who called. They said, "What about this?" And I said: "Sorry, it's not true. It's not my thinking."

On the council's plan to slow the National Aerospace Plane
The money that they wanted to pour into this program, it simply wasn't ready to absorb. Some of the people amongst the council said, "You're slowing it down too much." I said: "I'm not. We're getting pressure out there from certain contractors that just want money." I'm not interested in money; I'm interested in what they'll be able to produce.

On the Space Council's role in the Strategic Defense Initiative
Well, as the discussions go on, I've clearly had input through the National Security Council and just being where I am. I have an intense interest in SDI, so notwithstanding the role of the Space Council, I have a strong concern about where we're going with this Strategic Defense Initiative. But ... we're not getting into the programmatic decisions of SDI; we'll leave that to [Defense] Secretary [Dick] Cheney and others.

last October put the Space Council back on the table while amending the Senate-passed NASA bill, the White House again threatened a veto. Only after negotiations secured an agreement that the council would not be established until after he left office did Reagan finally sign the bill.

Considering how protracted was the course of its birth, it is ironic that the council was thrown into the bureaucratic fray at the beginning of March, a month and a half before Bush had even signed its charter.

A much-debated Reagan Administration decision to privatize the earth resources remote sensing program (taking high-resolution, multispectral pictures of the earth from space) despite its questionable commercial viability had left two operating Landsat satellites suspended over a budgetary chasm. *(See NJ, 7/25/87, p. 1903.)* In early January, the Commerce Department's National Oceanic and Atmospheric Administration (NOAA) put out the word that unless emergency funds were scraped together, it would be forced to shut the satellites down by the end of March.

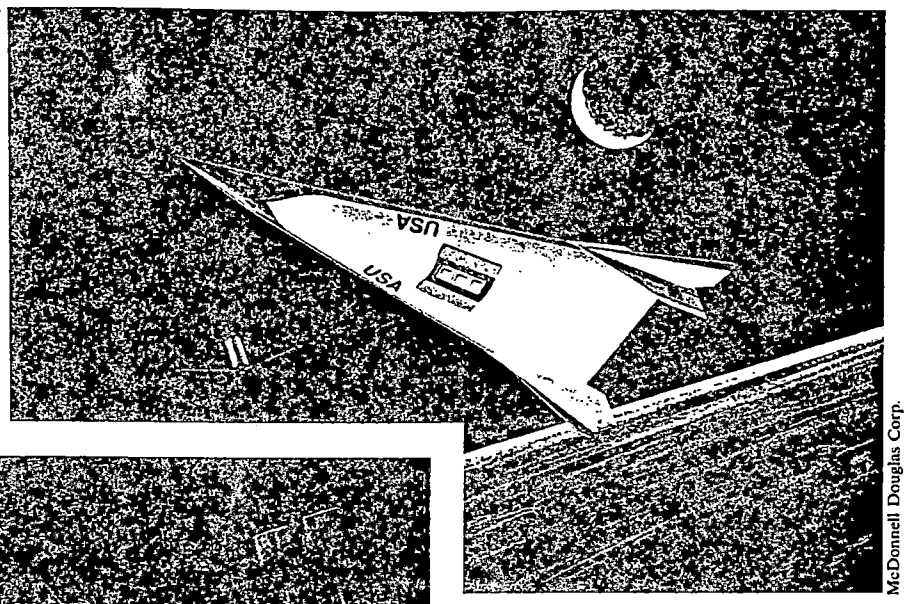
As the deadline neared, and as Congress began scheduling hearings on the pending crisis, Quayle moved into action. Several dozen officials from such interested agencies as the Agriculture, Commerce, Defense and Interior Departments and the CIA, NASA and the Office of Management and Budget (OMB) were called together to hammer out a solution.

Only that week, Quayle had tapped Mark J. Albrecht to serve as the new

Space Council's executive secretary. In fact, Albrecht was still working as a defense aide for Sen. Pete Wilson, R-Calif., on the day that Quayle gave him his marching orders to "not let this decision be made by a lack of attention."

"When I got briefed up for the meeting and walked into a room with 20-30 people who had been fighting [over Landsat policy] for nine years . . . , I couldn't even spell Landsat," Albrecht laughingly recalled. "But we needed $6 million pronto. So I said to this assembled group, all of whom are clutching their chairs, that we wouldn't leave until we had the $6 million and the breathing space to at least make an intelligent decision about Landsat."

Ninety minutes later, the money had been committed—with the Pentagon kicking in the lion's share. And two months later, at its first full formal meeting, the Council recommended a new Landsat policy that Bush subsequently endorsed. Landsats 4 and 5, now in orbit, will be sustained. Landsat 6, costing $257 million, will be completed and launched in 1991. The private EOSAT Co. will continue operating the satellites with revenues earned by selling the data they collect. But full privatization will be postponed until at least the turn of the century.



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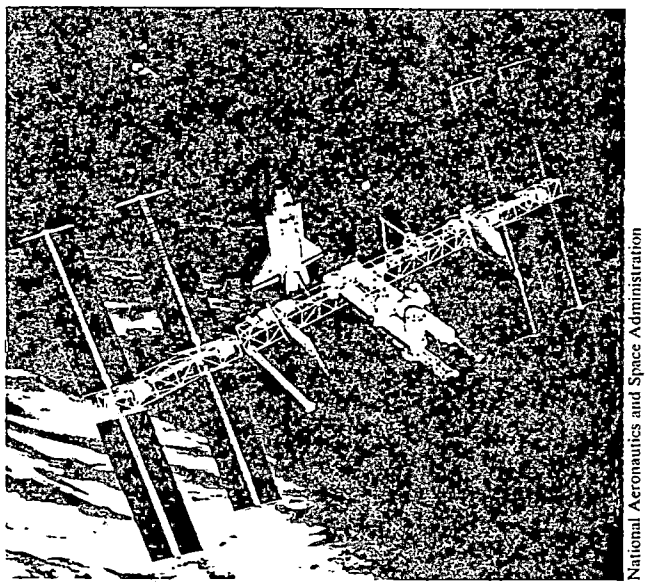
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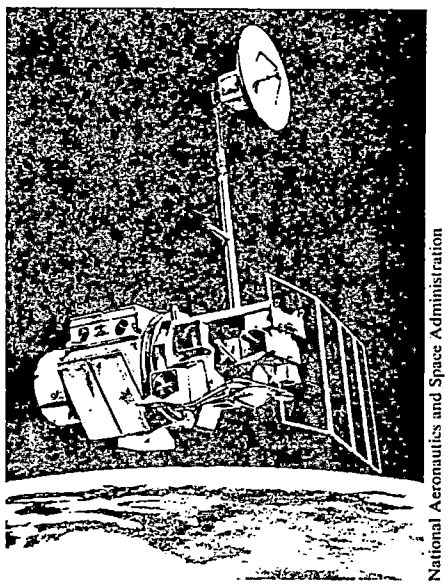
National Aeronautics and Space Administration

Aerospace Plane (top), Landsat (right) and space station
The Space Council has been active on all three projects.

"There had never been a statement of intent to assure the continuity of Landsat-type data beyond Landsat 6," said Thomas N. Pyke Jr., the assistant NOAA administrator for satellite and information services, who served on the council's Landsat working group. "All of that was new and represented a shot in the arm for the Landsat program."

Though the Landsat saga has been widely praised as a Space Council success story, it also shows that the council has no magic wand with which to wave away Washington's endemic money problems.

In marking up its spending bill in mid-July, the House Appropriations Subcommittee on Commerce, Justice, State, the Judiciary and Related Agencies failed to earmark the $19 million needed next year to operate Landsats 4 and 5. Commerce Secretary Robert A. Mosbacher had sent a letter of intent to the House and Senate committee chairmen. A subcommittee aide said, however, that "nothing formal had come over from the OMB at the time we marked up." In any event, he added, "We expect the other [Landsat-using] agencies to pay for that."

SAVING NASP

No sooner had the Space Council wrapped up the Landsat bailout than its second major crisis arose. In slicing $10 billion from his fiscal 1990 budget in mid-April, Defense Secretary Dick Cheney made a bid to bail out completely from the X-30 National Aerospace Plane (NASP) program. The Air Force was supposed to bear 80 per cent of the experimental hypersonic aircraft's $3.3 billion costs, and NASA was to pay the rest. *(See NJ, 6/24/89, p. 1664; 3/26/89, p. 798.)*

Quayle promptly phoned Cheney, persuading him to cut the Air Force's $300 million proposed fiscal 1990 NASP budget by only $200 million instead of eliminating it completely. In the meantime, the Space Council formed a NASP working group. At a June 30 meeting, it crafted a recommendation for Bush that would put the project on a new, slower course.

Instead of the Pentagon spending $689 million on the NASP over the next two years, the council would have it spend $285 million. NASA's two-year share would be $246 million. And, rather than make a decision in September 1990 on whether to build a hypersonic flight test vehicle, that threshold would not be crossed until March 1993. The first flight, consequently, would slip from 1995 to late in the decade, leading some to fear that the NASP will never take off.

One of Washington's most vociferous NASP advocates, A. Scott Crossfield, a former supersonic test pilot and now a technical consultant to the House Science, Space and Technology Committee, was furious about the new plan. The Space Council "put out our thousand points of light," he fumed in an interview. "They killed a program that came from grassroots America and went home to celebrate Independence Day."

A Reincarnated National Space Council

The National Space Council, formally chartered less than four months ago, is the reincarnation of an interagency space policy group born in the turbulent wake of Sputnik and killed off in the space slump after Apollo.

In drafting the 1958 National Aeronautics and Space Act, Congress created a Cabinet-level National Aeronautics and Space Council intended to unify federal space policy. To persuade President Eisenhower to sign onto the council, Senate Science Committee chairman Lyndon B. Johnson, D-Texas, made the President council chairman.

Nevertheless, Walter A. McDougall reports in *The Heavens and the Earth, a Political History of the Space Age* (Basic Books, 1985), Eisenhower never found much use for the council, which met only seven times during his Administration. He dozed off during a debate over a logo for the new National Aeronautics and Space Administration (NASA) during one of the council's sessions, and he later tried to abolish it, only to be foiled by Congress.

When John F. Kennedy became President in 1961, Vice President Johnson, a longtime space enthusiast, took up the council's reins. In April of that year, Johnson asked for and got from Kennedy a mandate "as chairman of the Space Council to be in charge of making an over-all survey on where we stand in space." A month later, in part as a direct result of Johnson's lobbying, Kennedy asked Congress in his famous "Urgent National Needs" speech for at least $20 billion for the Apollo Moon project.

The Space Council also played a role later that year in hammering out the 1962 Communications Satellite Act. But "thereafter, it became less important," said Alex Roland, a NASA historian from 1973-81 and now a Duke University history professor. "That [Moon project] decision solved most everything," he said. "It shaped the space program for the next 10 years."

Former President Lyndon B. Johnson
As Vice President, he headed first council.

After Johnson became President in November 1963, he had little need for the council as a policy tool, and Hubert H. Humphrey, who became Vice President in 1965, had little interest in space as an issue. So moribund was the council by the end of the decade that its then-chairman, Vice President Spiro T. Agnew, bypassed it in favor of using a "special space task group" in 1969 to draft post-Apollo space options for President Nixon.

The most ambitious of those called for a manned voyage to Mars by the mid-1980s; Nixon, however, picked the cheapest option: the space shuttle. Then, in a 1973 executive office reorganization, Nixon, never a science buff, opted to save $2 million annually by abolishing the Space Council and the White House Office of Science and Technology.

Like its predecessor, today's National Space Council was created by Congress over the objections of a President, this time Ronald Reagan. Reagan's space policy apparatus, established in July 1982, was the Senior Interagency Group (Space), or SIG Space. Chaired by the President's national security adviser, SIG Space's membership included the NASA administrator, the director of central intelligence and the chairman of the Joint Chiefs of Staff, but only the deputy secretaries of Defense, State and Commerce.

As in so many other arenas, space policy in the Reagan Administration was the subject of constant, protracted interagency disputes. And SIG Space, it became clear to many, was not the forum for resolving the disagreements.

"The policy statements that came out of SIG Space were negotiated to death," said American University space historian Howard E. McCurdy. "The paper that came out of SIG Space was so convoluted, with so many alternatives on the space station, that, had Reagan relied on the bureaucracy, the 1984 decision [to build the station] would never have been made."

A month before Reagan set up SIG Space, the congressional Office of Technology Assessment (OTA) had suggested in a report that an "attractive option" to "focus attention and sharpen debate on our national objectives in space" would be "a reconstituted and broadened National Aeronautics and Space Council."

In March 1983, Sen. Ernest F. Hollings, D-S.C., now chairman of the Commerce, Science and Transportation Committee, made a floor speech introducing a bill to implement another OTA recommendation, a National Commission on Space. Hollings complained that SIG Space too "often conducts its business behind closed doors [so that] the public will not know what the arguments are pro and con relative to the issues under consideration."

No less important, Congress, too, was cut out of the policy loop. "Those in the Congress who were excluded from the SIG system felt that the deficiencies were great and kept trying to find a national policy forum in which they could have some access," George Washington University space analyst John M. Logsdon said.

In its 1986 report, the National Commission on Space suggested that a "full-time space council at the presidential level [could] help ensure prompt and effective cooperation among government agencies and departments." A factor driving the commission's thinking, said the commission's staff director, Congressional Research Service space specialist Marcia S. Smith, was its feeling that a space council "would provide a second route to the President. When we sat, there was a very powerful chief of staff, Donald [T.] Regan, and if Regan didn't like [a proposal], it just never reached the Oval Office."

The council's Albrecht disputed the contention that the more sedate pace assures that a hypersonic plane will never be tested. "The expectation of this Administration is that we will buy a flight vehicle," he said. "But the notion that this is a race that needs to be won before 1995 just wasn't supported by any of the evidence that we had."

The council "didn't purposely slow [the NASP] down, it saved it; there was a proposal to cancel the program," NASA administrator Truly said. "I personally think that the program is on an achievable schedule and, I think, is stronger than it has been before."

In July 12 testimony, Air Force Secretary Donald B. Rice seconded that view, terming the council's approach "a sound, prudent, success-oriented program that makes it possible for the Air Force and the Department of Defense to stay involved."

Once again, however, money remains the issue. Rep. Dave McCurdy, D-Okla., a NASP advocate, announced that "I gave the Vice President fair warning; I'm going to keep the heat on." In fact, earlier that week, McCurdy successfully lobbied the House Armed Services Committee to bump the Air Force's fiscal 1990 NASP authorization up to $285 million. But the Senate Armed Services Committee has stuck with Cheney's request for only $100 million. And the House has cut $29 million of the $127 million in NASP funds that NASA had requested.

NASA's Truly, after running through the technical risks involved in devising a hypersonic, single-stage-to-orbit vehicle, not surprisingly identified "the big challenge" as being, "Will it be funded, even at that [lower] level?"

MEETING ITS MANDATE

In its ability to reach sweeping decisions, whatever their merits, and in fairly fast order, the Space Council so far appears to be meeting its basic mandate of doing more and doing it better than SIG Space.

Certainly it has not hurt to have the top dogs in all of the relevant departments on board as members, as distinct from the lower-tier bureaucratic involvement that hampered Reagan's SIG Space. (Nonetheless, more than a few agency heads have dispatched deputies in their stead to one or more of the three formal council meetings held to date.)

No less important to the council's success is having the Vice President in charge, instead of an appointed official such as the President's national security adviser, who chaired SIG Space. Quayle has so far run all of the council's meetings. "The Vice President is a gorilla," a Senate space aide said. "He has the ability to walk into a room and tell people, 'You do it.' "

Truly counts himself "very pleased" with the council. The staff work has been "efficient and good," he said, while the meetings "have been lively and the issues we've dealt with have been engaging. I think it's a good signal that maybe this will turn out to be an excellent way of dealing with space policy."

The council's permanent staff currently numbers only 9 out of an eventual 15-17 professional and support employees. Among those slated soon to join the council staff are detailees from the Commerce Department along with best-selling techno-thriller writer Tom Clancy. Clancy is unsure yet exactly how his role as consultant will shape up, he said in an interview. "But I'm hoping to be in a position where I can at least influence policy, and maybe even make a little bit of it."

Two of the five technical experts now on the staff come from NASA and two from the Air Force, including Col. Simon P. "Pete" Worden, a former Strategic Defense Initiative Organization up-and-comer who has been dubbed the "Ollie North of 'Star Wars' " by Federation of American Scientists space analyst John E. Pike.

The presence on its staff of Worden—along with Quayle's strong interest in defense matters and Albrecht's background as a CIA analyst and as Sen. Wilson's defense aide—has led some to fret that the council is being invested with a dangerous bias toward the "militarization" of space.

"I understand the inference, but that is absolutely not correct," Albrecht responded. "The best proof of that will be, in fact, what we do. In my view, the areas of space policy that require the most work are civil space policy and commercial space policy. I see us spending the most time in the next year on those two areas."

Among the items more immediately on the council's agenda—besides fleshing out Bush's July 20 space initiative, which the President said he wanted completed "as soon as possible"—is a recently completed review of the Reagan Administration's February 1988 space policy guidance. Quayle said "significant changes" should not be expected in the new directive, which is scheduled to be made public in early August.

The council is also looking at establishing a new type of presidential decision directive to lend additional weight to the Administration's space policy. Similar to the decision directives issued on national security topics, these would be called "national space policy directives."

But the top priority Quayle cited in the interview is the effort to push Bush's current space budget through the congressional Appropriations Committees. "In the next few weeks, we'll be putting on green eyeshades and talking about scoring and '302 B allocations,' " he promised.

Throughout the interview, Quayle epitomized the dilemma confronting space enthusiasts by ricocheting between ebullient reflection on the human and national imperatives to explore the solar system and what he termed "this very delicate balance, where we are with fiscal problems, with budget deficits and Gramm-Rudman-Hollings [Balanced Budget Act] targets to be met." In the end, the ebullience won out.

John Eisele

Council executive secretary Mark J. Albrecht
We'll emphasize civil and commercial space policy.

"If we had a continuation of the NASA budget in constant dollars from 1969 to now, we would have built the space station, we would probably have gone back to the Moon and we would be well on our way to [Mars]," Quayle said. "I think you have to fashion that [vision], and you have to be a little out ahead of reality.

"Someone will say, 'That's pie in the sky, Mr. Vice President.' [But] it's real if we set our mind to it. So don't be surprised if we make some bold statements. I will be—and I know the President will be, as well—robust in our attitude toward space." □

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JAMES J. FRELK WILLIS HAWKINS
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New Leadership for Space Exploration

Sending humans to the moon and Mars will provide rich rewards, but should NASA be the ultimate authority for these missions?

In July 1989, President Bush announced plans for establishing a manned base on the moon and sending humans to Mars, missions that have jointly been labeled the Space Exploration Initiative. The goals are worthwhile. But the "business as usual" approach now envisioned, with the National Aeronautics and Space Administration having central responsibility for planning and carrying out the missions, is no longer useful.

Instead, the government should create an independent National Technical Commission to guide planning, and perhaps implementation, of the missions. Only in this way can we ensure that the nation's best technological talent—within all branches of government as well as in universities and the commercial sector—is brought to bear in devising the safest, fastest, and least expensive means of extending our reach into space.

Many scientific returns

The lunar and Mars missions hold rich scientific potential. Astronomy conducted from a lunar base can examine the universe with 100,000 times more resolution of detail than has ever been seen before. An optical interferometer—a network of forty-two 60-inch telescopes spread across a six-mile area—will provide sufficient resolution to permit the direct detection of planets thought to be circling other stars. It will even be able to detect any ozone present in the atmosphere of these planets, which would indicate the presence of an abundance of oxygen and, almost certainly, the existence of plant life.

The lunar telescope network could also peer into the hearts of distant quasars, remarkable objects that produce the energy of many billions of suns in a space

mes J. Frelk is executive director of the George C. Marshall stitute (Washington, D.C.). Willis Hawkins is former senior e president of the Lockheed Corporation and past chairman he NASA Aerospace Safety Advisory Panel. Robert Jastrow he founder and director (retired) of NASA's Goddard Institute Space Studies. William A. Nierenberg is director emeritus of Scripps Institution of Oceanography, University of California, San Diego, and first chairman of the NASA Advisory ncil. Frederick Seitz is president emeritus of Rockefeller ersity and past president of the National Academy of Scien-

This article is adapted from the Marshall Institute's 1990 t, *New Directions in Space: A Report on the Lunar and Mars tives.*

LEADERSHIP...CONTINUED

universally regarded as a triumph of engineering talent and management skills. Its vigor and technical competence in that period added luster to the image of the United States as a "can do" nation. But the faith of the public, the media, and many members of the scientific community has been considerably shaken by the *Challenger* accident, the recent Hubble Space Telescope debacle, and continuing problems with the Space Shuttle.

The authority for deciding on the technical plan should be vested in a national commission.

It must also be admitted that NASA is a different institution from the innovative and entrepreneurial agency of the 1960s. One pertinent indicator of performance and cost-effectiveness, for example, is the number of people working for the agency in relation to the size of its program. NASA is considerably smaller than it was during the Apollo era. Its budget fell from a peak in 1965 of $27 billion (in 1990 dollars) to a low of $8.5 billion in the 1970s—down a factor of three from the peak value. Budget levels have risen during the past several years, but are still little more than a third of their peak value. Employment during this period fell far more slowly, however, and the agency now has two-thirds as many employees as it had during peak budget years.

In other words, NASA employs twice as many individuals per dollar of program money as it did at the height of its technical effort. Some economies of scale would have been lost during down-sizing, but not enough to explain the approximate doubling of the people-to-dollar ratio. These trends suggest the development of a serious institutional bloat in NASA as it matured.

Other personnel statistics reveal signs of an aging agency as well. In 1963, as the Apollo program moved into high gear, the average age of NASA employees was 30—the youngest of any federal agency at the time. In 1985 the average age was 44. Today, three quarters of NASA middle and senior management will be eligible for retirement within five years.

Bringing in help

The proposed role for NASA as the leader in planning and carrying out the manned lunar and Mars missions stems in large measure from tradition, inherited from the days when expertise in the new field of spaceflight technology was confined to a small group, and a broad technical base in the field had not yet been established. This management structure, which gives NASA monopoly power over decisions on the technical concepts for manned spaceflight, has not been seriously reexamined since the agency was established more than 30 years ago. However, the circumstances that made it appropriate to grant NASA this power have changed markedly. Today, the relevant expertise is widely available in the aerospace industry. It is also available to some degree in universities, and many vital areas of high technology are well represented in the laboratories of the Department of Energy and other government facilities.

