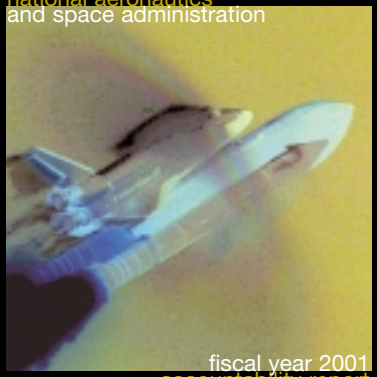
national aeronautics
and space administration



fiscal year 2001
accountability report

national aeronautics and space administration

FY 2001 accountability report

Foreword

The National Aeronautics and Space Administration (NASA) is an independent Agency established to plan and manage the future of the Nation's civil aeronautics and space program. This Accountability Report covers Federal Fiscal Year (FY) 2001 (October 1, 2000, through September 30, 2001), with discussion of some subsequent events. The Report contains an overview addressing the Agency's critical programs and financial performance and includes highlights of performance organized by goals and objectives of the Enterprises and Crosscutting Processes. The Report also summarizes NASA's stewardship over budget and financial resources, including audited financial statements and footnotes. The financial statements reflect an overall position of offices and activities, including assets and liabilities, as well as results of operations, pursuant to requirements of Federal law (31 U.S.C. 3515(b)). The auditor's opinions on NASA's financial statements, reports on internal controls, and compliance with laws and regulations are included in this Report.

Detailed reporting on all performance measures can be found in NASA's FY 2001 Performance Report. NASA's Strategic Plans, Performance Plans and Reports, and Accountability Reports are available through the Internet. For an electronic version of these documents, go to *http://www.hq.nasa.gov* and click on the appropriate topic located in the left menu. Further detailed information on NASA programs is contained throughout this Report and via NASA's Home Page at *http://www.hq.nasa.gov*. The Home Page is updated on an ongoing basis with current information relating to programs and their administration.

Contents

Message from the Administrator

FY 2001 was a year of challenge and accomplishment for NASA. The Space Shuttle turned 20 as NASA launched a new initiative to find better and cheaper access to space, while facing new fiscal realities that could fundamentally change the way the Agency does business. As part of NASA's implementation of the President's Management Agenda, we are placing particular emphasis on efforts to improve financial management. NASA's ability to continue to achieve great things depends upon its ability to build upon important lessons of its past, hard work of the NASA team, and continued support of the President, Congress, and the public. In FY 2001, programmatic accomplishments include new understandings in five strategic areas:

- The Space Science Enterprise studies the origin and operations of the universe. The Agency's Mars exploration program rebounded in 2001 when Mars Odyssey successfully entered orbit around Mars, following a 286-million-mile journey. In addition, the Submillimeter Wave Astronomy Satellite provided the first evidence of water-bearing worlds beyond our solar system.

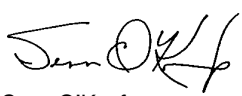
- The Earth Science Enterprise continues to provide invaluable satellite and aircraft observations that are unraveling the mysteries of Earth system processes. In FY 2001, NASA was able to create the first biological record of Earth by using data from NASA's Sea-viewing Wide Field-of-view Sensor.

- The Biological and Physical Research Enterprise uses the space environment as a laboratory for scientific, technological, and commercial research. In FY 2001, NASA-developed lasers led to the discovery of a way to stop, store, and then release a beam of light. The discovery could lead to next-generation technologies, such as increasing the speed of computers.

- The Human Exploration and Development of Space Enterprise celebrated the first full year of human habitation for the International Space Station (ISS). The ISS program faces significant financial issues, however. An independent task force made recommendations that are expected to get the program back on track.

- The Aerospace Technology Enterprise and its general aviation partners tested a revolutionary cockpit display that will offer pilots a "synthetic vision" of what is outside their windows, no matter the weather or time of day. Also, the Space Launch Initiative was designed to develop technologies to build a second-generation reusable launch vehicle to provide safer, more reliable, less expensive access to space.

In December 2001, I began my tenure as NASA's Administrator and therefore did not participate in the activities, including preparation of the financial statements, of FY 2001. In conveying the enclosed assurances, I am relying upon the information provided to me by the responsible NASA officials. The Agency faces a year of transition and new challenges as it reinvigorates its mission of discovery. These challenges are formidable, but our resolve is equally strong. NASA leads a unique expedition critical to the future security and vitality of our Nation and humanity. Through international partnerships, commercial ventures, and customer-driven projects, we will do things in space not possible here on Earth and prioritize cutting-edge research in science and technology as we continue to pioneer in the frontiers of air, space, and knowledge.



Sean O'Keefe
Administrator

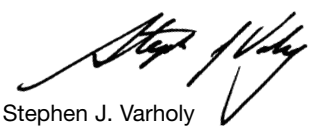
Message from the Deputy Chief Financial Officer

This Accountability Report consolidates reports required by various statutes and summarizes NASA's program accomplishments and its stewardship over budget and financial resources. It is a culmination of NASA's management process, which begins with mission definition and program planning, continues with the formulation and justification of budgets for the President and Congress, and ends with scientific and engineering program accomplishments. The report covers activities from October 1, 2000, through September 30, 2001, with a discussion of some subsequent events. Achievements are highlighted in the Statement of the Administrator and summarized in the Report.

In the past decade, there have been more legislative changes in Federal financial management than were made in the previous 50 years. Internal controls have been improved and budget and financial management streamlined. Financial statements were prepared in accordance with Generally Accepted Accounting Principles and reporting instructions specified by the Office of Management and Budget. The preparation of this Report required the teamwork and dedicated efforts of NASA's staff at Headquarters and the Centers. We appreciate their dedication and professionalism.

In the audit of NASA's financial statements, the independent auditor concluded that it could not express an opinion on the financial statements because NASA did not provide sufficient evidence on a timely basis to support certain amounts reported as obligations, expenses, and property in the Agency's financial statements. It is most regrettable that the independent auditor was unable to express an opinion. NASA is actively working with the independent auditor to develop a better understanding of what data the auditor needs and to work out a process for providing requested data to the auditor on a timely basis.

As stewards of the public's resources, we will seek to improve methods to carry out our fiscal responsibilities and continue to meet the challenges facing us.



Stephen J. Varholy
Deputy Chief Financial Officer

Management's Discussion and Analysis

Vision: NASA is an investment in America's future. As explorers, pioneers, and innovators, we boldly expand frontiers in air and space to inspire and serve America and to benefit the quality of life on Earth.

Mission: To advance and communicate scientific knowledge and understanding of Earth, the solar system, and the universe.

To advance human exploration, use, and development of space.

To research, develop, verify, and transfer advanced aeronautics, space, and related technologies.

Figure 1: Mission and Vision

NASA Overview

NASA Today

NASA has accomplished many great scientific and technological feats in air and space since its inception in 1958. Technology it developed has been adapted for many nonaerospace uses by the private sector. The Agency remains a leading force in scientific research and in stimulating public interest in aerospace exploration and science and technology in general. Perhaps more importantly, exploration of space has taught us to view Earth, ourselves, and the universe in a new way. While the tremendous technical and scientific accomplishments vividly demonstrate that humans can achieve previously inconceivable feats, we also are humbled by the realization that Earth is just a tiny “blue marble” in the cosmos.

NASA is a Federal research and engineering Agency that accomplishes most of its space, aeronautics, science, and technology programs through its Centers and contractors across the United States and its international partners. NASA also owns the facility known as the Jet Propulsion Laboratory (JPL). JPL, a Federally Funded Research and Development Center (FFRDC), is operated by the California Institute of Technology.

Organization and Structure

The NASA team is a dedicated, skilled, and diverse group of scientists, engineers, managers, and support staff that works cooperatively with industry, academia, other Federal agencies, and the space agencies of other nations. This team is dedicated to achieving NASA’s mission while maintaining the strongest possible commitment to safety, efficiency, and integrity (Figure 1).

The Agency consists of Headquarters in Washington, DC; nine Centers throughout the country; and a number of additional installations that support specific Centers. The roles of Headquarters and the Centers are distinct

(Figure 2). Headquarters determines the mission and explains why it is necessary; Centers determine how the mission will be implemented.

Headquarters

Headquarters develops, coordinates, and promulgates Agency policy. It sets program direction at the highest level, has primary responsibility for communications with the Administration and Congress, and is the focal point for accountability with external entities. It guides and integrates the budget, defines long-term institutional investments, and leads and coordinates Agencywide functions. The Headquarters organization consists of the Office of the Administrator, the five Strategic Enterprises, functional offices, and the Office of the Inspector General (OIG). The Office of the Administrator directs the conduct of policies approved by the President and Congress and oversees administrative and program management. The Strategic Enterprises have primary responsibility for strategic goals, objectives, and programs and for overseeing the Centers and serving customers. Agency functional offices establish and disseminate policy and leadership strategies in their areas of responsibility. As a group, they serve in an advisory capacity to the Administrator and work in partnership with the Strategic Enterprise Associate Administrators and Center Directors to ensure that activities are conducted in accordance with statutory and regulatory requirements, including fiduciary responsibilities. They also advise the Administrator and senior managers of potential efficiencies to be gained through standardization and consolidation and coordinate the implementation of approved initiatives.

Centers

Scientific and engineering work is largely performed at the Centers and the Jet Propulsion Laboratory. Centers

carry out the work of the Enterprises. Each Center has specific mission responsibilities and is responsible for providing certain types of expertise and infrastructure. Centers also are responsible for assigned NASA-wide programs—overseeing their implementation and ensuring that they meet safety, schedule, budget, and reliability requirements. Finally, each Center serves as a "Center of Excellence" for a specific discipline; examples are structures and materials, information technology, and human operations in space. Centers of Excellence shown in Figure 3 not only support immediate program needs, but also strengthen long-term capabilities of the Agency and

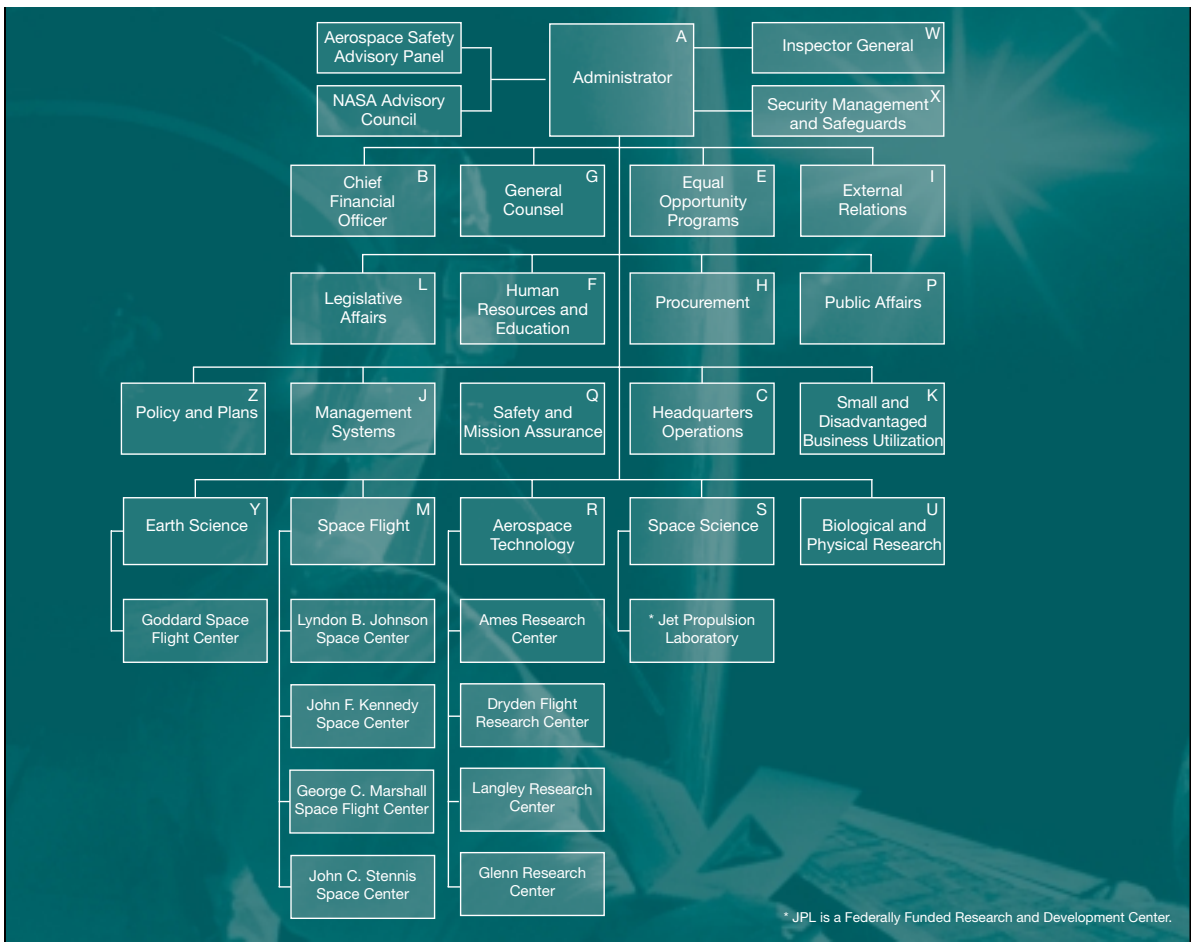


Figure 2: NASA Organization

the Nation in critical areas. Additional work is carried out by offsite contractors, the academic community, and international partners.

Programs and Planning

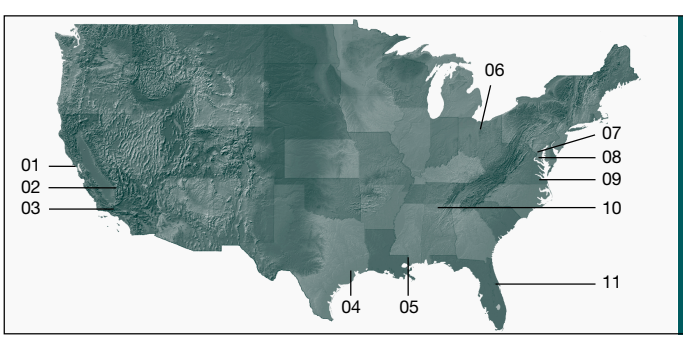
The Strategic Plan describes how we will pursue our vision, implement our mission, and seek answers to fundamental questions of science and technology that provide the foundation for our goals and objectives (Figure 4). In addition to the vision and mission, the strategic architecture consists of five Strategic Enterprises supported by four Crosscutting Processes. The Strategic Enterprises are NASA's primary mission areas. The Crosscutting Processes are common operating principles, coordinated across the Agency, that enhance the return on NASA's work toward diverse programmatic and functional objectives. They are the processes NASA uses to develop and deliver products and services to customers. The Agency's goals and objectives are organized by Strategic Enterprises and Crosscutting Processes.

Strategic Enterprises

The aeronautics and space program consists of a variety of national programs, projects, and activities. NASA's Strategic Plan transcends its organizational structure. Each of the Strategic Enterprises seeks to respond to a unique customer community. Each has its own set of technology needs, which are closely linked to performing future planned missions while reducing cost and technical risk. At the same time, there is considerable synergy among the Enterprise activities, which strengthens each Enterprise. The Strategic Enterprises comprise an integrated national effort. Detailed comprehensive program, project, and subproject requirements are consistent throughout the Agency and its systems, including budgeting and accounting. The Strategic Enterprises are as follows:

- Space Science (SSE)
- Earth Science (ESE)
- Biological and Physical Research (BPRE)
- Human Exploration and Development of Space (HEDS)
- Aerospace Technology (AST)

It is through the Enterprises that missions are accomplished and we communicate with external customers. For example, Space Science manages the Hubble Space Telescope and current missions to other planets. Earth Science is responsible for the growing knowledge of Earth



01. Ames Research Center
02. Dryden Flight Research Center
03. Jet Propulsion Laboratory (JPL)*
04. Johnson Space Center
05. Stennis Space Center
06. Glenn Research Center
07. Goddard Space Flight Center
08. NASA Headquarters
09. Langley Research Center
10. Marshall Space Flight Center
11. Kennedy Space Center

** JPL is a Federally Funded Research and Development Center.*

Figure 3: Centers of Excellence

Fundamental Questions

These questions pertain to the nature of life and the universe, to the fundamental processes of existence, and to how we may apply human intelligence and determination to transcend the known boundaries of time and distance, improving our lives and those of our descendants. These questions are the reason we undertake our mission and serve as the foundation for our goals.

1. How did the universe, galaxies, stars, and planets form and evolve? How can our exploration of the universe and our solar system revolutionize our understanding of physics, chemistry, and biology?

2. Does life in any form, however simple or complex, carbon-based or other, exist elsewhere than on planet Earth? Are there Earth-like planets beyond our solar system?

3. How can we utilize the knowledge of the Sun, Earth, and other planetary bodies to develop predictive environmental, climate, natural disaster, and natural resource models to help ensure sustainable development and improve the quality of life on Earth?

4. What is the fundamental role of gravity and cosmic radiation in vital biological, physical, and chemical systems in space, on other planetary bodies, and on Earth, and how do we apply this fundamental knowledge to the establishment of permanent human presence in space to improve life on Earth?

5. How can we enable revolutionary technological advances to provide air and space travel for anyone, any time, anywhere, more safely, more affordably, and with less impact on the environment; and how can we improve business opportunities and global security?

6. What cutting-edge technologies, processes, techniques, and engineering capabilities must we develop to enable our research agenda in the most productive, economical, and timely manner? How can we most effectively transfer the knowledge we gain from our research and discoveries to commercial ventures in the air, in space, and on Earth?

Figure 4: Fundamental Questions

as a planetary system. Biological and Physical Research takes advantage of the space environment as a laboratory. Human Exploration and Development of Space is responsible for the Space Shuttle and the International Space Station (ISS), space communications, expendable launch vehicles, and payloads. Aerospace Technology is responsible for advances in the capabilities and safety of civil aviation, as well as improved access to space.

Crosscutting Processes

In addition to these Strategic Enterprises, NASA delivers its products and services to customers through four processes that cut across all NASA organizations and have Agencywide impact. These Crosscutting Processes are as follows:

- Manage Strategically
- Provide Aerospace Products and Capabilities
- Generate Knowledge
- Communicate Knowledge

Budgets are oriented to be consistent with strategic planning and missions—explore, use, and enable the development of space; advance scientific knowledge; and research, develop, verify, and transfer space-related technologies. Resources are allocated to mission-related top priorities: safely operating the Space Shuttle, developing and operating the International Space Station, and maintaining a strong program of science and technology development.

Planning

Planning and management processes have been steadily improved, consistent with the Government Performance and Results Act (GPRA). For FY 2001, program and support activities were guided by a comprehensive strategic planning process and strategic management systems documented in the NASA Strategic Management Handbook (NASA Procedures and Guidelines (NPG) 1000.2) and NASA Strategic Plan (NASA Policy Directive (NPD) 1000.1). The FY 2001 Revised Final Annual Performance Plan reflects goals and objectives defined in the 1998 NASA Strategic Plan with 1999 Interim Adjustments—the Strategic Plan in force at the time the President's FY 2001 Budget was released. NASA's FY 2002 Performance Plan will reflect the Strategic Plan released in September 2000.

The organizational and program structure is aligned with the requirements of customers and stakeholders and integrated with strategic planning, budgeting, performance management, and accounting and reporting activities. Progress toward the achievement of goals and objectives is described in the "Strategic Enterprise and Performance Highlights" section of this Report; it provides a summary of accomplishments for each Strategic Enterprise and the Crosscutting Processes. Detailed reporting on all performance measures can be found in the FY 2001 Performance Report at *http://ifmp.nasa.gov/codeb/library/library.htm*

Due to the nature of aeronautics and space research, strategic objectives cannot usually be attained in a single year. As a result, annual performance targets reflect incremental steps toward achieving long-term strategic goals and objectives. To help bridge the gap between annual activity and ultimate objective accomplishment, NASA is moving toward using higher level performance targets in its Performance Plans. The targets have been developed to enable a better understanding of how the specific measures of output (indicators) contribute to the eventual outcomes that are a result of a number of years of research, development, and data analysis. The change in format will ultimately allow a more concise representation of the Agency's performance that will more readily span multiple years and enable decision-

making of the type intended by the authors of GPRA. NASA believes that this process improvement will better serve the interests of the public, our customers, and Agency management.

In addition, the Strategic Plan includes roadmaps depicting levels of accomplishment below full Agency objectives but above performance targets for any one year. The roadmaps cover near-, mid-, and long-term plans, showing anticipated progress toward achieving goals and objectives over the next 25 years. These goals and objectives are supported by the budget described in the "Financial Overview" section of this Report.

