Final Report to the President on the U.S. SPACE PROGRAM

January 1993

THE VICE PRESIDENT
WASHINGTON

January 7, 1993

The President
The White House
Washington, D.C. 20500

Dear Mr. President:

I am pleased to transmit to you this final report on the U.S. space program. It has been my great privilege to serve as Chairman of the National Space Council over these past four years. At the beginning of the Administration, you made it clear to me that you were determined to keep America first in space. We have accomplished that, and much more.

As you know, there were many challenges. At the outset of the Administration, the nation's space program was still recovering from the Challenger accident. Our commercial space enterprises were coming under increasing pressure from a variety of players in the domestic and international marketplace. The need for more reliable data on environmental change was placing new demands on the space program.

More recently, the collapse of the Soviet Union, unprecedented global political and economic upheaval, lessons learned from Operation Desert Storm, and increasing and often conflicting claims on spending priorities have forced further reassessments of many of our space policies. Last summer, I commissioned the Vice President's Space Policy Advisory Board to provide broad policy recommendations as the nation continues to adjust to these changes. The Board's recently released findings and recommendations are highlighted in this report.

In spite of all these challenges -- indeed, because of them -- this Administration will leave behind an important legacy of accomplishment. I believe the policy foundations that we have laid in response to these challenges will serve America well and will stand the test of time.

This report highlights the accomplishments of the Administration, identifies the policies and programs it has put in place, and points the way to the future. Like those who came before us, we must rely on our successors to build upon what has been achieved. The success of our space program over three and a half decades would not have been possible without a bipartisan coalition of engineers, scientists, government and industry leaders, and most importantly, generations of Americans with a shared vision and a strong belief in U.S. leadership. With that in mind, I conclude this report with a series of recommendations for the future which I hope will be received as they are intended -- to aid the next administration, Republicans and Democrats in Congress, and the American people as they shape our space program over the coming years.

Sincerely,

The National Space Council

The National Space Council is responsible for advising the President on national space policy and strategy, and coordinating the implementation of the President's policies. It was authorized by an act of Congress in 1988 and was established as an agency of the federal government by President Bush on April 20, 1989.

The Space Council is chaired by Vice President Dan Quayle, who serves as the President's principal advisor on national space policy and strategy.

National Space Council Membership

The Vice President
Dan Quayle
Chairman

The Secretary of State
Lawrence Eagleburger

The Secretary of the Treasury
Nicholas F. Brady

The Secretary of Defense
Dick Cheney

The Secretary of Commerce
Barbara Franklin

The Secretary of Transportation
Andrew Card

The Director of the Office of Management and Budget
Richard G. Darman

The Assistant to the President for National Security Affairs
Brent Scowcroft

The Assistant to the President for Science and Technology
D. Allan Bromley

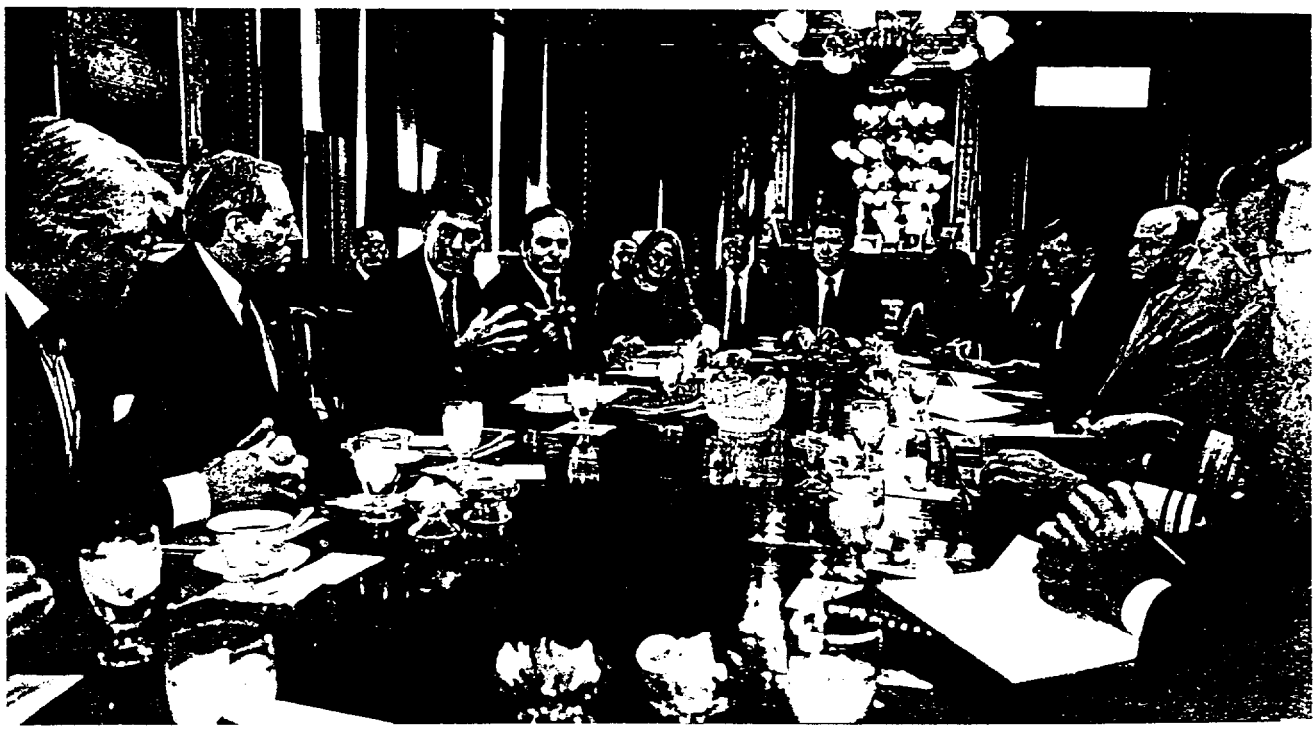
The Secretary of Energy
James D. Watkins

The Chief of Staff to the President
James A. Baker III

The Director of Central Intelligence
Robert Gates

The Administrator of the National Aeronautics and Space Administration
Daniel Goldin

National Space Council Executive Secretary
Brian D. Dailey



Contents

Space Leadership

Space is vitally important to our nation's future and . . . to the quality of life here on Earth . . . It offers a technological frontier, creating jobs for tomorrow. And space programs inspire an interest in math, science, and engineering in young people — knowledge so important for a competitive future. Space offers us the chance to unlock secrets billions of years old and billions of light-years away. Space is the manifest destination of a new generation and a new century.

— President George Bush

At the outset of this Administration, as the U.S. space program entered its fourth decade, a series of challenges faced space policymakers. Many of those challenges were the result of past policy decisions. We were just beginning to emerge from the shadow of the Challenger accident that had paralyzed our space program for over two years. The return to reliance on our aging expendable launch systems and our continuing dependence on the Space Shuttle had revealed the shortcomings of our overall space transportation capability in terms of both cost and performance. These shortcomings, among others, were placing U.S. companies at a competitive disadvantage in world markets for space goods and services, where a variety of foreign players were increasingly reaping the rewards of more deliberate and effective government support.