The government has in fact taken some steps to increase outside involvement in the lunar and Mars missions. For example, the National Space Council, headed by Vice President Quayle, has criticized NASA's plans, which are based for the most part on proven technologies and the methodical development of current space exploration concepts, as being unimaginative. Quayle has on several occasions requested that NASA "cast our net widely"—that the agency query academic researchers and aerospace industry engineers alike for their ideas on "different architectures, new systems concepts, promising new technologies, and innovative uses of new technologies."

The White House affirmed this idea in March 1990 when it released guidelines for the Space Exploration Initiative, which stressed the need for new approaches and the development of innovative technologies with the potential for major cost, schedule, and performance improvements. And in July, NASA Administrator Richard Truly announced the formation—at Quayle's direction—of a consulting group to solicit and review outside proposals for carrying out the missions. Dubbed the "outreach synthesis group," it is headed by Thomas P. Stafford, a former astronaut and retired Air Force lieutenant general. By spring 1991, the group is expected to produce at least two competing strategies for the missions, a list of technology research priorities, and some schedule milestones.

CONTINUED NEXT PAGE

LEADERSHIP...CONTINUED

The formation of the synthesis group is an encouraging step in the direction of enlisting the best technical minds in the U.S. for the implementation of the demanding lunar and Mars missions. But NASA's plans for the group are flawed by the fact that its chair reports to the NASA administrator. Thus, NASA still retains the dual roles of entrant and judge in the competition for the best designs. This arrangement leaves open the possibility that in-house NASA concepts will receive preferential treatment over innovative concepts submitted by outside sources.

It would be far better to vest the judging responsibility in a national commission comprised of leaders from the aerospace industry, universities, and the ranks of those who have served the government and understand the complexities of large technical programs. This commission could be built on the structure of the "outreach synthesis group," but only if the requirement of reporting to the NASA administrator were changed—its leader should report to the president, or to the chairman of the National Space Council, but to no lower level of authority. In this way, NASA's proposals would have to compete on an equal footing with all others.

Competing possibilities

Indeed, several potentially promising alternatives have already emerged. The most comprehensive proposal, for example, has been put forward by scientists at the Energy Department's Lawrence Livermore National Laboratory (LLNL). Called "The Great Exploration," the plan envisions setting up an orbiting work station and lunar base, and sending an expedition to Mars, within ten years and at a cost of roughly $10 billion.

One key factor in the LLNL design is the use of inflatable structures to provide large volumes of habitable working area, both in Earth orbit and at the manned bases on the moon and Mars. (NASA also foresees use of inflatable structures, but only for limited applications at surface bases.) The cylindrical structures would be fitted with internal systems and tested before launch, then compressed accordion-like into small packages for the trip into space. Once in orbit, the modules would be inflated and the internal equipment would pop into place. Because an entire orbiting work station could be carried aloft by one launch vehicle, costs would be greatly reduced.

The LLNL plan also addresses another significant concern: the health effects of exposure to zero or reduced gravity. Soviet experience during an 11-month stay in orbit and U.S. experience with Skylab indicate that prolonged exposure to zero gravity can be deleterious and possibly fatal. For instance, a voyager to Mars might suffer a 20 to 30 percent loss of bone mass during the two-year round trip. This would leave the weight-bearing bones of the skeleton—especially the legs and spine—relatively fragile and prone to fracture on return to Earth or during high acceleration or deceleration. It will therefore be essential to provide artificial gravity in the spacecraft headed for Mars.

NASA acknowledges the importance of the problem, but does not include artificial gravity in its list of vital technologies for development and apparently has left it out of initial plans for the Mars flight. The risks inherent in this decision are exacerbated by the proposed reliance on aerobraking to slow the spacecraft for descent into Mars orbit, which will place a load of several times Earth's gravity on a crew whose skeletons have been weakened by weightlessness en route.

The LLNL plan, on the other hand, calls for creation of artificial gravity by rotation of the spacecraft during flight. This holds the promise of eliminating at least one major element of risk in a mission that is certain to involve elements of danger under the best of circumstances.

Other alternatives target advanced propulsion systems, rather than using conventional chemical-fueled rockets as planned by NASA. For example, scientists at the Los Alamos National Laboratory have suggested using nuclear rockets based on the NERVA-class technology. Tested during the 1960s, these rockets may cut the time for a round-trip to Mars to roughly one year. Deployment of nuclear reactors in space may face formidable barriers of public acceptance, however. To help minimize concern, the interplanetary nuclear-powered rocket stage would first be boosted by conventional rockets to an altitude of some 600 miles, and only then would the reactor achieve significant power levels.

In another proposal, the National Commission on Space suggests using a "cycling" spaceship that would shuttle back and forth between the orbits of the Earth and Mars under the pull of gravity alone, without expenditure of fuel. Crews and cargoes would rende/-

LEADERSHIP...CONTINUED

vous with the craft in orbit at the start or finish of each interplanetary flight.

Models of success

Many other innovative proposals will undoubtedly be forthcoming as the national commission carries out its mandate. In practice, the commission might profitably be modeled on two earlier technical success stories.

One is the U.S. Navy's Polaris program. This was built on a solid base of existing technology, but went far beyond the then-current state of the art in search of solutions to problems never before faced. The project called for new concepts in propulsion, guidance, submarine design, and missile launch systems. Bringing these highly advanced technologies to fruition individually was a formidable task: combining them into an efficient operational system was even more daunting.

The Navy met the challenge by removing the responsibility for major technical decisions from the organizational units that would normally oversee the design and construction of a new submarine and placing this responsibility in a new management entity called the Steering Task Group. For membership, the Navy called on individuals of the highest stature in the pertinent fields of technology and technical management. For example, C. Stark Draper, head of the MIT Draper Laboratory, was chosen for expertise in missile guidance, and Edward Teller provided expertise in warhead technology. The head of the group reported directly to the Chief of Naval Operations.

Out of this effort emerged a product that met all technical requirements and came in very close to the original budget and schedule. The Polaris became the first U.S. ballistic missile propelled entirely by solid fuels, the first to rely completely on inertial guidance, and marked the first attempt at an underwater vertical launch—and it has remained for nearly 30 years a key component of the nation's strategic deterrent.

The other example comes from the U.S. Air Force's early ICBM program. Facing major developmental problems, the Air Force created an independent technical group outside the government. The group, which later became the Aerospace Corporation, was responsible for making critical technical recommendations and functioned in a manner similar to the Polaris Steering Task Group.

Here, again, a government agency up against formidable technical hurdles achieved success by vesting responsibility for major design recommendations in a new management structure. The new group recruited experienced and respected members, and reported only to the highest levels of authority. In this way, the government fostered free play for the competitive forces that should be at work in the marketplace of ideas. It ensured that technical innovation would not be smothered by the "not invented here" reflex, the "protect your rear" syndrome, and bureaucratic inertia.

Missions for exploring the moon and Mars warrant a similarly innovative approach.

Recommended reading

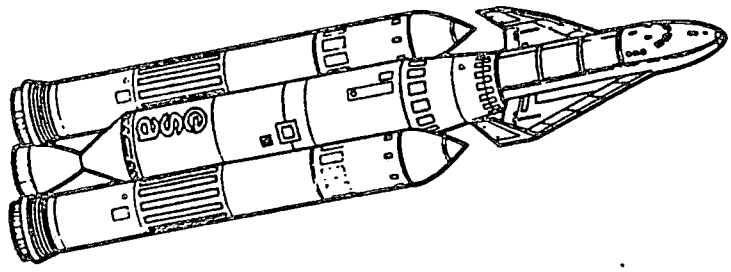
B. R. Finney and E. M. Jones, *Interstellar Migration and the Human Experience*. University of California Press, 1985.

R. Jastrow, *Journey to the Stars: Space Exploration—Tomorrow and Beyond*. New York: Bantam Books, 1989.

John Logsdon, "Leading Through Cooperation," *Issues in Science and Technology*, Summer 1988.

H. C. Mandell, Jr., *Barriers to America's Future in Space, and Some Possible Remedies*. University of Colorado, 1989.

National Research Council, Committee on Human Exploration of Space, *Human Exploration of Space: A Review of NASA's 90-Day Study and Alternatives*. Washington, D.C.: National Academy Press, 1990.



ADVENTURE 2

THE PHOBOS FACTOR

A trip to potato-shaped Phobos, one of the two tiny Martian moons, would be easier than heading straight to Mars. It might also be a good place to put a gas station

It would be a bit less glamorous than landing on Mars itself. But just in case America judges the Mars mission as too ambitious and expensive, NASA's planners are studying a quicker, simpler alternative that would still allow the United States to be the first nation to send people to a far piece of soil. NASA could mount a visit to the Martian neighborhood, instead—to Phobos, one of the planet's two tiny, mysterious moons. Unmanned Soviet probes are already scheduled to land there next spring. And NASA officials predict that a U.S. spacecraft carrying four crew members could reach the moon's surface by 2003, more than four years earlier than it could reach Mars.

The Phobos mission profile is similar to that of a Martian voyage. It, too, would require two vessels, a cargo ship followed by a manned craft. And it, too, would last 14 months. But the Phobos rockets would need only half the fuel load, since they wouldn't have to fight Martian gravity as hard to get back. In terms of the energy required, says John Aaron, head of NASA's exploration office, "it's about as easy to send a spaceship to Phobos as it is to send a spaceship to Earth's moon." What's more, since the Phobos ships would be so much smaller than those designed for a Mars mission, it would be possible to assemble them on Earth. Expendable rocket engines strapped onto the empty ships could boost them into orbit, where they could then be fueled for launch.

USN&WR DIAGRAM BY MATTHEW ZANG

Rendezvous with potato-shaped Phobos would also be easier than the Mars operation. The cargo and crew ships, leaving a year apart, would aerobrake in the Martian atmosphere and maneuver out to match Phobos's orbit, 3,700 miles above the Martian surface. Phobos is only 14 miles in diameter, and its gravity is so slight—just one thousandth that of Earth—that astronauts could drive the spaceship right up to the moon and position themselves a short distance away. One proposal is to tie up to the moon like a ship to a dock.

The gravity gap

Exploring Phobos would be a challenge because of its small gravity field. "If you jump off the surface," says Michael Duke, chief of the solar-system-exploration division at the Johnson Space Center, "it's likely to take you several minutes to come back down." Indeed, if an astronaut hurled a rock just right, it could orbit the entire moon and hit him in the back of the head. In such conditions, astronauts might have to move around like mountain climbers, hammering pitons into the surface and attaching ropes to them. If Phobos is too soft and dusty to hold pitons, astronauts could work at the surface by riding the end of a robotic arm extended from the spaceship like a cherry picker.

Astronauts in Phobos's orbit could also send a robotic rover to the Martian surface to explore. An astronaut in the spaceship could guide it with a video-game joy stick. That would be a much simpler system than the one required for rovers sent from Earth. They must have their own autonomous guidance aboard because Mars is so far from Earth that radio signals take 20 to 40 minutes or more to travel the distance.

While scientists are eager to learn more about Phobos, NASA's exploration experts have a special, admittedly far-out, interest. The tiny moon could be "a perfect place for a gas station," Aaron says. If Phobos's rocks contain crystalline ice, as some scientists suspect, heating them would produce water. A small processing plant carried to Phobos on later flights could break down the water into hydrogen and oxygen, which, as Aaron explains, are "exactly what we need for [rocket] propulsion." The plant could operate unattended to fill tanks with rocket fuel. Such an extraterrestrial fuel supply, says Aaron, would dramatically reduce the amount of weight that must be hurled from Earth to support manned missions to Mars. Eventually, he says, it might be possible for spaceships to leave Earth for Mars carrying no return fuel. To get home, they'd simply fill 'er up at Phobos. ■

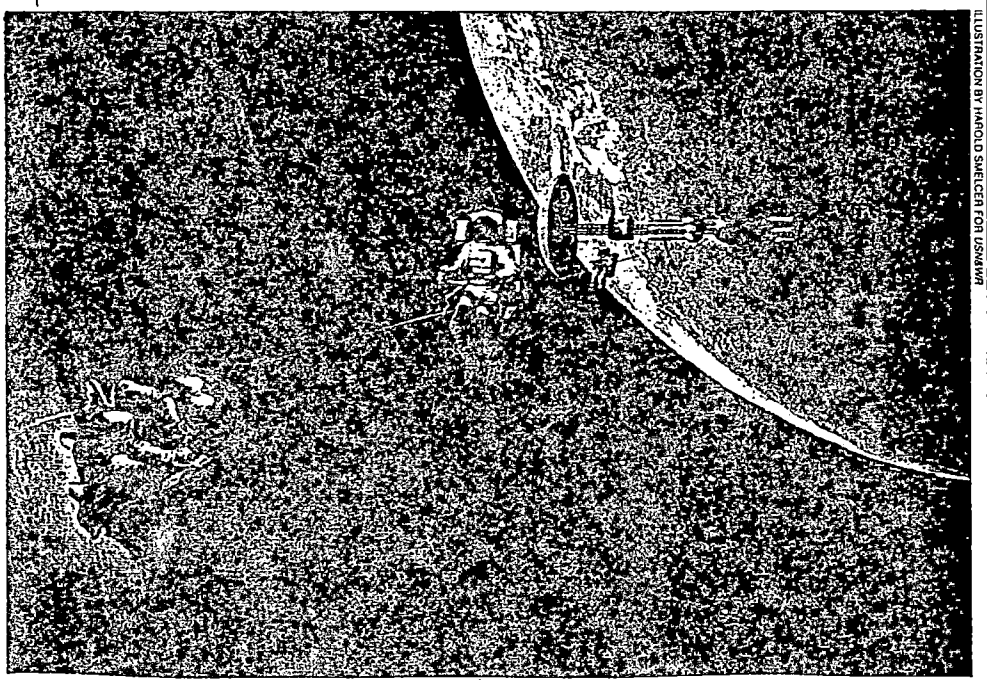


ILLUSTRATION BY HAROLD SHELCER FOR USN&WR

ADVENTURE 3

A LUNAR OBSERVATORY

On the far side of the moon, free of the electronic clamor from Earth, astronauts could deploy telescopes to relay spectacular views of the universe to terrestrial scientists

The far side of Earth's moon is extraordinarily clear and quiet. There is no atmosphere, and the land doesn't shake. The moon itself is a massive shield against the growing electronic clamor emanating from Earth. It is quite possibly the best location in the entire solar system for optical and radio telescopes, and NASA is exploring how to take advantage of it.

Building and operating an observatory on the side of the moon facing away from Earth could combine the drama of human space flight with the promise of high scientific yield. Like early Antarctic scientific outposts, the station would not be permanently inhabited, though astronauts would visit it two weeks a year to perform experiments, study the lunar geology and make repairs on the observatory's automatic systems.

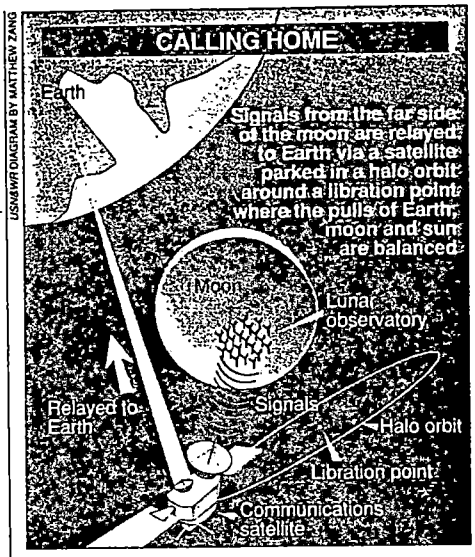
The observatory project, simplest of NASA's four options, is also clearly within our grasp. It is a step beyond Apollo, says Michael Duke, chief of the solar-system-exploration division at the Johnson Space Center, "but it's not a very big step. We could have accomplished it with Apollo hardware."

The lunar observatory's job would be to gather incredibly high-resolution views of the universe across the radio and optical spectrums. To accomplish this, astronauts would erect dozens of small radio-receiving antennas and mirrors across 10 to 15 miles of the bleak lunar landscape. Signals picked up by each antenna would be sent to a moon-based computer, which would integrate them into one image. The effect would be the same as if one gigantic single mirror or antenna had been deployed, instead of many.

Complex communications

The tricky part would be getting those wonderfully sharp images back to terrestrial scientists. The same characteristic that makes the far-side location so desirable for an observatory also makes it difficult to communicate with Earth: It's out of sight.

One elegant solution makes use of points in space where the gravitational pulls of Earth, sun and moon are in perfect balance. An object placed at such a libration point—a communications satellite, for instance—will stay there forever. Unfortunately, the closest libration point is behind the moon, also out of earthly view. But a satellite could be placed in a halo orbit around the point, an orbit wide enough to clear the moon. That way, signals could be relayed continuously between the observatory station and Earth (see diagram).



USN&WR DIAGRAM BY MATTHEW ZANG

The space station as currently planned would require only modest changes to accommodate the lunar-observatory mission. Additional living quarters would be needed for a crew that would service lunar vehicles, and a small hangar 50 feet wide and 100 feet high would have to be built for the 100,000-pound spacecraft that would be boosted up to the station to carry scientists and equipment back and forth between the station and the moon.

Four initial flights from the space station, starting around the year 2004, would be required to establish the observatory. An unmanned cargo ship would be the first to depart, carrying a 20-ton load of scientific apparatus and modules that would serve as living quarters on the moon's surface. That trip would take just three days. Then a two-stage piloted craft would be launched into lunar orbit, where it would function just like the vessels of the Apollo moon missions. One part would remain in orbit. The second, a lunar-excursion module (LEM), would fly to the surface. The LEM in this mission would be similar to the modules used in the Apollo program, but it would be about half again larger.

The LEM would carry four astronauts to the surface where they would spend one lunar day—14 Earth days—in intense labor setting up the living quarters, antennas and mirrors before returning to their orbiting mother ship. On the flight back, they would dive into Earth's atmosphere to aerobrake, then pop up again to park at the space station, where their ship would be refurbished for the next year's mission. ■

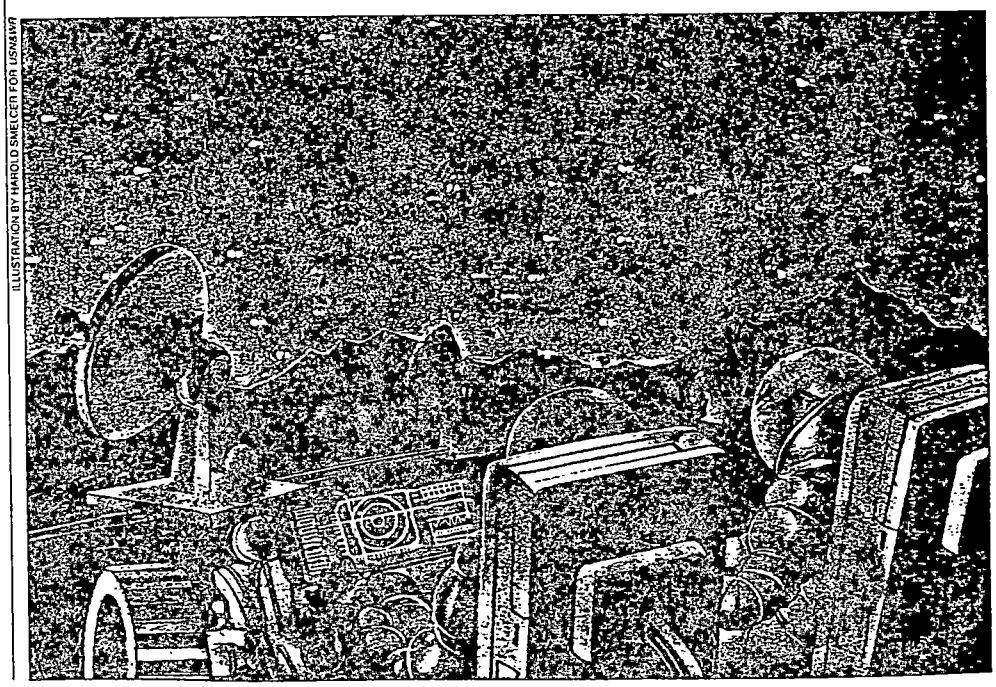


ILLUSTRATION BY HAROLD SMELCER FOR USN&WR

ADVENTURE 4

COLONY ON THE MOON

A lunar base would help people learn to live and work away from home, provide a launching station for other missions and embody the idea that we are in space to stay

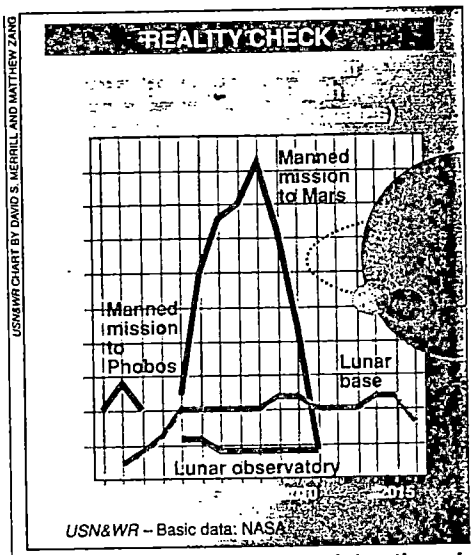
The final adventure, establishing a lunar oasis that would eventually serve as a launching station for points beyond, poses the hardest questions about why we want to go into space and what we intend to do there.

If we truly believe our destiny as a species is to move permanently beyond the bounds of Earth, a lunar base would provide a sensible first step toward cutting the umbilical. It would eschew the Apollo-style grand gesture, aiming, instead, at providing a long-term laboratory where humans could learn to live and work in extraterrestrial conditions. On two counts in particular, the lunar base is hugely appealing. In an age of limits, it offers the prospect of a space program that could be sustained with controllable annual budgets. And, eventually, it would give the entire push toward space a new sense of permanence.

We will never get very far into space if all supplies have to be carried on expensive rockets from home. Therefore, activities at the lunar base would be geared toward learning to live off the land. According to Wendell Mendell, chief lunar-base scientist at the Johnson Space Center, they would include a host of technologies familiar on Earth, from mining and power generation to construction and chemical processing.