Government investment decisions on funding for space and aeronautics research and technology cannot be made with advance knowledge of the full benefits ("outcomes") that will accrue from making the investments. Nor can we know when these benefits will be realized. We can, however, identify how achievement of these goals and objectives over the first quarter of the 21st century will benefit our ultimate stakeholders—the public—and contribute to priorities of the Nation: increasing the understanding of science and technology, protecting Earth's fragile environment, providing educational excellence, achieving peaceful exploration and discovery, and promoting economic growth and security.

Verification and Validation

NASA is committed to ensuring that the performance information it reports is valid and reliable. Data credibility is a critical element in the Agency's ability to manage for results and be accountable. Performance in developing and delivering products and services is evaluated at the Agency, Strategic Enterprise, Functional Office, program and project, Crosscutting Process, and individual levels. Each level is responsible for executing requirements and measuring, evaluating, and reporting results. Methods and procedures for collecting this information are evaluated and validated by program managers responsible for data collection and reporting. As each part of the organization completes its measurement process, data are used to verify that performance meets or exceeds planned performance. In those situations where performance does not meet the plan, opportunities for continuous improvement and reengineering are identified.

In the case of performance problems of particular concern, such as with the recent ISS concerns, special evaluations are performed and special mitigation programs are put into place. Results from efforts such as these are extensively examined for their implications for planning at the strategic, budget, performance, and program levels.

NASA uses a series of management councils to conduct ongoing internal evaluations. Throughout the year, Program Management Councils at Headquarters and the Centers assess program schedules, cost, and technical performance against established programmatic commitments. Twice a year, the Senior Management Council brings together Headquarters and Center Senior Managers to assess progress toward meeting Enterprise and Crosscutting Process performance. In addition, NASA's Capital Investment Council evaluates whether investment decisions adequately support goals and objectives.

There are also regular reviews for functional management activities, such as procurement, finance, facilities, personnel, and information resources management. There are standard monthly and quarterly project- and program-level reviews at the Centers, at contractor installations, and at Headquarters.

Reviews of science, engineering, and technology plans and performance are also conducted and include evaluations from nonadvocate review teams, as well as the collection of thousands of technical performance metrics, schedule milestones, and cost performance data for flight programs such as the International Space Station. The Office of Safety and Mission Assurance conducts assessments to verify the robustness of safety and mission assurance processes and performs independent assessments on selected programs that have need for a high level of assurance. In addition, the Inspector General conducts independent reviews and provides recommendations for corrective actions.

NASA also relies on external review processes. These evaluations include an extensive peer review process in which panels of outside scientific experts ensure that science research proposals are selected strictly on the merits of the planned research and expected performance. This process takes into account past performance for selection and continued funding.

There is also a broad and diverse system of advisory committees established under the Federal Advisory Committee Act, including the NASA Advisory Council and the Aerospace Safety Advisory Panel. The hundreds of science, engineering, and business experts on these committees provide external input on management, programs, Strategic Plans, and performance. Advisory committees explicitly review and evaluate performance-reporting information to assess accomplishments, not only integrating quantitative output measures, but also balancing these in the context of safety, quality, high performance, and appropriate risk. The results of their independent evaluations are a part of the annual Performance Report.

As appropriate, assistance is requested from other Federal agencies to provide expert advice and counsel. In some cases, these organizations are advisory bodies of experts from the public and private sectors that help establish priorities in particular scientific disciplines. NASA also relies on evaluations from completely independent external organizations such as the National Academy of Sciences, the National Academy of Public Administration, and the General Accounting Office.

An independent accounting firm annually audits NASA's financial statements; its opinion on NASA's FY 2001 statements can be found on pages 137 to 145 of this Report.

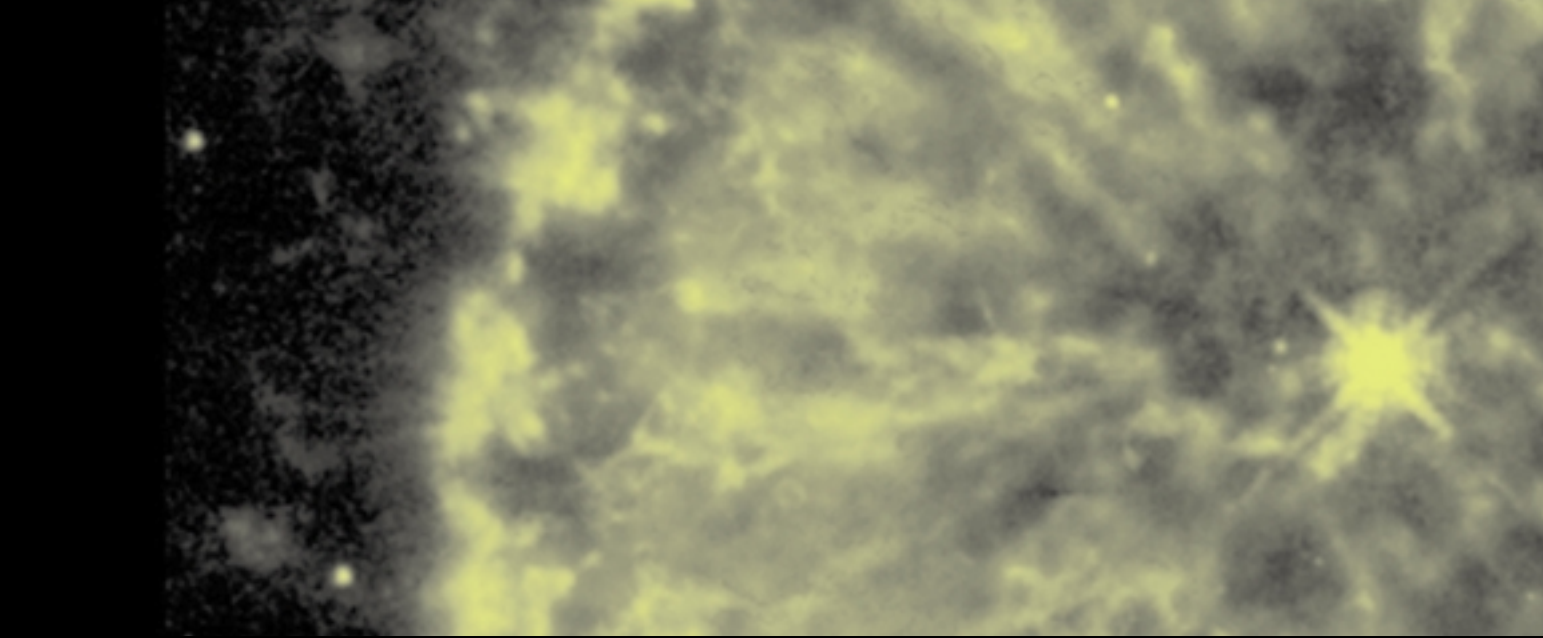
At its discretion, the Office of the Inspector General conducts a verification and validation audit of select annual performance metrics reported in the Performance Report.

Data Limitations

Understanding data limitations, eliminating them where necessary and cost-effective, and acknowledging those that remain when interpreting performance results are integral to performance measurement. Data sources used may include, but are not limited to, databases used for other purposes, third-party reviews, and certification by managers or contractors. In executing NASA's mission, data are not always available to verify or validate reported performance. NASA relies on individuals responsible for performance to validate and verify the information provided for GPRA compliance.

Another significant limitation of data used for performance measurement is its timeliness. Systems that collect data usually require processing time at the end of the data collection period to compile and analyze the data. Financial data are not available on a real-time basis. Headquarters and the Centers maintain their own general ledgers, linked by reciprocal accounts for controlling total funds and other resources. Headquarters retrieves, compiles, and analyzes accounting data in order to prepare internal and external financial reports.

Currently, the accounting data require post-data collection processing and are generally not available until several months after the fiscal year in which they were collected. In addition to computerized edit checks and analytical review procedures to look for inconsistencies, when a validation process is internal to the data collection system, it includes a number of procedures to verify and validate data quality at each step of the collection process. Implementation of the Core Financial System (CFS) will result in standard financial software to replace the various financial systems and processes currently used by Centers. Full implementation of CFS will be complete by the end of FY 2003. Data will then be available on a real-time basis to users. This will lead to more timely, consistent, and reliable information for management decisions.



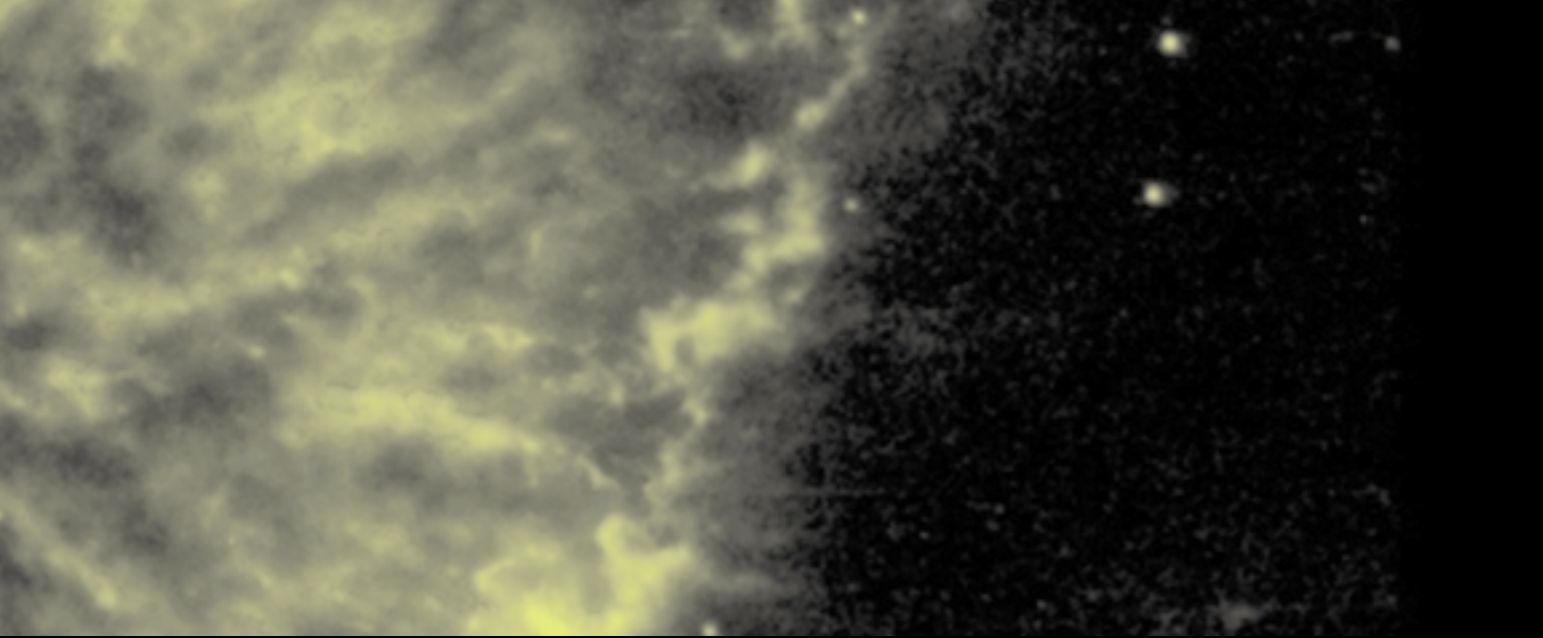
Looking Forward

NASA's charter is to look to the future in science and technology. By its nature, every mission is unique, with inherent and sometimes extensive risks. It is difficult to anticipate possible future effects of current and planned projects and missions because the outcome of those projects is unknown and future discoveries may lead to paths presently not contemplated. In considering possible future effects of significant existing conditions, it should be recognized that the future is unpredictable and will be influenced by factors outside NASA's control, including actions by Congress. It is difficult to find a balance in NASA's initiatives because various dynamics pull in opposing directions. Many of the challenges faced by NASA are faced by the entire Federal Government.

Security

Safety is a core NASA value, and security is an inherent part of that value. The continuing mission of the NASA security program is to protect people (employees, onsite contractors, visitors), missions, information, and property. The September 11, 2001, attacks profoundly and permanently altered the equation NASA uses to assess and manage risk; that equation seeks to balance threats, vulnerabilities, value, and our ability to respond. NASA is devising more robust countermeasures, analyzing and assessing threat and intelligence information, and seeking increased funding to meet new realities. Adequate resources must be invested to ensure that systems, information, property, technology, and personnel are safe and secure. Sufficient future funding will be vital. In response to the President's call for emergency funds after the September 11, 2001, attacks, NASA received $108.5 million for FY 2002.

Enhanced security countermeasures in the form of additional security personnel, more physical security equipment and procedures, and the restriction of sensitive information can all be expected as we look to the future.



Sufficient security to ensure that human space flight missions are not compromised is of great concern. Actions are being taken to further secure assets and enhance procedures and access to information involving human space flight missions.

While it is part of NASA's charter to disseminate and encourage public access to information, this activity must be balanced with long-standing security requirements and increased security concerns regarding data, technology, and other sensitive areas. Some of the Agency's most dynamic research and missions play an important role in our Nation's security, and NASA has a responsibility for both sharing and protecting information derived from those activities. NASA's relationships with over 80 different countries have helped it realize the goals of its programs. Vigilance must be maintained, however, in restricting access to sensitive material, such as unclassified but export-controlled technical data and industrial proprietary information, as well as classified information. Tension exists between the desire to foster collaboration with foreign colleagues and the need to impose constraints on open collaboration in order to protect U.S. technology. This area poses continuing problems for all Government agencies.

If security programs are not enhanced to cope with the reality of new threats, the Agency may not be able to fulfill its charter in the future. This failure may result in an increased risk to staff and data, the compromising of national security, a lack of encouragement for students to pursue science and engineering fields, the loss of the Nation's technological competitive edge, or the inhibition of international cooperation.

Strategic Resources Review

The President, Congress, and Office of Management and Budget (OMB) have asked NASA to 1) articulate a comprehensive agenda and strategy through a strategic

plan; 2) identify core competencies and critical capabilities and determine which capabilities must be retained by NASA; and 3) expand collaboration with industry, universities, and other agencies and outsource appropriate activities to fully leverage outside expertise.

The challenge is to develop a comprehensive plan that assumes no-growth budgets for the near future while addressing immediate budget and management challenges associated with the International Space Station, the Space Shuttle, and the Agency facilities infrastructure. Others possess capabilities to support the mission, and it is clear that NASA must sharply focus its internal capabilities while using outside resources.

Given an aging workforce and the downsizing of the past decade, NASA has critical skill gaps and is seeing significant competition for science, engineering, and management talent. The Agency is at a crossroads and must reevaluate its vision and how it accomplishes its mission. Through the Strategic Resources Review (SRR), NASA will develop a strategy for an integrated set of programs that fit within the budget, an infrastructure (workforce and facilities) sized to support programs that are affordable, and a set of capabilities performed within NASA that cannot be performed elsewhere.

Since beginning the SRR in June 2001, NASA has made progress in a number of areas. The Agency established a refined baseline of information regarding current and anticipated programs (Center 10-year projections), civil service and other workforce, physical infrastructure, and management approaches. It proposed an updated, more focused set of roles and responsibilities for each of the Centers. The Agency also identified a large number of potential transformational areas, associated with both what programs NASA should do and how the Agency should do its programs, and initiated more detailed studies in most areas. Finally, NASA started to identify the major, common implementation issues (e.g., legislative, human resources) associated with possible change activities.

Next steps of the SRR include developing integrated 10-year Agency and Center plans that encompass programmatic and managerial investments. The Agency will also complete a gap analysis between current and future states and develop and implement transformational actions coupled with identification of implementation issues and required tools. NASA will execute additional initiatives against a schedule consistent with FY 2004 budget planning milestones and put SRR leadership in place to ensure performance continuity and integration.

The Aging of NASA's Infrastructure—Its Facilities and Workforce

Through NASA, the American people have invested in a public aerospace research and development infrastructure consisting of a unique combination of physical resources and human talent. However, a large portion of NASA's facilities are over 40 years old, many having been built in the early 1960s when the huge push to space resulted in a rapid and extensive buildup of facility infrastructure. NASA is still using some World War II-era facilities that are approaching 60 years of age. Today, these aged facilities have significantly exceeded their original design lifespan, posing significant management challenges to operate them efficiently and safely in a dramatically different technological era. Aged facilities require more intensive maintenance; repair parts are scarce or unavailable. Extensive building alterations are required to meet new and changed mission and environmental requirements. The buying power of facilities budgets continues to decline. A parallel exists within the demographics of NASA's workforce.

Management is challenged by an aging employee population and the continuing potential for the loss of substantial "corporate knowledge" and experience. If these issues are not effectively addressed, the impact could be inadequate facilities and a less experienced workforce, which could jeopardize the achievement of goals and compromise the ability to meet the intentions of Congress expressed through the funds it appropriates. As shown in the Required Supplementary Information included in the financial statements in this Report, the Agency faces a backlog of maintenance and repairs of its facilities of approximately $912 million. There is no identified source of revenue to fund the cost of performing this deferred maintenance, which grows each year.

NASA and its workforce have experienced major changes over the past decade, and further change is expected as the Agency reexamines its strategic mission and core capabilities. Factors such as the planned competitive sourcing of Space Shuttle operations will change the makeup of the Agency, with far-reaching impact on the way it works. In addition, the potential establishment of university-affiliated research centers, similar to those of the Department of Defense, is being explored.

The entire Federal Government workforce is aging. NASA and the rest of the Government must prepare for the impending further loss of significant institutional experience and leadership. This need for talent comes at a time when skilled workers are in short supply and private-sector opportunities offer significant financial advantages over Federal employment.

In addition, the last decade of substantial downsizing at NASA devastated the science and engineering (S&E) "pipeline," resulting in fewer entry-level hires and an overall increase in the average age of the workforce. Concurrently, statistics on the number of undergraduates and graduate school students in S&E courses of study point to a critical shortage of scientific and technical expertise in the Nation, which will have a further adverse impact. Adding to the challenge is the apparent reluctance of future managers to seek Government employment. Traditional recruitment efforts are not enough. New and better tools are needed to attract the workforce that will provide leadership to America's aeronautics and space programs.

Upon returning to the employment market after several years' absence, NASA found that there is strong competition for individuals with necessary technical skills. People still find NASA's mission exciting and want hands-on experience, but, in many instances, the Agency is unable to compete with the private sector. In a FY 2000 joint OMB-NASA workforce review, the team met with new college graduates recently hired by NASA. These recent graduates stated that they and their fellow students received offers from the private sector thousands of dollars higher than NASA's. The recent hires cited the ability to perform hands-on work as the reason they chose NASA over the private sector. As we move out of spacecraft operations and more into research and development, there is concern about our ability to continue to acquire those individuals who will be critical for core S&E work and contractor oversight.

NASA's employees and partners are the linchpins of its present and future success. NASA must properly invest in the maintenance and professional growth of its most valuable resources—its human capital. To support full utilization of the workforce in achieving strategic outcomes, that workforce must have the tools, skills, knowledge, and experience for optimal performance.