Other challenges were the result of relatively new developments, including the demand for information to understand potential threats to the global environment. Speculation about the extent to which natural phenomena as

well as human-induced activities were contributing to adverse global environmental changes placed new requirements on the U.S. space program for reliable space-based data collection and systems to analyze that data.

But perhaps most significant were the more recent sweeping global political and economic changes. The collapse of the Soviet Union and the concomitant decline in U.S. defense spending, a global economic recession, and new and often conflicting demands on U.S. spending priorities all affected the U.S. space program and required — and continue to require — fundamental changes in U.S. space policy.

During these past four years, and particularly during this period of upheaval, this Administration has remained steadfast in its commitment to maintain U.S. leadership in space. Space contributes to our quality of life, to our national competitiveness, to the acquisition of knowledge, to our national prestige, and to our economy.

Space is also assuming an increasingly important role in our national security. Operation Desert Storm demonstrated that even with the Soviet threat diminished, threats to global security will continue to exist, and space will be crucial to our ability to provide for our national defense and maintain global stability.

The National Space Council, established by President Bush at the outset of the Administration, has provided direction and continuity during this period of great change. It was charged with developing recommendations for the President on space policy, developing a strategy for national space activities, and monitoring and coordinating the implementation of U.S. national space policy. It brought together the leaders of the departments, agencies, and White House offices with space program oversight and laid a comprehensive policy foundation for the U.S. space program.

Early on, the Council's efforts were focused on five strategic objectives:

- To develop U.S. space launch capability and related infrastructure as a national resource,

- To open the frontiers of space through both human and robotic exploration,
- To intensify our use of space in solving problems here on Earth,
- To use space to foster our economic well-being, and
- To ensure the freedom of space for exploration, development, and security.

Much was accomplished. America was challenged to build on its pioneering achievements in space exploration by moving forward with Space Station Freedom, returning to the Moon, and mounting a human expedition to Mars. Aggressive research and technology efforts were supported and enhanced through programs like the National Aerospace Plane (NASP). A commercial launch policy was developed to address the trading environment in which U.S. firms compete with a variety of foreign entities, and guidelines were issued to support and encourage commercial space activities at home. A national space launch strategy was established, calling for a transition away from our current expensive, inefficient systems through the development of a new, less costly, and more responsive family of launch vehicles. New international cooperative projects were undertaken with our traditional partners as well as with Russia. The civil remote sensing program was renewed and strengthened. These, and other accomplishments, are documented in this report.

On the assumption, however, that the post-Cold War era will require additional near-term and long-term adjustments to our space program, the Vice President's Space Policy Advisory Board was tasked last summer to undertake a series of forward-looking assessments. This nonpartisan group of experts was asked to consider what changes might be necessary for more effective implementation of our space launch strategy, to preserve our critical U.S. space industrial base, and to achieve an overall space policy structure that more accurately reflects current national and international conditions.

In three reports released recently, the Board recommended the continuation of several important Administration initiatives: to develop a new, cost-effective space launch system, to streamline acquisition and regulatory mechanisms, to foster and support U.S. private sector commercial ventures, to improve the space support infrastructure, and to aggressively pursue science and technology. The Board also recommended significant changes in the way the U.S. space program is managed and organized, as well as other important changes highlighted in this report.

When viewed as a whole, the seven National Space Policy Directives (NSPDs) signed by President Bush over the last four years, several other decision memoranda and policy statements, six major nonpartisan assessments including the three recent studies, a series of international agreements, as well as an aggressive commitment of resources, define the history of this Administration's stewardship of the space program, the policy foundation it has laid, and the challenges that lie ahead for the next administration. Many of these milestones are noted in an appendix to this report.

The following section highlights the policy initiatives and activities undertaken by the Administration in the areas of space transportation, national security, civil space, and space commerce and trade. The concluding section contains a series of policy recommendations that build on the accomplishments of this and preceding administrations and recently completed Advisory Board policy assessments. They are intended to assist the next administration in the important deliberations it will undertake on the future of this critical national asset.

Status of the U.S. Space Program

Space Transportation

America's space launch capability is the fundamental building block for all of its space activities. Yet the United States finds itself at a critical juncture. Our systems were developed decades ago, they are expensive to build and operate, and they lack operability and responsiveness. The policy decisions of the late 1970s, which committed the nation to exclusive reliance on the Space Shuttle, led to the termination of all investments in expendable launch vehicle (ELV) infrastructure. Following the Challenger accident, the nation was forced to spend more than $12 billion to restore ELV operations and transfer satellites designed for the Space Shuttle back to these aging launchers. Thus, our early decision to rely totally on the Space Shuttle delayed needed improvements in space launch by some two decades.

The Space Shuttle has now been returned to full flight status, and during the past year it flew eight times, more than in any year since before the Challenger accident. Of the total time Space Shuttles have spent in orbit, 20 percent occurred during the past year. In addition, a record seven out of eight flights were launched on schedule. This has been accomplished while simultaneously reducing operational costs and maintaining crew safety.

The loss of American dominance in the international launch market to foreign competitors demonstrates the importance of continued investments in space transportation technology and infrastructure. This is among the lessons to be learned from the stable funding and commitment to improved

performance we see overseas. The most conspicuous example is Europe's Ariane V program, which promises to result in a low-cost, reliable, and improved launch system for worldwide users.

Several exercises conducted under National Space Council auspices over the past three years have attempted to focus informed attention on the need to strengthen America's space launch capability. First, *The Report of the Advisory Committee on the Future of the U.S. Space Program*, chaired by Mr. Norman Augustine, Chief Executive Officer of Martin Marietta, recommended the development of a new national launch system. The so-called Augustine Committee found that the most significant deficiency in the nation's future civil space program is the lack of a reliable, flexible, and efficient space launch capability. The Committee recommended strongly that the nation move ahead quickly to develop a more robust launch capability.

The need for a new launch capability has been reinforced by every government study and outside advisory panel that has addressed this issue since the Augustine Committee report and, indeed, since the Challenger accident. Key members of the National Space Council, including the NASA Administrator and the Secretary of Defense, agree strongly with this recommendation.

In July 1991, the President issued the National Space Launch Strategy, NSPD 4, that established a long-range plan to meet America's space launch needs well into the next century. Agencies were directed to:

- Ensure that existing space launch capabilities, including support facilities, are sufficient to meet U.S. government manned and unmanned launch needs;

- Develop a new, man-rateable, space launch system to reduce costs and improve performance;

- Sustain a vigorous space launch technology program to apply to both existing and new space launch systems; and

- Actively consider commercial space launch needs and factor those needs into the decisions on improvements in space launch facilities and vehicles.

The environment in which these directives were to be implemented, however, has changed significantly with increasing international competition and difficult fiscal realities at home. Recognizing the urgency to refine our space transportation objectives and devise an effective implementation plan, a Task Group of the Vice President's Space Policy Advisory Board, led by former Secretary of the Air Force E.C. (Pete) Aldridge, Jr., recently conducted a study on *The Future of the U.S. Space Launch Capability.* The report, released in November 1992, endorsed the 1991 National Space Launch Strategy, but found that implementation by the key government agencies, Congress, and industry had not been adequate. Specifically, it found that while the United States is meeting the minimum basic needs of launching payloads into space to support government and commercial missions, it is not taking advantage of new efficient, reliable, and low-cost technological and manufacturing concepts. As a consequence, we are lagging farther behind virtually every other national or multinational launch program.