The first task of lunar astronauts would be to construct a place to reside. While the initial living modules would be transported from Earth, additional buildings could be constructed from moon-made materials. Workers would dig a hole, place a large, airtight balloon inside, then cover the balloon with sandbags filled with lunar soil or bricks made by compressing the soil into blocks. Lunar workers would live comfortably inside the balloons, insulated from radiation and cold.

At first, power would be produced from solar cells, later from small nuclear-fission plants, such as the SP-100 now being designed for use in space by the Department of Energy. With heat, electricity and buildings in place, life-support systems could be developed. Food would be grown locally and wastes recycled to reduce the supply line to Earth. The growing infrastructure could be shared by lunar bases established by other nations.



USN&WR CHART BY DAVID S. MERRILL AND MATTHEW ZANG

A comparison of the size and duration of efforts needed for different missions

The principal industrial activity at the base would be the production of lunar oxygen. The moon has no atmosphere, but its soil contains oxygen that could be recovered through chemical processing. That is critical for two reasons. First, the oxygen would support the base's inhabitants. Second, oxygen is a key rocket fuel, accounting for approximately 70 percent of a space vessel's weight.

Liquid oxygen manufactured at the moon would provide a crucial component for more-ambitious space projects. The moon's gravity is only one sixth that of Earth's, so launching oxygen fuel into lunar orbit or to the space station for a Mars rocket would be much easier, and cheaper, than sending the heavy liquid up from Earth. The lunar base also suggests another reason for an eventual expedition to Phobos. If it turns out that there is water on Mars's moon, it could be cracked into hydrogen and oxygen, then ferried relatively inexpensively to Earth's moon as yet another source of rocket fuel.

Developing a lunar base would require only half a dozen annual heavy-lift launches from Earth, compared with the 15 or more that would likely be needed during the peak year of preparation for a Mars expedition (see chart). This ground rule is designed specifically to keep the space budget in check and to force engineers to seek clever, low-cost solutions.

Forgoing the glamour

A commitment to go ahead would demand a major change in the way America views the space program. Taxpayers and budget makers would have to approach it as a strategic investment, forgoing the glamour of ambitious, one-shot missions for the slow, steady program already favored by the Soviet Union. In the words of NASA exploration chief John Aaron, "We'd patiently click off the rewards and returns along the way."

Those rewards could be enormous. Perhaps most important, the skills human beings would learn on the moon are precisely those they would need to set up an outpost on Mars, as early as 2014. That would give even greater impetus to the dream of expanding humanity's presence. No longer would space missions plant the flag quickly, then flee home. And someday, from the outposts they establish in the solar system, the world's space visionaries would be looking at even greater adventures, toward the stars. ■

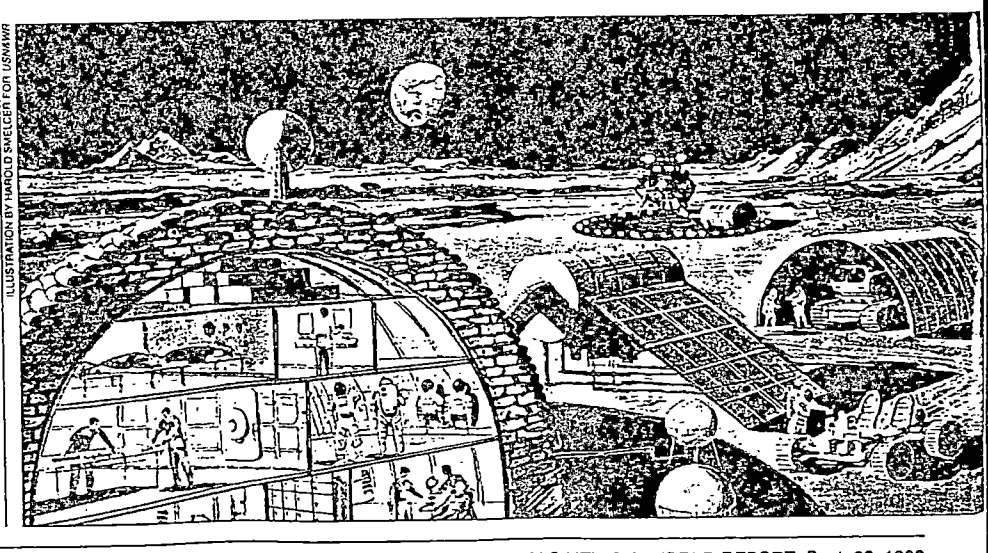


ILLUSTRATION BY HAROLD SMELCER FOR USN&WR

Colonizing the red planet will take the combined efforts of the world's best space brains. The $400 billion question: Can nations cooperate well enough to make this dream come true?

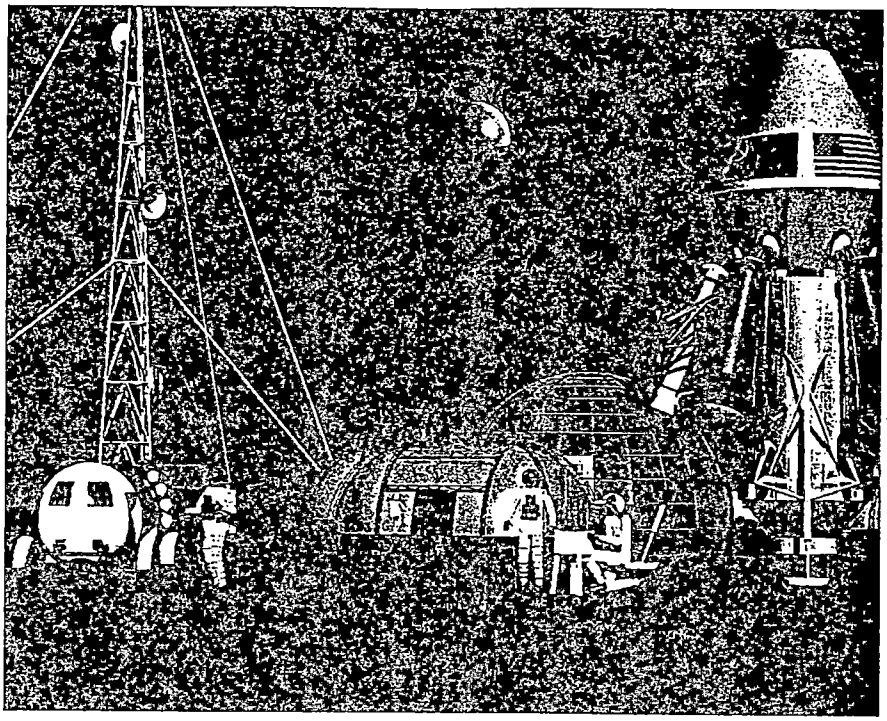
VOYAGE TO A FAR PLANET

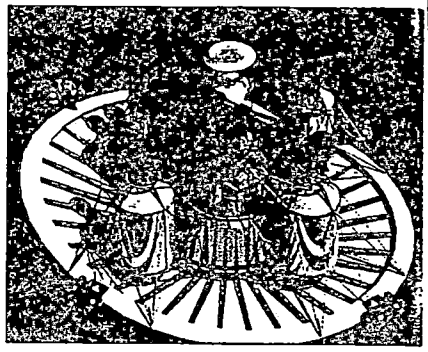
ARTICLE BY BRENDA FORMAN

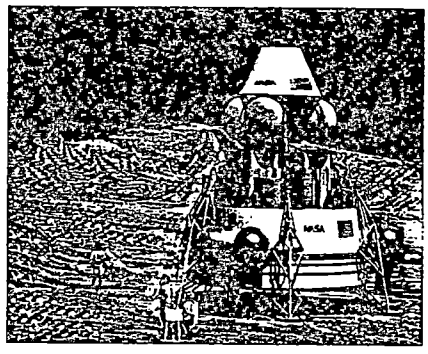
Aboard the spaceship *Glasnost,* 23 million miles on its way to Mars, Baryshnikov (so dubbed for his annoying habit of repeating the *Swan Lake* adagio for hours in the low-g exercise module) had stopped shaving his face. He had elected to use his electricity ration to do his armpits once a week instead. Spiderman was indifferent to this. He was more interested in the web of Kevlar monofilament he'd woven in the radiation shelter. Besides, he hadn't changed out of his black tights for half a year and Baryshnikov was the only one who had said nothing—so a silent bargain had been struck. Baryshnikov, a.k.a. F. Povich, cosmonaut of the USSR, and Spiderman, a.k.a. P. Hoffman, astronaut from Houston, had shown

PAINTING BY MICHAEL CARROLL

"Besides the $400 billion sticker shock, the space technology needed for the trip is no longer exclusively Made in America."







the unmistakable signs of irreversible space psychosis.

The six other crewmen had their *f-a-c-u-l-t-i-e-s* somewhat more intact. They had gathered in the galley to make the decision.

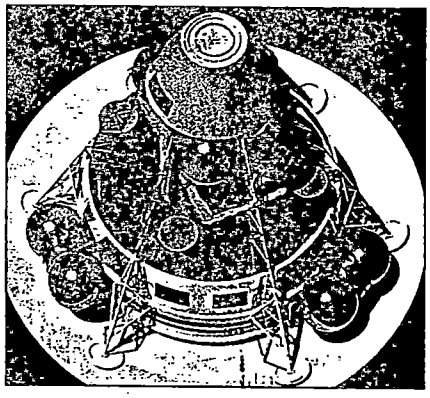
"They could sabotage the entire ship," Akira from Nagano, Japan, had pointed out.

"We must not act in an uncivilized and immoral fashion, however," advised Mohan from Bombay.

"We must conform to due process of law," Jean-Paul the Parisian agreed.

They decided to isolate Baryshnikov and Spiderman in the exercise and shelter modules. That way, if they blew an airlock, started an electrical fire, or found a more novel method to merge their souls with the black void, they wouldn't take the other six astronauts along with them.

The six did not discuss their decision with ground control. After all, who knew what the others back at the lunar base, or at mission control, might do?



The six were having a little trouble with the isolation, too.

"A trip to Mars will be the most challenging high-technology adventure of the twenty-first century," says Tom Paine, former NASA administrator and chairman of President Reagan's National Commission on Space. Getting there, however, makes a lunar flight look like a jaunt to the corner store. While the moon is a "mere" 250,000 miles away, Mars can be anywhere from 49 million to 235 million miles from Earth, depending on the time of year. One round-trip could take three years or more, not counting time spent on the surface.

Along the way, human colonists will live for months or years in cramped spaces. In the meantime, politicos will be maneuvering back on Earth, persuading half a dozen nations to split the tab on this pricey journey. The $400 billion (NASA's preliminary estimate) sticker shock, however, isn't the only reason that the United States is unlikely to go to the red planet on its own: The space technology that such a big journey demands is no longer exclusively Made in America.

The Soviet Union, the European Space Agency (ESA), Canada, Japan, and China all have very impressive space capabilities—including rockets, robotics, and space-medicine expertise. Recognizing this, President Bush announced in March that the United States plans to seek an "exploratory dialogue" with Europe, Canada, Japan, the Soviet Union, and other nations on international cooperation in the Space Exploration Initiative.

Even though no one knows what shape such "international cooperation" will ultimately take, there's certainly enough scientific and technological work to involve everybody.

"Every way you look at SEI [Space Exploration Initiative, i.e., moon–Mars in governmentspeak], it's a whole cluster of cooperative opportunities," says Peter G. Smith, director of international relations for NASA. Fitting the pieces together will be the most complex sys-

A roaming holiday: At the Martian outpost (top left), spacepersons prepare to board a surface craft. To get to Mars, voyagers will fly aboard a transfer vehicle (top right). To chart new territories on the surface, explorers use a larger surface craft (right). Colonists descend from orbit to the red planet aboard a reentry vehicle (below).

tems integration job ever. Meanwhile the project's international organizational structure will have to function for 30 years or more—a staggering prospect given the routine mulishness of politicians and the vagaries of history. (Remember the furor last year when NASA offered Congress a scaled-down space station design without first consulting the other nations involved with *Freedom*?) Even before the first crew leaves for Mars, there's a formidable clutch of technologies to master—both "hard" ones for hardware and systems, and "soft" ones for keeping space colonists sane and healthy.

IS "INTERNATIONAL COOPERATION" POSSIBLE?

"The Americans are talking about cutting their Mars mission budget once again, sir."

"They do this to us every year, don't they? You'd think they'd persevere in something they started themselves, but they never do. I suppose we should have learned that back in Space Station *Freedom* days."

"Minister says we should think about redesigning our module to be completely independent. Then we can let the Americans dither without queering our own projects."

"Mmm. More expensive that way, of course. But worth looking at."

The politics of moon–Mars will probably be absolutely Byzantine. "The technological challenge is probably equaled by the institutional challenge: to organize a sustained international effort extending over decades," explains Paine. Sending voyagers to Mars will involve a broad consortium of nations and stretch over three decades or more.

The only project remotely resembling such an ambitious endeavor, Space Station *Freedom*, has the United States as its leader, manager, and ultimate arbiter of operating decisions. "That could be the Mars model—if the United States cares to pay the bulk of the gigantic amount of money involved, as it is doing with the space station," says Ben Huberman, President Carter's deputy science adviser and now a Washington consultant on technology issues. Even more important, the nation would have to commit to paying out that money consistently over the extended time period of a Mars mission, a condition Congress will undoubtedly reject.

The *Freedom* model may not prove flexible enough for the moon–Mars initiative. Although big and complex, the space station is essentially just one single piece of hardware. Moon–Mars will require a very large number of separate elements—bases, stations, launchers, and landers—each of which could involve different players. For example, according to a high NASA official who requested anonymity, Japan is already deeply interested in lunar resources, so it might want to participate in a moon base. The Soviets, on the other hand, prefer a Mars mission over a return to the moon. Each piece of the action, therefore, will probably end up tailored to the various participants' goals.

Paine says a good management model might be Intelsat (International Telecommunications Satellite), to which each nation contributes to the degree it uses the system: "Pay your dues and get your ride." Another model: the approach ESA has pioneered in coordinating the space efforts of 13 countries with different technology levels, funding resources, and policy objectives.

But would the United States agree to any arrangement in which it would be a mere partner rather than the leader? "I don't think we'll go to Mars as part of an organization in which we lose the perception of the lead," says the same anonymous NASA official. "That tugs at the U.S. heartstrings. Leadership is one of the main reasons the President put forward the program."

Such nationalistic fervor could prevent Earthlings from ever reaching our red neighbor. Should the world's spacefaring nations overcome their instincts to go it alone, however, here's what a joint effort might lead to in the next 40 years.

GOING MY WAY?

"Ten, nine, eight..." The mammoth rocket sits on the Baikonur launchpad deep in the south central region of the Soviet Union, poised to truck another 100 metric tons of hardware to low Earth orbit. This is the twentieth such launch, and astronauts and cosmonauts in orbit are busily assembling all the payloads into a convoy headed for the moon. The booster is the Energia, pride of the Soviet launch stable and the biggest vehicle to rise from a pad since the Saturn 5 of Apollo days. Indeed the two rockets are in the same class: Energia can lift 220,000 pounds to low Earth orbit; the Saturn 5 lofted the 165,000-pound *Skylab*.

The first step to Mars: propelling thousands of tons of construction materials, rocket motors, spacecraft components, life-support systems, living modules, air, water, food, and humanity out of Earth's gravity well and into space. Neither the shuttle, with its 48,000-pound capacity, nor the biggest U.S. rocket, the Titan 4, which carries 40,000 pounds to orbit, could deliver such a massive amount of equipment. And what will be ESA's largest launcher, the Ariane 5, will lift only 46,200 pounds.

Comparing the Mars mission's lift requirements with those of the space station gives some feel for the magnitude

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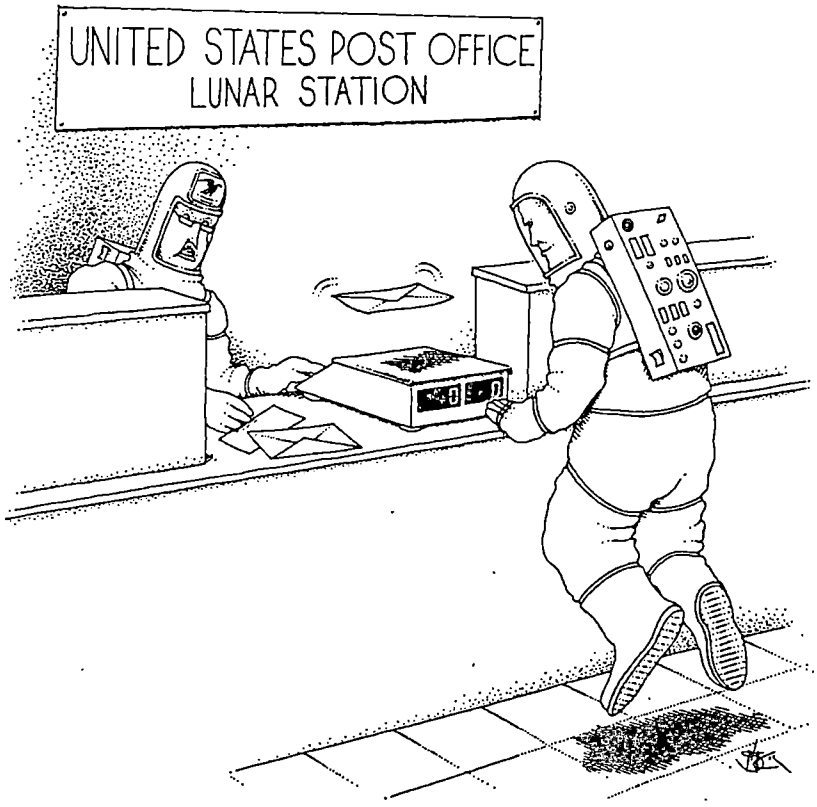

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FAR PLANET

CONTINUED FROM PAGE 38

of the effort. At present there are more than 380 station assembly elements scheduled for delivery to low Earth orbit on about 30 shuttle flights over a period of four and a half years, scheduled to begin in the mid-Nineties. Such an orbiting platform would be just one part of a moon–Mars program. A lunar base itself would need far more launch capacity than the station. Besides the living modules, rockets would also have to hoist heavier power plants, surface rovers, and more complex communications gear.

Only the Energia has the capacity to boost such tonnage to space. "The Soviets have built a heavy cargo vehicle," says Art Dula, president of Space Commerce Corporation, which is marketing Soviet launch services in the United States. "We need a dump truck and all we have is the family Rolls!"

Mere technical grounds rarely win this sort of argument, however, so don't expect the United States to depend on the Energia for its heavy-lift needs. It would be more likely to revive work on the Advanced Launch System (ALS). ALS started in 1987 as a program to revolutionize American rocket technology and lower the cost to orbit by a factor of ten. Lately the effort has had its funding cut for lack of a clearly defined mission. Moon–Mars just might turn out to be that mission.

Ultimately, nuclear fission or something even more advanced—such as fusion—will probably be the only way to bring down the cost and one-way travel time. Nuclear propulsion might cut the trip to 100 days from the 550 days a chemical rocket would take. Although Westinghouse started working with Los Alamos laboratories on this approach in the late Sixties, according to an industry insider who requested anonymity, the technology is still not operational. To get the voyage down to 50 days would take even more advanced motors—such as those using helium 3 for nuclear fusion. Unfortunately, after millions of dollars of government-funded research, scientists are still unable to control fusion reactions.

NASA's Lunar Energy Enterprise Case Study Task Force recently issued a report on helium 3, which is rare on Earth but plentiful on the moon. The group suggested that in the future the element could fuel fusion reactors to power spacecraft.

FIX IT OR DIE

"Mass approaching twelve o'clock, diameter ten centimeters, speed six kilometers per second, impact imminent!" The computerized voice echoes through the spacecraft; the impact shakes the structure. Everything necessary to repair the ship must be either available onboard or jury-rigged by an ingenious crew. There is no alternative: The voyagers are 3 million miles from Earth, and Mars is another 45 million miles ahead.

"You can't have a Cape Kennedy in orbit," declares Mark Craig, NASA's special assistant for exploration and point man for the moon–Mars initiative. "So how do you build a spacecraft that will exist in space for years with little or no human intervention? You need self-diagnostic ability and repairability."

Current manned space vehicles have an average MTBF (mean time between failures) of 10,000 hours; in other words, more than half of them may fail within a year. Even on the Soviet *Mir* space station, where replacement parts can arrive within 30 days, the crew spends large amounts of time repairing equipment, observes Nicholas L. Johnson, advisory scientist at Teledyne Brown Engineering and author of the annual compendium *The Soviet Year in Space*. "The Soviets have had significant problems, especially after the first two to three years, in maintaining the *Mir*," he says. "They've done a great job, but it's been at the cost of a

lot of lost cosmonaut time for conducting experiments." That's in low Earth orbit. For any deep-space mission, repairability is essential. "If you can't fix something," says Johnson, "you'd better have another one along with you."

R2-D2, CALL YOUR OFFICE

The robotic servicing unit's TV optical system transmits the faint glow of the ruptured nuclear power plant to the operator bent over her screen three kilometers away in the lunar module. *Damn,* she thinks, *yesterday's meteor impact breached the first two layers of the triple shielding; any more damage would have caused a meltdown.*

No human could go near a reactor in this condition and survive. Closeup repairs of the shielding are no problem for her teleoperated robot, however. Its "eyes" let her zoom in on the damage; the "smart" gloves she wears let her move the robot's "hands" to feel the reactor wall. Thanks to the dexterity with which she can manipulate her distant partner, repairs are finished in a single eight-hour shift.

Making repairs outside a ship in space is a risky business for humans. When possible, spacefarers will employ futuristic teleoperated or fully independent robots equipped with sensors able to distinguish texture, "hands" with "fingers" that can feel delicate gradations in pressure, plus enough artificial intelligence to learn from experience and program themselves. "This is an area where Japan can contribute a lot," says Hajime Furuta, MITI representative in New York, referring to Japan's demonstrated virtuosity in robotics.

Canada, the nation that gave the shuttle its manipulator arm, is also a major player in robotics and automation. At present Canada-based Spar Aerospace is developing the Mobile Servicing System that astronauts will use to build and maintain the space station. Furthermore, robotics will play a major role in mining the lunar regolith for construction materials and rocket fuel, and in covering habitation modules with soil to protect against radiation. "We have an active mining community," says Dr. Frank Vigneron, who chairs the Canadian Space Agency's Working Group on Moon–Mars Exploration, "so there's possibly a role for us in the production of robotic vehicles to do similar work on the moon."