Launch Vehicle Availability

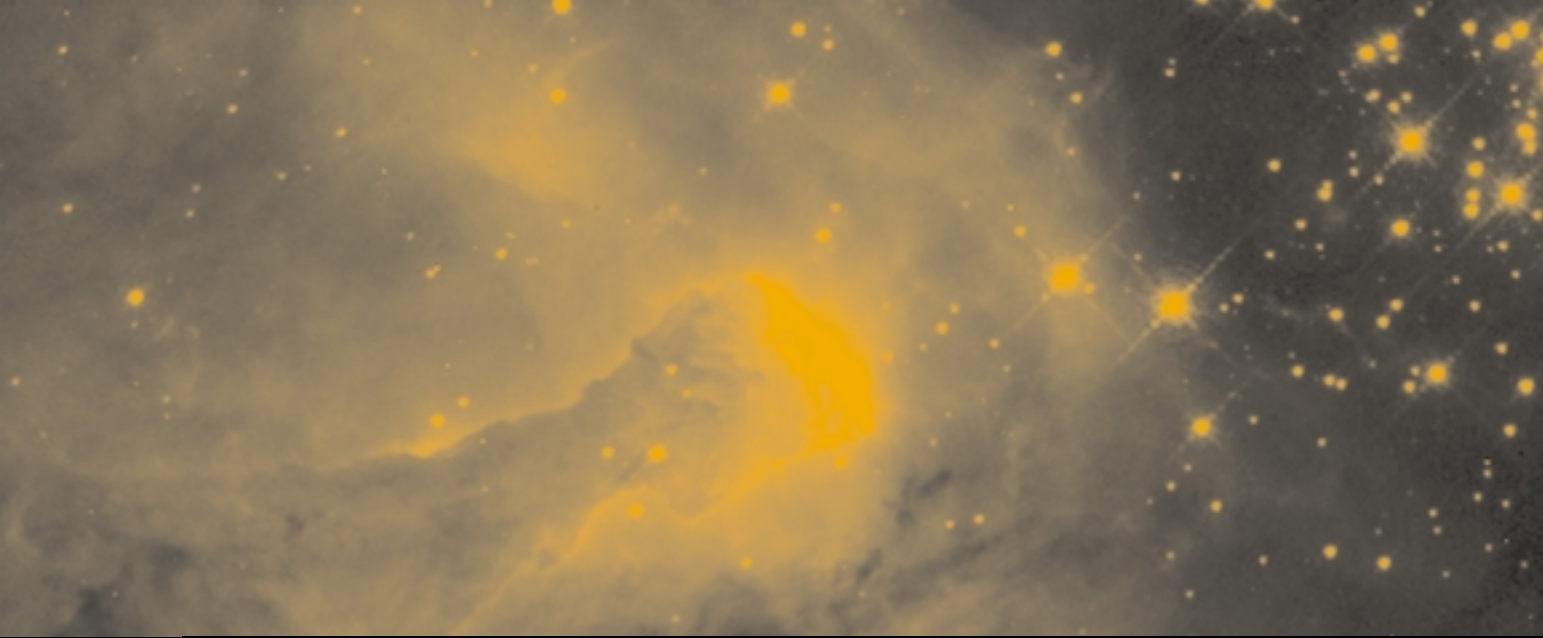
Over the next 10 years, approximately 43 percent of NASA launch requirements (including Space Transportation

System (STS flights)) assume launch on small (Pegasus-class) and medium (Delta II-class) expendable launch vehicles to provide economical and reliable access to space for a significant number of Space and Earth Science missions. The Explorer, Discovery, and Earth Observing System (EOS) Programs have each enjoyed a wealth of scientific success, which has, in part, been enabled by the availability of suitably sized and cost-effective launch vehicles. However, commercial market stagnation has affected the robustness of this market segment. NASA's faster-better-cheaper philosophy has resulted in its being the dominant user of U.S. launch services in these performance ranges.

The Pegasus and Delta II are ideally suited for NASA dedicated payloads, as they are capable of placing up to 1,000 pounds into low-Earth orbit (LEO) on a Pegasus, and over 10,000 pounds to LEO on a Delta II. Moving up to the intermediate class of expendable launch vehicle, represented by the Boeing Delta IV and the Lockheed Martin Atlas V, provides a tremendous increase in capacity—with higher launch cost, which poses a threat to the viability of current mission cost caps. Initial flight demonstrations are planned for mid- to late 2002. As a result of the increased capability on the intermediate class of expendable launch vehicle, it could be necessary to manifest multiple payloads should NASA choose to shift to this class of vehicles in lieu of current Pegasus and Delta II vehicles. Multiple manifesting introduces more complexity.

Accordingly, NASA, working with the U.S. Air Force (USAF), is taking steps to assure continued near- to mid-term viability of domestic sources in these performance classes to meet identified demand. Final costs associated with maintaining the Pegasus and Delta II capability are still under definition and should be complete by early 2002.

Strategic Enterprise and Performance Highlights



Space Science Enterprise

Mission

The Space Science Enterprise (SSE) serves the human quest to understand our origin, existence, and fate. The mission of the SSE is to chart the evolution of the universe from origins to destiny and understand its galaxies, stars, planets, and life. Innovative space technologies are developed, used, and transferred to support all the Enterprises and contribute to the Nation's global competitiveness. Scientific support is provided to the human exploration program, and knowledge and discoveries are used to enhance science, mathematics, and technology education, as well as the scientific and technological literacy of all Americans.

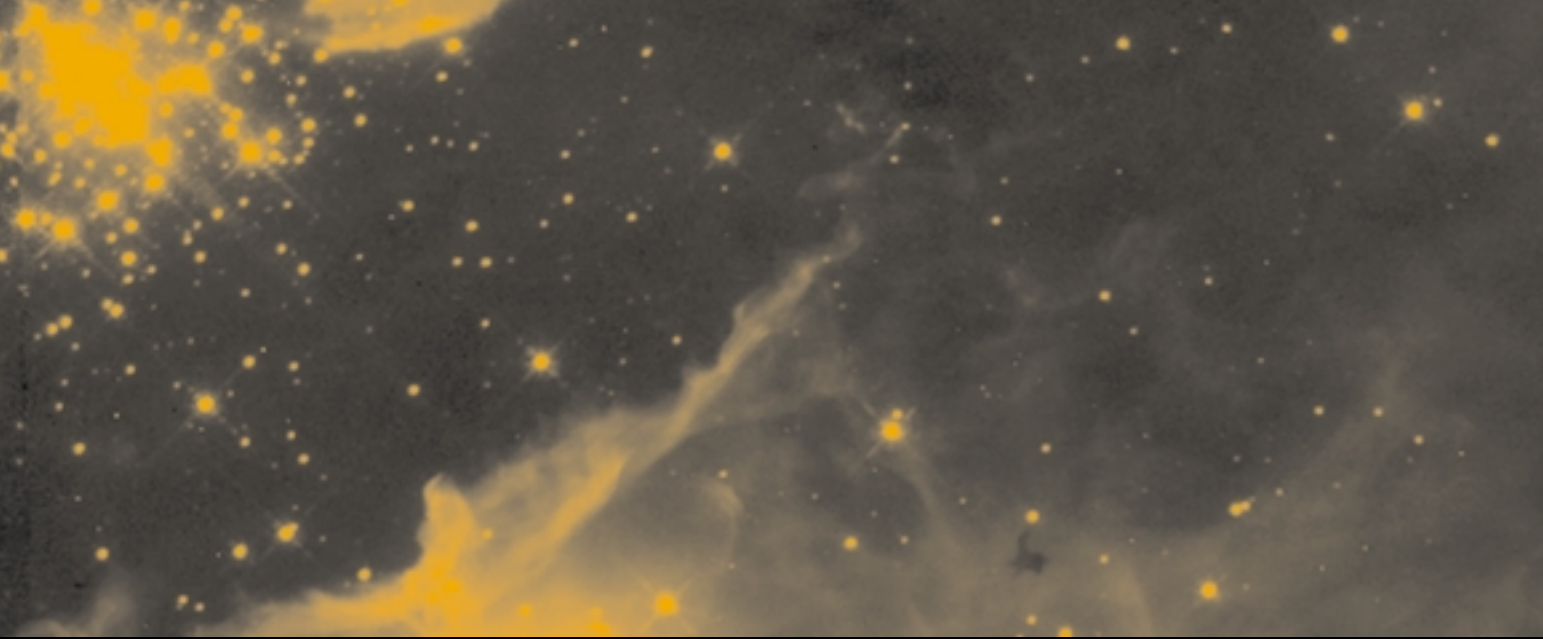
Strategic Goals and Objectives

SSE's goals and related objectives for FY 2001 were as follows:

- Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life:
  - Solve mysteries of the universe.
  - Explore the solar system.
  - Discover planets around other stars.
  - Search for life beyond Earth.

- Contribute measurably to achieving the science, math, and technology education goals of our Nation:
  - Make education and enhanced public understanding of science an integral part of our missions and research.

- Support human exploration through robotic missions:



  - Investigate the composition, evolution, and resources of Mars, the Moon, and small bodies.
  - Develop the knowledge to improve the reliability of space weather forecasting.

- Develop new technologies needed to carry out innovative and less costly mission and research concepts:
  - Develop new technologies needed to carry out innovative and less costly mission and research concepts.

SSE addresses fundamental questions 1, 2, and 6 (Figure 4). SSE's near-, mid-, and long-term plans (along with revised goals and objectives) are identified in the Space Science Roadmap in the NASA Strategic Plan and are elaborated in the Space Science Enterprise Strategic Plan. As described in those plans, these objectives are pursued through a comprehensive and balanced program of space science flight missions, technology development, and supporting scientific research.

Highlights of Performance and Accomplishments

With each space science mission NASA launches to study the planets, the stars, and other celestial phenomena comes new and profound scientific discovery. The discoveries made in recent years by NASA's space science missions are rewriting textbooks and shattering long-held scientific beliefs. The images we have captured of our universe—beautiful, mysterious, and even volatile—have attracted the fascination of not only the science community, but the general public worldwide. In the last year alone, space science images graced the covers of dozens of popular magazines and newspapers.

Endeavors of the Space Science Enterprise are high-risk by nature. By pursuing cutting-edge technological advances, the Enterprise succeeds in developing missions that produce cutting-edge science. Goals are scientific in nature and are ambitious. The next generation of spacecraft that will carry out our program of exploration must be more capable and reliable while achieving greater efficiency in mass and power consumption. Spacecraft and instruments must be capable of performing in the harsh environments of extreme temperatures and intense radiation fields. Current mission concepts call for advances in power and propulsion systems, autonomy, ultra-lightweight materials, high-rate data delivery, instrument and spacecraft miniaturization, and the ability to fly multiple spacecraft in precisely aligned formations.

Such challenges are the reason we develop technology early in a mission's life cycle. The examination and testing of technology options is an essential step in the process of minimizing risk prior to devoting substantial budget resources. Surprising results and the development of unanticipated alternatives are inherent in the process of pursuing and evaluating advanced technologies. Adjustments to schedules are a result of the process of development of technological options—if we are not taking well-managed risks, we are not doing our job. Similarly, responsible decisionmaking on highly challenging Space Science programs requires that all the latest information on technological developments and other programmatic considerations be taken into account.

Detailed discussion of FY 2001 performance measures is included in the FY 2001 Performance Report at *http://ifmp.nasa.gov/codeb/library/library.htm.* Highlights of the performance and accomplishments are discussed below.

Goal: Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, and life.

Objective: Solve mysteries of the universe.

Understanding our cosmic origins and destiny, how these are linked by cycles of evolution, and how our current universe is structured, is perhaps the most profound and universal objective of mankind. One of the great quests of the last half-millennium has been to understand where humanity fits within the cosmos. SSE seeks to answer the questions 1) how did the universe begin and evolve, 2) how did we get here, and 3) are we alone? In FY 2001, SSE produced excellent scientific results in this area while, at the same time, dealing with several issues in missions under development.

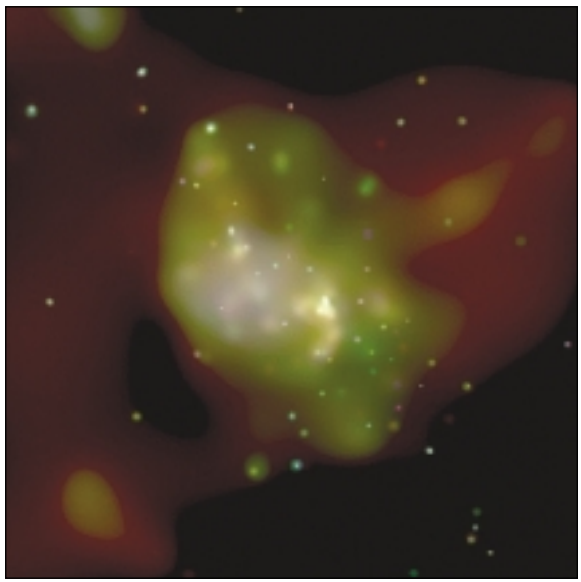


Figure 5: Supermassive Black Hole

The Chandra X-ray Observatory (CXO) continued to exceed efficiency and data recovery expectations in FY 2001. Many highly significant observations revealing the nature of black holes have been obtained from the CXO in the past year. For example, the CXO has yielded evidence that supports the case for the existence of a supermassive black hole at the center of our galaxy (Figure 5). A violent, rapid x-ray flare, captured by CXO, was observed from the direction of the supermassive black hole that resides at the center of our Milky Way galaxy. Such x rays are absorbed by the atmosphere and cannot be detected well by ground-based telescopes. Since scientists did not have an image of an x-ray flare before, some had suggested that the dense object in the center of our galaxy was a clump of dark stars rather than a black hole.

The Hubble Space Telescope (HST) is the optical space observatory that has produced some of the most amazing images of the universe. For example, a very small, faint galaxy has been discovered by a collaboration between the HST and the 10-meter Keck Telescopes at a tremendous distance of 13.4 billion light-years from Earth, making it the most distant galaxy ever seen (Figure 6). This has profound implications for our understanding of how and when the first stars and galaxies formed in the universe. The HST, looking 10 billion years back in time, has spotted the most distant exploding star ever observed. The discovery is prompting researchers to rethink how the universe works and bolsters the controversial theory that the universe is expanding at an accelerated rate. A supernova, or exploding star, occurs each second somewhere in space, and that single star beams brighter than the billions of stars in its galaxy combined (Figure 7). The supernova, barely discernible with the most powerful instruments, provides clues to dark energy. While dim, the dying star gleams brighter and moves differ-

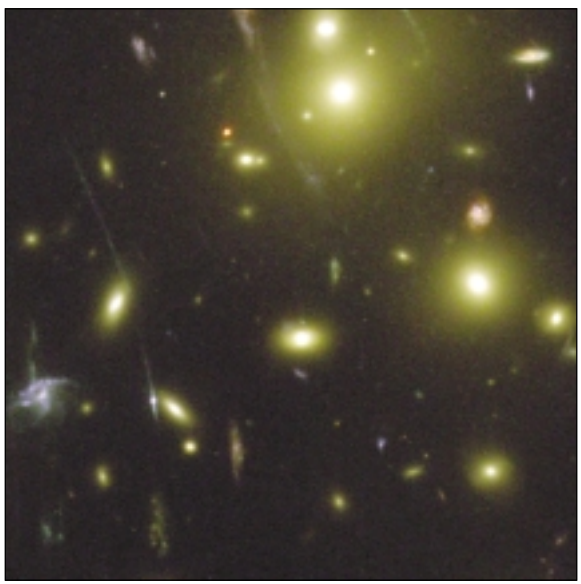


Figure 6: Most Distant Galaxy Ever Seen

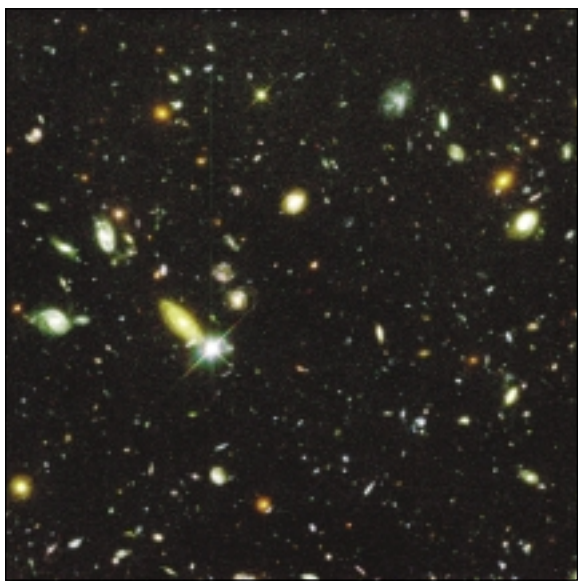


Figure 7: Distant Supernova

Figure 8: Halo of Hot Gas Around Milky Way-Like Galaxy

ently than it would if the universe had expanded at a steady rate since the beginning of time.

In conjunction with the Hubble Space Telescope, the CXO provided the first unambiguous evidence for a halo of hot gas surrounding a galaxy that is very similar to our Milky Way. The structure across the middle of the image (Figure 8) and the extended faint filaments (shown in orange) represent the observation from Hubble that reveals giant bursting bubbles created by clusters of massive stars. Scientists have debated for over 40 years whether the Milky Way has an extended corona, or halo, of hot gas. These observations and those of similar galaxies provide astronomers with an important tool in understanding our own galactic environment.

SSE faced challenges in various development programs during FY 2001. The Galaxy Evolution Explorer launch was delayed until mid-FY 2002 due to problems with detector development and telescope fabrication. In addition, the Cooperative Astrophysics and Technology Satellite, a part of the Student Explorer Demonstration Initiative, was canceled due to concerns over the lack of progress by the associated university and the resulting risks. Equally important in this decision was the fact that the original scientific rationale for the mission had eroded; the scientific question of the origin of gamma-ray bursts has been largely solved, and two other approved missions will better examine the question in light of more recent knowledge.

The Microwave Anisotropy Probe (MAP), an Explorer mission that will measure the temperature of cosmic background radiation over the full sky with unprecedented accuracy, was successfully launched (Figure 9). MAP is designed to capture the afterglow of the Big Bang, which comes from a time well before there were

Figure 9: Microwave Anisotropy Probe (MAP) Spacecraft

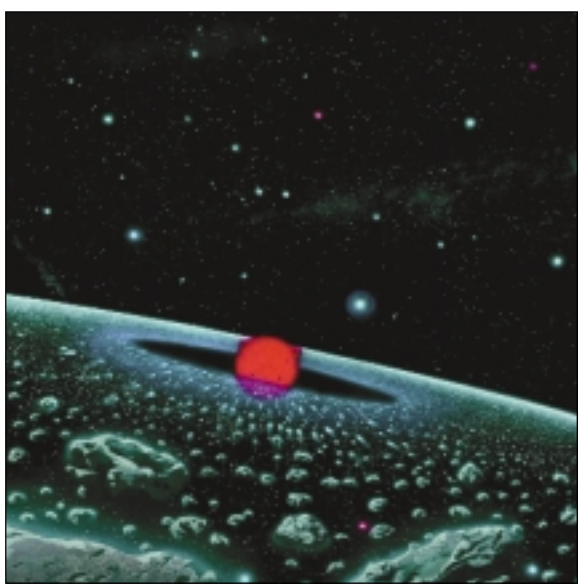


Figure 10: Water-Bearing Worlds Beyond Our Solar System

any stars, galaxies, or quasars. This map of the remnant heat from the Big Bang will provide answers to fundamental questions about the origin and fate of our universe. Scientists hope to determine the content, shape, history, and ultimate fate of the universe by constructing a full-sky picture of the oldest light.

The performance of operating missions was exceptional during FY 2001. For example, the Submillimeter Wave Astronomy Satellite (SWAS) detected substantial concentrations of water vapor around the aging giant star CW Leonis, located 500 light-years (almost 3,000 trillion miles) from Earth. The observations provide the first evidence that other planetary systems contain water, a molecule that is an essential ingredient for known forms of life, and suggest that other stars may be surrounded by planetary systems similar to our own (Figure 10).

Objective: Explore the solar system.

Exploration of our solar system revolutionizes our understanding of physics, chemistry, and biology. Earth and all of the other bodies in the solar system formed at about the same time from a disk of gas and dust that surrounded the Sun. Although these bodies share some characteristics, there are striking differences among them. SSE seeks to understand the physical conditions and processes that led to those differences. In FY 2001, Space Science made excellent progress.

For example, the Genesis mission, launched successfully in August 2001, will collect samples of charged particles in the solar wind and return them to Earth laboratories for detailed analysis after an airborne capture in the Utah desert. These particles are the original cloud of gas and dust that coalesced to form the solar system 4.6 billion years ago. Such data are critical for improving theories about the formation of the Sun and the planets, which formed from the same primordial dust and gas cloud.

In February 2001, the unmanned Near Earth Asteroid Rendezvous (NEAR-Shoemaker) spacecraft landed on a 21-mile-long rock tumbling through space and settled gently on its pitted, barren surface, becoming the first probe to land on an asteroid. This was the first landing of a space probe on a body with almost no gravity, and the gravitational force varies across the asteroid's irregular surface, making maneuvering around it more complicated.

Objective: Discover planets around other stars.

SSE seeks to determine whether habitable or life-bearing planets exist around nearby stars. In addition, learning about other nearby planetary systems provides valuable context for research on the origin and evolution of our own solar system. Discovering other planets outside of our solar system requires greater knowledge of positions and distances of stars and galaxies. Optical interferometry will enable us to make these determinations with far greater accuracy than previous programs.

Despite the numerous technical challenges inherent in efforts to image and characterize planets around other stars, Space Science has made progress in technology development for extra-solar missions. The earlier re-phasing of the ST-3/Starlight mission to align it with the Terrestrial Planet Finder (TPF) mission set a new schedule inconsistent with previously established measures, but progress in FY 2001 was good. SSE succeeded in combining the two Keck telescopes, creating a single optical instrument powerful enough to pinpoint planets orbiting other stars. However, the new design concept for the Space Interferometry Mission (SIM), which will detect planets around other stars and precisely locate very dim stars to an unprecedented accuracy, delays launch of the mission but will not diminish its science value.

Objective: Search for life beyond Earth.

Perhaps the most elusive and intriguing question we seek to answer is "Are we alone?" SSE has in place a well-developed strategy to investigate suitable environments for life in and beyond our solar system.