The principal recommendation of the Task Group was that the government should develop a new launch vehicle, dubbed "Spacelifter." Recognizing that at least 85 percent of U.S. launch requirements are in the range of 20,000 pounds — or less — to low Earth orbit, the Spacelifter program would focus initially on a medium-lift capability to satisfy most national payload requirements, but would have growth potential to fulfill heavier lift requirements up to 50,000 pounds.

The Task Group suggested that the development of a personnel launch system and a cargo transfer and return vehicle compatible with the Spacelifter could allow a phaseout of the Space Shuttle system by about 2005, with prudent time for overlap. The group also endorsed the Administration's commitment to NASP, and to other advanced technology programs such as space nuclear power and propulsion. NASP development, in particular, lays the foundation for revolutionary improvements in space launch and hypersonic flight, and can contribute to continued U.S. leadership in aerospace into the 21st century.

Finally, the Task Group recommended centralizing space launch management, continuing infrastructure improvements, and supporting advanced technology development.

As Dr. Sally Ride stated in her 1987 report, *Leadership and America's Future in Space,* "From now until the mid-1990s, Earth-to-orbit transportation is NASA's most pressing problem." During the intervening five years, efforts to secure support for a new launch system have been largely unsuccessful. The failure of our institutions — U.S. Government agencies, Congress, and the aerospace companies — to converge and agree to support and fund a new launch system not only is shortsighted, but will prevent us from achieving many — if not most — of our long-term space objectives. Though blame can be assigned to all parties, little will be gained from finger pointing. We must move ahead. If the United States is to control its own destiny in space, a nonpartisan effort must be directed immediately to implement a new launch program.

National Security

The importance of a strong military space program to U.S. national security was clearly demonstrated during the Persian Gulf crisis. The superiority of U.S. space communications, navigation, weather reporting, reconnaissance, surveillance, remote sensing, and early warning systems was critical to the success of the coalition forces in Operation Desert Storm. Secretary of Defense Dick Cheney later noted that our space systems were a prime example "of the way technology went to work making our troops more effective and . . . safer." Control of space was essential to our ability to prosecute the war quickly, successfully, and with minimum loss of American personnel.

Space assets enhance the ability of U.S. forces to reach their objectives and act as "force multipliers" for our air, sea, and land forces. The advanced command, control, and communications network provided by these assets reduces the size of the force necessary to accomplish a mission. Support for

ground and air operations during the Gulf War came from a combination of military and civil space systems.

Accurate, realtime weather information provided by the Defense Meteorological Satellite Program, combined with satellites of the National Oceanographic and Atmospheric Administration (NOAA), was critical to the success of our air operations and saved American and coalition forces lives.

The space-based Global Positioning System (GPS) — a constellation of satellites that can transmit extremely accurate position information to hand-held receivers — was used for the first time in combat and was invaluable in guiding coalition forces movements across trackless desert sands. In contrast, some Iraqi units were unable to navigate in their own terrain, lacking access to space-based positioning systems.

The Defense Support Program, our early warning satellite system, allowed rapid identification of Iraqi Scud missile launches and quick alerts to our troops, enabling Patriot missile batteries to target and destroy the incoming missiles. The Landsat satellite broad-area, multispectral images of the Persian Gulf region were extremely valuable in the preparation of tactical maps for combat operations. Surveillance systems helped identify enemy targets and validated the success of allied strikes.

The Chairman of the Joint Chiefs of Staff, General Colin Powell, noted that the ability of the United States to use military force effectively relied heavily on support from the "high ground" of space. The important role of space systems to the success of Desert Storm did not go unnoticed by our allies, or by our potential future adversaries. Accordingly, many nations are moving to acquire space systems to improve their military capabilities.

For the past twenty years, the United States has been ambivalent and indecisive about the desirability of maintaining a comprehensive space control capability. Until the early 1970s, the United States operated an antisatellite (ASAT) missile system capable of destroying space-based assets of our adversaries. Its principal purpose was to deny the use of space to the former Soviet Union in time of war. That program was terminated and a successor

program, the Air Force Miniature Homing Vehicle, was never deployed operationally.

Supporters of an ASAT system have argued that the capability to deny the use of space to an adversary can add great protection to U.S. land, sea, and air forces during hostile military action. Its opponents, however, have argued that U.S. interests are best protected by seeking to avoid an "ASAT race" with the former Soviet Union, thereby preserving a "space sanctuary." But the proliferation of space systems has changed profoundly the space control equation, and the "space sanctuary" concept has been overtaken by events. Sixteen nations today have some degree of indigenous capability to employ militarily useful satellites. That number is expected to double by the beginning of the next century. Had the Iraqis possessed militarily useful space systems during Operation Desert Storm, coalition maneuvers could have been detected and many American lives might have been lost.

To counter such threats, the nation more than ever needs a comprehensive space control capability, including space surveillance systems that can detect and track hostile objects in space, satellites that are impervious to interference from hostile forces, and a comprehensive antisatellite capability to deny the military use of space to future enemies. The United States would never tolerate the flight of enemy airborne reconnaissance vehicles over U.S. military forces. Similarly, the United States should not allow hostile space-based reconnaissance systems to overfly and threaten U.S. forces with impunity.

In addition, we must continue to demand that all our space partners comply with current nonproliferation treaties and norms, and continue to ensure adherence to the Missile Technology Control Regime and other non-proliferation guidelines. While it is unlikely that we can halt completely the proliferation of space technology to destabilizing regimes, at a minimum we must make every effort to hinder and slow down the acquisition of such systems.

Many national security space systems have applications in the civil space sector, and vice versa. Our current fleet of ELVs was originally designed and built to meet defense requirements. The Space Shuttle was also designed, in

part, to fulfill military requirements. These government launch systems opened the door for the emergence of commercial launch providers and supported our civil systems. Defense satellites are being used for many civilian applications including air traffic control, general navigation, terrain and feature mapping, global environmental observation, and space debris tracking. The GPS navigation system, developed and operated by the Air Force, was made available for civilian applications when it first became operational. Today, GPS applications abound, and we may one day become as dependent on this technology as we are on the telephone today. GPS assists surveyors, geologists, fishermen, hunters, and campers and is used for auto and truck fleet management and air navigation. The United States has also permitted access to GPS for use in international air traffic control.

President Bush's decision to begin the process of decompartmentalization and declassification of information about the National Reconnaissance Office (NRO) and its capabilities will enable the United States to make better use of those assets. By disseminating information gathered by satellites built and operated by the NRO, we will expand the use of our intelligence-gathering systems into innovative and nontraditional secondary missions such as environmental monitoring. In addition, systems and technology under development for the Strategic Defense Initiative, particularly Brilliant Eyes, can be used to enhance our environmental monitoring program.

Similarly, commercial sector space systems have many national security applications. Commercial communications satellites were used by coalition military forces in Operation Desert Storm. Scientific and commercial Earth-observation systems provided useful low-resolution data for military mapping and broad-area surveillance. In addition, the Department of Defense (DoD) and NOAA regularly exchange space-derived weather data.