Mining, construction, and other robotic activities, however, will consume more energy than existing power-generation techniques can supply. Space Station *Freedom*'s big solar arrays, for example, are expected to provide a total of about 75 kilowatts—barely enough to keep the station running and do any work onboard.

A moon–Mars mission will require far more power than the station. "I think nuclear power will be needed," says Huberman. "The United States is working on the SP-100 nuclear power source, and the Soviets run their Rorsat with nuclear reactors. So to the extent that nuclear is required, it will be an American–Soviet show."

A LITTLE SHORTER IN THE PANTS, PLEASE

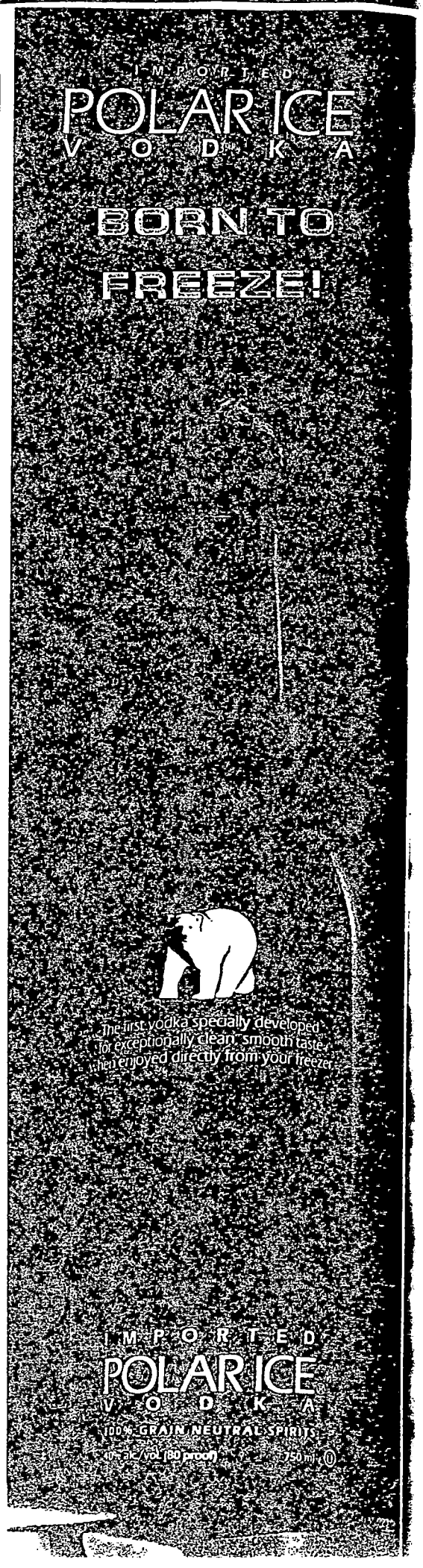
"Two dozen suits in the locker and not a damn one working in my size!" fumes the geologist intent on getting out onto the Martian surface while the pink Martian sky is still bright with sunlight. Within limits, the suits can be resized to fit different human frames, but right now all the ones suitable to her height and build are out of commission. Whether in the vacuum of space, the airless surface of the moon, or the tenuous atmosphere of Mars, the fragile human body must be sheathed and supported by the elaborate protection and life-support systems of a space suit.

The International Latex Corporation space suit used on the shuttle is a remarkable piece of gear—but is too delicate for regular wear in space or on the dirty surfaces of the moon or Mars. The garment needs hundreds of hours of repair and reconditioning after every spacewalk and takes days to resize to a differently proportioned person. It also takes hours to get into one and prepare to leave the ship.

To avoid developing the bends, even before dressing, the intrepid traveler must spend from 40 minutes to four hours breathing oxygen before setting out on the EVA. The reason: Shuttle space suits operate at a very low 4.3 pounds per square inch (psi).

First an astronaut dons a liquid cooling and ventilation garment, designed to keep internal temperature bearable, laced with a network of flexible tubing. At this time the urine collection device is also put on. Next come the lower torso pants, boots, hip, knee, and ankle joints. Then follows the upper torso, including arms, the umbilical and electrical harness containing communications, power and oxygen lines, connections to the portable life-support systems—and the Hamilton Standard life-support backpack. Finally the spacefarer slips into gloves, helmet, and visors.

Unfortunately, shuttle suits are too heavy for use in the lunar or Martian gravity fields. Built for zero gravity, one weighs more than 200 pounds on Earth. "The weight has to come down," says Lee Weaver, a California consulting pilot engineer who has worked in every EVA program (and worn these suits) since Gemini. "The suit has to have better lower body mobility and it has to be able to stand up to the lunar or Martian environment.



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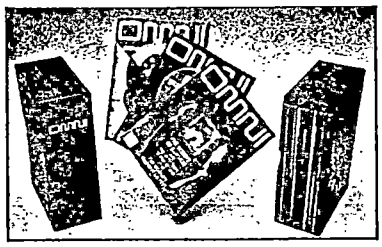

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SATISFACTION GUARANTEED

"EVA is going to be a make-or-break factor in assembly and surface operations," he continues. "Unless and until we have nuclear power to support planetary surface operations, human muscle is going to be one of the primary ways to make things happen." That will require major advances in space suit design.

NASA is now working on better garments. At Johnson Space Center a team is developing an 8.6 psi outfit that would eliminate the need to breathe oxygen for hours before an EVA. Unfortunately, the suit has to be sturdier to handle the increased pressure. "That, in turn, makes glove dexterity a problem," says Weaver. "And you can't use pure oxygen at that pressure because it's too flammable, so you have to use both nitrogen and oxygen, which requires the addition of pumps, regulators, and gas sensors. That adds to the weight—and we need lighter, not heavier, suits to operate in the gravity fields of the moon or Mars."

A completely hard suit, the AX5, is in the works at NASA's Ames Research Center. Its all-aluminum shell offers a vast safety improvement over soft suits, according to Weaver. It does have a challenge to meet, however: In a gravity environment the AX5 will have to be modified to stand up by itself when inflated (as a soft suit will).

STRING THING

"Ahhh, that's better! Gravity at last. Ten years in the space biz and I still get spacesick when we hit orbit!" The computer systems troubleshooter relaxes gratefully onto her couch and lets her stomach settle down as the habitat module starts to spin at the end of its kilometer-long Kevlar tether and the resulting centrifugal force creates a modest level of gravity. Tomorrow an elevator will crawl up that cable, taking her to weightlessness again at the spin center of gravity, where she will attempt to coax a balky computer system into functioning properly. For now, at least, she'll be able to relax in comfort—and keep her dinner down.

The absence of gravity does very nasty things to the human body. After even a few days, astronauts lose bone calcium, cardiovascular conditioning, and electrolytes. The most commonly used preventive measure discovered to date: two to four hours of strenuous exercise every day. On a three-year mission such a workout schedule might prove both hard to maintain and inadequate to the cumulative health impact of zero g. Some form of artificial gravity, therefore, may play an essential role in the Mars voyage.

One way to create gravity is through the centrifugal force generated by spinning two objects (such as a spacecraft and a counterweight) connected by a long "string."

Such tethers will be long cables of woven Kevlar deployed like huge fishing lines from space platforms. Research into this technology has progressed quietly in recent years—to the point where the shuttle is slated to test one in September 1991. Plans call for astronauts to uncoil a 20-kilometer-long tether with an Italian satellite at its end. How much time might it take to scale up from this demonstration level to an artificial gravity system for a functioning spacecraft?

"Not too long," predicts Al Schallenmuller from Martin Marietta, which has been working with NASA for years on tethers. "The main areas that we need to master are some of the dynamics in the cable and some of the electrostatic charges generated in it when it's flying in space."

Another way to simulate gravity: Create centrifugal force by spinning the spacecraft alone. "But if you do that," says Larry Bell, director of the Sasakawa International Center for Space Architecture at the University of Houston, "you also create problems with orienting communications antennas, radiators, and solar power arrays." Beyond these difficulties, the craft must rotate in a wide enough arc to avoid causing an inner ear disorder called the Coriolis effect, which results in a loss of balance. "With a radius of fifty-six feet, we can reach six revolutions per minute, which provides two thirds the earth's gravity," says Schallenmuller. "But higher rotation rates," he adds, "would require a longer radius and create a need to shore up the structure to brace it against propulsion stresses."

GLOW FOR THE GOLD

"How many more flights are they going to allow you?"

"Only one. I'm already pushing the radiation dosage limit."

"That's a heartbreaker. Who's going to finish out your experimental series?"

"One of my graduate students, I think. He's smart enough—if he decides he wants to risk the possible chromosome damage. I think he wants kids eventually. He just doesn't want them to have two heads!"

The two scientists laugh hollowly, contemplating the difficulties of conducting research in space. After all, some necessary experiments take longer than human tissue can withstand the onslaught of solar and cosmic radiation.

Experts in space medicine now place such risks at the top of the health hazards list. "We're using standards that are very, very speculative," warns Bell. "We're already allowing dosages for astronauts that are ten times what we allow for radiation workers on

Earth. It's not simply a matter of adding shielding, either. That increases the ship's weight, and far worse, spacecraft walls can become ionized, making the radiation problem worse. This issue is a potential showstopper—and it's the one we know the least about!"

NASA is now talking to the Soviets about their space medicine experiences. The agency has even discussed joint research efforts—such as flying U.S. astronauts and using American medical protocols aboard *Mir*. Two important areas in which such a program would help: an assessment of the need for artificial gravity and research on radiation effects.

FARMER IN A DRUM

"Well, let's see, you raise the fish in the rice paddy tanks, and you filter the water by running it through the soil in your vegetable garden—you better have enough termites in there to clean up the dirt, by the way—and oh, yes, I'd stock some chickens that still know how to sit their eggs—they bred it out of the stock twenty years ago, you know—and..." The space ecologist talks on, while his listener strives to grasp the complexity and expense of equipping a completely self-contained spaceship capable of taking his Martian Tours customers ("For the Traveler Who's Been EVERYwhere!") safely and comfortably to the red planet.

To stay alive in orbit and on the lunar and Martian surfaces, people will need closed life-support systems that can recycle air and water, grow food, and stay habitable for years or even decades at a time. There is nothing of the sort available now. Neither the shuttle nor *Mir* has closed life support; both depend on resupply from Earth. The shuttle lands between missions. Approximately every 60 days the Soviets launch a Progress to *Mir* carrying two and a half metric tons of various supplies—such as propellants, water, air, food, film, and space suit spare parts. "To support a two-man crew for a year takes five to six such flights," says Johnson. "That's about fifteen tons of material every year for just two people." Although Space Station *Freedom* originally had a closed oxygen system, last year that idea was dropped in favor of the *Mir* approach, to save money. No such option will be available for a Mars journey; there aren't any supply depots along the way. It's recycle or die.

Let's assume engineers master all these problems of equipment and hardware. The hardest part still remains: keeping fragile, ornery humans physically and psychologically healthy for months and years cooped up in spacecraft or surface structures the size of biggish school buses, in a hostile environment, away from family, friends, fresh air, blue skies, and the earth's gravity field. "The human being is the weak link in the chain, and it's a very weak link," says Susanne Churchill, associate director of the Institute for Circadian Physiology in Boston. "We typically put enormous effort and money into building spacecraft but nowhere near the necessary level of work into the matter of the crew. Unless we focus on the human aspects, we may engineer ourselves a perfectly elegant ship to launch to Mars—and find we can't in good conscience put people in it."

TIGHT QUARTERS

"I can't stand it any longer!! If you whistle that tune one more time, I'll kill you!" The technician clings to a hand brace on the wall of the spacecraft's galley, menacing his shipmates with a knife, his eyes wild. The others hover at a cautious distance while the ship's psychologist tries to calm the distraught man down. It's his third crack-up this week. *The trip's too long; we're too far away from home,* she worries. Even the best prelaunch psychological profiles can't predict what will drive people crazy several million miles from Earth.

MISSION POSSIBLE: HOW TO GET TO MARS

As the argument grows over the best way to go to Mars, the White House National Space Council refuses to be rushed into a premature decision about mission architecture. It has already stated that it will take several years to define two or maybe even more mission plans. In the meantime there are already three major proposals:

- NASA's "90-Day Study," done in 1989 at the request of the National Space Council. Its chief characteristics are caution and the minimization of risk. Plans call for the development of heavy-lift vehicles to truck equipment and humans to low Earth orbit for assembly operations at Space Station *Freedom*. Unmanned robotic precursor missions to case the lunar and Martian surfaces in detail would also be scheduled. (Apollo mapped only part of an equatorial strip between roughly 40° north and south on the moon, and we know even less about the closeup details of the Martian surface.) The study estimates that it will take a decade or more to research ways to counteract the effects of low or zero gravity on the human organism. During this time a permanent base established on the moon will serve as a proving ground for the move to Mars. Price tag: a cool $400 billion over 30 years by NASA's preliminary estimate. The final cost is likely to be a lot higher.
- Lawrence Livermore National Laboratory's "Great Exploration" proposal concentrates on getting to Mars by the end of the century, because "there has never been a successful twenty-five- to thirty-year federal technology program." Its salient characteristic is a reliance on inflatables instead of heavy, rigid structures, thereby drastically lowering projected lift requirements. Price tag: about $10 billion but at the cost of a much higher level of risk. This gives the proposal a certain air of dash and adventure. Everybody seems to admit that it deserves at least further study.
- "Bridge Between Worlds," laid out in the 1986 report of the President's National Commission on Space, *Pioneering the Space Frontier* (the "Paine Commission Report"): The grandest vision of all calls for a full-fledged interplanetary infrastructure linking Earth, the moon, and Mars. When completed, it would include spaceports orbiting each body and permanent bases on the lunar and Martian surfaces—all tied together by a fully equipped cycling spaceship permanently orbiting both the earth and Mars. No price tag estimated but sure to be a humdinger.

Spaceflight is tough duty even close to home in low Earth orbit. When this reporter first met Dr. Oleg Atkov, the Soviet cardiologist who spent nearly eight months in orbit on *Salyut 7*, she mistakenly complimented him on enduring 236 days there. "Two hundred thirty-seven," he ruefully corrected, "because every day you count!" With cosmonauts staying in orbit for as much as a year at a time, the Soviets have accumulated more experience than any other nation in the psychological problems of spaceflight. The techniques they've developed attest to the complexity of the problem. Every mission has a full-time ground-based psychological support group. Cameras onboard the space station allow psychologists on the ground to monitor crew interactions, watching for indications of tension. Cosmonauts' voices are monitored for signs of stress. Regular radio and TV contacts with families, friends, and prominent Soviet personalities boost crew morale. Mail, pictures, and tapes of Earth sounds go up on every Progress resupply module. Thus far, it's worked. Nobody has murdered anybody else in space. But that's only in low Earth orbit. Psychologists will need a whole new set of techniques to deal with people who are many millions of miles away for years at a time. Perhaps by the time people venture to Mars, advances in computer and other technologies will let them talk to Hal-like psychologists based in the ship's computers, gaze at holograms of their loved ones and their favorite vistas, or dream in some form of suspended animation to pass the time.

DO SVIDANYA, Y'ALL

If we overcome all these technical and political hurdles, the day may come when, finally, humankind sets out for Mars. The journey might go something like this: Dateline 2030: Built by the biggest consortium of nations in history, piloted by a multinational crew, supported by an international lunar base, and fueled by propulsion materials mined from the lunar regolith, the huge spacecraft, assembled in lunar orbit, is finally poised to depart for Mars. Supplies are waiting for it there, pre-positioned by unmanned vehicles on the surface of the planet.

To have gotten this far is a triumph of technological wizardry. But even greater is the political triumph. Persevering somehow through four decades of national rivalries, budget crunches, and conflicting priorities, the participants have built cooperative institutions and techniques for managing conflict that may look oddly like the nucleus of a world government. History may note that in going to Mars together, the world finally discovered how to work together on Earth. ☐

BODY

CONTINUED FROM PAGE 22

a glint from the reflection off the cornea. Because the glint is a direct reflection of infrared light, it remains stationary, but the bright eye—an *indirect* reflection of light bounced off the retina—fills the pupil and moves as the person shifts his gaze. The camera tracks the distance between the center of the retinal reflection and the center of the glint to determine the exact spot on the screen the user is focusing on—his "gaze point." When the user's gaze point remains steady for half a second, it signals the digital image-processing card in the computer to comply with the command on that area of the screen, much as a Macintosh user might move and click his mouse.

Hutchinson has already produced six ERICA systems in his lab; within five years, he says, he hopes to miniaturize the unit so it can control a motorized wheelchair and go wherever its user goes. In 1988 U Va licensed the ERICA design to LC Technologies of Fairfax, Virginia; the company calls its model the Eyegaze System and has already sold nine of the $25,000 units. According to company owner Joseph Lahoud, further applications include installing Eyegaze in operating rooms so surgeons can call up computerized information using only their eyes.

IBM recently unveiled *SpeechViewer*, a program developed to motivate deaf and speech-impaired kids—and adults—to use their voices and speak clearly. *SpeechViewer* teaches them to translate graphics into sounds, form understandable vowels, and modulate their voices, using colorful displays like balloons that expand as voice volume increases, thermometers that register pitch, and trains that indicate the onset of speech. Another IBM device still in the research stage could help profoundly deaf kids make the jump from American Sign Language (ASL) to reading written speech. Deaf kids tend to have a tough time learning to read because ASL and English have different grammatical structures and they can't *hear* where one word stops and another starts. The new system features a touch-sensitive screen that lets the user ask questions by touching the puzzling part of a story. If he's still confused, the program signs the response, much as closed-caption TV programs feature simultaneous translation into ASL.

On a strictly human level, the new computers work miracles by improving kids' lives. "A lot of kids in special ed have only learned to fail over and over again," says Dr. Linda Tsantis, senior planner for IBM's Washington Center for Technology in Education. "Through the combination of technology and software, they suddenly find themselves succeeding—and enjoying it."

Leah, a child whose cerebral palsy prevents her from walking, talking, or even sitting effectively, might have been one of those who never tried. But in first grade she began participating in a pioneering experiment to permit word processing without hitting a keyboard. The approach worked: Today Leah is an active member of her junior high school class. The program she used, called *KidWord*, runs on an Apple IIe computer. Leah controls the computer by leaning the side of her head against a single switch mounted on her wheelchair's headrest. An adaptive firmware card—hardware that tricks the computer into thinking the switch is the keyboard—scans the alphabet in groups of five letters; when the desired group is highlighted, a gentle touch of the head activates the space bar and selects that group. The program then scans the letters inside the group. The first sentence Leah tapped out—at the age of six: IT'S ABOUT TIME.

Further down the line, kids may wear baseball caps that activate computers, says Paul Snayd, special needs program manager for IBM. With the cap aimed at the screen, a slight movement of a forehead muscle could enable the user to select an item from those scrolling past. "The head is the last place to lose muscle control," Snayd explains, "so children who can think but not move could use the computer." ☐

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THE NEW FRONTIERS

NASA is plotting four great adventures in space to serve science and to enrich the human spirit

by William J. Cook

When the space shuttle Discovery thunders into Earth orbit next week, Hurricane Gilbert and systems permitting, it will carry five seasoned astronauts and a dream revived. In the 2½ years since Challenger exploded, killing seven adventurers and, for a time, our spirit, almost everything has changed. Out of the anguish and self-examination have come both a safer shuttle and a new vision, embodied in a presidential declaration that America intends to expand human presence and activity beyond Earth into the solar system.

That new frontier has given NASA a focus it has lacked since the Apollo program ended nearly two decades ago with Americans ankle-deep in lunar dust. The shuttle is no longer a cargo hauler on a trip to nowhere. It is now the first link in a system that will carry people to a space station 220 miles above Earth. Starting in 1996, the station itself, approved by Congress in 1984 as a scientific laboratory, is a way station to the stars in the new vision: a transportation depot where manned rocket ships could be assembled and launched to the moon and beyond.

When John Kennedy pledged to put men on the moon, space travel was not his primary goal. Apollo was a national-security exercise to prove our missiles superior. That done, U.S. manned missions languished, falling far behind the Soviets. This time, though, superpower competition does not drive the star-struck. Sending humans heavenward may not return sufficient economic, scientific or military benefits to justify the enormous expense. This time it's for "inspiration," says NASA chief James Fletcher. And more. Becoming a multiplanetary species, beams astrophysicist Carl Sagan, "is the grandest evolutionary step yet."

Not everyone agrees. Planetary scientists, eager to explore the universe with robotic probes, consider manned missions scientifically unproductive. Money matters, certainly more than it did in Kennedy's day, and there are men and women of good conscience who argue that America must first spend its precious resources on the citizens of Spaceship Earth.

But more than bread feeds the human soul. NASA's new Office of Exploration is already plotting four great adventures in space for consideration. Each seeks a different objective. Each could be performed alone or in cooperation with other space-faring nations, even the Soviet Union. All raise complicated questions that must be resolved before any mission can begin. The plans will be ready for the next President, if he chooses to act.

ADVENTURE 1

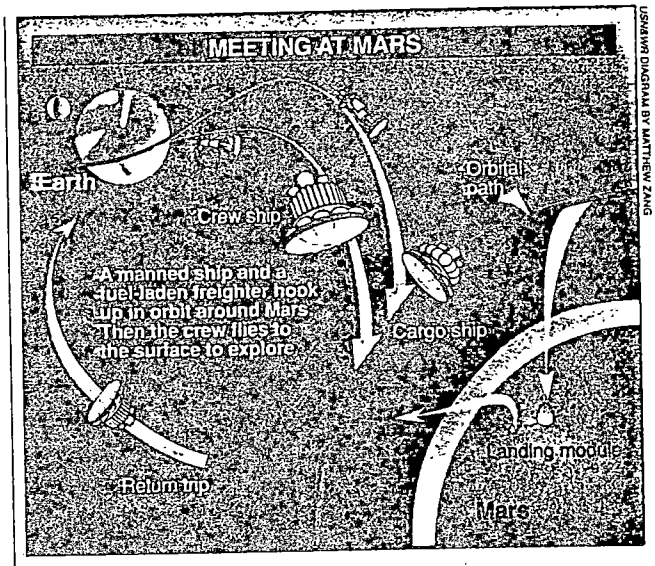
THE MARTIAN CHRONICLES

It is by far the most ambitious, the most difficult and the most expensive of the plans NASA is considering. But a manned trip to the red planet is also the most exciting

An expedition to Mars. Of all the missions contemplated, it is the space adventure that most fires the Earthbound imagination. We know, academically at least, that those aren't really canals up there on the red planet's sere surface. The patterns that primitive telescopes suggested might be signs of intelligent life were probably only weather systems. And yet what C. S. Lewis called "the silent planet," our closest planetary neighbor, continues to inspire cosmic curiosity.