The Mars Global Surveyor (MGS) completed its primary mapping mission and continued its unprecedented success in its extended mission during FY 2001. MGS mapped landing sites for the 2003 Mars Exploration Rover mission and discovered potential evidence of present-day climate change.

The Mars Odyssey mission, which will improve our understanding of Mars's climate and geologic history, was launched in April 2001, and arrived at Mars in October 2001, and has begun a new phase of unprecedented scientific reconnaissance (Figure 11). High-resolution orbital imaging will follow up on MGS results that suggest the presence of near-surface water in recent times. The TPF mission continued procurement activities and successfully tested the starlight nulling breadboard (technology hardware used to demonstrate the principle that light received directly from a planetary system's star can be masked to allow light reflected off individual planets to be identified). TPF will be able to search about 200 nearby stars for planets that possess atmospheres that would indicate the possible presence of life.

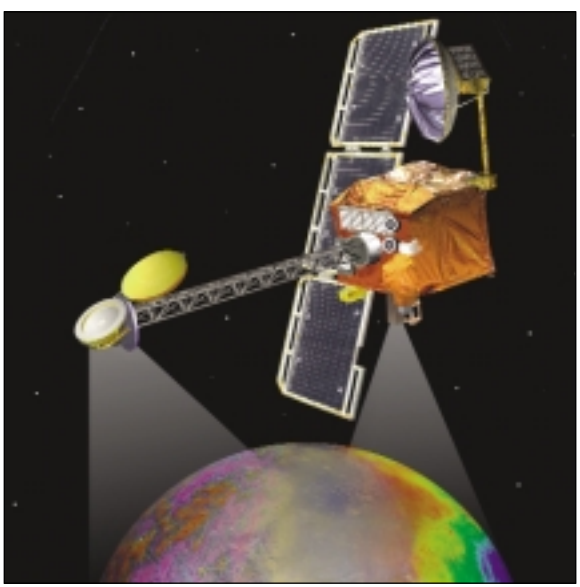


Figure 11: Mars Odyssey

Goal: Contribute measurably to achieving the science, math, and technology education goals of our Nation.

Objective: Make education and enhanced public understanding of science an integral part of our missions and research.

SSE is committed to making measurable contributions towards achieving the science, math, and technology education goals of our Nation. Education and enhanced public understanding of science are being made an integral part of each mission and research program. In short, no space science flight mission or research project is considered complete until the excitement and discoveries from that mission or project have been made available and accessible to the education community and the public.

The role of education and enhanced public understanding of science in SSE research and flight programs has substantially expanded during FY 2001, with over 400 Enterprise-funded education and public outreach (E/PO) activities carried out during the year. Taking into account the fact that many of these activities involved multiple events that took place in a variety of venues, the total number of E/PO events in FY 2001 was nearly 3,000, with

events having taken place in all 50 States, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands.

Included within these activities were special efforts to respond to the needs of various groups. The need to increase the numbers of underrepresented minorities with interest in and understanding of space science was addressed in part through a set of grants to minority colleges and universities for developing space science capabilities in education and research on their campuses. In FY 2001, a number of minority universities began work on Enterprise-funded space science development activities under the Space Science Minority University Initiative. Included among these institutions were Historically Black Colleges and Universities (HBCU), Hispanic-Serving Institutions (HSI), and Tribal Colleges and Universities (TCU). Additional activities underway at minority universities in FY 2001 included new funding for Hampton University to undertake a concept study for a possible new Small Explorer mission, as well as continued funding of research grants to HBCUs and HSIs, continued operation of the Far Ultraviolet Spectroscopic Explorer mission through a ground station at the University of Puerto Rico at Mayagüez, and continued operation of a facility for launching scientific high-altitude balloons by New Mexico State University at Fort Sumner, New Mexico.

The need to provide content resources to educators was addressed in part by providing a space science presence through exhibits, materials, workshops, and personnel at national and regional education and outreach conferences. Examples include national conferences sponsored by the American Indian Science and Engineering Society and the National Conference of Black Physics Students, regional conferences of various State library associations, State science teachers associations, and the National Science Teachers Association, and a number of other local or regional meetings.

The need to provide public access to recent space science missions and discoveries was addressed in part through a number of Enterprise-sponsored space science exhibits or planetarium shows on display or on national tours at major science museums or planetariums across the country.

Space Science E/PO projects received awards from external organizations during the year, including awards for excellence in educational Web sites. These awards included such prestigious honors as the Infinity Award for Applied Photography given to the Hubble Space Telescope Heritage program for valuing “both scientific information and aesthetic presence” in producing celestial photographs, and the International Technology Education Association’s Presidential Citation awarded to the New Millennium Program’s Space Place Team “for efforts above and beyond the call of duty in service to the Technology Education profession.”

Several of the major science center exhibitions on display or being developed during FY 2001 are a direct result of collaborations with the Smithsonian Institution and joint funding by the National Science Foundation (NSF). Such collaborations take advantage of the science content that is SSE’s primary resource and leverage it through the expertise of the Smithsonian at developing and displaying exhibits and the funding available from NSF for supporting such exhibits.

Goal: Support human exploration through robotic missions.

Objective: Investigate the composition, evolution, and resources of Mars, the Moon, and small bodies.

Scientific exploration of Mars continues, with the successful insertion of Mars Odyssey into orbit around the planet on October 23, 2001, concluding its long journey

to this exciting world. Mars Odyssey joins the Mars Global Surveyor (MGS) spacecraft, now orbiting Mars, which is mapping landing sites for the 2003 Mars Exploration Rover. As part of this program, MGS has been monitoring the largest planet-encircling dust storm since 1971, in conjunction with Hubble Space Telescope (HST) imaging from Earth orbit (Figure 12). Instruments on the spacecraft not only provided spectacularly detailed images, but also measured an 80-degree rise in atmospheric temperatures and a drop in ground temperatures during the storm. A fuller understanding of the environment around Mars will be of significant public benefit in optimizing both our future robotic and, one day, our future human exploration missions to this world. A major collection of research articles from MGS was published in the Journal of Geophysical Research (Planets), and Mars discoveries made the cover of major science journals twice this past year (Science in December and Nature in July).

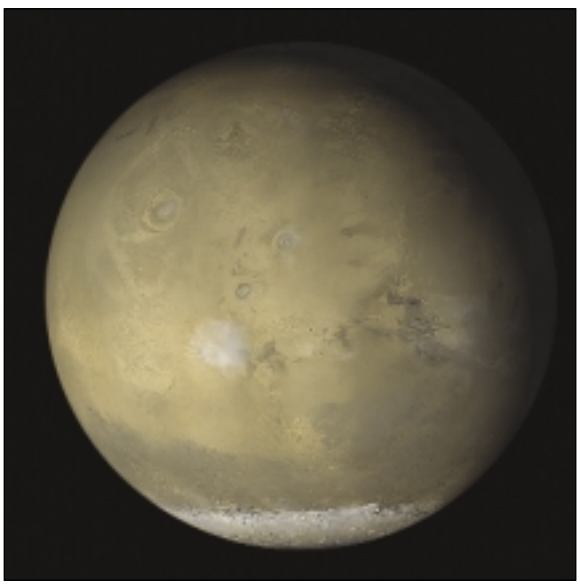


Figure 12: Mars Dust Storm

Objective: Develop the knowledge to improve the reliability of space weather forecasting.

Solar variability affects life and society by causing "space weather," which can affect space assets vital to the national economy (communications, military, and weather satellites), shortwave radio communications, the electric power grid, and astronauts. Solar variability is a natural driver of global climate change, which appears to have affected Earth's climate in the past. Our missions are dramatically advancing our knowledge of how the Sun works, through such means as studies of solar interior dynamics. With our growing fleet of spacecraft, we are increasingly able to make coordinated measurements of events that start at the Sun, propagate through space, and impact Earth's magnetosphere and upper atmosphere. These coordinated observations permit insights into how the Sun works in a variety of ways.

Exploration of the complex interplay of forces and processes between Earth and the Sun remains among the highest priorities of SSE and continues with the highly successful Solar Heliospheric Observatory (SOHO) and Transition Region and Coronal Explorer (TRACE) missions, and with the important progress being made in the Living With a Star Program.

Observations by the International Solar-Terrestrial Physics Program (ISTP) SOHO mission yielded critical science results. The Michelson Doppler Imager (MDI) SOHO instrument has discovered how to "see" through the Sun and now, on a daily basis, uses this technique to study sources of activity on the far side. This is an important breakthrough because it provides warnings of the growth of potentially hazardous active regions fully a week before they come into view on the limb of the Sun. SOHO has also discovered how a sunspot is made. A huge sunspot, 13 times larger than

the surface area of Earth and the largest to appear in a decade, rotated with the Sun to face Earth (Figure 13). The MDI instrument has enabled us to peer below the solar surface, observe the subsurface structure, and measure key characteristics of these intriguing features to help explain how they work.

Using telescopes from ground observatories, a Living With a Star research effort by solar physicists has discovered that the long-term, as well as seasonal, changes in the amount of sunlight reflected by Earth can be measured by its illumination of the Moon. This method provides a unique way of measuring variations in solar-reflected energy caused by changes in Earth's atmosphere, knowledge that is helpful in understanding global climate change.

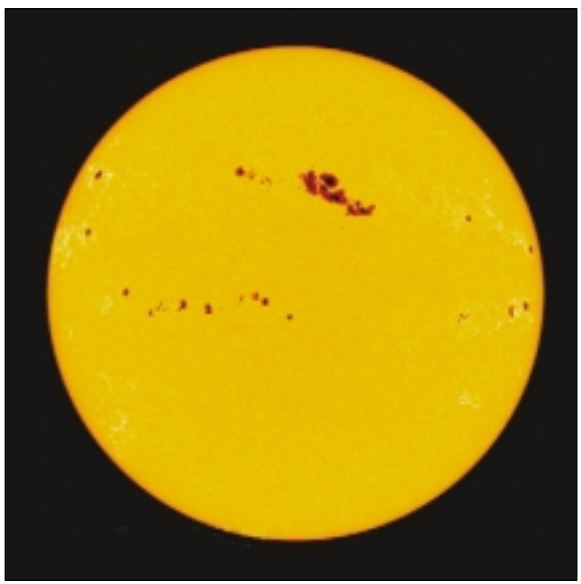


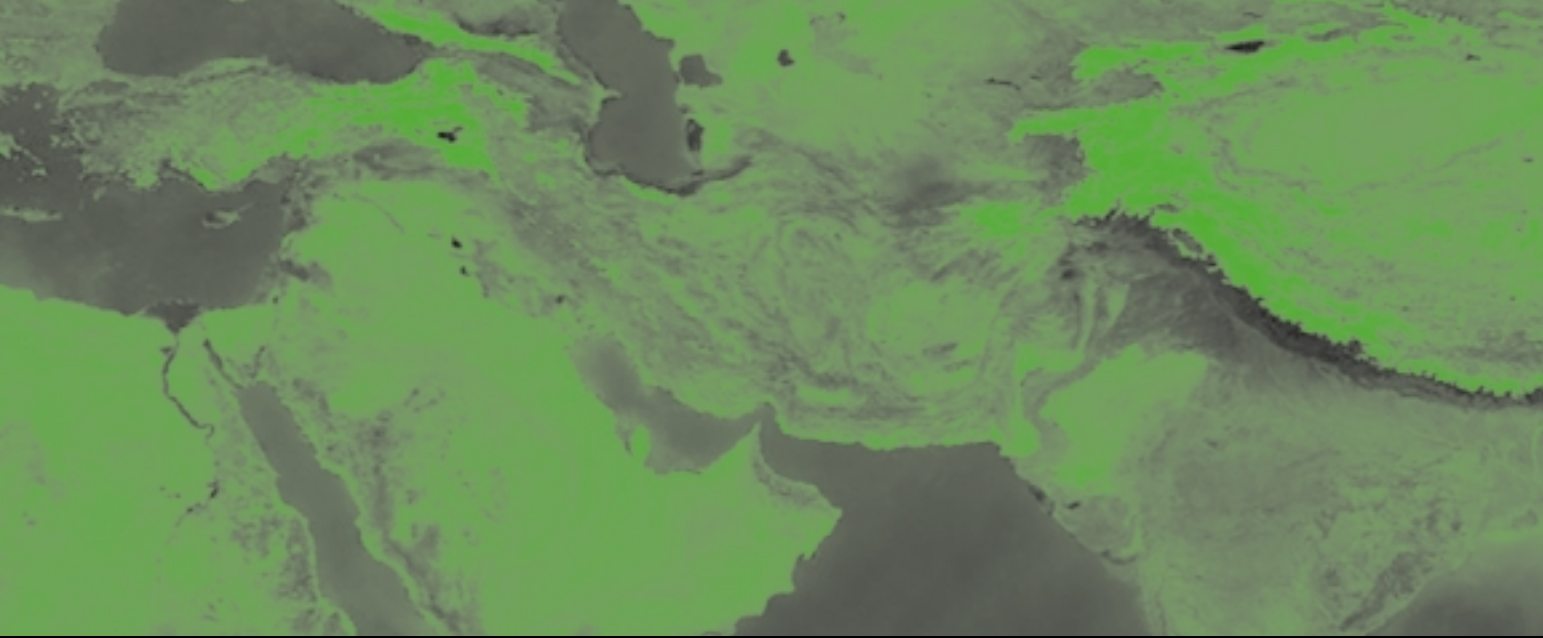
Figure 13: Huge Sunspot Group

Goal: Develop new technologies needed to carry out innovative and less costly mission and research concepts.

Objective: Develop new technologies needed to carry out innovative and less costly mission and research concepts.

The Space Science technology program encompasses three key objectives: 1) development of new and better technical approaches and capabilities; 2) if necessary, validation of these improved and demonstrated approaches so that they may be used in flight missions; and 3) infusion of these capabilities into our missions and, where possible, transfer to U.S. industry for the public good. The Enterprise continues to work with the NASA Commercialization Technology Division to seek ways in which these technologies can more effectively be made accessible to the U.S. economy. Particular examples this past year include presentations and discussions of NASA technologies at national conferences on robotics, sensors, and advanced household appliances.

The New Millennium Program (NMP) is probably the best example of how SSE manages the development and infusion of technologies. Since launch, Deep Space-1, the first new Millennium Program mission, has demonstrated 12 advanced technologies in space, a number of which—among them, notably, electric propulsion—are highlighted as priorities for future missions. Recently, Deep Space-1 flew by Comet Borrelly and is well underway into a successful extended mission.



Earth Science Enterprise

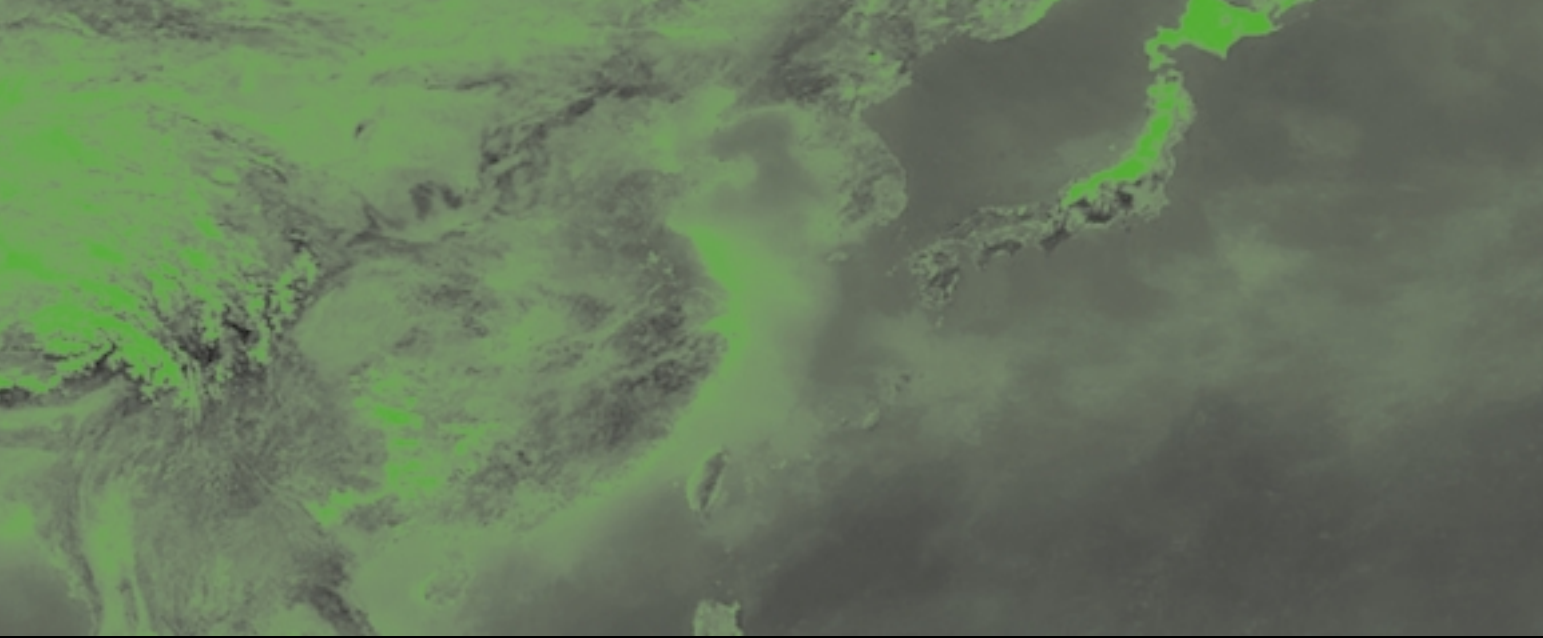
Mission

The mission of NASA's Earth Science Enterprise (ESE) is to develop a scientific understanding of the Earth system and its response to natural and human-induced changes in order to enable improved prediction of climate, weather, and natural hazards for present and future generations. NASA brings to this endeavor the unique vantage point of space, allowing global views of Earth system change. ESE programs advance the new discipline of Earth system science, with a near-term emphasis on global climate change. The results will contribute to the development of environmental policy and sound economic investment decisions. The ESE mission also includes developing innovative technologies to support Earth Science programs and making these technologies available to decisionmakers for solving practical societal problems. Knowledge and discoveries are shared with the public to enhance science, mathematics, and technology education, as well as to increase the scientific and technological literacy of all Americans.

Strategic Goals and Objectives

ESE's goals and related objectives for FY 2001 were as follows:

- Expand scientific knowledge by characterizing the Earth system:
  - Successfully launch spacecraft.
  - Understand the causes and consequences of land-cover/land-use change.
  - Predict seasonal-to-interannual climate variation.
  - Detect long-term climate change, causes, and impacts.
  - Understand the causes of variation in atmospheric ozone concentration and distribution.
  - Identify natural hazards, processes, and mitigation strategies.



- Disseminate information about the Earth system:
  - Implement an open, distributed, and responsive data system architecture.

- Enable the productive use of ESE science and technology in the public and private sectors:
  - Develop and transfer advanced remote sensing technologies.
  - Extend the use of Earth Science research for national, State, and local applications.
  - Support the development of a robust commercial remote sensing industry.
  - Increase public understanding of the Earth system through education and outreach.
  - Make major scientific contributions to national and international environmental assessments.

ESE addresses fundamental questions 3 and 6 (Figure 4). ESE near-, mid-, and long-term plans (along with revised goals and objectives) are identified in the Earth Science Roadmap in the NASA Strategic Plan and are elaborated in the ESE Strategic Plan. As described in those plans, these objectives are pursued through comprehensive and balanced programs, advancing new disciplines of Earth Science, with near-term milestones on a path to long-term inquiry, research, and analysis of Earth.

Highlights of Performance and Accomplishments

Detailed discussion of FY 2001 performance measures is included in the FY 2001 Performance Report at *http://ifmp.nasa.gov/codeb/library/library.htm*. Highlights of the performance and accomplishments are discussed below.

Goal: Expand scientific knowledge by characterizing the Earth system.

The use of space to conduct cutting-edge research on the Earth system has become an ESE hallmark. In FY 2001, numerous satellite missions, field campaigns, and data analyses significantly improved our understanding of the Earth system.

Objective: Successfully launch spacecraft.

Launching spacecraft with cutting-edge technology and instruments in a timely and cost-effective manner is a key element in ensuring the continued success of ESE research and analysis on the Earth system.