Fostering linkages such as these and increasing the synergism between civil and national security space operations are important elements of a successful national space program in the 21st century. The emphasis on space programs within the defense budget must remain strong, because our nation's space assets are a critical force multiplier and the backbone of an effective military capability. In addition, investing in space systems keeps our defense and

commercial industrial base healthy, maintains American leadership in advanced technology, and strengthens the competitiveness of our industry in the international marketplace.

Civil Space

When the history of the 20th century is written, the achievements of America's civil space program will stand among the great events of the era. Mercury, Gemini, Voyager, Viking, and especially Apollo will be recorded as great triumphs of technology, engineering, perseverance, and national will. Through these accomplishments, America has earned the respect and admiration of the world, fired the collective imagination, and inspired our youth. We have produced science and technology that have improved the lives of people around the globe. And we have achieved and maintained our civil space policy goal of space leadership.

At the start of this Administration, however, the civil space program was widely viewed with concern. Recovery from the 1986 Space Shuttle accident had been time-consuming and difficult. A series of widely reported technical problems was sapping public enthusiasm and draining the morale of NASA employees. There was a lack of consensus about where the space program should be going.

Recommendations had been provided to the previous administration by the National Commission on Space, chaired by Dr. Tom Paine. Dr. Sally Ride had also published a report identifying the need for challenging new goals. But the choices called for in these reports had not been made. The National Academy of Sciences and the Center for Strategic and International Studies provided reports to the new administration in 1989. Each called for decisive actions to rejuvenate America's civil space efforts.

As a result, the civil space program was an early and frequent focus of the National Space Council. The Council used a combination of internal policy reviews and external advisory committees to assist in this effort.

Perhaps most notable among these was the Advisory Committee on the Future of the U.S. Space Program, the Augustine Committee. That group, which included many of the nation's most respected space authorities, conducted a far-reaching assessment of the future of the civil space program, including both management issues and program content. The Committee heard from all branches of government, visited many space facilities across the country, and took testimony or otherwise received the advice of hundreds of citizens.

The Committee's recommendations called for fundamental changes in the civil space program. At the core of its conclusions was the recommendation that the space program's goals be organized around two central missions: First, a Mission to Planet Earth, to use space to observe the Earth and its environment to facilitate the study of environmental change and the potential for global warming. Second, a Mission from Planet Earth, to explore space through both human and robotic missions with the goal of returning to the Moon and mounting a human expedition to Mars. The Committee recommended that both missions be supported by a solid base of transportation infrastructure, science, and technology.

The Augustine Committee also recommended a series of management and organizational changes designed to streamline the execution of programs and to focus in the future on smaller, less expensive programs that could be accomplished relatively quickly.

These core recommendations, as well as many other specific program and policy recommendations, were widely endorsed in the space community and in the Congress, formed the basis for many of the Administration's subsequent policy decisions and actions, and have continued to guide both Administration policymakers and department and agency managers.

Mission to Planet Earth

Mission to Planet Earth is an effort to use space-based assets to better understand the Earth as an integrated system by exploring climatic, ecological,

and environmental changes. In recent years we have become acutely aware that human actions, as well as natural phenomena, can affect the environment on a global scale. Space provides a uniquely broad vantage point from which our expertise in remote sensing can be used to determine whether global warming is in fact occurring, to study deforestation and land erosion, and even to detect and examine earthquakes.

The Administration's efforts to support this core element of our civil space program were focused on its two key programmatic elements — the Earth Observing System (EOS) and the Landsat earth remote sensing program.

The Landsat program presented the National Space Council with its first challenge. Landsat remote sensing imagery is important not only for global change research and environmental monitoring, but for national security, law enforcement, natural resource estimates, and a host of commercial enterprises. In early 1989, the program faced termination as a result of a decision in previous years to commercialize the program. This decision had been based on faulty assumptions about private sector demand for Landsat data, and the absence of near-term commercial viability had resulted in a funding crisis.

The National Space Council, meeting for the first time in May 1989, recognized that Landsat data was critical to a host of civil and national security activities as well as to the private sector, and that commercialization of the program would not be feasible in the foreseeable future. It recommended that the government provide near-term operational funding and that a solution be found to ensure the long-term stability of the program, recommendations supported by a Presidential decision.

Subsequent decisions by the Administration, including National Space Policy Directive 5, guaranteed stable funding and management for the program. The Administration and the Congress worked together to enact legislation which will ensure that continuity of Landsat-type data is maintained for the foreseeable future. The legislation will also encourage future commercial opportunities in remote sensing by:

- Supporting investment in new remote sensing technologies,

- Removing unnecessary restrictions on the dissemination of privately gathered data,

- Streamlining the licensing process for private remote sensing systems, and

- Encouraging growth of the market for remote sensing data by pricing federally provided data at the cost of fulfilling user requests, but no higher.

The EOS program presented the Administration with a different set of challenges. EOS is a constellation of satellites, and a complementary data handling system, designed to measure worldwide environmental parameters such as air and ocean temperature, humidity levels, and atmospheric chemistry. It is a key component of the U.S. program for environmental research, an effort in which the United States is investing more resources than the rest of the world combined. The program enjoys broad support within the Administration, the Congress, and the space and environmental communities. It will produce quantities of data an order of magnitude beyond what is currently available, and will provide the basis on which future environmental policies can be based.

However, there was mounting concern that the space-based component of the program was centered around two large, unnecessarily complex and expensive satellites. These two satellites, each carrying a large array of instruments, put large segments of the program at risk of single-point failure, and the entire program at considerable budget and schedule risk.

The Augustine Committee recommended that consideration be given to restructuring the program and deploying, instead, "a combination of different size spacecraft." A panel of technical experts, led by Dr. Edward Frieman, Director of the Scripps Institute of Oceanography, was commissioned to assess this recommendation. The Frieman panel concluded that the two large satellite platforms should be broken down into a series of smaller platforms, each with fewer instruments. This resulted in a Presidential decision, embodied in National Space Policy Directive 7, to redesign the system using an architecture of smaller satellites.

NSPD 7, issued in June 1992, established a comprehensive, multiagency Space-based Global Change Observation System to address global warming and other potentially adverse environmental changes. In addition to directing NASA to develop EOS using small and intermediate-sized satellites, it assigned global change observation functions to various government agencies, and encouraged international cooperation in global change observation. Significantly, classified national security information and archives are now being made available to support our environmental monitoring efforts.

Mission from Planet Earth

NASA's Mission from Planet Earth is nearly as old as NASA itself. Among the first missions the nation embarked upon in the earliest days of the space program were human missions into space, including landings on the Moon, and robotic missions to explore the planets.

At the outset of this Administration, the human exploration component of NASA's Mission from Planet Earth was focused almost exclusively on two programs — the operational Space Shuttle program and the developmental Space Station program. The Space Shuttle is a multipurpose program, but its principal function is to provide transportation to and from space. Secondarily it serves as a temporary laboratory in space, but it lacks the capability to provide the research and scientific data that a permanent Earth-orbiting space station could provide.

The potential benefits of deploying an Earth-orbiting station in space were recognized and understood long before access to space became a reality in the late 1950s. Early space science pioneers, Wernher von Braun and others before him, had conceived of plans for a human outpost in Earth orbit that would be the steppingstone for human exploration of the Moon and the planets. A space station had remained a distant goal throughout the first two decades of the space program.