Of all the options under consideration, a trip to Mars is also the most daring, the most difficult and the most costly. It would begin with an unmanned cargo ship so large that it would have to be assembled at the space station in Earth orbit. The million-pound freighter, most of its weight liquid oxygen and hydrogen fuel for a return trip to Earth, would embark around the year 2006 on a fuel-saving, nine-month path to a Martian orbit. About a year later, once the cargo ship's safe arrival was certain, a second craft—2½ times bigger and carrying eight passengers—would sprint off on a more direct, six-month flight. The two ships would rendezvous in orbit; then, four astronauts would fly to the surface of Mars for an exploratory mission 10 to 20 days long. They would return to the mother ship, by now refueled, with a treasure trove of geological samples and scientific observations for the flight home.

The scale of such an adventure vastly exceeds the Apollo program that sent astronauts to Earth's moon. Over 25 years or so, it could cost as much as $300 billion (although, because of the much expanded U.S. economy, that sum would consume a smaller proportion of GNP than Apollo did). To begin with, by the late 1990s the space program would have to develop new expendable, heavy-lift rockets able to hoist fuel and segments of the Martian craft from Earth to the space station in 200,000-pound loads, four times the shuttle's capacity. NASA's initial estimates suggested that more than 15 of these monsters would have to fly from Earth to orbit every year during the peak preparation period. Now, NASA planners are trying to reduce the total by examining flight years in which the planets will be in their most favorable alignment.



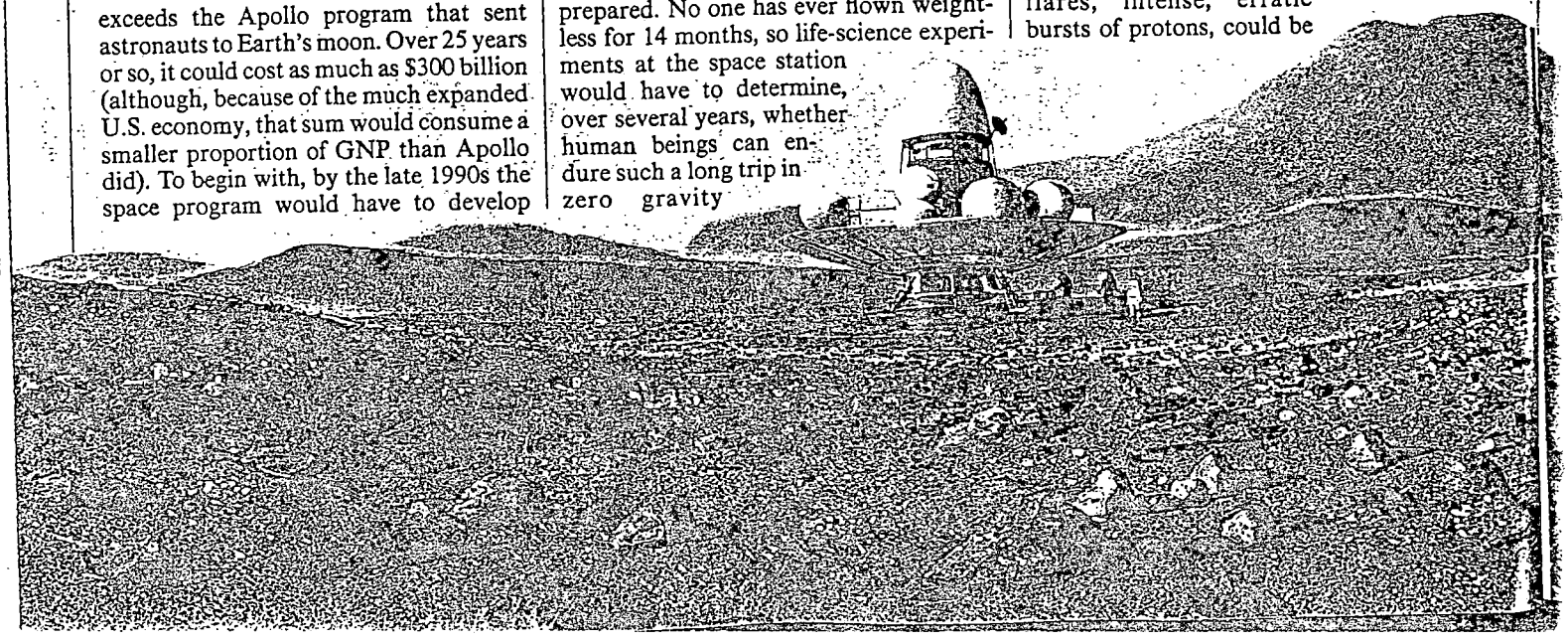
USN&WR DIAGRAM BY MATTHEW ZANG

Preparing the astronauts

Far-more-delicate machines, the humans who would fly the mission, also have to be prepared. No one has ever flown weightless for 14 months, so life-science experiments at the space station would have to determine, over several years, whether human beings can endure such a long trip in zero gravity and arrive on Mars able to do useful work. If it turns out that vigorous exercise on treadmills and stationary bikes isn't sufficient to prevent bone loss, atrophied muscles and even suppression of the immune system, as Soviet scientists have begun to conclude on the basis of long cosmonaut flights, some form of artificial gravity would be required.

If that is necessary, it would require an even larger, more complex ship. Some scientists speculate that crew members' physical conditions might be maintained by spending part of each day en route whirling in a big centrifuge, perhaps kept company by a small television set, says Arnauld Nicogossian, the director of NASA's life-sciences division. If that isn't good enough, the entire crew compartment could spin constantly like a carnival ride to press the crew toward the outer walls. The spacecraft could even be divided into two parts linked by a tether so they would revolve around a point between them. A tether 2,000 feet long, allowing one revolution per minute, would generate gravity equal to that of Mars (about one third of Earth's level). But some scientists fear the rotation would disorient crew members and make them motion sick.

Then there are the dangers lurking in space itself. It is very difficult to shield against the cosmic rays that bombard a spaceship in flight. According to Nicogossian, "They would not kill you, but they could increase the risk of cancer" for crew members after they returned to Earth. A second form of radiation, solar flares, intense, erratic bursts of protons, could be



deadly if the crew didn't retreat into a shielded "storm cellar" in the spaceship. The warnings would have to come from orbiting observatories that could see the flares leave the sun.

More psychological research is also needed. Experience with past space flights, Antarctic explorations and nuclear submarines shows that crew members in close quarters can become irritable and depressed and have trouble sleeping, leading to poor performance. One question for which no one has good answers: Should the crew include both men and women?

Before a crew could set foot on Mars, landing sites would be examined by robotic flights, such as the Mars Rover Sample Return Mission, which NASA hopes to launch in 1998. Autonomous vehicles would spend about 200 days roving the terrain the astronauts would later explore, to make the best use of their limited time.

Assembling the ships

Once the life-sciences questions are on their way to solution and the robotic precursor missions flown, the enormous job of assembling the Mars ships could begin. The functions now provided by ground crews at Cape Kennedy would be moved 220 miles up to the space station and performed by a handful of astronaut construction workers. Their first job would be to convert the space station into a transportation depot. One plan doubles its size by adding an enormous hangar.

All that construction would not be helpful for delicate scientific experiments that are also scheduled to be done aboard. James Odom, associate administrator for the space station, explains that some of these processes could be automated, once equipment has been developed on board, and some experiments could be transferred onto platforms that fly in formation with the station.

Assemblies hauled up from Earth by heavy-lift rockets would be parked in orbit near the station. An "orbital maneuvering vehicle" would act like a tugboat, nudging the pieces of the spaceships to the hangar. There, long mechanical arms operated by remote control would manipulate the parts into position. The million-pound cargo craft would be built first and launched, clearing the way for construction of the 2.5-million-pound crew ship.

But the really hard part of a Mars mission would begin once the ships had made the long journey, 34 million miles when Mars and Earth are in their closest alignment. The crew vessel would have to establish an orbit around Mars, then find the cargo ship. If the crew missed that crucial docking, they would be marooned without enough fuel to return.

Success depends on using the thin Martian atmosphere to slow the ships when they arrive, an intriguing but so far untried procedure called aerocapture. A ship makes a fiery dip to within 25 miles of the planet's surface, retarded by friction against a blunt heat shield at the bow called an aerobrake (see diagram, page 56), an aerodynamic structure that can also maneuver the craft. Once enough speed is burned off, computers steer the ship out of the atmosphere. A short rocket burn is then all that's needed to establish a circular orbit around the planet. NASA calculates that aerocapture could halve the size of a Martian spaceship, since it would not need to carry fuel for braking retrorockets.

Exploring the surface

The point of going to Mars, of course, is to explore the planet. Once in orbit, four of the eight astronauts would board an excursion module and land at a preselected site. They would be seeking answers to questions that have haunted scientists since the days of early telescopes. How old are Martian rocks? What processes caused the volcanoes? Did water once cut canyons into the surface? "A field geologist can do things you can't with a robot," says Donald Rea of the Jet Propulsion Laboratory, who is managing the planning for the Mars Rover Sample Return Mission. The explorers, perhaps motoring around in an electric car like those used by Apollo astronauts on the moon, would also look to see where a future outpost might be established on which scientists could live for a couple of years. They would see only a tiny fraction of the planet on the first trip, at least; the land area of Mars, with no oceans, is virtually the same as that of Earth.

Return to Earth would be as dramatic as reaching Mars. The spaceship would plunge into Earth's atmosphere, then climb out of it to park once again at the space station. Then crew members would board the shuttle for the last leg of their long, historic journey. Once home, they—and their samples—would be quarantined for a time to make sure they didn't bring back some hitherto unknown "Andromeda strain" organism that could infect earthly biota. Only then would they be ready for the ticker-tape parades. ■

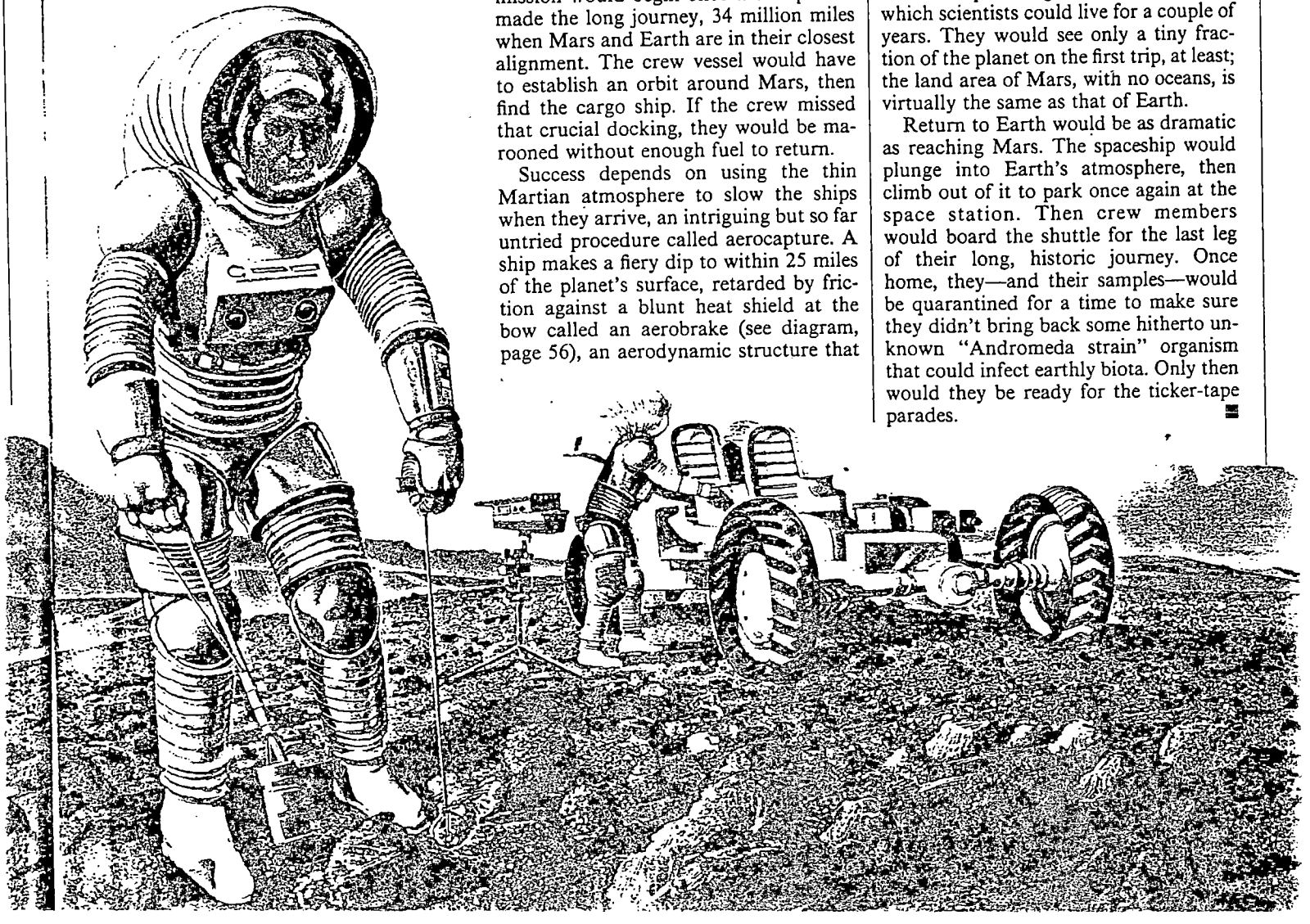


ILLUSTRATION BY HAROLD SNELLGER FOR USN&WR

Talks With the Palestine Liberation Organization

Q. Mr. President, you specified that the PLO dialog has been positive and productive, but you haven't really told us in what way. Could you be a little more specific about that? What productivity do you see in it?

The President. I think the very fact we are talking can—and that's one of the reasons I would hope that it can be restored—can eliminate differences. And I would like to feel that the PLO, because of our dialog, doesn't see us as quite the hostile country that once they did. There's all kinds of small points that are taken up by our Ambassador Pelletreau in Tunis that I think have reduced the levels of misunderstanding.

I don't want to leave you the wrong impression: that I think the dialog has resulted in a more dynamic peace process. But I do think that it's good, and I think that it encourages moderation within the PLO ranks. I think we lose sight of the fact that Arafat did something that was predicted no Palestinian leader could do when he recognized Israel's right to exist as a state. And some might say, Well, it's about time. And I'm one of them. But that was quite a step forward. It was quite a step forward when he recognized Resolution 242, and I think that was positive. And then I think we've had a chance to solidify those gains, modest though they might have been, through dialog. But I can't point to the fact that that has really solved the question of Middle East peace. I just feel that talking offers more potential than stiff-arming each other. And yet we can't digest it as long as this terroristic act is sticking in our throat. And properly so, as a country that decries international terrorism.

Space Program Funding

Q. A question about space. How serious are you about this lunar base and Mars mission proposal? Would you go so far as to veto the bill that contains NASA appropriations if Congress decides to delete all the money?

The President. I haven't even contemplated any veto strategy. I'd like to get what I want. I think it's in the national interest. I think that the United States must remain way out front on science and technology; and this broad program that I've outlined, seed money that I've asked for, should be supported. But I think it's way too early to discuss veto strategy. We took one on the chops in a House committee the other day, and I've got to turn around now and fight for what I believe.

Q. Mr. President, how far will you go to protect the NASA budget in the future? Can you remove it from HUD [Department of Housing and Urban Development] and give it some security?

The President. It's pretty hard, given the way Congress functions, and that is a function of the Congress, not of the executive branch—to decide under what committees these budgets are worked. But I think it is fair to say that I will fight for a fully funded space program. We've put forward what I think is a bold one. I've taken some shots—saying, Hey, how can you propose something this big when we have such a large deficit? And I understand the question. But we're talking about stretched-out financing, and we're talking about, hopefully, a continued dynamic economy. And between the two, we can accommodate this goal if we all get with it.

Suspension of Talks With the Palestine Liberation Organization

Q. Was there not a need here, sir, to not appear to be indulging to the PLO at a time when the administration has been tougher than perhaps any recent administration has been with Israel?

The President. That's not what made my decision. And I don't know that we've been tougher. I'm the President of the United States. The United States has a policy. And I'm supposed to, I think, go forward with our policy. And one of the big problems we've had is the question—between ourselves and the Israeli Government—is this question of settlements. But I wouldn't read my decision here to go as follows: He made this decision because he's concerned about a complicated relationship with Israel at this point. That's not why I made the decision, but some may read it as that. But we're staying with our concept on the peace process, and we are staying with our policy on settlements. And this action that

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cations], to that before you leave here. I mean, I want you to have it. It's not come to me yet.

Taxes

Q. Governors, including Governor Bill Clinton of Arkansas, have complained repeatedly in the past that your no-new-taxes pledge that you made at the Republican Convention in 1988 has dramatically limited the ability to raise needed tax revenues at the State and local level. Did you intend for "Read my lips!" to apply to the local level?

The President. No, it's a good question, and I think I've spoken out on that. I know I have before, because certain States have found that they have had to raise revenues. And I am not about to criticize, and have not criticized, Governors, Democrat or Republican, who have gone that route, or ballot proposals that take an opposite view from that. What I'm talking about is the Federal role. And so, I'm glad to have a chance to clear it up, and it's a very good question.

We'll take two more on the aisle here.

Environmental Policy and Employment

Q. A followup to the earlier question on the spotted owl. Were you saying that you are trying to influence Mr. Turner's [John F. Turner, Director of the U.S. Fish and Wildlife Service] decision on whether the owl should be listed?

The President. No. We have very limited control over that. I'm saying I care very much about environmental concerns, and I care very much about family concerns. It's tough when a person is thrown out of work in this country, and we've got to keep in mind family concerns as well as environmental concerns. But I'm glad you raised it because, really, the act provides a certain mechanism for addressing problems of this nature. And the administration has very little way to get involved in that.

Space Exploration

Q. You've spoken optimistically about the need for a space station—it's going to cost about $35 billion, four times its original estimate—a Moon-Mars mission, which could cost as much as $500 billion over the next 30 years. How do you get Congress, at a time when NASA is notorious for cost overruns and when they've got to tighten the budgets everywhere, to go along with your vision for space, or in the alternative, how do you convince the American public that this is not just a grandiose, feel-good plan from the White House?

The President. Well, of course, some of the proposals we're talking about are stretched out over many years. But you know, I've been very pleased that Congress has been willing, in difficult fiscal times, to support a meaningful space program. I think it is important not only to be out front in terms of scientific achievement but also to recognize that what Sally Ride [shuttle astronaut] called a visit to planet Earth, I believe, is important. In other words, there's benefits that come to medical science and to environment and to everything else from having a very active space program.

And you put it well because there's a tremendous demand for dollars in a budget, especially when you have an enormous deficit to face, like we're doing. And so, I've been pleased that our proposals have had broad supports, crossing party lines, Democrat and Republican, in the sense of support for the objectives in space that I've spelled out. And I hope that support remains because I think there is benefit to the United States and I think it's always been our heritage, our pride, to reach out and be on the cutting edge of science. And so, I think the American people will continue to support that. You ask how the people—I don't believe Congress would be supporting it if the American people looked at it quite differently.

I really do have to go, and thank you all very much.

Q. Mr. President, will you do this again?

The President. Now, wait a minute, you're changing this again. You already asked two questions. Get out of here. [*Laughter*] Thank you all very much. You have a question—aw, aw, no two questions. [*Laughter*]

Q. Will you do this again? Will you do this again?

The President. This is a walking exit. This is a walking exit. I may not answer it if it's

not the kind in general.

Transportation Policy

Q. With airline deregulation and Greyhound bankruptcy, many cities have lost their airline and inner city bus services. Does the Federal Government have a responsibility to preserve transportation options for rural America?

The President. I think the Federal Government would like to see options preserved, and they'll like to see it done by supply and demand. I would like to see it done not by the Federal Government coming in and saying you've got to have this carrier here and that mode of transportation there but by having the market provide the transportation that is often essential, and that's the way of it. But I am concerned when you have a major carrier like Greyhound having the fiscal problems they do because it could be enormous interstate inconvenience. So, we're taking a look at that one right now.

Thank you all very much.

Note: The President's 50th news conference began at 11:14 a.m. in Room 450 of the Old Executive Office Building.

Nomination of Townsend B. Friedman, Jr., To Be United States Ambassador to Mozambique

June 13, 1990

The President today announced his intention to nominate Townsend B. Friedman, Jr., of Illinois, a career member of the Senior Foreign Service, Class of Counselor, to be Ambassador Extraordinary and Plenipotentiary of the United States of America to the People's Republic of Mozambique. He would succeed Melissa Foelsch Wells.

Since 1987 Mr. Friedman has served as Director of the Office of Southern European Affairs at the Department of State. Prior to this, he served as Deputy Director of the Office of Southern European Affairs, 1986–1987; Political Counselor at the U.S. Embassy in Athens, Greece, 1983–1986; student at the National War College, 1982–1983; political officer at the U.S. Embassy in Buenos Aires, Argentina, 1979–1982; labor-political officer at the U.S. Embassy in Buenos Aires, Argentina, 1978–1979; and political officer at the U.S. Embassy in Athens, Greece, 1975–1978. In addition, he has served as a Special Assistant for Policy Planning, 1973–1974; Special Assistant to the Counselor, 1973; information officer at the Department of State, 1972; political officer at the U.S. Embassy in Santiago, Chile, 1968–1972; staff aide at the U.S. Embassy in Santiago, Chile, 1967–1968; analyst for the Bureau of Intelligence and Research at the Department of State, 1965–1967; vice consul in Porto Alegre, Brazil, 1964–1965; and a junior officer at the U.S. Embassy in Rio de Janeiro, Brazil, 1962–1964. Mr. Friedman joined the Foreign Service in 1962.

Mr. Friedman graduated from Cornell University (B.A., 1962). He was born January 4, 1940, in Chicago, IL. Mr. Friedman is married, has two children, and resides in Potomac, MD.