In FY 2001, ESE successfully developed and launched three spacecraft. On November 20, 2000, ESE launched the Earth Observing 1 (EO-1) technology demonstration mission and the Satelite de Aplicanciones Cientificas-C (SAC-C) satellite, a cooperative Earth Science mission with the Argentine Space Agency. EO-1 was the first launch under our New Millennium Program and will serve as a springboard for future scientific research. One of the main mission objectives was to demonstrate new and cheaper technologies compared to the current standard Landsat series. In doing so, EO-1 included new instruments for better characterization of Earth, such as the world's first space-based hyperspectral sensor, which will open the market for the next great science and applications opportunities in Earth remote sensing. At one-quarter the weight and one-third the cost of traditional Landsat satellites, EO-1 demonstrated our ability to produce Landsat-like imagery at a fraction of the previous Landsat mission costs. In addition to ushering in a new era of significantly cheaper and lighter spaceborne sources of hyperspectral data, EO-1 products are being validated by the public and private sectors for operational uses. EO-1 data was used in the response and recovery phase of the World Trade Center tragedy (Figure 14) and is also being used as a pathfinder for Department of Defense intelligence-gathering operations. SAC-C provides a spaceborne platform for important observations of land and coastal zone environments and tests new remote-sensing technologies, including a novel gas remote-sensing capability. EO-1 flies in formation with our Earth Observing System Terra (EOS-Terra) satellite, Landsat 7, and a joint U.S.-Argentina satellite to demonstrate the satellite constellation concept in which the combined capabilities create a super-satellite. On July 12, 2001, the Geostationary Operational Environmental Satellite-M (GOES-M) was successfully launched from the Kennedy Space Center (KSC). Developed and launched by ESE and operated by the National Oceanic and Atmospheric Administration (NOAA), GOES-M supports weather forecasting, severe storm tracking, and meteorological research. Both EO-1 and GOES-M remain operational. A third satellite by ESE, the Quick Total Ozone Mapping Spectrometer, was lost in a commercial launch failure.

Figure 14: Manhattan on September 12, 2001, Via Instrument Aboard EO-1

Objective: Understand the causes and consequences of land-cover/land-use change.

Determining how land cover and climate changes affect agricultural productivity and terrestrial and marine ecosystem health is an important ESE research goal. The carbon cycle is one of the major Earth system processes tied to land cover and global climate. Accordingly, NASA research on the biology and biogeochemistry of ecosystems and the global carbon cycle aims to understand and predict how terrestrial and marine ecosystems are changing. This research theme addresses ecosystems as they are affected by human activity, change due to their own intrinsic biological dynamics, respond to climatic variations, and affect climate. Emphasis is on understanding the processes of the Earth system that affect its capacity for biological productivity and the role of the biosphere in the Earth system.

Results from the Boreal Ecosystem-Atmosphere Study field experiment have dramatically improved the accuracy of weather forecasts for the boreal, or northern, region of plant and animal life and enabled ecosystem model results to agree with actual ground measurements. In addition, three years of well-calibrated, validated Sea-viewing Wide Field-of-view Sensor (SeaWiFS) data were used to compute, for the first time, time-lapse series of oceanic and terrestrial production that accurately portray seasonal and interannual variability. These model results have set the baseline against which any future model improvements will be judged. SeaWiFS captures the location of the Earth's plant life using data collected during the period 1997–2000. On land, dark greens show where there is abundant vegetation, and tans show relatively sparse plant cover. In the oceans, reds, yellows, and greens show regions of the ocean that are the most productive over time, while blues and purples show where there is very little of the microscopic marine plants called phytoplankton. Such information is giving scientists a better understanding of our complex Earth system and the human impact upon that system.

Objective: Predict seasonal-to-interannual climate variation.

In the form of such variables as polar ice sheets, tropical rainfall, and clouds, the global water cycle is an important element in seasonal and interannual climate change. Accordingly, ascertaining the rate at which water cycles through Earth's system and detecting possible changes are top priorities for ESE. Current ESE program activities in the water cycle area include establishing the existence (or absence) of a trend in the rate of the global water cycle, investigating relationships between large-scale climate anomalies and weather patterns, and accurately representing the integrated effect of water vapor absorption and clouds in a way suitable for use in climate models. The overarching goal is to improve understanding of the global water cycle to the point at which useful predictions of regional hydrologic regimes can be made. This predictive capability is essential for practical applications in water resource management and for validating scientific advances through the test of real-life prediction.

ESE research on the global water cycle continued in FY 2001 with important applications of Tropical Rainfall Measuring Mission (TRMM) and Earth Observing System Terra (EOS-Terra) data. The TRMM satellite was launched in cooperation with Japan in 1997 and continues to monitor and study tropical rainfall and associated energy release. TRMM has now completed four years of flight and is producing the most accurate rainfall observations ever available to the scientific community. TRMM data are being used to accurately determine the total precipitation in the Tropics, variations related to El Niño/La Niña, and precipitation processes critical to understanding the global water cycle. By continuing to combine TRMM results with the older Special Sensor Microwave Imager results for a record

Figure 15: MODIS Global Mosaic

of more than 10 years of tropical precipitation estimates, ESE helped eliminate some of the wide disparity in precipitation estimates. The EOS-Terra satellite, launched in December 1999, is the ESE flagship for understanding global climate change. During FY 2001, ESE continued to archive and analyze data from such EOS-Terra instruments as the Moderate Resolution Imaging Spectrometer (MODIS), the Multi-Angle Imaging Spectrometer (MISR), and the Clouds and Earth's Radiant Energy System (CERES) for a better understanding of the heating and cooling of Earth's surface and atmosphere (Figure 15).

Objective: Detect long-term climate change, causes, and impacts.

Climate is no longer perceived as a static property of the environment. Rather, it is a dynamic state expected to evolve in the future. Some major components of the climate system are ocean circulation, the polar ice sheets, and the atmosphere. Currently, ESE research on these topics seeks to understand the mechanisms of climate variability and predict future changes, understand the way in which Earth's climate responds to changes in external forcing factors or surface boundary conditions, and assess the current mass balance of polar ice-sheets and potential future changes, including effects on sea level. One of the main ESE contributions to this research is the development of cutting-edge modeling and predictive capabilities. Using its unique global perspective from space, ESE is able to gain comprehensive data from our satellite system and apply it in state-of-the-art models for better understanding and prediction of climate change.

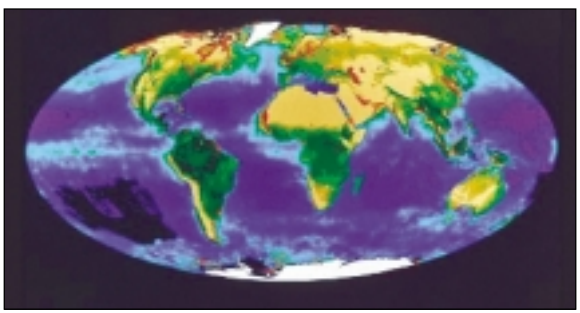


Figure 16: Climate Modeling

In July 2001, ESE announced a breakthrough in climate modeling (Figure 16). Using the newly developed 512-node silicon graphic supercomputer, ESE researchers were able to simulate more than 900 days of Earth's climate in one day of computer time. Previous capability had been limited to the simulation of 70 days. This supercomputer is of great value for Earth scientists because it enables more accurate computer models of climate change using global satellite observation data collected by NASA. For example, in FY 2001, researchers were able to demonstrate experimental seasonal climate predictions using ESE data sets from the Ocean Topography Experiment (TOPEX/Poseidon), SeaWiFS, TRMM, and Terra satellites. The combination of a faster computer, more accurate climate models, and more global satellite observations will result in more accurate prediction of climate change for policymakers. Ultimately, ESE would like to develop the supercomputing capability to integrate all components of the climate system into a model of the living, breathing Earth.

Objective: Understand the causes of variation in atmospheric ozone concentration and distribution.

Atmospheric change is the result of strongly interactive chemical and physical processes. Chemistry plays a role in determining weather and climate, while the physics and dynamics of the atmosphere influence chemical processes and composition. The goals of the ESE Atmospheric Chemistry Research Program are 1) to measure and understand how atmospheric composition is changing in response to natural and human-induced

factors and 2) to enable accurate prediction of future changes in ozone and surface ultraviolet radiation, climate forcing factors, and global pollution.

Conducted in March and April 2001, the successful Transport and Chemical Evolution over the Pacific (TRACE-P) airborne campaign has added significantly to our understanding of atmospheric chemistry. The primary mission objectives were to understand the atmospheric plume flowing out of East Asia, the way in which it changes as it moves eastward over the Pacific Ocean, and its contribution to global atmospheric chemical composition. To conduct this research, ESE scientists combined data collected by two specially equipped NASA airplanes flying near Hong Kong and Japan with satellite and ground station measurements taken over the 45-day campaign. By studying the seasonal airflow from Asia across the Pacific, researchers gained insight into the way in which natural and human-induced changes affect global climate. Preliminary analysis indicates that TRACE-P has significantly improved modeling capabilities.

Objective: Identify natural hazards, processes, and mitigation strategies.

ESE uses a combination of space-based and airborne assets to monitor and assess impacts of natural hazards such as volcanoes, earthquakes, forest fires, hurricanes, floods, and droughts. The short-term objective is to assess impacts of these events on national and international agriculture, food production, water resources, and commerce. The long-term objective is to apply scientific understanding toward developing a predictive capability. Results of this and other relevant activities are developed and applied to the assessment and mitigation of natural disasters, as well as the practice of disaster management, in conjunction with practitioners at the international, Federal, State, and local levels.

In FY 2001, ESE improved our ability to detect and understand earthquakes using space-based observations by completing installation of the Southern California Integrated Global Positioning System Network (SCIGN). NASA was the lead organization for implementation of this network containing 250 Global Positioning System (GPS) locators and receivers that provide millimeter-scale measurement of the crustal deformation in Southern California. The SCIGN network is moving toward ever more rapid data collection and processing at the millimeter level. JPL maintains an archive of the data and distributes it to researchers for improved scientific analysis. Of note, real-time global decimeter-scale positioning has been implemented through a commercial collaboration with the John Deere Corporation. The software for this system won NASA's Software of the Year Award for 2001. In related work, ESE established a commercial partnership to place advanced GPS receivers in tractors, giving American

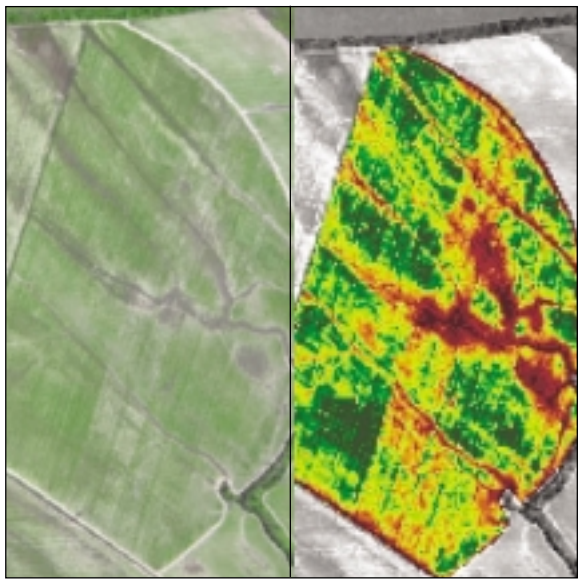


Figure 17: Global Positioning System Technology

farmers access to precision farming technologies (Figure 17). Using GPS technology in tractors and combines, farmers are given the tools to make such key decisions as the best timing and location of fertilizer, herbicide, and pesticide applications, and to accomplish the early prediction of yield and harvest quality. NASA has even developed the technology to precisely gauge varying crop yield over a field by integrating precision-locating technology with combine uptake measurements.

Goal: Disseminate information about the Earth system.

The dissemination of information resulting from Earth Science research is accomplished through the Earth Observing System Data and Information System (EOSDIS).

Objective: Implement an open, distributed, and responsive data system architecture.

The EOSDIS manages data from NASA's past and current Earth Science research satellites and field measurement programs by providing data archiving, distribution, and information management services. Structurally, data are acquired from the network of ESE satellites and is "dumped" to ground stations around the globe, where it is processed and distributed to any one of several Distributed Active Archive Centers (DAAC), Science Investigator-led Processing Systems, or Mission Data Systems. At this stage, the data are again refined into a form conducive to scientific research and is then distributed to the end users. Evolving from a network, or federation, established in 1998, full development of this system is expected by October 2002.

Earth science data were disseminated to enable our science research and applications goals and objectives. ESE is distributing more data faster as the median delivery time for orders has been reduced to less than one day. Providing this comprehensive data archive to researchers around the world in a timely manner, free or at marginal cost, greatly enhances our ability to better understand the Earth system.

Goal: Enable the productive use of ESE science and technology in the public and private sectors.

ESE places great value on conducting cutting-edge research and development and ensuring that the results find practical use in the public and private sectors. To that end, ESE encourages commercializing our technology, collaborating with the private sector in joint development, educating Government decision-makers on the uses of remote sensing, and sharing the excitement of Earth system science with educators and students.

Objective: Develop and transfer advanced remote sensing technologies.

NASA has a core competency in developing futuristic aerospace technology. ESE plays an important role in this by continually developing new remote-sensing and modeling capabilities. Through the work of the ESE Applications Division at NASA Headquarters and such programs as the Stennis Space Center (SSC) Commercial Remote Sensing Program (CRSP), we ensure that the technologies reach the private sector.

In FY 2001, numerous ESE technologies were developed in partnership with the private and public sectors and were transferred to the private sector. For example, NASA, other Federal agencies, and commercial partners worked in FY 2001 to validate all nine of the technologies aboard the EO-1 satellite. As part of the partnership, commercial partners are allowed to market the technologies after they have been validated. In FY 2001, the EO-1 X-Band Phased Array Antenna was validated and is open for commercialization by the Boeing and Lewis companies. The EO-1 Carbon-

Carbon Radiator was also validated and is open for commercialization by Amoco Polymers, BF Goodrich, and Lockheed Martin.

Objective: Extend the use of Earth Science research for national, State, and local applications.

ESE works with national, State, and local government entities to help them develop remote-sensing applications products to address issues of importance to them. These include agricultural productivity, natural resources management, environmental assessment, and urban and regional planning.

In FY 2001, ESE continued work on a collaborative project with the Department of Defense to monitor and predict disease outbreaks early enough to prevent them or reduce their impact on society. Researchers have studied five years' worth of satellite data and determined that rising sea surface temperatures in the western equatorial Indian Ocean, combined with an El Niño in the Pacific, led to abnormally heavy rains in east Africa. These rains created a favorable habitat for mosquitoes that carry the Rift Valley Fever (RVF) virus, spreading it to humans and animals. Using near-real-time satellite vegetation measurements and associated climate data sets, including sea surface temperatures and satellite-derived cloudiness indices, scientists developed the capability to make predictions about emerging RVF epidemics in east Africa several months before an outbreak occurs. Outbreaks can be devastating to the farming economies of rural east Africa and can cause significant human morbidity and mortality. Monitoring the state of sea surface temperatures, rainfall, and ecological conditions guides the effort in identifying areas of potential RVF outbreaks. The ability to map such areas of potential RVF activity two to five months before outbreaks occur could permit vaccination of domestic animals and implementation of appropriate mosquito control programs. The Department of Defense publishes RVF risk maps on its Web site, and they have been used by such decisionmakers as the World Health Organization. Additionally, ESE investigators provided data support to the Walter Reed Army Institute for Research during an RVF outbreak in Saudi Arabia and Yemen.

Objective: Support the development of a robust commercial remote sensing industry.

NASA is committed to a growing relationship with the commercial remote-sensing industry that enhances the utility of Earth science information in the U.S. economy. Commercial firms are both potential sources of science-quality remote-sensing data and producers of "value-added" information products from U.S. research satellites.

In 2001, ESE often worked closely with the private sector to conduct joint commercial applications research projects, in which ESE contracted with a commercial source to purchase remote-sensing data or in which ESE helped validate commercial remote-sensing products. Through the NASA Stennis Scientific Data Purchase program, ESE contracted with Orbital Imaging Corporation, in July 2001, for the purchase of data from their soon-to-be launched Orbview 4 satellite. Demonstrating the unpredictable nature of satellite launches, the Orbview 4, along with another ESE satellite, was lost in a failed commercial launch in September 2001. This was one of the few setbacks in FY 2001 as more than 10 new market commercial products were developed through a variety of joint commercial applications research projects and data products from the commercial IKONOS satellite were developed after being validated by ESE.

Objective: Increase public understanding of the Earth system through education and outreach.

Earth science missions and research programs make a unique contribution to education and the public under-

standing of Earth science. Through student research grants, teacher training, and child education programs, NASA provides a steady return of discoveries and new knowledge and hopes to inspire future generations of researchers and scientists.

In FY 2001, graduate student research grants and early career grants were extended for a variety of important research endeavors. Training educators on teaching methods for Earth system science was also a top priority. Through workshops for K–12 teachers, educators received information on Earth science education. ESE also continued to support the Global Learning and Observation to Benefit the Environment program that increased its membership and the number of participating countries.

Objective: Make major scientific contributions to national and international environmental assessments

Due to the nature of the discipline, it is vital that Earth science research be conducted through cooperation and partnerships with other agencies and with other countries. The ESE will continue to contribute scientific knowledge and observations and modeling results to national and international scientific environmental assessments. Some examples for FY 2001 include:

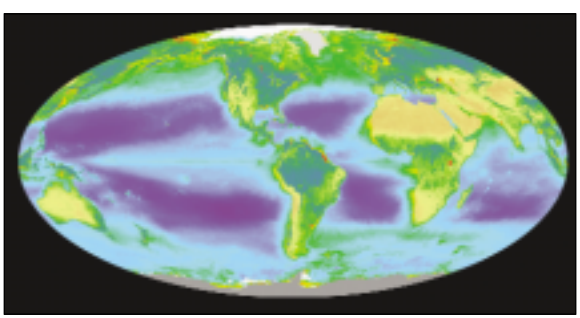
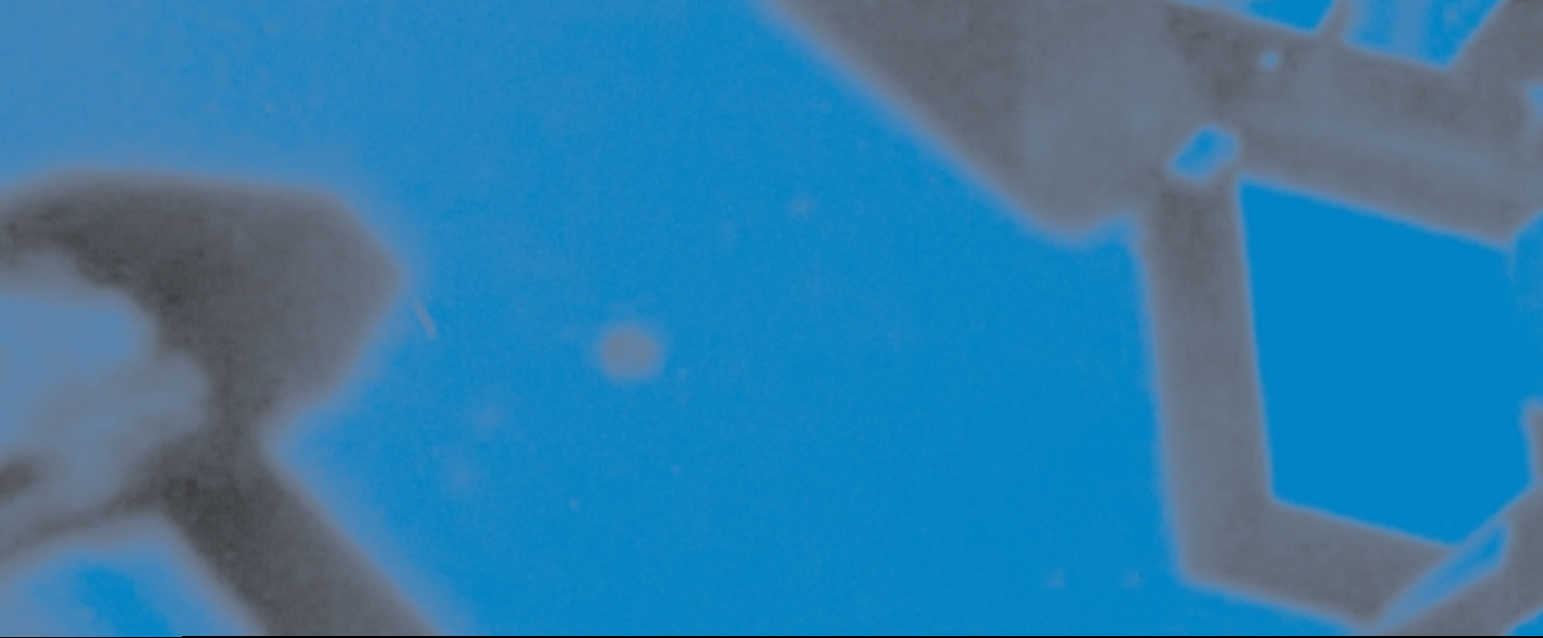


Figure 18: SeaWiFS Data

- Furthering the national goal of improved weather forecasting and storm tracking by developing and launching the GOES-M satellite for operational use by NOAA.
- Contributing EOS-Terra satellite data towards the national effort to track and fight forest fires in the Western United States.
- Partnering with several Federal agencies under the United States Global Change Research Program. Under this program, NASA announced the creation of the first complete "biological record" of the Earth, as reported in *Science* magazine. Using data from SeaWiFS, NASA researchers compiled the first-ever detailed record of the global carbon cycle. The study was based on three years of continuous observations from the ocean and land-viewing instrument. The SeaWiFS record provides a baseline against which future estimates of Earth system carbon cycling can be compared. Scientists will use the new record of the Earth's surface to study the fate of carbon in the atmosphere, the length of terrestrial growing seasons and the vitality of the ocean's food web (Figure 18).
- Partnering with the National Space Development Agency of Japan to analyze and apply cutting-edge data from the joint TRMM satellite contributing to a better understanding of global precipitation.