In 1984, President Reagan approved a plan for NASA to begin development of what is now known as Space Station Freedom. The designs for the Space

Station that had emerged were for a facility that — like the Space Shuttle — would serve many purposes. It would be a laboratory for scientific research on the effects of long-term exposure to a zero-gravity environment on humans, enabling preparation for long-duration human spaceflights. It would serve as a transportation depot for equipment and supplies for other space missions. It would contain laboratories for research on materials processing in space, potentially leading to breakthroughs and applications in chemistry, medicine, and physics. It would be used as a platform for Earth remote sensing and as an astronomical observatory, and provide for a host of other applications.

Amid the multiplicity of demands on both the Space Shuttle and the Space Station, however, there did not exist a clear focus on longer term human exploration goals, nor was there a plan or policy in place that outlined the next incremental step. Where were humans to go next and what were they to do?

On July 20, 1989, the 20th anniversary of the first Apollo Moon landing, President Bush outlined just such a long-term vision for human space exploration by proposing to the nation that it complete Space Station Freedom, then return to the Moon — "this time to stay" — and mount a human expedition to Mars. He directed the National Space Council to begin developing policies and plans to accomplish these objectives.

In March 1990, the President issued the first of several policy decisions on what became known as the Space Exploration Initiative (SEI). In that first decision, he directed that the SEI give early focus to technology development and a search for new and innovative technical approaches. The Moon and Mars missions were to be driven not by schedule, but by investments in high-leverage, innovative technologies that would have the potential to improve mission cost, schedule, and performance and could enhance the nation's technology base. He also directed that several years be invested in defining two or more significantly different mission architectures from which later policymakers could choose, while developing and demonstrating technologies broad enough to support all.

At the request of the Administration, Lt. Gen. Thomas P. Stafford, USAF (Ret), a former astronaut and space pioneer, led a group of technical experts that developed a set of mission architectures and identified key enabling technologies to be developed. Their findings and recommendations are contained in *The Report of the Synthesis Group on America's Space Exploration Initiative*, released in June 1991.

Additionally, the President directed that consideration be given to inviting other nations to participate in SEI, including our partners in Space Station Freedom, other traditional allies, and the former Soviet Union.

Based upon the so-called Synthesis Group report and Presidential decisions, NASA developed a long-term plan for accomplishing Moon and Mars missions. Two near-term precursor orbital missions to the Moon are planned, followed by an unmanned lunar lander. A goal of NASA's longer term plans for manned Moon and Mars missions is to provide significant technology and science benefits to the nation and to challenge young engineers and scientists.

In the meantime, however, the Space Station program had experienced several crises. The initial cost projections had seriously understated the funding requirements for the program. Out-year funding profiles began to grow by significant margins, and the annual appropriations debates in Congress had become increasingly contentious. Several serious attempts to cancel the program were supported by significant numbers of members in both houses, beginning in the late 1980s. During this period, several redesigns of the facility were initiated — some at the direction of Congress — which reduced the Station's costs and capabilities, but the debate continued. A contributing factor was the overall magnitude of the funding requirements combined with a lack of confidence that cost growth would not continue. Another was concern that the Space Shuttle would not be able to perform the relatively large number of flights required to deploy and operate the program.

But central to the debate was the lack of a well-understood program focus. Among the many arguments made was that most of the requirements for the program could be better met by a series of discrete, focused efforts — both on Earth and in space — and at considerably less overall cost.

In early 1991, the National Space Council undertook an overall assessment of the program in the course of a review of NASA's most recent redesign of the facility. It found that the redesign had significantly reduced development costs, had decreased the demands on the Space Shuttle, and had successfully addressed a number of other logistics problems. The Council concluded that though the Space Station will appropriately enable a great deal of valuable scientific research and innovation, the science returns may not, in and of themselves, justify the investment. But most significantly, it concluded that, in any case, pure scientific research was not the compelling rationale for the Space Station. It found that the underlying purpose for building and operating the Space Station is exploration, although the synergism of activities obviously provides greater weight to its overall benefit. Indeed, the Council concluded that the Space Station is the *necessary* next step in space exploration and Mission from Planet Earth. In so doing, it laid the policy foundation on which future deliberations about the Station's merits and purpose can reasonably take place. And more importantly, it reaffirmed the Administration's commitment to build the Space Station and to an aggressive Mission from Planet Earth.

Alongside human exploration, the Mission from Planet Earth component of the civil space program has included a series of exciting robotic explorers. Scientific discoveries gained through missions such as Viking and Voyager provided answers to some of mankind's oldest questions and rank among the greatest accomplishments of the modern age. But during the 1980s, our civil space resources were focused on the development of the Space Shuttle, and funding for robotic exploration was curtailed.

However, a new age of robotic exploration began with the launch of the Magellan mission to Venus in 1989. Magellan was a spectacular success. Galileo is now on its way to Jupiter, and the Mars Observer spacecraft will reach that planet in August 1993. Cassini is being readied for its exploration of Saturn and its moon, Titan. Meanwhile, the Hubble Space Telescope is unlocking secrets of distant galaxies. Additional Great Observatories are planned including the Advanced X-ray Astronomy Facility, which will gather exciting new scientific information about the origin and nature of the universe.

But the size and complexity of this new generation of robotic spacecraft resulted in development programs that stretched out over a decade or more and cost many hundreds of millions and even billions of dollars. Because of the high cost of each program, there were few of them, leaving the careers of many astronomers and planetary scientists heavily dependent on the success of a single spacecraft. And because of the long development times, many scientists will have dedicated large portions of their professional lifetimes to a single project before they receive the first scientific return.

Also, because robotic exploration programs are so few, so large, and so expensive, the consequences of technical problems are magnified. Any single failure can have an enormous scientific impact and can seriously undermine public confidence and support for the space program. Hubble's flawed mirror and Galileo's jammed communications antenna are current examples. For these and other reasons, many promising young students are turning away from space sciences and applying themselves to other disciplines.

The crisis in space science is broadly recognized, and it reflects a problem that needs to be addressed. Beginning right away, new programs should be designed in ways that allow construction and launch to occur in no more than about five years. This will keep costs down and allow a greater number and variety of programs to be conducted. Some of these programs should look outward beyond the region that mankind can aspire to visit — toward Pluto, for example. An increasing share of scientific effort should be focused on learning more about our human exploration goals — the Moon and Mars. As much as any other aspect of the space program, civil science and robotic exploration demand faster, better, and less costly systems.

International Space Activity

The United States has sought to involve foreign partners in its civil space program from its inception. The 1958 National Aeronautics and Space Act, which established NASA, charged it with conducting its activities in ways that contribute "materially to . . . cooperation by the United States with other nations." For more than three decades our cooperative initiatives have

resulted in important and highly successful research missions and space infrastructure programs.

During the four years of the Bush Administration, both the volume and range of our projects with international partners have increased. Indeed, with the exception of advanced technology development and applications projects with commercial potential, virtually every area of NASA activity now involves international partners. The preeminent example of this is Space Station Freedom, the largest international science and technology project ever undertaken, which is currently being developed by the United States along with Europe, Canada, and Japan. Each of our partners has made a large, long-term financial commitment, and Space Station-related work now dominates their overall space programs. Each partner will contribute substantial hardware and expertise to the Station, and all will share responsibility for its operation.