Nomination of Richard C. Brown To Be United States Ambassador to Uruguay

June 13, 1990

The President today announced his intention to nominate Richard C. Brown, of Maryland, a career member of the Senior Foreign Service, Class of Minister-Counsel-

McNally/Martin
Oct. 2, 1989, 2:00 p.m.
Draft Two (B:SPACE)

PRESIDENTIAL REMARKS: CHALLENGER CENTER GALA DINNER
RAMADA RENAISSANCE TECHWORLD
WASHINGTON, D.C.
WEDNESDAY, OCTOBER 4, 1989

Good evening. Thank you all. [[ACKNOWLEDGEMENTS]]

Barbara and I are very honored to be here tonight, and grateful for this opportunity to visit with you and to tell you all just how important we believe your work is.

The mission of the Challenger Center is very close to our hearts -- and close to our vision of an America that gives its children the best possible education for their challenging future.

The mission of Challenger Center is to spark in our young people an interest -- and a joy -- in science. A spark that can change their lives -- and help make American enterprise the envy of the world.

We applaud your private efforts. And our Administration has matched these kinds of commitments with one of our own.

The Educational Excellence Act we submitted last spring calls for science scholarships for over 500 of our best high school seniors -- up to $10,000 a year for four years, to be used at the school of their choice. We look forward to Congressional action on these initiatives -- so that, as the Center's motto says -- we can bring these scholarships **"from dreams to reality."**

Like the 25,000 Americans who have contributed to the Challenger Center, our science scholarship proposals represent an

investment. **An investment not in technology -- but in people. An investment in the future.**

We are a nation of trail-blazers, risk-takers, and dream-makers. The Challenger Center believes, as Barbara and I do, that the future is bright -- if we Americans are dedicated to making it so. That dedication is what we see in the remarkable programs of the Challenger Center.

In January 1986, Barbara and I grieved for the Challenger families, as did all of America. And the courageous Challenger astronauts were very much on my mind earlier this year, when we gathered on the 20th anniversary of the Moon landing to chart a course for the new century: **Back to the Moon. Back to the future. And this time -- back to stay.** [[PAUSE]]

I said then that our fallen astronauts have taken their place in the heavens -- so that America can take its place in the stars. And today, we are moved by the continuing faith and commitment that have brought the Challenger Center into being.

And so we salute you tonight, for all that you have done for our common future. And we pledge you our continuing support as you move forward with the vision and the determination to carry out the Challenger mission.

Congratulations on the tremendous progress you have made. Godspeed you in your dreams. Good night, God bless you all. And God bless the United States.

# # #

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DIRECTIONS WORLD MEDIA IN SCIENCE

PHILOSOPHY

Discovery, Science, Technology, And the 'Illusion of Knowledge'

By Peter Grier

Staff writer of The Christian Science Monitor

WASHINGTON

THE fact of the matter is, Christopher Columbus didn't really know where he was going.

When he sailed from the mouth of the Rio Tento on the morning of August 3, 1492, he believed ocean covered only one-seventh of the globe, with the rest dry land – was that not the conclusion of orthodox Christian authorities? He believed the Western Ocean narrow, and that Asia extended further eastward than it does. After all, many of his carefully studied geographies said so.

After four trips to the New World he died believing he had been exploring the east coast of Asia. But his path of discovery eventually led Europeans to the knowledge that their certainties about geography had been false.

"The great obstacle of man is the illusion of knowledge," says Daniel Boorstin, distinguished American historian and Librarian of Congress emeritus. "The great significance of the voyages of discovery was their discovery of ignorance, of European man's ignorance of the world."

This thread, says Dr. Boorstin, links the voyages of Columbus with the modern explorations of another kind of new world: science and technology. From Newton to Einstein the history of science is a history of disproved thought. Take nuclear physics. The atom was once considered a unity, the smallest element of matter. The very word "atom" expresses that, as its Greek root "atomos" means "indivisible."

Today researchers are busy in labs showing how the boundaries of the known are, in fact, false. "It's a parable of the problem of science in all ages," says Boorstin in an interview at his Library of Congress office.

But Boorstin worries that over the last 500 years mankind has lost something. Once "discovery" meant something physical, a throwing of oneself into the unknown. Now it's something undertaken by someone wearing a white coat and worrying about tenure or promotion.

There is a real difference in the mindsets of inventors and what Boorstin calls "questors" such as Columbus. Inventors focus on something specific, Boorstin says, something meant to satisfy an identified need. They work on computers that will react to the spoken voice; cars that get 100 miles per gallon of gas. They work on the imaginable. Boorstin speaks somewhat disparagingly of Thomas Edison, who in the course of research on light bulb filaments discovered certain aspects of atomic physics he did not care to further explore.

"Edison was not interested in knowledge. He was interested in payoff," says Boorstin.

Questors, on the other hand, do not apply the rules of cost-benefit analysis, says Boorstin. They don't really know where their discovery will take them, and they don't care. Theirs is a sort of high-minded vagrancy.

"Space exploration is the obvious parallel today," he says.

Today's technological explorations also differ from geographical ones in their pace. It took centuries for the full impact of Columbus's encounter with the West to develop. The automobile transformed transportation in decades; the transistor, in years. The obsolescence cycles of some computer parts can now be measured in months. And of course the explosion of the atom changed the world in the blink of an eye.

With this speed comes unpredictability. The irony is that the very power of technology means those who unleash it don't have much control over where it goes. "Even when men think they have a why for their technological revolution, as indeed Albert Einstein ... had, they are deceived," writes Boorstin in his book "The Republic of Technology."

And the complications introduced by technology are irreversible. The antique is charming and there are also modern-day Thoreaus in voluntary search of simplicity, but for most the world of the VCR is something to be entered into without a backward glance. "The march of modernity is ruthless," Boorstin writes.

Boorstin has himself turned to the role of explorer these days. Since leaving the post of Library of Congress director four years ago, he has been writing a successor to his thick 1983 tome "The Discoverers," which covered everything from development of the Babylonian lunar calendar to Michael Faraday's work in electrical fields.

The new book, to be called "The Creators," is due for publication next year. It's about artists and "the search to make," he says. After a career as a scholar of purely American history he turned to these sweeping works because he wanted to do something with a more global view, and could think of nothing more expansive than studying how man fulfills himself.

Perhaps with an eye to taking advantage of the publicity surrounding the Columbus quincentenary, "The Discoverers" is being reissued in a special two-volume edition. As something of a

Columbus scholar, Boorstin decries the revisionist vision of 1492 now in vogue. He calls it that "vulgar anti-Columbus vendetta."

He doesn't minimize Columbus's role as an enslaver of native populations, or environmental despoiler. But he says much of the criticism seems to stem from a belief that progress can be carried out in a cost-free manner.

With advancement come problems. "The Garden of Eden must have been a very boring place," he says.

The world Columbus encountered, or discovered, or at least revealed to the West, has found its advancements in a different manner than the Old World, Boorstin says. To the nations of Europe, creativity or genius resided in the soul of one's own kind: The fulfillment of the nation rested in exhibiting the purebred spirit of Frenchness, or Germanness, or Italianness. To America it lay in mixing old national characteristics together freely, in new ways, at what Boorstin terms "the Fertile Verge."

This difference was the result of, among other things, Americans' openness to change and self-awareness. The very nation was a geographic verge, writes Boorstin in his book "Hidden History," with development flourishing not so much in old capitals as the cities on the verge of the frontier – Cincinnati, then Chicago, Kansas City, Denver, and Los Angeles.

Thus American government was formed on the political verge between colonialism and self-government, between state and federal power. Its industry flourished on a technological verge, with for instance German and Swiss gunsmiths breaking old-world habits and building new types of guns whose lightness and range better suited them for the American forest. The so-called "melting pot" of the cultural verge is today an American cliché.

Boorstin believes that new Fertile Verges will emerge in new epochs of American experience. These verges are developing even now, perhaps in America's unique education establishments, perhaps in its vast research and development institutions.

"Surely we are not the last New World," concludes Boorstin in "Hidden History."

Scientific Cooperation

54

AS we move further into the 1990s, a "new world order" seems to be emerging in scientific research as well as in geopolitics.

Science has always had an international style, with scientists cooperating and sharing information widely. Their borders have tended to demarcate fields of interest rather than national boundaries. Now cash-short national governments are finding they too need global partnerships to pursue the more costly areas of basic research.

Thus President George Bush will go to Japan seeking support for America's newest high-energy physics project as well as freer trade. Japan has been reluctant to make the billion-dollar contribution the Bush administration would like to help fund the Superconducting Supercollider particle accelerator under construction in Texas. White House aides have suggested that, this time, Japan will be forthcoming. Such a commitment would help persuade Congress to continue its funding for the $8.3 billion project.

Also, this summer France will launch the American-built Topex/Poseidon ocean-mapping satellite. This will be the first National Aeronautics and Space Administration satellite to ride a foreign rocket. It is a major element in NASA's "Mission to Planet Earth" program to study our environment from space. The space agencies of both countries decided several years ago to cut their individual costs for this important project by pooling resources.

A similar spirit of joint enterprise underlies the International Thermonuclear Experimental Reactor (ITER) program. Japan, the European Community, Russia, and the United States have joined as equal partners to study engineering aspects of hydrogen fusion power.

The trend seems clear. Nations have often cooperated in coordinated research programs such as Antarctic studies or ocean surveys. Europe, the United States, and the former Soviet Union have all accommodated guest researchers of many nationalities at their facilities. They have cooperated in, and provided instruments for, one another's space science missions.

Yet in spite of this international flavor, each nation's efforts remained essentially national in character. Now even the leading scientific countries are forming partnerships to conduct some kinds of research that they once would have pursued individually.

The report on Directions in Science in today's Monitor reflects this trend. It also represents a new kind of international joint enterprise in journalism. Under the title of World Media Project, 24 news publications around the world combine resources to report on mutually agreed topics – in this case, scientific advances. Some of the advances covered are still pursued largely on a national basis. Others – notably physicists' search into matter's basic nature – illustrate the kind of research that demands resources national budgets no longer can easily provide.

These latter projects offer little commercial payoff but produce knowledge that benefits all humanity. The time has come to share the planning, the management, and the costs of such ventures more widely among the beneficiaries.

WASH. POST: 12/22/91

What the Russians Could Teach Us

The U.S. Should Quickly Buy Into the Soviets' Enormous Technical Talent

By John W. Kiser III

THE COLLAPSE of the Soviet Union offers the Bush administration an extraordinary opportunity to use hard-headed American know-how—not "charity"—to identify world-class technologies from the former empire's vast military-industrial complex and import them to our mutual commercial civilian benefit.

A creative government-industry effort could save untold tax dollars in U.S. research and development costs, help industry gain a competitive edge and teach the Russians about Western commerce. It also could cement new, strategically significant relations with some of the most important high-tech research centers and production enterprises still functioning in the former Soviet empire.

Our effort should focus on "dual use" (military or civilian) research and development and advanced technology that can be used directly by federal agencies or U.S. industry. Aside from its raw materials, the former empire's greatest asset is its scientific and technical talent, the best of which was employed in defense-related research. But 45 years of the Cold War gave U.S. intelligence agencies, Beltway think-tanks and high-tech aerospace and weapons firms considerable knowledge about advanced Soviet technological "threats." These Soviet advances, some already discovered by U.S. specialists, offer us opportunities to buy, lease or set up joint ventures with the former Soviet enterprises to use those technologies ourselves.

Attention should be directed toward areas where we know the Soviets have built better mouse traps. Indeed, some small-scale efforts in this direction are already underway, pioneered in 1988 by the Pentagon's Strategic Defense Initiative, working with small entrepreneurial firms. For years the U.S. defense industry and government laboratories such as Los Alamos and Lawrence Livermore have been benefiting from Soviet high technology, such as rail guns, tunable lasers and stealth design concepts. The Soviets themselves are doing much to sell new, recently declassified technology. We would be foolish not to gain from Soviet investment in defense technology, especially that with commercial applications. Some examples:

- *Combustion synthesis of materials.* Three U.S. firms are evaluating unique Soviet expertise in this field. First identified by the U.S. Army as a novel technology for making light ceramic armor for tanks, it employs precisely controlled high-temperature burning to synthesize a wide range of advanced ceramic materials for aerospace and industry.
- *Thermionics.* Through SDI, the Defense Department has acquired some advanced Soviet research and devices in a field of electronics that use electrical current passing through a gaseous medium (vacuum tube) instead of a solid state (semiconductor), permitting use in high-temperature and radiation environments in which existing electronic devices fail. The Soviet thermionic converters, which create electrical energy from a heat source, and "tacitron" switches, now at the University of New Mexico for evaluation and development, should save millions of U.S. development dollars for space power and commercial applications.
- *Electric propulsion engines.* The Jet Propulsion Laboratories are evaluating these advanced Soviet engines for use on satellites. The Fakel enterprise in Kaliningrad is the world's sole manufacturer of zenon plasma thrusters for satellite station keeping. By eliminating the need for heavy liquid fuel tanks, Fakel lightweight thruster-equipped satellites can reduce launch weight by 25 percent. A U.S. firm is negotiating a worldwide joint venture to sell the thrusters integrated with U.S. subsystems for use on commercial satellites.

There are certain to be other Soviet advances that could be easily converted for civilian use—at huge savings to industry and government. Leo Steg, former vice president for R&D at GE Aerospace, has noted a general rule of thumb for R&D: A third of R&D dollars go to determine if something can be done, the other two-thirds to doing it. Using proven Soviet technological advances would surely free U.S. dollars for other needs.

None of this is far-fetched. For years, U.S. industry has benefited in a small way from advanced Soviet technology in fields such as metal processing, welding, cryogenics, rocket propulsion and medicine. Kaiser Aluminum, Olin, Dupont, Maxwell Laboratories, Texas Utilities and other companies have purchased such technology in the past. A trickle could become a flood of advanced know-how and devices if the administration were to send the right signals to its own agencies and the defense industry.

How to proceed in the chaotic setting of the Soviet collapse? While central authority has shriveled, individual entities survive—research institutes, cooperatives and factories. Agreements must be made directly with them that transfer part of their technology to the West. By such replanting, risks drop, and jobs may ultimately be created. As an example, U.S. Surgical of Stamford, Conn., a $600-million maker of surgical staples, was founded 20 years ago as a venture to exploit Soviet patents.

For those concerned about stability in the former empire, there is one stabilizing force to consider—well placed dollars, which represent not charity, but exchange for value received. In some cases, these transactions can slow the metastasis of Soviet strategic know-how, which is also dual-use.

At a minimum, Congress and the White House should give a green light to executive agencies that buying Soviet technology and hardware is in the national interest. Told this, certain agencies may move aggressively to shop for good buys. To do this, no new money has to be allocated. Rather, allow hard-nosed government program managers to make their own decisions on how to spend the money they've got for the new technology.

High-tech scouting missions by specialists at the Defense Department, Energy Department, NASA and other agencies with acquisition interest should be speedily organized and dispatched. U.S. firms would follow suit, spawning still more industry activity in this once forbidden zone.

Direct, open access to the sources will allow a businesslike relationship with Soviet sellers, who will have to stand behind their claims or not get fully paid.

I would also propose a specific authorization of $100 million for a more commercially oriented exploitation of Soviet resources. This Russian High Technology and Science Fund could be used to set up joint ventures with up to 300 former Soviet institutes and enterprises to bring their technology, patent rights and scientific and technical knowledge into Western business ventures. This fund could be administered the way the East European country funds, through the Commerce Department, now are managed by private investment banking groups. Those funds receive proposals, invest seed capital and find commercial partners. Soviet partners would have a stake in the venture through equity interest.

It's win-win: The West can gain advanced technology through licensing, joint ventures or direct purchase; the Russians would get a chance at making a commercial venture work in which they have an interest, may see their technology get used in the real world and get paid for their efforts.

The U.S. government has an unusual opportunity to influence and direct how these technological swords are being used, at a time of growing risk that they may be misused.

John Kiser is president of Kiser Research Inc., which for 10 years has specialized in technology transfer from the former Soviet bloc.

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DIRECTIONS WORLD MEDIA IN SCIENCE

HUMANITY AND SPACE

How Space Colonies Could Benefit Earth

By Gregg Maryniak 54

SPACE colonization means much more than Antarctic-style research habitats on the moon or other planets for an elite group of astronauts. Space can be colonized and provide Earth with the equivalent of the New World that Columbus "discovered" in the 15th century.

Space colonies can supply clean energy necessary for human survival in the 21st century. In addition, they can provide new homelands and an expanded ecological niche for our species.

For many people, the term "space colony" brings to mind visions of domed cities on the moon or the surface of a hostile planet. Since September 1974, however, the words have had a very different meaning. That month's issue of Physics Today contained an article by Princeton University professor and nuclear physicist Gerard K. O'Neill entitled, "The Colonization of Space." Dr. O'Neill proposed construction of large-scale habitats built in free space rather than on the surface of planets. **(See interview, Page 17.)**

Building the structures in space would allow the inhabitants to select whatever gravity level they desired by controlling the rate of rotation of the habitat. O'Neill showed that even if relatively simple materials such as steel cables were used in colony construction, habitat cylinders of up to 20 miles (32 kilometers) in length and 4 miles (6.4 kilometers) in diameter could be built to house up to 1 million people under comfortable conditions.

Early habitats would be much smaller, with populations of hundreds or thousands. Each habitat would have provisions for agriculture and closed-cycle life support so that once a colony is established, very little outside material would be required to sustain it.

To obtain construction materials for these settlements from Earth would obviously not be economical. Instead, O'Neill proposed using materials already in space.

The first source of raw materials would be the surface of the moon. Thanks to the Apollo missions and the Soviet sample return probes, we know that the required elements are present in abundance.

Because the moon has no atmosphere and only one-sixth Earth's gravity, it is possible to use an electromagnetic catapult (called a mass driver) to launch raw materials to a point in space without incurring the costs of chemical-rocket transport.

Space colonies were the subject of three studies the National Aeronautics and Space Administration conducted in 1975, 1976, and 1977. These projects examined the issues of closed-cycle life support, radiation shielding, habitat design and construction, economics and logistics, and lunar and asteroid mining.

The initial economic reason for the colonization of space would be to use the resources of space to provide for the needs of our home planet. O'Neill proposed that the space colonists use low-cost space resources to construct large solar platforms to collect the sun's energy and convert it into electricity. This electrical power would be transmitted to Earth's surface in the form of a high-frequency radio beam. The beam would be received by a special antenna and rectifier array, which would convert it back into electricity with an efficiency of about 90 percent.

Solar-power satellites would provide electricity without the air pollution and atmospheric heating caused by burning fossil fuels. The use of space resources would enable these satellites to be built at less than 10 percent of the cost of launching construction materials from Earth.

Self-sufficiency of colonies

In addition to the workers and their families, space colonies would contain many of the professions found in any small terrestrial town. Space settlements would also address human needs beyond the physical and economic. By its very nature, each habitat would have a high degree of self-sufficiency and independence.

Independence in space colonies need not, however, mean isolation. Communications between Earth and space colonies, or from one colony to another, would be a relatively simple matter with thousands of communities within a few light-seconds of each other. Although transport from Earth's surface to a colony or colony group is likely to remain relatively expensive, the cost of travel from one free-space habitat to another can be very small.

Ultimately, space colonies could be built anywhere in the solar system. By increasing the size of the mirrors used to direct sunlight into the living and agricultural sections, it would be possible to support habitats beyond the orbit of Pluto if we so desire. Given the known resources of the asteroids, there is sufficient material to construct habitats capable of supporting populations thousands of times larger than that of Earth. By increasing our ecological niche to include the solar system, the human species would become much less likely to be destroyed by a single natural or made-man catastrophe.

Since 1977, most of the research on space colonies and related technologies has been carried out by the nonprofit Space Studies Institute (SSI) of Princeton, N.J. SSI conducts research and serves as an information resource to industry, government, and academia.

A space colony has three essential characteristics. First, a colony must have a tightly closed-cycle ecological system capable of replenishing the colonists' air, water, and food with only trace elements required from outside the system. Second, it must have enough radiation-shielding so that indefinite stays are possible. Third, it must provide sufficient artificial gravity to permit the inhabitants to reside on a permanent basis without bone-calcium loss or other harmful effects of prolonged exposure to microgravity.

In addition to this description of technical characteristics, to be viable the colony would need an economic basis as would any successful town on Earth.

We know quite a lot in general about how to provide radiation-shielding for a space habitat. The secret is to have sufficient mass to stop the high-energy particles collectively known as cosmic rays, as well as radiation from the sun.

At present, space stations such as Skylab, Salyut, and Mir have flown in such low orbits that Earth's magnetic field has provided considerable protection. During the Apollo flights to the moon, it was physically impossible to provide shielding, so the astronauts' exposure to cosmic rays was limited by time. When we have the capability to process lunar soil for construction materials and propellants, we will have slag and other "waste" products that can be used as a radiation barrier. It is also theoretically possible to use superconducting magnets to provide an artificial magnetic field. However, it is unlikely that such a system would be as reliable as a simple physical shield.

Life-support systems

Research groups in the United States and the former Soviet Union are advancing the state of the art in Closed Environmental Life Support Systems (CELSS).

For many years, the Soviets were the undisputed leaders in CELSS research, with humans involved in systems experiments in large-scale facilities such as the Bios-3 experimental chamber in Krasnoyarsk, Russia. A privately funded US organization called Space Biospheres Ventures has recently surpassed the scale of the Soviet experiments by constructing a facility in the desert outside Tucson, Ariz. This facility is currently supporting eight people in near-complete material closure for a planned two-year period.

This large facility, called Biosphere II, encloses about three acres and contains several different climate zones, including a tropical rain forest and an intensive agricultural area. These projects and work underway at the Kennedy Space Center, the Disney Epcot Center's Land pavilion, and the Environmental Research Laboratory of the University of Arizona indicate that it will be feasible to sustain relatively complex closed-cycle ecological systems beyond Earth's atmosphere.

Since Isaac Newton, scientists have known how to provide "artificial gravity" by rotation. For purposes of space colony design, however, we still lack the answer to one fundamental question: How much gravity does it take to maintain normal human functions in space?

According to many scientists, there is a threshold level of gravity that will trigger normal physiological response. At present, we simply have no data to determine what level of gravity is necessary. In 1986 President Reagan's National Commission on Space recommended that the US develop a variable-gravity research facility that could provide the needed information.

During the NASA space-colony design workshops, participants assumed that Earth-normal gravity would be required in some locations. If, however, one assumes that a human needs only one-sixth of terrestrial gravity, or even less, one could construct small-scale space colonies in the very near future from such raw materials as empty space-shuttle external tanks.