Biological and Physical Research Enterprise

Mission

NASA's Biological and Physical Research Enterprise (BPRE) addresses the opportunities and challenges of space flight through basic and applied research on the ground and in space. BPRE seeks to exploit the rich opportunities of space flight for fundamental research and commercial development, while conducting research to enable efficient and effective systems for protecting and sustaining humans in space.

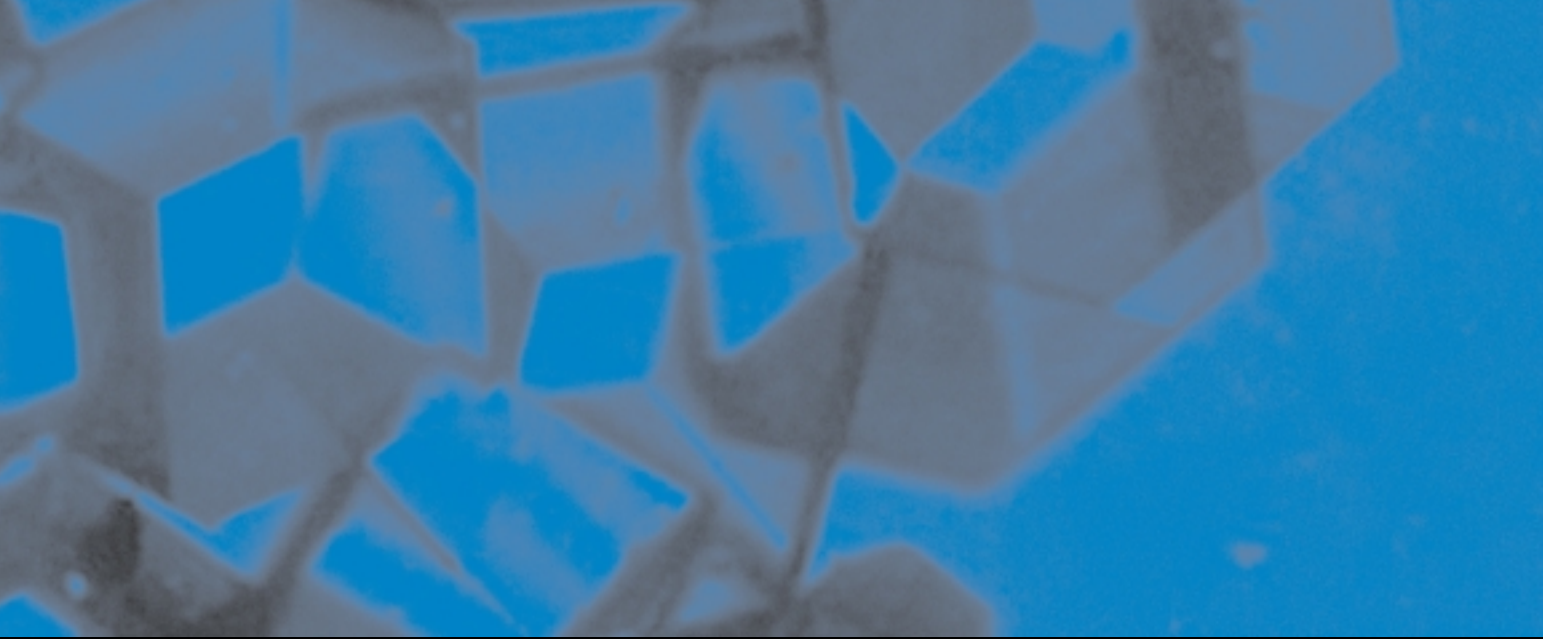
BPRE is committed to fair, open, and competitive peer review processes for the selection of scientific research. The Enterprise seeks to take full advantage of the broad pool of scientific and technical talent at universities, in other Government agencies, and in industry. In addition to regular, open solicitations for investigator-initiated research proposals, the Enterprise pursues its goals through academic consortia, commercial space centers, and memorandums of understanding with other Federal agencies and non-Government organizations. Investigations, consortia, and commercial centers are regularly reviewed for merit by independent experts.

Strategic Goals and Objectives

In FY 2001, the former Office of Life and Microgravity Sciences and Applications was separated from the HEDS Enterprise to form a new Enterprise called the Biological and Physical Research Enterprise (BPRE). As a result, performance responsibilities from the FY 2001 Performance Plan were reassigned between the two Enterprises.

The resulting BPRE goals and related objectives for FY 2001 were to accomplish the following:

- Expand scientific knowledge:
  - In partnership with the scientific community, use the space environment to investigate chemical, biological, and physical systems.



- Enable and establish a permanent and productive human presence in Earth orbit:
  - Ensure the health, safety, and performance of humans living and working in space.

- Expand the commercial development of space:
  - Facilitate access to space for commercial researchers.
  - Foster commercial participation on the International Space Station.

- Share the experience and benefits of discoveries of human space flight to benefit all people:
  - Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.

BPRE addresses fundamental questions 4 and 6 (Figure 4). The near-, mid-, and long-range plans of BPRE are defined in the BPRE roadmap of the NASA Strategic Plan and will be further clarified in the BPRE Strategic Plan.

Highlights of Performance and Accomplishments

Detailed discussion of FY 2001 performance measures is included in the FY 2001 Performance Report at *http://ifmp.nasa.gov/codeb/library/library.htm*. Highlights of the performance and accomplishments are discussed below.

NASA created BPRE to affirm its commitment to the essential role biology will play in the 21st century and to strengthen NASA's integrated program of research in space. FY 2001 included major efforts to restructure ISS research. These efforts responded to substantial reductions in available budgets for research equipment (facilities), support, and operations. The Enterprise initiated a program of research on the ISS to take advantage of available resources during the construction phase, released three research announcements, and strengthened its research investigator community. BPRE established a new memorandum

of understanding with the U.S. Department of Agriculture, conducted a joint research solicitation with the National Cancer Institute, and continued work under other agreements with the National Institutes of Health. BPRE closed its first fiscal year with a significant record of accomplishment.

Goal: Expand scientific knowledge.

Objective: In partnership with the scientific community, use the space environment to investigate chemical, biological, and physical systems.

The space environment offers a unique laboratory in which to study biological and physical processes. Researchers take advantage of this environment to conduct experiments in physics, chemistry, and biology in search of answers to basic and applied research questions. A broader program of ground-based research supports research progress in space and develops new hypotheses for testing.

FY 2001 was a banner year for BPRE basic physics research. Early in the year, researchers reported that they had "brought light to a full stop, held it, then sent it on its way" (*Physical Review Letters*, Vol. 86, Issue 5, January 29, 2001). Researchers used lasers developed with BPRE funding to bring a beam of light to a complete stop in a specially designed trap and then released it again. Another team of researchers created a gas cloud riddled with tiny whirlpools like those that cause "starquakes" (*Science*, Vol. 292, No. 5516, April 20, 2001). They used an ultra-cold cloud of sodium gas and quantum effects to create a physical model of phenomena that take place deep inside distant stars (Figure 19). The importance of this kind of low-temperature physics research was reinforced at the end of FY 2001, when Dr. Wolfgang Ketterle was awarded the Nobel Prize in Physics for his seminal BPRE-funded work on Bose Einstein Condensates—a new state of matter in which individual atoms merge into each other. He plans to extend and expand this ground-based research on the ISS. These experiments represent substantial milestones in physicists' quest to study quantum phenomena (physical phenomena that are ordinarily only observable on microscopic scales) in macroscopic systems. This research could have far-reaching implications for the future of information and communication technologies.

In the biotechnology arena, a research group at the Massachusetts Institute of Technology grew heart tissue with "significantly improved" structural and electrophysiological properties, using NASA bioreactor technology (*Journal of Physiology—Heart and Circulatory Physiology*, January 2001). Unlike tissue grown using more conventional technology, the tissue

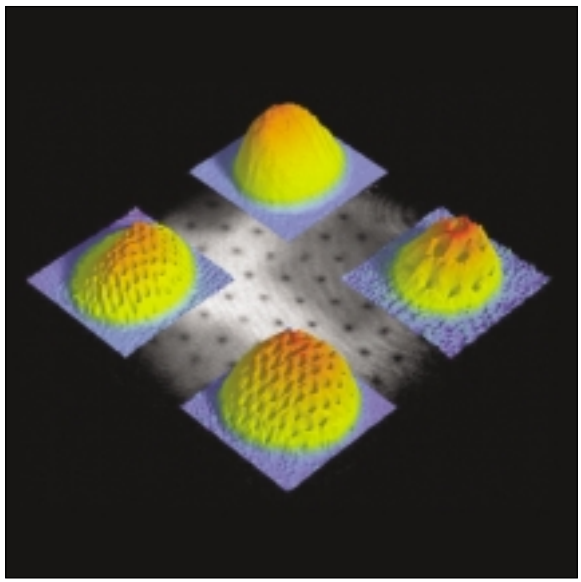


Figure 19: Sodium Gas Cloud Experiment

grown in the bioreactor was actually made to beat like native heart tissue. The bioreactor allows researchers to grow, in the laboratory, tissues that much more faithfully reproduce the properties of natural tissues in the body. These tissues allow researchers to explore mechanisms of disease and may ultimately improve processes for creating engineered tissue for use in treatment and transplant.

Cell cultures, including colon, kidney, neuroendocrine, and ovarian cell cultures, were grown aboard the ISS in FY 2001. This accomplishment represents our first opportunity to use a sophisticated bioreactor to grow cells in space. Bioreactor cell growth in microgravity may permit cultivation of tissue cultures of sizes and quantities not possible on Earth. Cells may grow in low gravity more like they grow in the human body, increasing research capability in areas pertinent to human diseases.

Goal: Enable and establish a permanent and productive human presence in Earth orbit.

Objective: Ensure the health, safety, and performance of humans living and working in space.

BPRE conducts fundamental and applied research in the biological and physical sciences to reduce the health risks of space travel and to develop technology for efficient, self-sustaining life-support systems. The Enterprise supports ground-based research at laboratories around the country, as well as flight research on the Space Shuttle, ISS, and free-flying spacecraft. FY 2001 is the first year of a broad transition in flight research: a shift in focus from the Space Shuttle to the ISS as the primary platform for flight research.

ISS outfitting for research began with the delivery of the Human Research Facility in March. NASA delivered two research equipment racks in mid-April and an additional two at the beginning of Expedition 3 in August. The Agency is on track to deliver another five research equipment racks by the end of FY 2002. Despite underestimation of ISS maintenance requirements and a greater-than-expected volume of "off-normal" activities during Expeditions 1 and 2, the ISS team was able to meet the minimum research objectives of these increments.

The Expedition 1 crew initiated a small number of U.S. research activities, including crew Earth observations, the educational Space Exposed Experiment Developed for Students (SEEDS) experiment (plant growth in microgravity), biological crystal growth (structural biology), space technology motion and vibration experiments, and human research baseline data collection.

With Expedition 2 (completed in July), the ISS research program was underway. Eighteen experiments were conducted. The Expedition focused on biomedical research and included studies of biological effects of space radiation, characterization of the ISS radiation environment, bone loss, spinal cord response during space flight, and interpersonal influences on crewmember and crew-ground interactions (Figure 20). Other experiments included plant germination and growth, Earth observations, and macromolecular crystal growth experiments.

Research on Expedition 3 included 8 new and 10 continuing experiments. New Expedition 3 experiments included investigation of the mechanism of space-flight-induced orthostatic intolerance, which has symptoms such as lightheadedness, palpitations, tremulousness, and poor concentration; a study of pulmonary function in space and as affected by ExtraVehicular Activities; a study of the risk factors associated with kidney stone formation during and after space flight; new techniques for structural biology in

Figure 20: Torso Model with Radiation Measuring Devices

space; and a study of materials passively exposed to the space environment around the ISS to better define changes in material properties and onorbit degradation trends. BPRE's Properties of Colloids in Space experiment is already yielding unique new data on never-before-seen colloidal crystallization patterns (Figure 21).

Research results from the ISS will be forthcoming as data are collected and analyzed. Results reported in FY 2001, based on earlier researcher missions and ground-based experiments support, continued progress in understanding and controlling the negative effects of space travel.

Flight research published in FY 2001 suggests that our minds contain an internal model of gravity and that this model may be very difficult or potentially even impossible to "unlearn" (*Nature Neuroscience*, Vol. 4, pp. 693–94, 2001). Astronauts quickly adjust to many of the challenges of orientation and movement associated with space flight, but the new results suggest that there may be limits to this adaptability (Figure 22). Astronauts attempted to catch a "falling" object moving at different constant speeds. The test subjects proved unable to adjust to the fact that such objects do not "fall" faster and faster in space. The expectation that a "falling" object would accelerate proved impossible to unlearn over the course of the experiment. This experiment raises the possibility that the nervous system may contain a "hardwired" model of gravity. If confirmed, this would be a fundamental discovery that could influence medical treatments for people with damaged or impaired nervous systems. In addition, this finding has important implications for the design of safe and efficient environments and systems for human space flight.

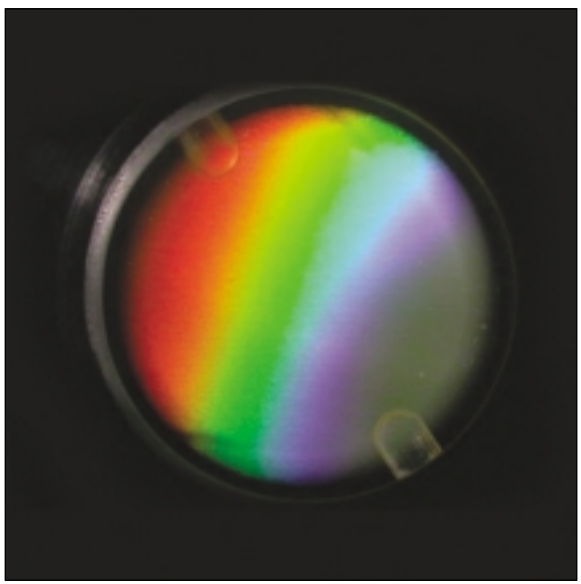


Figure 21: Properties of Colloids in Space

Figure 22: Neurolab Research

BPRE investigators tested the drug midodrine as a remedy for the dizziness and fainting (called orthostatic intolerance) that astronauts sometimes experience when they attempt to stand immediately after returning to Earth. The drug proved effective in ground-based test subjects and will be tested in space. This research is important for ensuring the safety of future space travelers who may need to evacuate a returning spacecraft in an emergency or operate a spacecraft without assistance after landing on another planet.

In what may be a breakthrough for astronauts and osteoporosis victims alike, researchers were able to prevent bone loss using mild vibrations (*Federation of American Societies for Experimental Biology Journal* (*FASEB J*), October 2001). Normally, rats lose bone when their hind limbs are suspended and no longer support the weight of the body. Researchers were able to counteract this bone loss by exposing the rats to mild vibrations. This study opens the door to a new method for controlling the one-percent-per-month loss of bone that astronauts experience in space, and clinical studies are planned to determine the usefulness of vibration for treating or preventing osteoporosis on Earth (Figure 23).

Goal: Expand the commercial development of space.

Objective: Facilitate access to space for commercial researchers.

BPRE provides knowledge, policies, and technical support to facilitate industry investment in space research; it enables commercial researchers to take advantage of space flight opportunities for proprietary research.

Figure 23: Bone Loss Research

Figure 24: Study of Antibiotic Production in Space

Bristol-Myers Squibb and the Center for BioServe Space Technologies successfully demonstrated that production of antibiotics is substantially greater in microgravity than on the ground (Monrden at 200-percent improvement, Actinomycin D at 75-percent improvement.) (Figure 24). They are working to apply this research to ground-based processes.

The Center for Commercial Applications of Combustion in Space at the Colorado School of Mines established an agreement to work with Sulzer Orthopedics Biologics and other partners on the development of a ceramic-metal composite that may lead to more durable bone replacements. Industry is planning to invest over $6 million to perfect these materials.

BPRE's Center for Biophysical Sciences and Engineering (CBSE) formed an exclusive partnership with Athersys, Inc., a premier genomics company. Genomics is the science of describing the proteins that are encoded by the genes in our DNA. CBSE has developed a world-class capability to determine the exact shapes and structures of proteins through the process of protein crystallography. Precise information on the protein structure is critical to the design of highly specific and effective new drugs.

Objective: Foster commercial participation on the International Space Station.

FY 2001 included continued growth in the number of commercial partners participating in the program and an initial set of five to six experiments conducted aboard the ISS. ISS resource pricing and intellectual property rights policies are completed and in place. These policies can be found at *http://commercial.nasa.gov*. BPRE continues to expand its relations with the commercial research community by working through its Commercial Space Centers to engage additional commercial partners and by establishing a clear policy framework. Commercial participation aboard the ISS will generate results directly relevant to improved production process, products, and services for the American economy.

Goal: Share the experience and discoveries of human space flight.

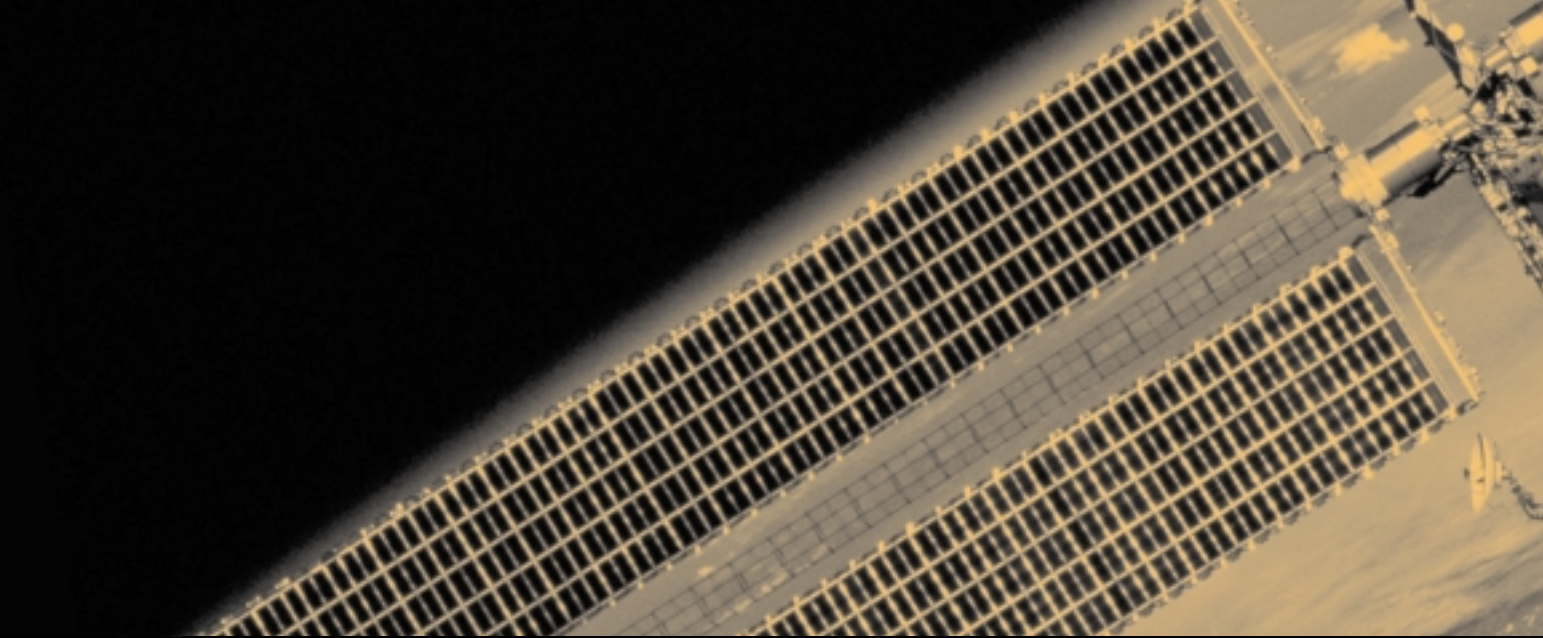
Objective: Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.