A review of the major projects completed during this past year demonstrates further the degree to which international partnerships have become integral to achievement of our overall national space goals. These included the Topex/Poseidon satellite, a joint U.S./French project to study ocean circulation and its role in regulating global climate, which was successfully launched in August on a European Ariane vehicle; several Space Shuttle missions such as the International Microgravity Laboratory, involving experiments from Canada, Europe, Japan, and the United States, flown in January with an international crew; the first Atmospheric Laboratory for Applications and Science (ATLAS) mission in March, which involved a full complement of international instruments and an international crew; and, a joint U.S./Japanese Spacelab mission in September that involved 34 Japanese experiments and the first Japanese payload specialist flown aboard the Shuttle.

This past year also saw a historic reshaping of our relationship with the republics of the former Soviet Union, particularly Russia. During Russian President Boris Yeltsin's June visit to Washington, Presidents Bush and Yeltsin signed a new space cooperation agreement, which provides the basis for new and important interaction between the world's two major space powers in a wide range of areas — space science, exploration, and applications.

Soon after this agreement was signed, we and the Russians moved swiftly to implement a number of ambitious initiatives that had been proposed during the June meetings. In July, NASA signed a contract with the Russian space entity NPO Energia to study potential application of specialized Russian hardware in our spaceflight and exploration programs, in particular the possible use of the Russian Soyuz-TM vehicle as an interim Assured Crew Return Vehicle for Space Station Freedom. In October, NASA and the Russian Space Agency signed an agreement on a series of joint human spaceflight missions: Russian cosmonauts will fly on the Space Shuttle in November of this year and American astronauts will be aboard the Russian Mir Space Station for as long as 90 days in 1995. Also in 1995, the Space Shuttle will rendezvous and dock with Mir using a Russian docking system that will ultimately be used for Space Station Freedom. In October we signed an agreement on the flight of two U.S. scientific instruments on the Russian Mars '94 mission. All told, 1992 was the most dynamic year of cooperative activity in the history of America's space program.

Not coincidentally, we engaged in this activity with countries that are also among our strongest industrial competitors. Budgetary constraints and the inherent desirability of pursuing certain important goals jointly will continue to increase the pressure for more cooperation with an ever more diverse group of players. Successful partnerships can generate positive results: international good will, a favorable impression of U.S. policies and programs, and a constructive means for demonstrating U.S. scientific and technological leadership. But we cannot lose sight of the elements that form the basis for success — careful integration of first-rate technical and scientific resources and a sense that the interests of all partners have been advanced by virtue of their interaction.

It is important to note that the primary motivation for joint pursuit of space goals is and always has been self-interest. This is true of us and it is true of our partners, old and new alike. It is also true, though often unacknowledged, that the expertise and systems possessed by the world's major space powers are the results of strategic decisions to enhance national scientific, technological, and industrial performance. These strategic objectives, not foreign policy objectives, are now driving space programs

worldwide. The potential partners for important cooperative space activity are now so numerous precisely because their efforts to achieve these objectives have yielded such impressive results. Cooperative projects are assessed by individual countries, in large part, from the standpoint of their potential to advance these objectives further.

Our challenge is to devise policies and procedures that encourage maximum mutually beneficial engagement with international partners across the full range of government and industrial space activity. These policies and procedures may need to be more flexible than those employed in the past, but they cannot be less protective of our national economic and security interests.

Space Commerce and Trade

A separate, nongovernmental commercial space sector was first explicitly addressed in the National Space Policy issued by President Bush in November 1989. That document highlights the value of U.S. commercial space activity by noting that "expanding private sector investment in space by the market-driven commercial sector generates economic benefits for the Nation and supports governmental space sectors with an increasing range of space goods and services."

Total revenue from U.S. commercial space activity was at least $5 billion in 1992 and is growing at a rate of about 20 percent per year. The largest portion of these revenues was generated by the communications satellite industry. The space communications equipment and services industries are the most mature and fastest growing elements of U.S. commercial space activity. Superior technology and manufacturing techniques have made American industry the world leader in this area and secured for it roughly 70 percent of satellite sales to domestic and international customers in 1992. U.S. companies are continuing to develop the most innovative and commercially promising satellite applications.

More recently, space transportation has become another important commercial activity in the United States. Unlike communications satellite systems, which have been privately operated since the 1960s, private entities were only permitted and encouraged to operate space launch systems starting in the early 1980s. The first major private commercial U.S. launch did not take place until August 1989. In contrast to all foreign competitors, U.S. companies have invested more than $700 million of their private capital in vehicle upgrades and infrastructure improvements. These companies have secured roughly 50 percent of the launch contracts competed openly in domestic and international markets.

U.S. leadership in any area of space activity, but particularly commercial space activity, requires technological preeminence. As emphasized elsewhere in this report, the United States is not currently meeting this requirement in the space transportation area. Every major space policy report since 1985 reflects the view expressed in the Aldridge Report: "The failure to fund [a next-generation launch vehicle] is equivalent to an implicit policy decision to forego U.S. competitiveness in space launch and increase the long-term cost to the government." Although we have emphasized commercial activity in our space policy statements, we have tended to lose sight of a fundamental reality in the launch arena: Virtually all launch systems in operation in the world today were developed by governments. And, unlike the United States, all other nations involved in commercial launch either have a highly efficient launch capability or are attempting to develop one.

At the same time, we should not overlook one of this Administration's major commercial space policy accomplishments: recognition that technology development is only one side of the commercial coin. The advantages that can be derived from developing the best technologies — whether in launch systems or spacecraft — will be blunted, if not negated, without rules of fair play in markets for space goods and services. U.S. satellite and launch vehicle manufacturers should have access to foreign customers that is comparable to the access foreign suppliers have to the large domestic U.S. market. We define commercial space activity in the National Space Policy and elsewhere as *nongovernmental*, an element largely unique to the United States. Our satellite and launch vehicle manufacturers are private companies, not state-

owned or -managed enterprises, as is the case not only in China and Russia, but in Europe as well. In all markets in which U.S. companies must compete, domestic and foreign, either their competitors are the beneficiaries of government support that we would consider excessive or improper, or their competitors are governments themselves. In what is, in effect, competition with foreign governments, U.S. firms will have limited success without appropriate international standards regarding subsidies and other forms of government involvement in commercial space activity.

Accordingly, NSPD 2, Commercial Space Launch Policy, calls for both development of new launch technology and establishment of a free and fair commercial launch trading environment which will, in the end, provide a level playing field. Relying on the detailed roadmap provided in that document, U.S agencies, led by the Office of the U.S. Trade Representative, are discussing guidelines and principles for international space trade with Europe, Russia, and China.

With respect to the domestic policy environment, the U.S. Commercial Space Guidelines, issued as NSPD 3 in 1991, are intended to promote the transfer of government-developed technology to the private sector and encourage agencies to participate in cooperative research and development programs with the private sector. This directive also mandates that government agencies use commercially available space products and services to the fullest extent possible; that they make available for commercial use any unused capacity of space assets, services, or infrastructure; and that they implement new acquisition procedures such as "anchor tenancy" to promote commercial space enterprise.