Much progress is being made in technologies essential for the construction of space colonies. For example, prototype mass-driver electromagnetic launchers have been developed at the Massachusetts Institute of Technology and Princeton University. Accelerations have gone from 33 gravities to more than 1,800 gravities. This means that the length of the accelerator on the moon can be reduced from 8,900 meters (about 5 miles) to 160 meters (about 500 feet). Physical- and chemical-processing techniques to obtain propellants and construction materials from lunar soil have been demonstrated at laboratory scale.

Studies by General Dynamics and SSI have shown that most of the mass of solar-power satellites can come from lunar materials. SSI's work shows that the cost of a lunar-sourced power satellite is only 3 percent of the cost of the same satellite built from Earth-launched materials.

In 1988, NASA conducted what it called the Lunar Energy Enterprise Study in cooperation with representatives of electric-power utilities and other industries. This study recommended further examination of lunar-sourced solar-power satellites.

In 1991, a workshop conducted by the International Astronautical Federation at a conference on solar-power satellites suggested a vigorous program of international experimentation on the use of space resources to provide energy to Earth. Although we have general information about the composition of the moon and asteroids, one of the largest opportunities in the development of space is the search for specific resource sites.

Today there is a growing realization that the world's space programs must generate real value for their constituents. Providing clean energy for Earth and new lands for settlement and exploration can take space exploration and development beyond the "flags and footprints" missions of the 1960s. In undertaking space colonization, we can provide genuine hope for both our people and our planet.

■ *Gregg Maryniak is executive vice president of the Space Studies Institute of Princeton, N.J.*

tional Safety and Health Administration at the Department of Labor, 1983–1986. Mr. Rodgers was appointed by President Reagan to the Federal Services Impasses Panel, 1982–1983. He also served as a consultant on government relations, labor, energy, and politics, 1981–1982; as a special consultant on labor and energy at the Office of Policy Development at the White House, 1981; as a labor adviser for the Reagan-Bush campaign, 1980; and as director of government relations and energy, International Brotherhood of Teamsters, 1974–1981.

Mr. Rodgers graduated from the Cornell University School of Labor Relations in 1952. He served in the U.S. Army during World War II. Mr. Rodgers was born October 1, 1926, in the Bronx, NY. He is married, has five children, and resides in Silver Spring, MD.

Nomination of Sheldon J. Krys To Be an Assistant Secretary of State
July 19, 1989

The President today announced his intention to nominate Sheldon J. Krys to be Assistant Secretary of State for Diplomatic Security. He would succeed Robert E. Lamb.

Since 1988, Mr. Krys has served as Assistant Secretary of State for Administration and Information Management. Prior to this, he served as Ambassador of the United States of America to the Republic of Trinidad and Tobago, 1985–1988. He served in several capacities at the Department of State, including Executive Assistant to the Under Secretary for Management in Washington, DC; Deputy Director for Management Operations, 1983–1985; and Executive Director of the Bureau of Near Eastern and South Asian Affairs, 1979–1983. In addition, he served as a Foreign Service inspector, 1977–1979; administrative counselor in Belgrade, Yugoslavia, 1974–1976; and Director of Personnel for Latin America, 1969–1974. He has served as special assistant to the U.S. Ambassador in London, 1966–1969; management officer in London, 1965–1966; educational and cultural affairs officer and Director of the Department of State Reception Centers, 1962–1965. Mr. Krys also served as a consultant to the Director of the Federal Mediation and Conciliation Service, 1961. In 1983 he received the Presidential Meritorious Service Award.

Mr. Krys graduated from the University of Maryland in 1955. He was a Distinguished Graduate of the National War College in 1977. He was born in New York in 1934. He is married, has three daughters, and resides in Washington, DC.

Remarks on the 20th Anniversary of the *Apollo 11* Moon Landing
July 20, 1989

Thank you all very, very much. And thank you, Mr. Vice President, for your introduction and for undertaking to head the National Space Council and for already demonstrating your skill for leadership there. And thanks to all of you, who have braved the weather to join us today.

Behind me stands one of the most visited places on Earth, a symbol of American courage and ingenuity. And before me stand those on whose shoulders this legacy was built: the men and women of the United States astronaut corps. And we are very proud to be part of this unprecedented gathering of America's space veterans and to share this stage with three of the greatest heroes of this or any other century: the crew of *Apollo 11*.

It's hard to believe that 20 years have passed. Neil [Armstrong] and Buzz [Aldrin], who originated the moonwalk 15 years before Michael Jackson ever even thought of it. [*Laughter*] And Michael Collins, former director of this amazing museum and the brave pilot who flew alone on the dark side of the Moon while Neil and Buzz touched down—Mike, you must be the only American over age 10 that night who didn't get to see the Moon landing. [*Laughter*]

And later this evening after the crowd disperses and the Sun goes down, a nearly full Moon will rise out of the darkness and shine down on an America that is prosperous and at peace. And for those old enough to remember that historic night 20 years ago, step outside tonight with your children or your grandchildren, lift your eyes skyward, and tell them of the flag—the American flag—that still flies proudly in the ancient lunar soil. And for those who were not yet born or then too young to recall—you who are the children of the new century, raise your eyes to the heavens and join us in a great dream, an American dream, a dream without end.

Project *Apollo*, the first men on the Moon—some called it quixotic, impossible—had never been done. But America dreamed it, and America did it. And it began on July 16th, 1969. The Sun rose a second time that morning as the awesome fireball of the *Saturn V* lifted these three pioneers beyond the clouds. A crowd of one million, including half of the United States Congress, held its breath as the Earth shook beneath their feet and our view of the heavens was changed forevermore.

Three days and three nights they journeyed. It was a perilous, unprecedented, breathtaking voyage. And each of us remember the night. Barbara and our daughter, Dorothy, were with me in our red-brick house right here on the outskirts of Washington, where we moved up here to represent Houston in the United States Congress. Our 12-year-old kid, Marvin, was on a trip out West with family friends and remembers stopping at a roadside motel to watch. Second boy, Jeb, 16 that summer—teaching English and listening by radio in a small Mexican village where electricity had yet to arrive.

The landing itself was harrowing. Alarms flashed, and a computer overload threatened to halt the mission while *Eagle* dangled thousands of feet above the Moon. Armstrong seized manual control to avoid a huge crater strewn with boulders. With new alarms signaling a loss of fuel and the view now blocked by lunar dust, Mission Control began the countdown for a mandatory abort.

America, indeed the whole world, listened—a lump in our throat and a prayer on our lips. And only 20 seconds of fuel remained. And then out of the static came the words: "Houston—Tranquility Base here: The *Eagle* has landed."

Within one lifetime, the human race had traveled from the dunes of Kitty Hawk to the dust of another world. *Apollo* is a monument to our nation's unparalleled ability to respond swiftly and successfully to a clearly stated challenge and to America's willingness to take great risks for great rewards. We had a challenge. We set a goal. And we achieved it.

So, today is not only an occasion to thank these astronauts and their colleagues—the thousands of talented men and women across the country whose commitment, creativity, and courage brought this dream to life—it's also a time to thank the American people for their faith, because *Apollo*'s success was made possible by the drive and daring of an entire nation committed to a dream.

In the building behind me are the testaments to *Apollo* and to what came before—the chariots of fire flown by Armstrong, Yeager, Lindbergh, and the Wrights. And in the National Archives, across the great expanse of grass, are preserved the founding documents of the idea that made it all possible—the world's greatest experiment in freedom and diversity. And here, standing between these twin legacies, is a fitting place to look forward to the future, because the *Apollo* astronauts left more than flags and footprints on the Moon; they also left some unfinished business. For even 20 years ago, we recognized that America's ultimate goal was not simply to go there and go back, but to go there and go on. Mike Collins said it best: "The Moon is not a destina-

tion; it's a direction."

And space is the inescapable challenge to all the advanced nations of the Earth. And there's little question that, in the 21st century, humans will again leave their home planet for voyages of discovery and exploration. What was once improbable is now inevitable. The time has come to look beyond brief encounters. We must commit ourselves anew to a sustained program of manned exploration of the solar system and, yes, the permanent settlement of space. We must commit ourselves to a future where Americans and citizens of all nations will live and work in space.

And today, yes, the U.S. is the richest nation on Earth, with the most powerful economy in the world. And our goal is nothing less than to establish the United States as the preeminent spacefaring nation.

From the voyages of Columbus to the Oregon Trail to the journey to the Moon itself: history proves that we have never lost by pressing the limits of our frontiers. Indeed, earlier this month, one news magazine reported that *Apollo* paid down-to-earth dividends, declaring that man's conquest of the Moon "would have been a bargain at twice the price." And they called *Apollo* "the best return on investment since Leonardo da Vinci bought himself a sketch pad." [*Laughter*]

In 1961 it took a crisis—the space race—to speed things up. Today we don't have a crisis; we have an opportunity. To seize this opportunity, I'm not proposing a 10-year plan like *Apollo*; I'm proposing a long-range, continuing commitment. First, for the coming decade, for the 1990's: Space Station *Freedom,* our critical next step in all our space endeavors. And next, for the new century: Back to the Moon; back to the future. And this time, back to stay. And then a journey into tomorrow, a journey to another planet: a manned mission to Mars.

Each mission should and will lay the groundwork for the next. And the pathway to the stars begins, as it did 20 years ago, with you, the American people. And it continues just up the street there, to the United States Congress, where the future of the space station and our future as a spacefaring nation will be decided.

And, yes, we're at a crossroads. Hard decisions must be made now as we prepare to enter the next century. As William Jennings Bryan said, just before the last turn of the century: "Destiny is not a matter of chance; it is a matter of choice. It is not a thing to be waited for; it is a thing to be achieved."

And to those who may shirk from the challenges ahead, or who doubt our chances of success, let me say this: To this day, the only footprints on the Moon are American footprints. The only flag on the Moon is an American flag. And the know-how that accomplished these feats is American know-how. What Americans dream, Americans can do. And 10 years from now, on the 30th anniversary of this extraordinary and astonishing flight, the way to honor the *Apollo* astronauts is not by calling them back to Washington for another round of tributes. It is to have Space Station *Freedom* up there, operational, and underway, a new bridge between the worlds and an investment in the growth, prosperity, and technological superiority of our nation. And the space station will also serve as a stepping stone to the most important planet in the solar system: planet Earth.

As I said in Europe just a few days ago, environmental destruction knows no borders. A major national and international initiative is needed to seek new solutions for ozone depletion and global warming and acid rain. And this initiative, "Mission to Planet Earth," is a critical part of our space program. And it reminds us of what the astronauts remember as the most stirring sight of all. It wasn't the Moon or the stars, as I remember. It was the Earth—tiny, fragile, precious, blue orb—rising above the arid desert of Tranquility Base.

The space station is a first and necessary step for sustained manned exploration, one that we're pleased has been endorsed by Senator Glenn, and Neil Armstrong, and so many of the veteran astronauts we honor today. But it's only a first step. And today I'm asking my right-hand man, our able Vice President, Dan Quayle, to lead the National Space Council in determining specifically what's needed for the next round of exploration: the necessary money, manpower, and materials; the feasibility of international cooperation; and develop realistic

timetables—milestones—along the way. The Space Council will report back to me as soon as possible with concrete recommendations to chart a new and continuing course to the Moon and Mars and beyond.

There are many reasons to explore the universe, but 10 very special reasons why America must never stop seeking distant frontiers: the 10 courageous astronauts who made the ultimate sacrifice to further the cause of space exploration. They have taken their place in the heavens so that America can take its place in the stars.

Like them, and like Columbus, we dream of distant shores we've not yet seen. Why the Moon? Why Mars? Because it is humanity's destiny to strive, to seek, to find. And because it is America's destiny to lead.

Six years ago, *Pioneer 10* sailed beyond the orbits of Neptune and of Pluto—the first manmade object to leave the solar system, its destination unknown. It's now journeyed through the tenures of five Presidents—4 billion miles from Earth. In the decades ahead, we will follow the path of *Pioneer 10.* We will travel to neighboring stars, to new worlds, to discover the unknown. And it will not happen in my lifetime, and probably not during the lives of my children, but a dream to be realized by future generations must begin with this generation. We cannot take the next giant leap for mankind tomorrow unless we take a single step today.

To all of you here, our able director of NASA and others who've served so well—to all of you here, and especially the astronauts: We wish you good luck in your quests, wherever that may take you. Godspeed to you, one and all, and God bless the United States of America. Thank you all very, very much.

Note: The President spoke at 10:30 a.m. on the steps of the National Air and Space Museum. In his closing remarks, he referred to Richard H. Truly, Administrator of the National Aeronautics and Space Administration. Prior to his remarks, the President viewed the "Apollo 11" lunar module in the museum. Following his remarks, he participated in the unveiling of a stamp commemorating the "Apollo 11" mission.

Remarks at a White House Barbecue on the 20th Anniversary of the *Apollo 11* Moon Landing

July 20, 1989

America's astronauts and spouses, friends in the United States Congress, NASA officials, and other honored guests: I say welcome—but for most of you, welcome back to the White House. Barbara and I are delighted that you've joined us for this important anniversary. Planning the picnic was a little hectic. We didn't know whether you preferred hamburgers grilled or served out of a tube. But, nevertheless—[*laughter*]—and also, thanks for coming to the commemoration there, earlier on at the Air and Space Museum. I liked what I heard from our famous lunar astronauts. It's a pleasure, indeed, to welcome the present administrators at NASA and those who served so admirably in the past, running that fantastic organization.

All of you here, in one way or another, have had important roles in supporting the space program. And that support comes from many corners. Many of you have seen those wonderful Ad Council spots that highlight how space technology benefits all humanity. And I'd like to take a moment to recognize someone here who has contributed her time and talent to this campaign. We call her America's leading lady, and that is Helen Hayes, who is there somewhere—right here. Helen, would you—we are so grateful to her. And she's found the only cool place on the lawn, too. [*Laughter*]

As you might expect from a former Navy pilot who lived much of his adult life in Houston, I, too, am a longtime supporter of the space program and the fine work of the

men and women gathered here. In our administration's first budget proposal, the largest single percentage increase is for the space agency. And thanks to you and your colleagues at NASA, 20 years after *Apollo 11*, we still live in a world that is alive with wonder. Two weeks ago, *Voyager 2* discovered a new moon around Neptune. And we're still getting acquainted with neighborhoods that we didn't even know about.

On the way back from the Moon, Buzz Aldrin spoke of the never-ending wonder of space. "This has been far more than three men on a voyage to the Moon," he said. "This stands as a symbol of the insatiable curiosity of all mankind to explore the unknown." And I might add, that voyage, like the efforts that came before and the efforts that have come since, is also a symbol of all the men and women of unique talent and character who made it possible, a tribute to the commitment, ingenuity, and nerve of tens of thousands of people working all across the Nation. No one knows better than you, those assembled here today, that *Apollo*'s missions to the Moon raised more questions than they answered.

My commitment today to forge ahead with a sustained, manned exploration program, mission by mission—the space station, the Moon, Mars and beyond—is a continuing commitment to ask new questions, to seek new answers, both in the heavens and on Earth.

I am delighted that my able Vice President, our able Vice President, is heading the Space Council. He's a young man, knows how to dream still, knows how to plan. And that Space Council is in very able hands.

James Michener was right when he told Congress: "There are moments in history when challenges occur of such a compelling nature that to miss them is to miss the whole meaning of an epoch. Space is such a challenge," he said. Well, today's announcement is our recognition that the challenge was not merely one that belonged in the sixties; it's one that will occupy Americans for generations to come. And the American people have led the way on this. The American people, I'm convinced, want us back in space—and this time, back in space to stay.

Somewhere out there, maybe on the Mall today, maybe listening on a radio somewhere, the Americans who will first walk on Mars are now only children, perhaps your children. And along with our congratulations to all of you, we leave you today with the hope of that day when another President stands with those pioneers and echoes the last words spoken to the departing *Apollo 11*: "Good luck, and Godspeed." And so, once again, thank you for the contributions to the greatness of the United States of America. I'm just delighted you came our way. Thank you very, very much.

Note: The President spoke at 1:01 p.m. on the South Lawn at the White House.

I've taken today is consistent with our policy on antiterror.

Violence and Terrorism in the Middle East

Q. Mr. President, do you feel that Israel has committed acts of terrorism when it bombs Palestinians?

The President. We spoke out on the recent violence in the Gaza. And please note my last comment calling for peaceful resolution to these questions as opposed to violence and international terror. And that's the way I would respond on that.

Governor Guy Hunt of Alabama

Q. Mr. President, sir, can we go back to why you're here in Huntsville, sir? If you are here to help raise money for Governor Guy Hunt's gubernatorial campaign——

The President. I'm not standing right here to do that, but I was downtown doing exactly that. And I hope we were successful because I am totally committed to his reelection. I have respected the progress the State of Alabama has made under his leadership. And as I look at the way my philosophy of government works, the Governors are very, very important on all this. I cite not just the education summit, in which I worked closely with Guy, but this whole concept that the States and localities have a significant role to play not just in the money end of it but in the whole setting of objectives and goals. So, I'm glad you raised it; and, yes, that part of the trip was strongly to support him, to support other political leaders, too.

Q. You have goals for your space initiative. Do you believe Governor Hunt can help you reach some of those by being so strong in the Tennessee Valley?

The President. I think he's a proponent of the space program that I've set forth. I think he's got great credibility with other Governors. If I'm not mistaken, I think he's hosting the national Governors down here, and that will give him to have an opportunity to make the case for space or any other initiatives for. But he is seen by other Governors to know what he's talking about in this area and clearly to be a strong proponent. So, I guess the bottom line is, yes, I think Governor Hunt here can be helpful to our objectives in terms of a vibrant space program.

Tennessee Valley Authority Appointment

Q. Mr. President, are you going to nominate or appoint Governor Hunt's nominee to the TVA board?

The President. I don't know that I'm going to carry my enthusiasm that far. [*Laughter*] But he's made a strong case for a person that he believes in, and he did it in his typical way, typical of Guy Hunt: right, direct. He told me exactly why he favored a certain nominee and then seemed to be saying, Look, I recognize that you have a lot of factors to weigh in this decision. But I leave here understanding exactly why he has taken the position he has, and the position has respect. And I'm not prepared to discuss further what I might or might not do in this TVA—you're talking about the TVA appointment.

Q. Did you say how long you would take to make an appointment?

The President. Matter of days. [*Laughter*]

Q. What about OCS [Outer Continental Shelf offshore oil drilling]?

The President. A few days, a few days. Not for him, for this.

Thank you all very much.

Note: The President's 51st news conference began at 1:40 p.m. in the Space Exploration Initiative Exhibition Room at the George C. Marshall Space Flight Center. In his opening remarks, he referred to Richard H. Truly, Administrator of the National Aeronautics and Space Administration, and T.J. Lee, Director of the Center. Prior to the news conference, the President toured the facilities and was briefed by the Center's staff.

Remarks to Employees of the George C. Marshall Space Flight Center in Huntsville, Alabama

June 20, 1990

Dick, Admiral Truly, I'm very glad to be here. Let me just say something very personal: I can't tell you how fortunate the country is to have Admiral Truly lead NASA through these very exciting times. I salute him, and I'm very grateful to him.

And I'm pleased to be here with the Governor of this State, a man whose unwavering support for the space program is so well-known. I want to thank Jack Lee, the director of this center and my tour guide today. I'm grateful to him. There is no quiz. If there was I would probably fail, because I am mightily impressed with the dedicated NASA workers, men and women, young and old, who are doing such a superb job on the cutting edge of science.

I was sorry we were a little late getting started. These arrangements affect everything. Even I couldn't find a parking place. [*Laughter*] Reminds me of my days in college. Everybody would gather around to get cooled off watching me strike out.

But nevertheless, I really am pleased to be back in Alabama, back in Huntsville. And I'm very proud of this State, proud of this special facility. The Marshall Space Flight Center is the birthplace of America's first satellite, America's first space station, and the world's first Moon rocket; and it was here with Saturn 5 that humankind began its historic journey to the stars.

Because of these traditions, Huntsville has a special importance to America and, indeed, to the entire world. And it has a special importance to me, as well. It was to Huntsville that I journeyed in the fall of 1987 to give a campaign—for me, at least, a first major address on space. And on that October day 2½ years ago, I promised to create a National Space Council, chaired by the Vice President. I pledged to underwrite Mission to Planet Earth, to boost space science, and to launch a dynamic new program of both manned and unmanned exploration of the solar system.

And today I'm pleased to return to Marshall to report that we have made good on these promises. And we've done it the old-fashioned way, done it the American way—step by step, program by program, all adding up to the most ambitious and far-reaching effort since Marshall and *Apollo* took America to the Moon.

The Space Council I proposed is not only up and running but under the dynamic leadership of our Vice President. It's leading the way into the 21st century. Mission to Planet Earth, a bold and unprecedented initiative to preserve our precious environmental heritage, has been plucked off the drawing board and placed in the hands of the scientists who will make it happen. And now that the shuttle program has put America back in space, we stand at the dawn of a new era in space science, with wonders like that magnificent Hubble Space Telescope and the fantastic voyage of *Galileo* to Jupiter.

Exactly 11 months ago, I was at the Air and Space Museum in Washington to commemorate a special anniversary for you who work at the Marshall Space Flight Center: the 20th anniversary of *Apollo 11*'s thunderous journey to the Moon. And standing with Neil Armstrong and dozens of other astronauts, I announced three major space policy objectives: first, to have space station *Freedom* up before the century is out, and second, for the new century, a permanent lunar base. And we're going back to the Moon, back to the future, and this time back to stay. And the third objective was refined last month in Texas, where I went to announce a new age of exploration with not only a goal but a 30-year timetable. I declared—permit me to read it again—before *Apollo* celebrates the 50th anniversary of its landing on the Moon, the American flag should be planted on Mars.

Being first in space is not just America's dream: it is indeed our destiny. And to see this happen, we're matching rhetoric with resources. Our budget proposes $15.2 billion for NASA, an increase of nearly 25 percent and the largest increase for any major agency of the United States Government.

Now for the bad news. Unfortunately, not everyone on Capitol Hill shares this commitment to investing in America's future. And last week, the House Appropriations Subcommittee for Space voted to pull the plug on this historic undertaking, completely gutting the seed money we proposed for the Moon-Mars mission.

But you know, space used to be a bipartisan effort, just a plain American effort. And the last time a President visited Marshall, John F. Kennedy compared those who were uncertain about America's leadership in space to those in Queen Isabella's court who counseled, in effect, "Turn back. Leave the riches and rewards for other nations and braver hearts."