BPRE seeks to use its research activities to encourage educational excellence and improve scientific literacy from primary school through the university level and beyond. BPRE delivers value to the American people by facilitating access to the experience and excitement of space research. It strives to involve society as a whole in the transformations brought about by research in space.

During FY 2001, the Enterprise printed and distributed thousands of folders for education and general-public audiences explaining our new emphasis on multidisciplined science and highlighting a variety of scientific accomplishments for the year 2000.

The Enterprise held its first interactive education and public outreach broadcast as part of a technically oriented Pan Pacific Microgravity Workshop. A morning session reformatted technical science sessions for educational audiences, linking school classes that came to the California Science Center in Los Angeles, Columbus Science Institute in Ohio, Louisville Science Center in Kentucky, and the Liberty Science Center in New Jersey. An afternoon interactive broadcast translated an array of technical topics for members of the general public, linking audiences at the California Science Center, Bishop Science Center/Hawaii, and Flinders University, Australia.

In addition, BPRE revamped its material on the World Wide Web to reflect its new Enterprise status and mission and to group material specifically for the public, education, and technical audiences. The Enterprise had requests for and distributed thousands of interactive compact discs (CD) explaining space flight and space research to the layman and educator as a result of our electric light tower exhibit touring the country. In collaboration with the USAF Academy Department of Biology, we completed development of an undergraduate-level course in space biology. We sent speakers and exhibits to public and educational national conventions, in addition to numerous industrial conferences and NASA community open houses.



Human Exploration and Development of Space Enterprise

Mission

The mission of the Human Exploration and Development of Space (HEDS) Enterprise is to open the space frontier by exploring, using, and enabling the development of space and to expand the human experience into the far reaches of space. HEDS makes possible U.S. leadership of international efforts to extend a permanent human presence beyond the bounds of Earth, involving both machines and humans as partners in innovative approaches to exploration. HEDS engages the private sector in the commercial development of space in order to enable the continuation of current space business and to create new wealth and new jobs for the U.S. economy. The foundations of HEDS are the Space Shuttle and the International Space Station (ISS) (Phase II of ISS construction is now complete), space communications, and expendable launch vehicles that provide access to space and platforms for scientific research, technology development, and commercialization in space.

Strategic Goals and Objectives

Prior to FY 2001, the HEDS Enterprise comprised the Office of Space Flight and the Office of Life and Microgravity Sciences. In FY 2001, the Office of Life and Microgravity Sciences and Applications was separated from the HEDS Enterprise to form a new Enterprise designated the Biological and Physical Research Enterprise (BPRE). As a result, responsibilities from the FY 2001 Performance Plan were reassigned between the two Enterprises.

The resulting HEDS goals and related objectives for FY 2001 were as follows:

- Expand the space frontier:
  - Expand human exploration through collaborative robotic missions.
  - Define innovative human exploration mission approaches.

- Invest in enabling high-leverage technologies.

- Enable and establish a permanent and productive human presence in Earth orbit:
  - Provide safe and affordable access to space.
  - Deploy and use the ISS to advance scientific, exploration, engineering, and commercial objectives.
  - Meet sustained space operations needs while reducing costs.

HEDS addresses fundamental questions 4 and 6 (Figure 4). The near-, mid-, and long-range plans of HEDS are defined in the HEDS roadmap of the NASA Strategic Plan and are further clarified in the HEDS Enterprise Strategic Plan. As described in those plans, the accomplishment of these goals enables historic improvements in our understanding of nature, in human accomplishment, and in the quality of life.

Highlights of Performance and Accomplishments

Detailed discussion of FY 2001 performance measures is included in the FY 2001 Performance Report at *http://ifmp.nasa.gov/codeb/library/library.htm.* Highlights of the performance and accomplishments are discussed below.

Goal: Expand the space frontier.

The Advanced Programs Office of the HEDS Enterprise focuses on enabling future collaborative human and robotic exploration and commercial development of space. These goals are pursued through integrated and coordinated efforts involving all the Enterprises, Centers, industry, and academia. Understanding and approaching the challenges with viable solutions is achieved by leveraging resources and expertise.

Objective: Expand human exploration through collaborative robotic missions.

Preparations were completed for experiments for a 2001 mission to Mars that was canceled. HEDS continues to participate in planning for future robotic missions to Mars and is holding its Mars In-situ Propellant Production Precursor (MIP) experiment in storage should the opportunity for a new mission arise. With the support of HEDS, the National Research Council has made real progress in its study to better understand risks and solutions associated with future human exploration of Mars.

Objective: Define innovative human exploration mission approaches.

Throughout FY 2001, and despite cancellation of funding for the externally competed HEDS Technology and Commercialization Initiative (HTCI) Cooperative Agreement Notice (CAN), NASA continued to define potential human and robotic exploration architectures and technologies through the separately funded efforts of an interagency planning team. As reported in FY 2000, the Decadal Planning Team (now known as the NASA Exploration Team or NEXT) focused upon science-driven and technology-enabled capabilities for future applications and destinations. Completed studies have been very fruitful and will continue into FY 2002.

Objective: Invest in enabling high-leverage technologies.

The HTCI, funded at a level of $20 million in FY 2001, was initiated following a six-month program formulation involving numerous Enterprises, Centers, universities, and companies. The focus of this initiative was to identify new concepts and develop new technologies to enable the future human/robotic exploration and commercial development of space.

The HTCI issued a CAN in February 2001 (planned to be the first of an annual competitive solicitation for HEDS Research and Development (R&D)) that yielded 152 submitted proposals, from which 43 were recommended for funding in May 2001. The resulting program would have had a total scope of $40 million over 24 months, including $12 million in cost-sharing from non-NASA sources. In the second quarter of FY 2001, however, HTCI funds were frozen, and in the fourth quarter of FY 2001, they were transferred to the ISS Program to cover budget issues. In lieu of HTCI as a means of implementing technology research in the near term, efforts to foster development continue by means of cooperative interaction among the Enterprises and Centers.

Figure 25: Space Shuttle *Discovery*

Goal: Enable and establish a permanent and productive human presence in Earth orbit.

Objective: Provide safe and affordable access to space.

There were seven successful expendable launch vehicle launches in FY 2001. The Space Shuttle continues its outstanding record of safely and successfully supporting all of its customers, including the ISS and HST. The goal of the Space Shuttle program is to provide safe, reliable, and affordable access to space. The Shuttle is the only U.S. vehicle that provides human transportation to and from orbit (Figure 25). The priorities of the program are to 1) fly safely, 2) meet the flight manifest, 3) improve mission supportability, and 4) continuously improve the system. Process improvements, along with hardware and software enhancements, have reduced the risk of loss of vehicle and crew during ascent.

Figure 26: STS-98 Spacewalk

Seven successful Space Shuttle missions were supported in FY 2001 as planned, with all scheduled Shuttle flights going to the ISS. All NASA-managed launches successfully deployed their payloads in the proper orbit.

- STS-92 marked the 100th Space Shuttle mission. This mission added features to ISS, including the first exterior truss structure, the third docking adapter port, and a non-propulsive electrically powered attitude control system.
- STS-97 provided solar arrays, which are necessary for an early power supply on the ISS.
- The U.S. Destiny Research Lab was delivered to ISS on STS-98. This marked the 100th spacewalk by an American (Figure 26).
- Two ISS crew transfer missions were accomplished on STS-102 and 105.
- STS-100 delivered the Canadian Space Station Remote Manipulator System, the Station's mechanical arm, which is needed to perform assembly operations on later flights.
- STS-104 delivered the Joint Airlock, which provides ISS-based ExtraVehicular Activity, or spacewalking, capability. It was also the inaugural flight of the new Block 2 engine (which, because of increased pump robustness, will result in a more reliable and safer engine).

In April 2001, the Shuttle program celebrated the 20th anniversary of the first Space Shuttle flight, having carried more than three million pounds of cargo and six hundred passengers into space to date. Space Shuttle *Columbia*'s initial flight took place on April 12, 1981.

The primary objective of the safety upgrades is to achieve major reductions in long-term operational risk.

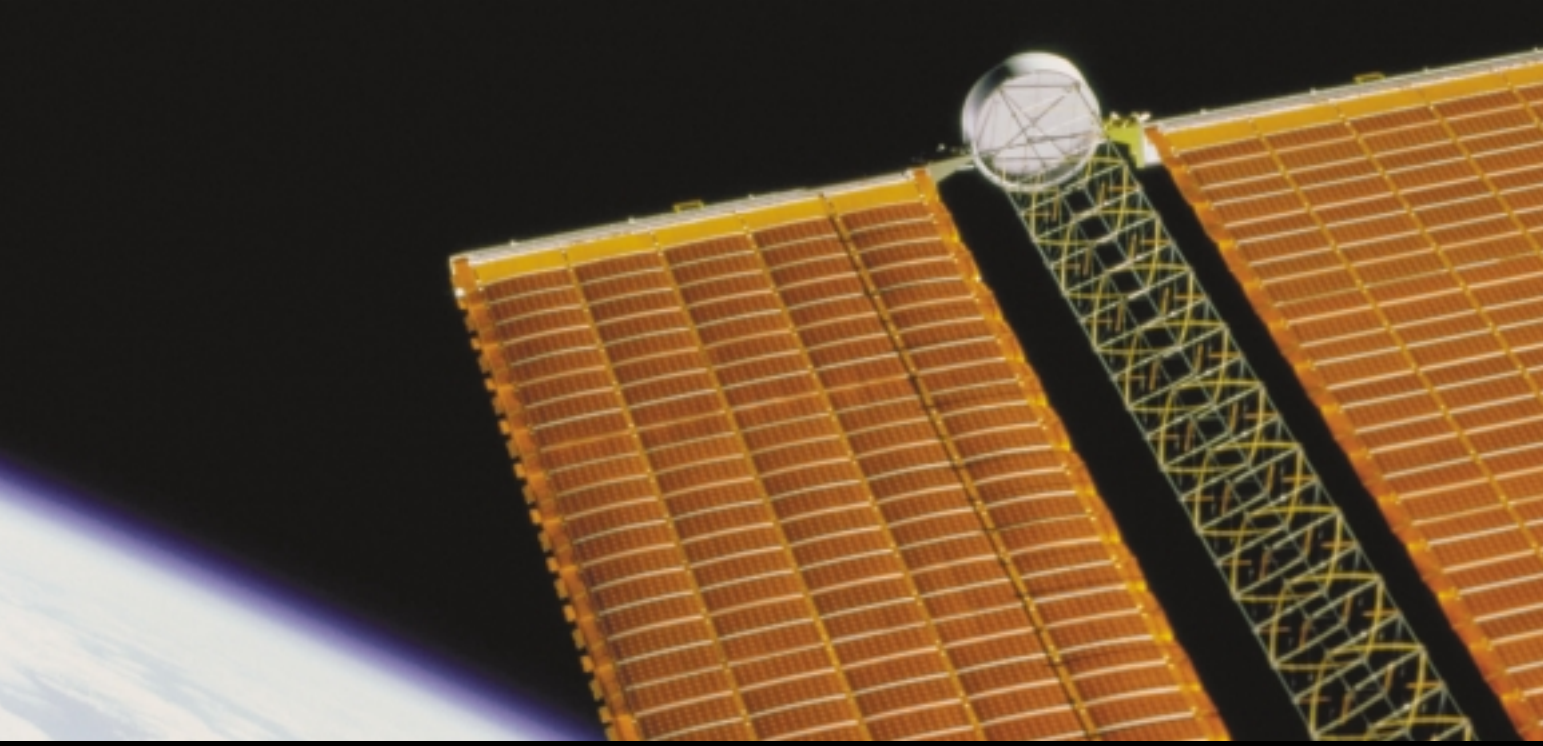


Figure 27: Solar Array

During FY 2001, all flight-certification testing of the high-pressure fuel turbopump was accomplished. In addition, system development approval was obtained for the Advanced Health Management System (AHMS) Phase I, External Tank Friction Stir Weld, Main Landing Gear (MLG) Tire/Wheel Improvement, and Cockpit Avionics Upgrade (CAU) Increment I.

The primary objective of supportability upgrades is to provide replacement systems for those existing systems that are already or are becoming obsolete and that will not reliably support Space Shuttle operations through at least 2012. Supportability upgrades primarily mitigate obsolescence issues and potentially enhance performance, reduce processing time, or reduce operations costs. Currently, there are several supportability upgrades in development.

Figure 28: The International Space Station

Objective: Deploy and use the ISS to advance scientific, exploration, engineering, and commercial objectives.

The ISS made remarkable onorbit and technical progress during FY 2001. The year began with the Unity Node, Zarya Functional Cargo Block, and Zvezda Service Module operating normally onorbit. Since October 2000, seven Space Shuttle missions and eight Russian Progress and Soyuz vehicle missions have been completed to the ISS. Phase II of the ISS program has been achieved, providing a fully functional onorbit facility with research capability. NASA continues to work with the Administration, Congress, other advisory groups, and the international partners to resolve its remaining challenges related to ISS and discussed beginning on page 89 of this Report.

In October 2000, the first exterior framework truss structure segment and third docking adapter port were launched. Permanent human presence on the ISS began in November 2000 with the launch of a Russian Soyuz spacecraft carrying U.S. Commander William Shepherd and the Expedition 1 crew of Yuri Gidzenko and Sergei Krikalev. Batteries, thermal radiators, and two solar power arrays contributing an additional 19 kilowatts of power were added in December 2000 (Figure 27). Expedition 1 included five payloads in the areas of technology development, human research, and education. The heart of the U.S. research and operational control system was deployed in February 2001 with the launch of the U.S. Laboratory Destiny, the first long-term U.S. orbiting lab in over 20 years.

Leonardo, the first Italian-built logistics module, delivered the first research payload rack to the ISS in March 2001, allowing the second Expedition crew, also launched in March 2001, to increase research activities while continuing ISS outfitting (Figure 28). There were 18 different experiments, primarily

focused on biomedical research, initiated during the second Expedition. In April 2001, the primary contribution of Canada was deployed, a 60-foot-long state-of-the-art robotic arm, Canadarm2, which will play a key role in further assembly, operations, and maintenance activities (Figure 29). Rafaello, the second Italian-built logistics module, also carried two research payload multipurpose Express Racks to orbit. The U.S. Airlock Quest was installed in July 2001 enabling the ISS crew to conduct ISS-based spacewalks without the Shuttle present (Figure 30).

In August 2001, the third Expedition Crew and Leonardo carried two additional research payload multipurpose Express Racks, bringing the total research rack number to five (Figure 31). Ten new and eight ongoing payloads in the biomedical and microgravity areas continue operations on board the ISS. The U.S. and Russia continued throughout the year to provide logistics resupply with Shuttle outfitting flights, Russian Progress resupply missions, and Soyuz crew vehicle flights. The most recent contribution to what is already the most capable spacecraft ever deployed to orbit was the addition of the Russian Docking Module Pirs on September 17, 2001. This module provides additional docking ports for Progress and Soyuz vehicles and an airlock for supporting spacewalks using Russian spacesuits.

The ISS program dedicated more than 8,000 onorbit crew hours to assembly, vehicle operations, and payload operations during FY 2001. Assembly and operations experiences have demonstrated NASA's ability to integrate the large and complex ISS structure onorbit. To date, over 182,000 kg (400,000 pounds) of U.S. hardware have been delivered to KSC, with over 56,800 kg

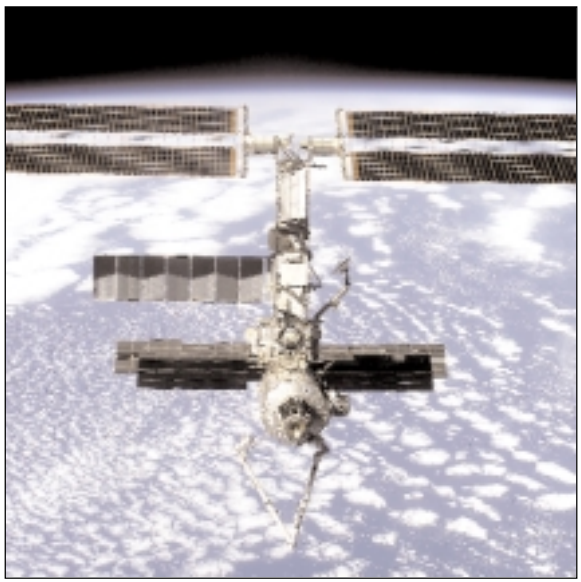


Figure 29 Space Station and Robotic Arm—Canadarm2

Figure 30: The U.S. Airlock Quest

(125,000 pounds) of U.S. hardware launched to orbit over the last year, bringing the total onorbit weight to over 138,000 kg (303,000 pounds). The prime contractor vehicle development work is now 98 percent complete. NASA continues onorbit research preparations, through fabrication and test of five additional research racks which will be onorbit by the end of 2002, as well as ongoing crew training and development of ground support infrastructure.

Objective: Meet sustained space operations needs while reducing costs.

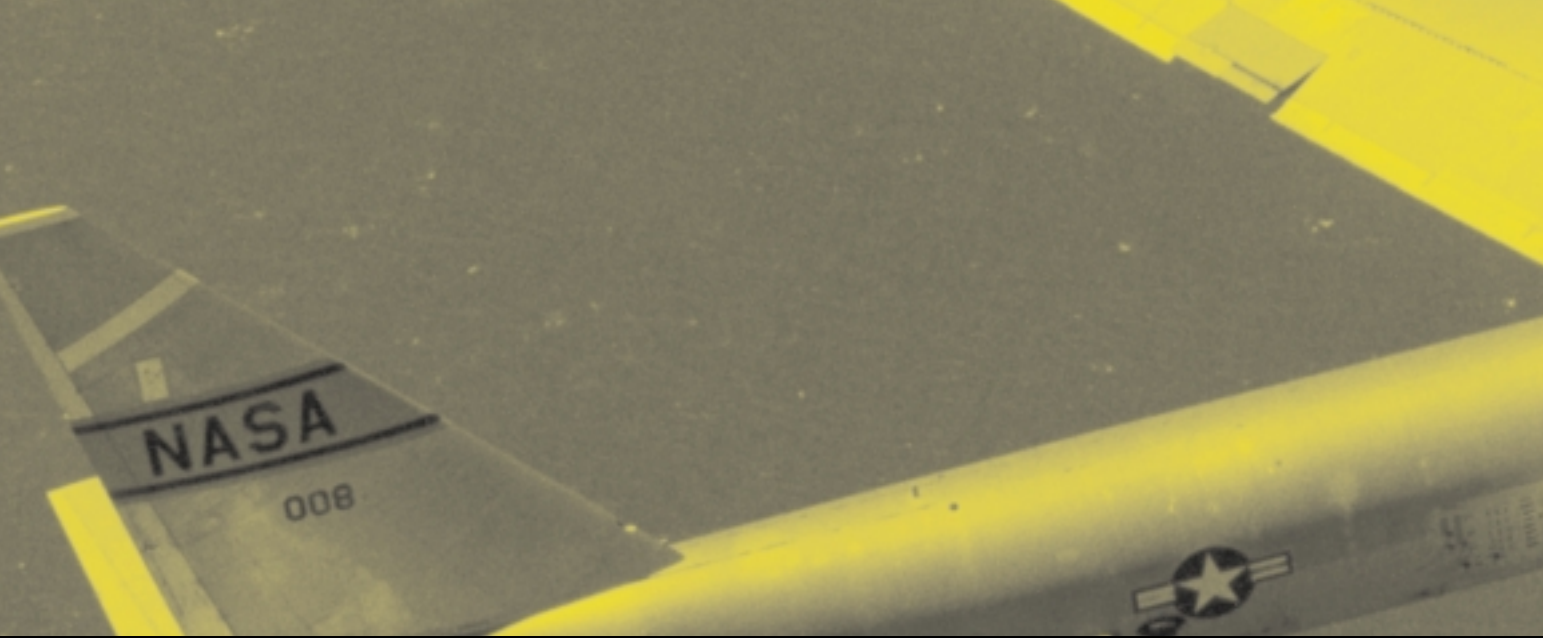
The Space Communications program serves the needs of users throughout NASA and has consistently met its planned objectives for commercialization and data delivery. The Consolidated Space Operations Contract (CSOC) successfully completed their second full year of operational support. To facilitate commercialization, the Space Communication program utilized 15 percent of its CSOC budget for commercial services in FY 2001. In addition, the Space Communications program successfully supported the ISS and all Space Shuttle missions. Overall, the networks provided almost all planned delivery data for all customers.

Figure 31: Expedition Crews 2 and 3

Goal: Share the experience and benefits of the discoveries of human space flight to benefit all people.