NASA is developing technology for direct commercial application in several areas. It has established 17 Centers for Commercial Development of Space — consortia of government, industry, and academia focusing on research with commercial potential. This program provides vital support to U.S. industry in a number of high-technology markets, including materials research, remote sensing, space power and propulsion, automation and robotics, and life sciences. Among these efforts are development of the Commercial Experiment Transporter system for launching and retrieving space

experiments, and the SPACEHAB module, an example of the government serving as an "anchor tenant" in a privately funded project.

The Defense Advanced Research Projects Agency has continued its unique efforts to encourage commercially promising projects by providing seed funding and developmental assistance. These projects have included the development of small spacecraft experiments, known as lightsats, and the Pegasus launch vehicle.

As important as these efforts to encourage commercial space enterprise have been, more is needed. Our long-standing efforts to streamline government regulations should not only be continued but accelerated. In addition, a Vice President's Space Policy Advisory Board Task Group headed by Daniel J. Fink recently issued a report on *The Future of the U.S. Space Industrial Base* that made several policy recommendations intended to facilitate the growth of the commercial space sector. Among these are changes in our policies on technology exports, export financing, and government procurement; market-opening measures; implementation of a fair-trade agreement; and the encouragement of multiple, small programs for developing space technology. And, echoing the findings of many earlier studies, it emphasized the urgency of developing a new low-cost, reliable launch system that, in addition to meeting U.S. government needs, would be competitive in commercial markets.

Planning for the Future

America's space program is a continuum of activity that stretches back more than three and a half decades. With its origins in the Eisenhower Administration, during a period in which Democrats controlled the Congress, the space program evolved largely independent of partisan influences. The triumphs of human space exploration, new scientific discoveries from a variety of human and robotic programs, and the continuing success of our intelligence and other national security programs are among the nation's greatest achievements.

Our space program was a direct outgrowth of our ideological conflict with the Soviet Union, and it was focused initially on demonstrating America's technological capabilities. As our technology matured, an increasing number of applications were identified and developed, and space is now an integral part of our national security, intelligence, civil, and commercial infrastructure. The activities of the National Space Council over the past four years were predicated on the assumption that space infrastructure is vital to a host of government functions. The Council also believed that space will increasingly contribute to the competitiveness of the U.S. private sector in the international marketplace.

Consequently, the National Space Council, and the government as a whole, have acted to expand activity in space. Regulations have been reduced to encourage commercial opportunities and foster entrepreneurship. New goals have been set for the civil space program, and serious efforts have been

undertaken to reform and revitalize the civil space agency. Military space programs have continued to receive priority for funding and support even as overall defense spending has declined.

The fundamental principles guiding the conduct of U.S. space activities were established nearly 35 years ago. The government's basic policy, and its regulatory and organizational framework, still reflects the international tensions as well as the economic and technological constraints of the past. However, the world has changed in many important respects. The Cold War has ended. We have had a revolution in electronic and other space-related technologies. The international demand for space capabilities has increased along with the proliferation of space technology to other nations. And Operation Desert Storm taught us many new lessons about the military use of space in combat.

These and other factors present new opportunities and new challenges. Overall budget constraints and reduced defense spending have made it necessary, more than ever before, for the United States to ensure that it gets maximum return from its investments in space.

To aid in understanding whether — and what — fundamental changes are necessary to adjust America's space activities to the post-Cold War era, three nonpartisan Task Groups of the Vice President's Space Policy Advisory Board were assembled in mid-1992. The first two Groups, which dealt specifically with the space-related industrial base and with space launch, were discussed earlier in this report. Those assessments provide a foundation for addressing what I believe is the central question facing our space program in the post-Cold War era: How should our space policy be adjusted to respond to a changing world?

To address this question, the third Task Group was formed under the leadership of the Advisory Board Chair, Dr. Laurel Wilkening, the Provost and Vice President for Academic Affairs at the University of Washington, and included policy experts from across the political spectrum. The members brought to this effort hundreds of man-years of experience in civil, military, and commercial space activities. Among its members were prominent

scientists, business leaders, the former chairman of a key congressional committee, retired military leaders, industry leaders, and former government executives, both Democrats and Republicans.

The Task Group's report, *A Post Cold War Assessment of U.S. Space Policy*, concludes that fundamental changes are needed in the way government space activities are organized and managed. The Task Group also found that the United States must take a number of steps needed to foster the competitiveness of its space industries and take the lead in defining a new cooperative strategy for expanded international cooperation in both civil and military space.

The Wilkening Task Group report provides a solid basis for reshaping government policies. While all of these recommendations will require careful implementation and, in a few cases, further study, the Task Group has identified the core issues facing U.S. space policymakers.

On the basis of this report, taking into account many other assessments I have received over the years from both organizations and individuals, and drawing on the individual and collective wisdom of the National Space Council members, I would urge the next administration to consider the following policy and program recommendations:

1. Government Organization

The organizational structure that evolved during the Cold War should be adjusted to encourage greater cooperation and synergism and less duplication among government space activities. A strong White House focus is needed to implement those changes. Sharing technology and systems, consolidating management organizations, and streamlining program review and approval processes can substantially increase the return on investments and maintain America's competitive high-technology edge. Implementing these changes will involve difficult political challenges, but it is essential if the nation is to invest in, and realize the benefits of, new space initiatives in the future.

2. Security and Classification

Current security regulations should be changed. There can be no doubt that strict security protection was necessary to safeguard military and intelligence space activities in the early days of the space program. However, we paid a high price for this security: lack of synergism among government activities, higher than need-be costs, lost opportunities for foreign sales revenues, and restrictions on the use of data for public and private purposes.

With the end of the Cold War, the national security imperative has shifted from the strategic threat posed by the former Soviet Union to the support of U.S. forces engaged in regional conflicts. Relaxed security restrictions can facilitate such operational support. And sharing our capabilities, within prudent limits, with allies and friendly states could deter the proliferation of space technologies, foster U.S. leadership, and enhance our overall national security.

3. Space Control

The proliferation of space capabilities internationally puts U.S. interests and global security at risk. Many nations have learned the lessons of Operation Desert Storm, including the importance of space support to the successful conduct of modern warfare. The United States benefited greatly from the freedom to exploit space in support of coalition forces.

The intelligence community estimates that today, at least 16 nations have some indigenous capability to use space to support their military operations. By the turn of the century, this number could double. We should continue our aggressive efforts to curb the proliferation of these technologies through security and export controls. And carefully crafted cooperative military space agreements will reduce the incentive for some nations to develop indigenous space capabilities. But it is unlikely that we will succeed in denying this capability to all potential adversaries, and we should not gamble that space capabilities will not be used against us in

future regional conflicts. Thus, one unexpected outcome of the end of the Cold War is the increased need to develop and maintain our ability to deny the use of space to our adversaries during a crisis or in wartime. Space control is an area that needs attention and additional investments.

4. Space Industry Regulation

Our space industries evolved to meet the needs of government space program requirements and, as a result, have traditionally been highly regulated. It was an overall policy goal of this Administration to eliminate unnecessary government interference in private enterprise. Our space-related industries are capable of growth and can provide greater economic benefits for the nation if the process of regulatory reform is quickened and expanded. The new administration and the Congress should work together to implement the actions outlined in both the Wilkening and Fink Task Group reports aimed at facilitating this growth. In addition, U.S. agencies should give priority to concluding the pending regulatory proceedings on new satellite technologies and granting the authorizations needed to introduce these technologies into the market.