Some say the space program ought to wait, that we should only go forward once the social problems today are completely solved. But history proves that that attitude is self-defeating. Had Columbus waited until all the problems of his time were solved, the timbers of the *Santa Maria* would be rotting on the Spanish coast to this very day. And instead, he went forward, he ventured forth, and his travels brought Spain to the zenith of her stature as a nation.

Many an American schoolkid has read the story of Columbus' doubters and shook their heads in disbelief that these naysayers could have been so shortsighted. We must not let the children of the future shake their heads at our behavior. And right now, in the funding wars on Congress, we face a central question—the question of whether America will continue to be a pioneering nation.

And when John F. Kennedy stood before the Congress in 1961 and spoke about the Moon, he spoke to a nation of pioneers. Now some in Congress appear ready to give up on that pioneering spirit, to turn their sights inward, to concede that America's days as a leader in space have passed. Well I, for one, am not ready to give up. America has always been and will always be a nation of pioneers. I may not be around in the year 2019, but all of you guys will, and a lot of people out here in this marvelous, young, vigorous work force will. And on that special day 30 years from now, I want you to think back to the commitment that we made here today as you look at the TV monitors, maybe right here at Marshall, and watch the first American plant his feet on Mars. It's going to happen. With your work and our support it is going to happen.

During the *Apollo* era, America's space efforts grew at unprecedented rates. The Government hired the biggest and the best scientific force in history, and colleges and universities swelled with applicants and graduates in science and engineering. And it produced a golden age of American technology and advancement, an age that, today, we can recapture and begin anew.

Wernher von Braun was the giant who, in a sense, put Huntsville on the map. And when someone asked him what it would take to build a rocket to reach the Moon, Von Braun replied simply, "The will to do it." And so, I'm here today at this monument to daring, this monument to imagination that Von Braun built, and call on the American Congress to step forth with the will that the moment requires. Don't postpone greatness. History tells us what happens to nations that forget how to dream. The American people want us in space. So, let us continue the dream for our students, for ourselves, and for all humankind.

Thank you for your dedicated work to this great country of ours. God bless the United States of America. Thank you for this warm, warm welcome. Thank you very much. Thank you.

Note: The President spoke at 2:26 p.m. on the grounds of the Center. In his remarks, he referred to Richard H. Truly, Administrator of the National Aeronautics and Space Administration, and Gov. Guy Hunt of Alabama. At the conclusion of his remarks, the President traveled to Charlotte, NC, where he participated in a Point of Light recognition ceremony at Charlotte/Douglas International Airport for the Duke Power Co.

Nomination of Edwin D. Williamson To Be Legal Adviser of the Department of State

June 20, 1990

The President today announced his intention to nominate Edwin D. Williamson to be Legal Adviser of the Department of State. He would succeed Abraham D. Sofaer.

Since 1964 Mr. Williamson has been with the law firm of Sullivan and Cromwell, serving as a partner in Washington, DC, since 1988; partner in New York, NY, 1979–1988 and 1971–1976; resident partner in London, England, 1976–1979; and an associate, 1964–1970.

Mr. Williamson graduated from the University of the South (B.A., 1961) and New York University School of Law (J.D., 1964). He was born September 23, 1939, in Florence, SC. Mr. Williamson served in the U.S. Marine Corps Reserve, 1958–1960. He is married, has three children, and resides in Washington, DC.

experience on the front lines, if you will, the necessary commitment to fully implement this strategy.

In closing, again I want to thank you, the individuals who are helping make this strategy work, putting in the long hours and making everyone proud, very proud indeed, of our Federal effort.

Thank you very much. And now I understand that John Walters will conduct a briefing to flesh out some of what I've said here. But I think the bottom line is this nation simply must succeed in this fight. And, you know, I expect some wonder whether I am totally preoccupied with events halfway around the world. And I really wanted to take this opportunity to come over here to you who have done so much in this fight to let you know you're not alone. And I will do my level best to support you every inch of the way.

Thank you all very, very much.

Note: The President spoke at 1:55 p.m. in Room 450 of the Old Executive Office Building. In his remarks, he referred to William S. Sessions, Director of the Federal Bureau of Investigation; William P. Moss, Chairman of the President's Drug Advisory Council; and the following officials of the Office of National Drug Control Policy: Reggie B. Walton, Associate Director for State and Local Affairs; John P. Walters, Chief of Staff and Acting Director; and Bob Martinez, nominee for Director.

Message to the Congress Transmitting the 1991 National Drug Control Strategy

January 31, 1991

To the Congress of the United States:

I am pleased to transmit today for the consideration of the Congress and the American people the 1991 National Drug Control Strategy, in accordance with section 1005 of the Anti-Drug Abuse Act of 1988 (Public Law 100–690; 21 U.S.C. 1504).

This is the third National Drug Control Strategy, and it should be viewed as a companion to the previous two submitted in September 1989 and January 1990. This Strategy lays out a comprehensive plan for Federal drug control activities for fiscal year 1992. The principal goal remains unchanged: to reduce the level of illegal drug use in America. This goal cannot be achieved by the Federal Government acting alone, and so this Strategy calls upon all segments of our society to continue to do their part. In crafting this Strategy, we have sought the counsel not only of Federal officials and Members of the Congress, but also State and local officials; experts in the fields of drug prevention, treatment, and enforcement; and public-spirited citizens.

I am pleased to be able to report that there are indications that we are embarked on the right path: although much remains to be done and serious problems still confront us, numerous indicators show that we are beginning to see significant declines in drug use throughout the Nation. Continued congressional support is essential to ensure progress.

George Bush

The White House,
January 31, 1991.

Message to the Congress Transmitting a Report on Aeronautics and Space Activities During 1988

January 31, 1991

To the Congress of the United States:

I am pleased to transmit this report on the Nation's progress in aeronautics and space during calendar year 1988, as required under section 206 of the National Aeronautics and Space Act of 1958, as amended (42 U.S.C. 2476). Not only do aeronautics and space activities cut across many sectors of our Federal Government as represented in this report, but the results of this ongoing research and development affect the Nation as a whole. This report details the accomplishments of the 14 contributing departments and agencies, with the National Aeronautics and Space Administration (NASA) and the Department of Defense the major contributors.

In 1988 we were proud to return to successful spaceflight with the launch of two

space shuttle flights and the additional successful launch of six unpiloted expendable launch vehicles, putting in orbit a wide variety of space tracking, science, navigational, weather, and defense satellites. In addition, many other kinds of achievements highlighted the year. Global climate change and ozone depletion were intensely studied. The world's fastest supercomputer was installed, permitting solutions to aerodynamic problems far too complex to be handled by previous computers. The Department of Defense completed delivery of all 100 B–1B bombers and saw the rollout of the first B–2 Stealth bomber. Progress was made at the Federal Aviation Administration in the modernization of air navigation and air traffic control and many safety research projects, including new ways of reducing aviation problems caused by adverse weather. Spin-offs, or benefits to the Nation resulting from practical applications of space technology, have resulted in an estimated $27 billion from contributions to sales or savings since 1978. It should not be overlooked that U.S. aeronautical products are one of the principal positive contributors to the U.S. balance of trade. Significant developments in technology applications included a cooperative effort to use space technology to improve the sight of persons with impaired vision and a joint project to improve laboratory identification and monitoring of cancer cells. These are just a few of the many accomplishments our fiscal year 1988 $26.6 billion space budget and $7 billion aeronautics budget have produced.

In 1988 we reaffirmed our commitment to the exploration and use of space in support of our national well-being. Our mission to provide leadership in critical areas of space activities in an increasingly competitive international environment urges us to build on the great achievements of those who have gone before and continue with the extraordinary aeronautical and space achievements that this Nation has so capably demonstrated.

George Bush

The White House,
January 31, 1991.

Message to the Congress Submitting a Report on the International Space Year

January 31, 1991

To the Congress of the United States:

I am pleased to submit the attached report on plans and programs for the International Space Year (ISY) in 1992, prepared by the National Aeronautics and Space Administration in response to Senate Joint Resolution 75 (Public Law 101–339, July 31, 1990). The report shows considerable progress since the ISY was first proposed by the Congress in 1985 and advanced internationally by NASA at President Reagan's direction.

The report indicates a broad acceptance for the ISY that confirms the original intent and expectations of the Congress. The ISY celebrates a new age that inspires a unifying perspective on Earth as we continue to push back the frontiers of space. I invite the American people to develop activities for 1992 that foster the ISY's global perspective.

The ISY will place important emphasis on education. The language of science and the perspective of space are both global in scope. They will be united during the ISY in many science education programs in which challenging subjects such as astronomy, geology, physics, and chemistry will draw on the universal appeal of space science and exploration. Similarly, other public education activities ranging from television programs to expositions will carry the ISY's universal message to the widest possible audience.

I invite the leaders of all the nations of the world to join me in endorsing and actively supporting the International Space Year in 1992. In particular, I urge their continued support for the Space Agency Forum on the ISY (SAFISY), whose membership includes 28 space agencies plus eight affiliated international organizations, including the United Nations. The SAFISY has adopted Mission To Planet Earth as the central ISY theme and is also supporting ISY activities concerning human exploration, education, benefits for developing nations, and space science. I look forward to continued progress in those areas as the ISY approaches.

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Thank you all very much.

Note: The President spoke at 12:16 p.m. in the Rose Garden at the White House. In his remarks, he referred to William J. Bennett, Director of National Drug Control Policy, and John C. Lawn, Administrator of the Drug Enforcement Administration.

Nomination of Susan J. Koch To Be an Assistant Director of the United States Arms Control and Disarmament Agency

January 17, 1990

The President today announced his intention to nominate Susan Jane Koch to be an Assistant Director of the United States Arms Control and Disarmament Agency for the Bureau of Strategic Programs. She would succeed William H. Fite.

Since 1988 Dr. Koch has served as Principal Director of Nuclear Forces and Arms Control Policy in the Office of the Assistant Secretary of Defense for International Security Policy. Prior to this, she served as a staff analyst for Strategic Defense and Space Arms Control Policy in the Office of the Assistant Secretary of Defense for International Security Policy, 1985–1988; as a Special Assistant to the Deputy Assistant Secretary of Defense for Nuclear Forces and Arms Control Policy in the Office of the Assistant Secretary of Defense for International Security Policy, 1982–1985; branch chief in the Office of European Analysis and Office of Policy Analysis at the Central Intelligence Agency, 1980–1982; intelligence analyst in the Office of Political Analysis and Office of Political Research at the Central Intelligence Agency, 1975–1980; and an assistant professor in the department of political science at the University of Connecticut, 1971–1975. In addition, Dr. Koch has served as an instructor in the department of political science at Mount Holyoke College, 1970–1971.

Dr. Koch graduated from Mount Holyoke College (A.B., 1964) and Harvard University (M.A., 1968; Ph.D., 1971). She was born January 24, 1943, in Bridgeport, CT. Currently, Dr. Koch resides in Washington, DC.

Telephone Conversation With the Astronauts Aboard the Space Shuttle *Columbia*

January 18, 1990

The President. Hello, Fred, can you hear me? Dan? Are we talking to space?

Commander Brandenstein. Yes, sir, Mr. President. Welcome aboard *Columbia*. We hear you very clearly.

The President. Well, Dan, is that you, the captain, the boss of that outfit?

Commander Brandenstein. Well, that's what they say, but everybody contributes a lot, and I just kind of stay out of the way so they can get their jobs done.

The President. Well, listen, I just was calling you to congratulate you. Dan Quayle is sitting here next to me in the Oval Office, and as you know, he's taken a very active role in this Space Council. But what I'm calling to do is to congratulate you and the crew, after all those somersaults—but doing a superb job up there on this mission. And we followed the LDEF [Long Duration Exposure Facility] and the very exciting grab, and I just wanted to hear firsthand how it was going.

Commander Brandenstein. Well, Mr. President, I think it's going well. We've pretty much concluded most of the major objectives of this mission, and obviously, the retrieval of the LDEF was one of the highlights, and we're very happy we have it back onboard. We believe it's a real treasure that's going to help very much in designing future space satellites and shuttles and space stations.

The President. Well, I think that's wonderful. And how do all the new guys behave—Jim, Marsha, and David? Can they talk, or are you doing the speaking for this crowd?

Commander Brandenstein. I want to give them all a chance. In fact, we'll let G. David tell you how it is to be a new guy.

The President. All right, fire away, Dave.

Mr. Low. Well, Mr. President, it's a pleasure to be up here. I've enjoyed this flight very much. We've enjoyed a lot of success with a lot of help from all the folks on the ground. It's a real pleasure to be up here to contribute to our space program.

The President. Well, I'm delighted. How's Marsha doing? Is she near a mike there?

Ms. Ivins. Yes, sir, I have a mike. I think we new guys are really excited. We've waited a long time for this, and it's sort of a dream come true. The world—looking at it from up here—is incredible.

The President. I don't want to date your commander, the captain there, Dan, but I had dinner over at the White House 2 nights ago with Dick Truly, who reminded me that they had flown together sometime back. Dan, sorry about that.

Commander Brandenstein. That's true. And in fact, I've been taking my share of hits this mission. I just had a birthday yesterday, and I've been taking a lot of grief.

The President. All right. Well, listen, is Bonnie there? Who else have we not—I'd like to say hello to everybody.

Commander Brandenstein. Certainly. We'll let Jim Wetherbee tell you. He's the other new guy. And we'll let him tell you what he thought of it, and then we'll turn you over to Bonnie.

Lieutenant Commander Wetherbee. I'm proud to be here. It's a pleasure being part of this program. I'm happy to be part of watching Dan recover that satellite. He's about the best in the world at grabbing satellites at Mach 25.

The President. Unbelievable. Well, I'm glad to see a Navy pilot—could you use a 65-year-old Navy pilot up there?

Commander Brandenstein. Navy pilots don't get that old.

The President. Oh, yeah? I'm one. [*Laughter*] Hey, listen, there seems to be a long pause.

Ms. Dunbar. Well, I'm delighted to be here, Mr. President, and feel fortunate to do it again. But I know that it takes a lot of work on the part of many, many people. And I want to thank all the people at Johnson Space Center, and NASA in general, for making this possible. It's been an incredible mission.

The President. Well, you know, that's one thing that does come through. There you all are working, and people following very keenly what you're doing. But I think one thing the American people do see as a result of a highly complex mission like this is this enormously effective teamwork. And I must say, I'd like to join you in saluting everybody involved. And I wish you well as you wrap it up now and come on back. But we're proud of you, and I look forward to seeing you at the White House, as does the Vice President, when you can get around to getting up here after you get back.

So, well done. We're proud of you, and we will follow the rest of the mission, as we have the beginning, with great interest. And, Dan, to you and your wonderful crew, congratulations.

Commander Brandenstein. Well, thank you very much for taking the time and speak with us this morning, Mr. President. And we're proud to have had the opportunity to represent our country and to conduct this mission, and along with all the other people that make up the NASA and the space team in this country.

The President. Okay. Well, we'll let you go to work, and well done. Thank you very much. Over and out.

Commander Brandenstein. Goodbye.

Note: The conversation began at 7:39 a.m. The President spoke from the Oval Office. In his remarks, he referred to Richard H. Truly, Administrator of the National Aeronautics and Space Administration. The space shuttle crew included Capt. Daniel C.

City College in 1951, the U.S. Coast Guard Academy in 1957, and the Massachusetts Institute of Technology (M.S., 1964). He is married to the former Valerie Joan Hiddlestone.

Statement by Press Secretary Fitzwater on International Cooperation in the President's Space Exploration Initiative

March 30, 1990

The President announced today that the United States would seek an exploratory dialog with Europe, Canada, Japan, the Soviet Union, and other nations on international cooperation in the Space Exploration Initiative.

The President's announcement comes as part of a series of policy implementation decisions stemming from his address of July 20, 1989, the 20th anniversary of the *Apollo* lunar landing. On that historic occasion, the President set the future direction of the U.S. space program by proposing a long-term, continuing commitment to completing Space Station *Freedom*, returning permanently to the Moon, and sending a manned expedition to the planet Mars.

To chart this course, he asked the Vice President to lead the National Space Council in determining, among other things, the feasibility of international cooperation in this endeavor. The Council recently completed a review of potential international cooperation and concluded, in part:

- The President's Space Exploration Initiative will be of profound significance for all mankind.
- International cooperation in this endeavor is feasible and could offer significant benefits to the United States, subject to the satisfaction of national security, foreign policy, scientific, and economic interests.

Acting on the recommendations of the Vice President and the National Space Council, the President decided that:

- The United States will take a sequential and orderly approach to decisions on involving specific countries consistent with decisions made on the overall Space Exploration Initiative.
- The United States will seek an exploratory dialog with Europe, Canada, Japan, the Soviet Union, and other nations as appropriate on international cooperation on the initiative.
- The exploratory dialog will focus solely on conceptual possibilities for cooperation.
- The dialog will be based on guidelines expeditiously prepared by the National Space Council. The guidelines will be consistent with the National Space Policy, taking due account of U.S. national security, foreign policy, scientific, and economic interests.
- The National Space Council will ensure interagency coordination and review during the development of international cooperation on the initiative and provide recommendations to the President as appropriate.

These decisions by the President follow on and relate to earlier decisions on the Space Exploration Initiative announced in the White House press release of March 8, 1990.

that asked a four-word question. It went like this: "Is This Dream Possible?" And when I look around this room and when I talk to the Director, I know the answer to that one. In this room are 28 folks who refused to surrender, 28 reasons why I really now believe, as Bill does, that we are going to win.

A few months ago, Bill Bennett wrote a booklet called "Fighting Back." And many of you here were profiled in that piece. Almost every story was different. But almost every story began the same way. It began when one man or woman threw down the hat, took off the gloves, stepped forward, armed with the most powerful force known to man: the force of an idea. You fought back. You got involved. You made a difference, and you proved to America that this war can be won.

So, I think you are America's hometown heroes—unconventional warriors, but this is an unconventional war. You've shown how the communities under siege can be united in a battle for life and how they can be restored to health and safety, doing it your way, on your turf.

It's sometimes hard to see with all these lights, but the ceiling here is decorated, and you can see it, with a field of golden stars. Just like real stars, we often forget to notice them. You are the stars in America's war on drugs. You shine through the dark, you give hope in the night. And we're here today really to say that someone noticed. Bill Bennett noticed. And I noticed. And I hope all of America will notice.

This used to be the Navy's library right here, and of course, stars have a special significance to those who navigate on the seas. And in this sense, stars like you do far more than fuel hopes and prayers. You are also beacons to thousands of other people, immovable lights by which they can chart their course to victory. So, I just wanted to stop by here to say thanks, to assure you that we're going to keep on fighting against drugs and fighting for you, for your neighborhoods, and most of all for the kids, the children out there. And we're going to remember the rallying cry of Chicago's Father George Clemens: "There are more of us than there are of them."

Congratulations and thank you all for what you're doing. Thank you very much.

Note: The President spoke at 1:39 p.m. in the Indian Treaty Room at the Old Executive Office Building. In his remarks, he referred to William J. Bennett, Director of National Drug Control Policy; Alvin L. Brooks, director of the Kansas City, MO, Human Relations Department and executive director and founder of the Ad Hoc Group Against Crime; and Erma Scales, chairwoman of the Acres Homes War on Drugs Committee in Houston, TX.

Statement by Press Secretary Fitzwater on the President's Space Exploration Initiative

March 8, 1990

On July 20, 1989, in a speech commemorating the 20th anniversary of the *Apollo* Moon landing, the President announced three major space policy objectives of the administration: the completion of Space Station *Freedom*, a return to the Moon to stay, and a manned expedition to Mars. In that speech, he asked the Vice President to lead the National Space Council in developing policies and plans to accomplish these objectives.

The President announced today he has approved the first of a series of policy decisions for the long-term space exploration initiative he announced on July 20. Acting upon the recommendation of the Vice President and the National Space Council, the President has approved a program that will give early focus to technology development and a search for new and innovative technical approaches to the Moon and Mars missions.

The policy consists of the following elements:

- The initiative will include both lunar and Mars program elements.
- The early program will focus on technology development with a search for new and innovative approaches and technologies.
- The program will include investment in high leverage innovative technologies with potential to make a major impact on cost, schedule, and/or performance.
- The program will take at least several years defining two or more significantly different human space exploration reference architectures, while developing and demonstrating technology broad enough to support all. Selection of a baseline program architecture will occur after that time.
- The program will perform mission, concept, and system analysis studies in parallel with technology development.
- The program will include robotic science missions.
- By spurring research and development in high technology fields, the space program will help promote American economic leadership.
- The program will require the efforts of several agencies. NASA [National Aeronautics and Space Administration] will be the principal implementing agency. The Department of Defense and the Department of Energy will also have major roles in the conduct of technology development and concept definition. The National Space Council will coordinate the development of an implementation strategy for the exploration initiative by the three agencies. To facilitate coordination, the Department of Energy will be added as a formal member of the National Space Council.

Remarks at a Presentation Ceremony for the Panama Campaign Streamer at Fort Myer, Virginia

March 8, 1990

Thank you all very much, Secretary Cheney and General Powell, and all the members of the Joint Chiefs, service secretaries, men and women of the Armed Forces. We are here today to add another campaign streamer to the rollcall of glory, the roster of great American campaigns: Yorktown, Gettysburg, Normandy, and now, Panama. Let us never forget that our Armed Forces have always fought for the children of America, for they are America's future. Panama was no different. The children of Panama deserve a future of freedom and democracy. And the people of that nation, Panama, needed us to stand with them to defend that struggle for democracy and for the opportunity that Americans have enjoyed for over 200 years.

The moment of decision came from me when the lives of America's servicemen stationed in Panama and the lives of American citizens there were threatened. That's when a silent phrase passed the lips, I think, of every American: Enough is enough. Our Armed Forces united in an operation appropriately labeled Just Cause, and 27,000 of America's finest sprang into action. They descended in C–130's, choppers, parachutes. They came in the cover of darkness, and they came in frontal assault with the sun at their backs. All braved death. All fought with distinction. So, it is especially fitting that the fabric of this streamer is woven with the colors of all the services.

Just last week, General Powell and General Thurman brought a few of these service men and women over to the White House. I heard tales of heroism, all of them told with reluctance, all of them told plainly and as matters of fact. And it was a matter of duty, they told me. I met an Army medic who, though wounded, pulled one serviceman after another from the line of fire before collapsing. This medic now wears