5. International Cooperation and Trade

In western Europe, Russia, and elsewhere the same fundamental questions are being asked: What should we be trying to achieve in space given the competing demands made for scarce resources? How do we obtain the greatest, most beneficial results from the resources we invest in space? I believe that we can do more, do it faster, and do it at lower cost through carefully structured cooperation with other nations.

Our current national space policy calls for the United States to "conduct international space-related activities expected to achieve significant scientific, political, economic, or national security benefits to the nation." The Wilkening Task Group recently considered our international space policies and concluded that expanded international cooperation presents

us with strategic opportunities. It recommended that the United States take the initiative in shaping a common international agenda in selected areas of civilian and national security space activity.

Expanded international space activity can yield important benefits both for U.S. government space agencies and for U.S. industry. These benefits need not be secured at the expense of our national economic and security interests — interests that must be safeguarded in our dealings with international space cooperative and trading partners. Moreover, transactions involving our space assets should not be used primarily as a means for rewarding or stimulating desirable behavior in other areas.

New or refined policies and procedures should be developed to guide U.S. government agencies and private U.S. firms that engage in international space activity, particularly with respect to proposed activity involving the space organizations of the former Soviet Union. At a minimum, these agencies and firms must understand the limits of their ability to enter into agreements involving purchase or sale of space technology.

With respect to trade in space goods and services, the United States must come to terms with the fact that other spacefaring nations — including Japan, China, Russia, and the Europeans — are determined to establish the strongest possible market presence in all sectors of aerospace trade. We should focus more attention on the issues that will increasingly confront our suppliers of communications satellite equipment as competitive pressures in that area intensify. In the launch area, the effort to establish a multilateral framework for free and fair trade should be accelerated. U.S. agencies must redouble their efforts to achieve this goal and should avoid actions that impede or undermine these efforts.

6. Space Launch

The nation must develop a new, modern space launch capability. As we have stated repeatedly over the past four years, our current ELV systems — Titan, Atlas, and Delta — are aging. They are not responsive to the

needs of spacecraft users. They are expensive to operate, which adds to the cost of military and civil space programs. These systems will become less competitive over time in the international marketplace as new foreign government-developed systems enter that marketplace.

The "Spacelifter" concept recommended by the Vice President's Space Policy Advisory Board represents the kind of capability the nation will need for the 21st century. The time has come to replace our current launch vehicles, and the time to effect this transition is in the early years of the next century when the next generation of several satellite systems being planned today will be ready for launch. If we delay, the nation will be locked into its current expensive systems for another decade or longer, consuming funds and foreclosing new initiatives for another generation. For these reasons, we should plan to phase over to a new launch capability by about the turn of the century.

The Space Shuttle is also aging. It is too expensive to operate and lacks responsiveness. As a result, space transportation consumes too large a share of civil space resources, foreclosing opportunities for new science and new technology initiatives.

I endorse recent efforts to reduce the cost of Space Shuttle operations, but believe they cannot go far enough without sacrificing safety. A serious assessment of human spaceflight options is needed. Our goal should be to begin transitioning to a more cost-effective and efficient human spaceflight system by about 2005 and retire the Space Shuttle program soon thereafter.

7. Space Exploration

The nation should continue to pursue a long-range goal of human space exploration. While Congressional concerns about affordability have delayed funding for the Space Exploration Initiative, the goals of a permanent settlement on the Moon and the human exploration of Mars are both achievable and affordable if managed skillfully. Future science and

technology initiatives should be focused on gaining the knowledge critical to enabling these endeavors.

Space Station Freedom is the essential first step toward human exploration of the solar system. It will be mankind's laboratory in space, providing, among other things, the knowledge of human physiology necessary to support future long-duration space flight.

However, the Space Station will continue to be threatened by political and budget challenges. There have been three concerted efforts in the last years to cancel the program in Congress. If the nation is to have this important capability, there must be confidence that the facility will be completed within its current budget projection and on the schedule currently planned. The management and integration of Space Station is one of the most difficult programmatic challenges facing NASA, and the involvement of foreign partners adds another layer of complexity. Any significant additional cost overruns or schedule delays will put the program at serious risk of termination.

To contain costs, overhead should be reduced by consolidating management responsibility within a single NASA center and by assigning a single contractor with overall responsibility for program integration. Unnecessary supporting activities should also be cancelled.

8. Faster, Cheaper, Better Programs

The size and complexity of future programs, particularly civil science programs, should be constrained. The crisis in space science is primarily the result of too much reliance on too few large projects. The EOS program is among the large and important projects confronting technical and budget challenges.

As originally conceived, the EOS satellites were too complex, cost too much, and took too long to build. Recognizing these problems the Frieman panel identified a number of design and program deficiencies

including the size of the satellites. NASA has begun restructuring EOS along the lines the panel recommended. At a minimum, this restructuring should be completed and *all* the panel's recommendations implemented. Even so, continued vigilance will be required to guard against the temptation to add further capability and complexity to the satellites and their supporting ground processing systems. If not, EOS cost overruns will force the deferral or termination of other important science programs, eliminating the balance that currently exists among scientific missions.

For the future, EOS should have direct oversight at the highest level of management within NASA, and regular external reviews, along the lines of the Frieman panel, should be conducted. New science missions should be designed in ways that allow their construction and launch to occur in no more than about five years. Exercising this discipline will yield more timely data and reduce the probability of schedule delays and cost growth in future programs.

Taken together, this Administration's activities over the last four years have resulted in a forward-looking U.S. space program — one that is vigorous, nonpartisan, and provides for our nation's security and its international competitiveness. Our space program has been strengthened, and a framework and vision for the future have been created. It will be up to the new administration to pick up the challenge, adjust to the new environment, and build on what has come before.

Appendix I

Chronology of Bush Administration Space Policy Activities

April 20, 1989	President signs Executive Order 12675 establishing the National Space Council
June 1, 1989	President announces continuation of the Landsat program.
July 20, 1989	President announces the Space Exploration Initiative.
July 25, 1989	President announces continuation of the National Aerospace Plane Program as a high-priority effort to develop a single-stage-to-orbit vehicle.
November 2, 1989	President announces NSPD 1, National Space Policy.
March 8, 1990	President announces program elements of the Space Exploration Initiative.
March 30, 1990	President announces the United States will explore participation of other nations, including the Soviet Union, in the Space Exploration Initiative.
September 5, 1990	President announces NSPD 2, Commercial Space Launch Policy.
December 17, 1990	*The Report of the Advisory Committee on the Future of the U.S. Space Program*, prepared under the leadership of Norman Augustine, is released.
February 12, 1991	President announces NSPD 3, U.S. Commercial Space Policy Guidelines.
May 17, 1991	Vice President appoints Dr. Laurel Wilkening to serve as Chair of the Vice President's Space Policy Advisory Board.
June 11, 1991	*The Report of the Synthesis Group on America's Space Exploration Initiative*, prepared under the leadership of Thomas Stafford, is released.