Objective: Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.

Three student-designed competitions related to planetary scientific exploration were completed. These projects highlight fresh ways to accomplish exploration objectives and build relationships among students, educators, and NASA scientists and engineers. The fourth annual HEDS-UP competition provided an opportunity for university design groups to share their studies with other schools, NASA, and industry representatives. Students and faculty, including undergraduate and graduate teams representing 13 universities, participated during the 2000–01 academic year. The third annual NASA Means Business project, sponsored by JSC and NASA Headquarters, competitively selected university teams to develop Customer Engagement Plans for the Mars Robotic exploration program and produce an outreach project. The eighth annual Great Moonbuggy Race, sponsored by MSFC, was held in April. High school and college students from 20 States applied their engineering skills and team spirit in designing, building, and operating human-powered vehicles along a simulated lunar terrain obstacle course. Prizes were awarded for best design and quickest traversal of the lunar course.



Aerospace Technology Enterprise

Mission

The mission of the Aerospace Technology (AST) Enterprise is to pioneer identification, development, verification, transfer, application, and commercialization of high-payoff aeronautics and space transportation technologies. The Enterprise plays a key role in maintaining a safe and efficient national aviation system and an affordable, reliable space transportation system. It directly supports national policy in both aeronautics and space as directed in the President's Goals for a National Partnership in Aeronautics and Research Technology, the National Space Policy, and the National Space Transportation Policy.

Strategic Goals and Objectives

AST's goals and related objectives for FY 2001 were as follows:

- Global civil aviation—Develop an environmentally friendly global air transportation system for the next century, of unquestioned safety, that improves the Nation's mobility:
  - Reduce the aircraft accident rate.
  - Reduce emissions of future aircraft.
  - Reduce perceived noise levels of future aircraft.
  - While maintaining safety, increase the aviation system throughput in all weather conditions.

- Revolutionary technology leaps—Revolutionize air travel and the way in which air and space vehicles are designed, built, and operated:
  - Invigorate the general aviation industry.
  - Provide next-generation design tools.
  - Provide next-generation experimental aircraft.

- Space transportation—Achieve the full potential of space for all human endeavor through affordable space transportation:

- Reduce the payload cost to low-Earth orbit.
- Reduce the cost of interorbital transfer and travel time for planetary missions.

- Research and Development (R&D) services—Enable and, as appropriate, provide, on a national basis, world-class aerospace R&D services, including facilities and expertise:
  - Provide world-class aerospace research and development services, facilities, and expertise.

AST addresses fundamental questions 5 and 6 (Figure 4). Near-, mid-, and long-range plans (along with revised goals and objectives) are identified in the Aerospace Technology Roadmap in the NASA Strategic Plan and elaborated in the Aerospace Technology Enterprise Strategic Plan. The outcome-focused nature of the objectives projects a preferred end state within air and space transportation systems. Achievement of these objectives requires a multiyear investment in research, technology development, and both ground and flight verification tests.

Highlights of Accomplishments and Performance

The Enterprise produced many exciting accomplishments in support of its goals and objectives that will directly benefit the American people through safer, more affordable, and environmentally friendly air travel and more efficient and affordable access to space. Detailed discussion of FY 2001 performance measures is included in the FY 2001 Performance Report at *http://ifmp.nasa.gov/codeb/library/library.htm*. Highlights of the performance and accomplishments are discussed below.

Goal: Global civil aviation—Develop an environmentally friendly global air transportation system for the next century, of unquestioned safety, that improves the Nation's mobility.

Research and technology play a vital role in ensuring the safety, environmental compatibility, and productivity of the air transportation system and in enhancing the economic health and national security of the Nation. However, numerous factors, including growth in air traffic, increasingly demanding international environmental standards, an aging aircraft fleet, and aggressive foreign competition, represent a formidable challenge to the Nation.

Objective: Reduce the aircraft accident rate.

During FY 2001, system design concepts showing the greatest promise for meeting the safety objective were selected in the areas of fire prevention, fire detection, synthetic vision, and integrated vehicle health management for continued development. Synthetic vision system (SVS) research is developing technologies with practical applications to eliminate low-visibility conditions as a causal factor to civil aircraft accidents, as well as replicating the operational benefits of flight operations on a clear, sunny day regardless of the outside weather condition or time of day. Flight demonstration of both head-up and head-down SVS display concepts intended for retrofit in commercial and business aircraft were conducted over a three-week period in August and September 2001. Seven evaluation pilots representing an aircraft manufacturer, the Federal Aviation Administration (FAA), and 3 major airlines conducted 11 research flights for a total of 106 airport approaches. The concepts were evaluated in flight tests designed to evaluate pilot acceptability and usability, including specific terrain awareness benefits. Early results indicate that pilot terrain awareness was significantly higher when using selected SVS display concepts than it was with present-day displays (Figure 32).

Figure 32: Synthetic Vision Display

Objective: Reduce emissions of future aircraft.

Oxides of nitrogen (NO_x) emissions are a known pollutant that degrades local air quality, while carbon dioxide (CO_2) affects global air quality and impacts climate. NASA research is targeted at vehicle, propulsion, and flight system technologies that significantly reduce pollution from aircraft through a two-prong approach: first, by developing critical engine technologies that provide a significant reduction in emissions (primarily NO_x), and second, by developing other technologies that provide a dramatic increase in efficiency that will result in reduced fuel use. By reducing the fuel use, both NO_x and CO_2 emissions will likewise be reduced.

Maturation of technology is key to its successful transition to industry. This is normally accomplished through a buildup of complexity, from laboratory testing of subcomponents to component testing in more realistic environments, to fully integrated testing in a relevant environment. Through system analysis performed in FY 2001, industry and NASA teams developed conceptual designs of advanced engines for each of the different classes of aircraft incorporating technologies in laboratory-level development. Analysis of these engines' designs indicates that both the goals of 1) 70-percent NO_x reduction relative to the 1996 International Civil Aviation Organization standard and 2) 15-percent CO_2 reduction for the subsonic transports relative to the current technology baselines are reachable if the promising subcomponent research continues to progress and is successfully matured.

Figure 33: Airframe and Engine Source Noise Testing

Objective: Reduce perceived noise levels of future aircraft.

NASA's vision for our air transportation system is to develop technology that will enable objectionable aircraft noise to be contained within compatible land-use areas around airports. Engine and airframe technologies, as well as aircraft operations, are being investigated to address these goals. Systems studies have shown that reduction in engine and airframe noise sources must be addressed simultaneously to effect a reduction in total aircraft noise. This way, an air transportation system free of noise constraints will meet citizens' quality-of-life expectations.

During FY 2001, full-scale static engine testing was conducted on a Pratt & Whitney 4098 engine to validate noise reduction from a combination of active/passive liner to control fan blade passage frequency, improvements to the scarfed inlet, and a reduced blade count fan/stator. Airframe noise reduction concepts (flap edge, slat cove, flap and slat trailing edge treatments, and landing gear modifications) were validated on a detailed 26-percent-scale Boeing 777 model tested in the Ames Research Center's 40 x 80-Foot Tunnel (Figure 33). In addition, two flight tests were conducted to validate engine system noise reduction. A "chevron" nozzle and other jet-noise-reduction concepts were validated on a Lear 25 aircraft, and both jet- and fan-noise-reduction concepts were validated on a Falcon 20. System analysis is underway to project the level of noise reduction, for large transports, of the concepts validated, but the 2-decibel minimum reduction goal was validated in flight tests for business-jet-class aircraft.

Objective: While maintaining safety, increase aviation system throughput in all weather conditions.

Flight delays in the U.S. aviation system have increased significantly over the past six years, with peak delays during summer months having doubled in only four years

(from 1996 to 2000). These delays are driven by both passenger demand and adverse weather and are expected to continue to escalate as a result of predicted increases in demand for passenger and cargo flights. In close concert with the FAA, NASA is developing technologies that will sufficiently increase the capacity of the National Airspace System to alleviate these delays without compromising safety.

During FY 2001, several decision-support tools were developed to improve communication and scheduling among users and controllers of the National Airspace System. The Collaborative Arrival Planner (CAP) tool was developed to exchange real-time air traffic control information with Airline Operational Control centers so that decisions made by the latter regarding their aircraft operations could be based on the most up-to-date information possible. The CAP has provided airlines with real-time air traffic situational awareness previously only available to the FAA and enabled them to make better decisions regarding flight diversions, gate utilization, push-back times, and so on, leading to improved efficiency of operation and financial savings. Also, an en route decision-support tool for efficient, conflict-free routing was developed, and the "Direct-to" decision-support tool underwent field testing in the Fort Worth Air Route Traffic Control Center, showing consistent flight savings for one Dallas/Fort Worth departure route that could be extended to other routes.

Goal: Revolutionary technology leaps—Revolutionize air travel and the way in which air and space vehicles are designed, built, and operated.

In order to develop aerospace systems of the future, revolutionary approaches to system design and technology development will be necessary. Pursuing technology fields in their infancy today, developing knowledge bases necessary for designing radically new aerospace systems, and performing efficient, high-confidence design and development of revolutionary vehicles are challenges in innovation. These challenges are intensified by the demand for safety in our highly complex aerospace systems.

Objective: Invigorate the general aviation industry.

NASA's general aviation investment is aimed at greatly expanding small aircraft operations at thousands of local and regional airports in the United States during nearly all weather conditions. This increase in reliable access offers transportation services that would allow more people to travel to more places in less time at an affordable price, as well as presenting new commerce opportunities for businesses.

During FY 2001, an enhanced navigation capability called "Highways in the Sky" was successfully flight-tested and subsequently demonstrated at the Oshkosh Air Show. Four "laboratory teams," each with a representative from the State aviation and transportation departments, private industry, general aviation user groups, and academia and other non-profit organizations, were also established to help develop and demonstrate Small Aircraft Transportation System (SATS) operating capabilities.

Objective: Provide next-generation design tools.

In FY 2001, significant improvements were demonstrated in time-to-solution on several engineering analysis tools for aerospace applications:

- Achieved a full jet engine compressor simulation in 2.5 hours—2,400 times faster than 1992 baseline.
- Achieved a full jet engine combustor simulation in 1.9 hours—1,617 times faster than 1992 baseline.

- Achieved capability to compute very complex flows about complex geometry in about 2.5 days—17 times faster than 1999 baseline.

- Demonstrated the ability to calculate instantaneous surface pressures and particle traces of a rocket engine turbopump in less than 1.3 days—32 times faster than 1999 baseline.

Objective: Provide next-generation experimental aircraft.

Environmental Research Aircraft and Sensor Technology (ERAST): The solar-powered Helios Prototype flying wing aircraft accomplished a new world record altitude of 96,863 feet over the Pacific Ocean on August 13, 2001 (Figure 34). This was the first time a non-rocket-powered aircraft has maintained flight this far above Earth. The record flight sets the stage for follow-on missions using a regenerative energy storage system under development to enable Helios to remain aloft for months at a time. The record altitude was achieved during daylight hours, relying on solar cells on the 247-foot wing's surface to provide electrical power. Production variants of Helios could see service as long-term Earth environmental monitors, as well as communications relays, reducing dependence on satellites and providing service in areas not covered by satellites. The successful flight at high altitude also provides NASA with information about flight on Mars, since the atmosphere at that height above Earth is similar to the atmosphere near the Martian surface.

Hyper-X Experimental Aircraft: NASA's X-43A is a 12-foot-long unpiloted research vehicle designed and constructed to demonstrate an airframe-integrated, "air-breathing"

Figure 34: Helios Prototype Aircraft

Figure 35: Hyper-X Release from B-52 Carrier Aircraft

propulsion system called a scramjet. Through a planned three-flight test program, the X-43A is obtaining aerodynamic and propulsion flight data to validate and extend ground-based results and analysis, including overall performance and operability. The first two tests are planned to achieve flight speeds approaching seven times the speed of sound (Mach 7), followed by a subsequent flight approaching Mach 10.

During the initial test on June 2, 2001, following separation from NASA's B-52 carrier aircraft, a malfunction occurred about eight seconds after ignition of the Pegasus motor, which caused the Hyper-X stack (X-43A vehicle and Pegasus booster) to depart from controlled flight (Figure 35). The booster was destroyed using the onboard flight termination system, with resulting debris safely contained within the pre-cleared range impact area in the Pacific Ocean. A Mishap Investigation Board established shortly after the flight has been gathering and analyzing the facts of the mishap to determine its cause(s) and recommend corrective actions to help achieve success on the second flight of the test program.

Goal: Space transportation—Achieve the full potential of space for all human endeavor through affordable space transportation.

Safe, affordable Earth-to-orbit space transportation is the key enabler of the commercial development, civil exploration, and national security of space. Human space flight remains a hazardous endeavor in spite of advances in aerospace technology. Bold new markets such as space tourism, space business parks and space solar power remain closed due to the high cost and low reliability of current systems. NASA is addressing these challenges through development of technologies and architectures for the next generation of Reusable Launch Vehicles (RLV) and concurrently developing advanced technologies required for future generations of RLVs. These future transportation systems will enable a broad expansion in scientific research, ensure the seamless security of aerospace, open new commercial markets, and enable human exploration and development of space.

Objective: Reduce the payload cost to low-Earth orbit.

The Space Launch Initiative (SLI) is a comprehensive research and technology development effort aimed at dramatically increasing the safety, reliability, and affordability of space transportation systems. Under the SLI, NASA awarded contracts valued at $767 million dollars to 22 contractors, including large and small companies, to foster maximum competition during FY 2001. This initial investment will be used to develop concepts and technologies to pioneer this extraordinary effort, which is expected to make the space transportation vehicle at least 10 times safer and crew survivability 100 times greater—at one-tenth the cost of today's space launch systems.

Although neither the X-33 nor the X-34 technology demonstrators were selected for continuation under the SLI competitive solicitation, an opportunity to gather applicable component validation was exercised through testing of the electromechanical actuators on the X-33's linear aerospike engine (Figure 36).

Objective: Reduce the cost of interorbital transfer and travel time for planetary missions.

The Propulsive Small Expendable Deployer System (ProSEDS) is an experiment in the area of tether transportation systems aimed at demonstrating innovative low-cost orbit transfer and power generation. The development of the secondary payload experiment was completed in preparation for a planned August 2001 launch on a Delta II rocket, but the launch was delayed due to launch provider priorities. The ProSEDS experiment has been rescheduled as part of a June 2002 launch.

Figure 36: Linear Aerospike Flight Engine Test

Goal: Research and Development (R&D) services—Enable and, as appropriate, provide, on a national basis, world-class aerospace R&D services, including facilities and expertise.

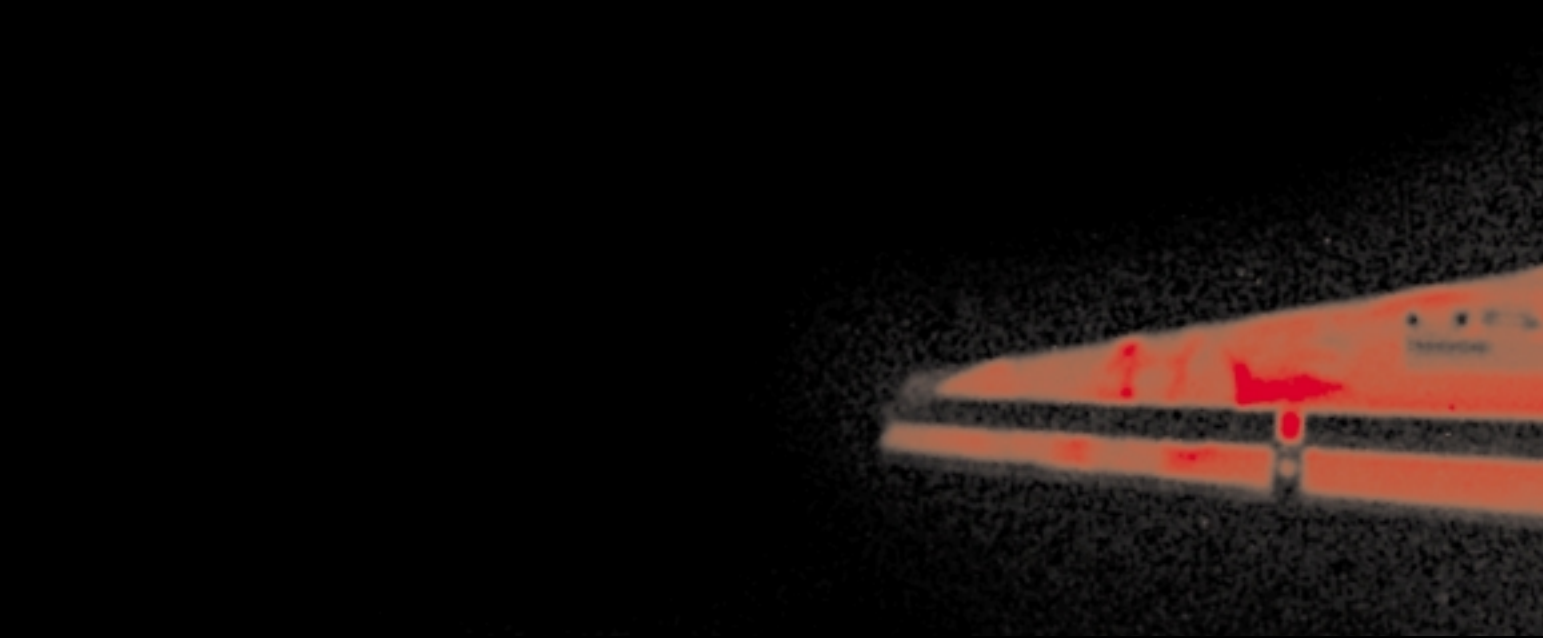
Objective: Provide world-class aerospace research and development services, facilities, and expertise.

It is essential that NASA technology be actively transferred to "end users" such as U.S. industry, the FAA, and the Department of Defense in order to yield a benefit to the Nation's economy, national security, and quality of life. During FY 2001, the user community acknowledged transfer of the following new technologies and processes from the Enterprise:

- Modifications to aerospace design codes that enable efficient use of parallel and distributed computer systems;
- CART3D software package for conceptual and preliminary design of aerospace vehicles;
- PEGASUS 5 software for joining overset grids;
- Highway in the Sky navigation system;
- Deployment of native multicast protocols within their network domains (e.g., Sprint, Qwest, Level3);
- Multicast capabilities in Cisco Systems, Inc., routers;
- Numerical Propulsion System Simulation (NPSS) V1 software (General Electric, Pratt & Whitney);
- Low NO_x combustor technology utilized in PW4000 TALON II;
- Spatial Auditory Display Technology (speech communications) to BreakAway Technologies;
- Ultra Safe Gear design/guide;
- Composite Stringer Fatigue Life Model;
- Highly accurate computer analysis for predicting helicopter crash damage in soil and water and designing safer, more crashworthy aircraft;
- Web-based, highly efficient design tools for designing lighter, stronger aircraft structures;
- New lightweight graphite composite material for fire-resistant engine compartment doors that can withstand a 2,000-degree Fahrenheit flame for 15 minutes; and
- New fly-neighborly, low-noise approach paths to reduce rotorcraft noise by 10 decibels.

Three NASA Research Centers (Ames, Glenn, and Langley) conduct customer satisfaction interviews at selected wind tunnels and motion-based simulators to gauge and improve their services to users. All respondents during FY 2001 were "satisfied" with the service, and 80 percent were "highly satisfied."

AST research and technology programs provide important contributions to education and public understanding of air and space transportation. A close working relationship with the educational community is a vital component of the Enterprise mission. Education products from existing education programs in FY 2001 included the production of a jet engine demonstration model for Explorer Scouts and other student programs; "The Plane Game" for grades 2 through 6; development of educational videos and CDs, development of programs broadcast on NASA's distance-learning television programs: *NASA Connect*, *The "Why" Files*, and *Destination Tomorrow*; and supporting teacher and student workshops at the various NASA Centers. In addition, education plans were developed for all new programs in FY 2001, including the Small Aircraft Transportation Systems Program, the Quiet Aircraft Technology Program, the 2nd Generation Reusable Launch Vehicle Program, and the Intelligent Systems Program. These plans have been designed in collaboration with Center Education Offices to address goals and objectives of the overall NASA education program while involving educators and students in the unique activities of NASA's AST Enterprise.



Crosscutting Processes

The work of the Enterprises is supported by four Crosscutting Processes. Crosscutting Processes are common operating principles, coordinated across the Agency, that enhance returns on NASA work toward diverse programmatic and functional objectives. Processes used to develop and deliver products and services to customers are as follows:

- Manage Strategically,
- Provide Aerospace Products and Capabilities,
- Generate Knowledge, and
- Communicate Knowledge.

Through these processes, inputs such as policies and resources are transformed into outputs such as knowledge.

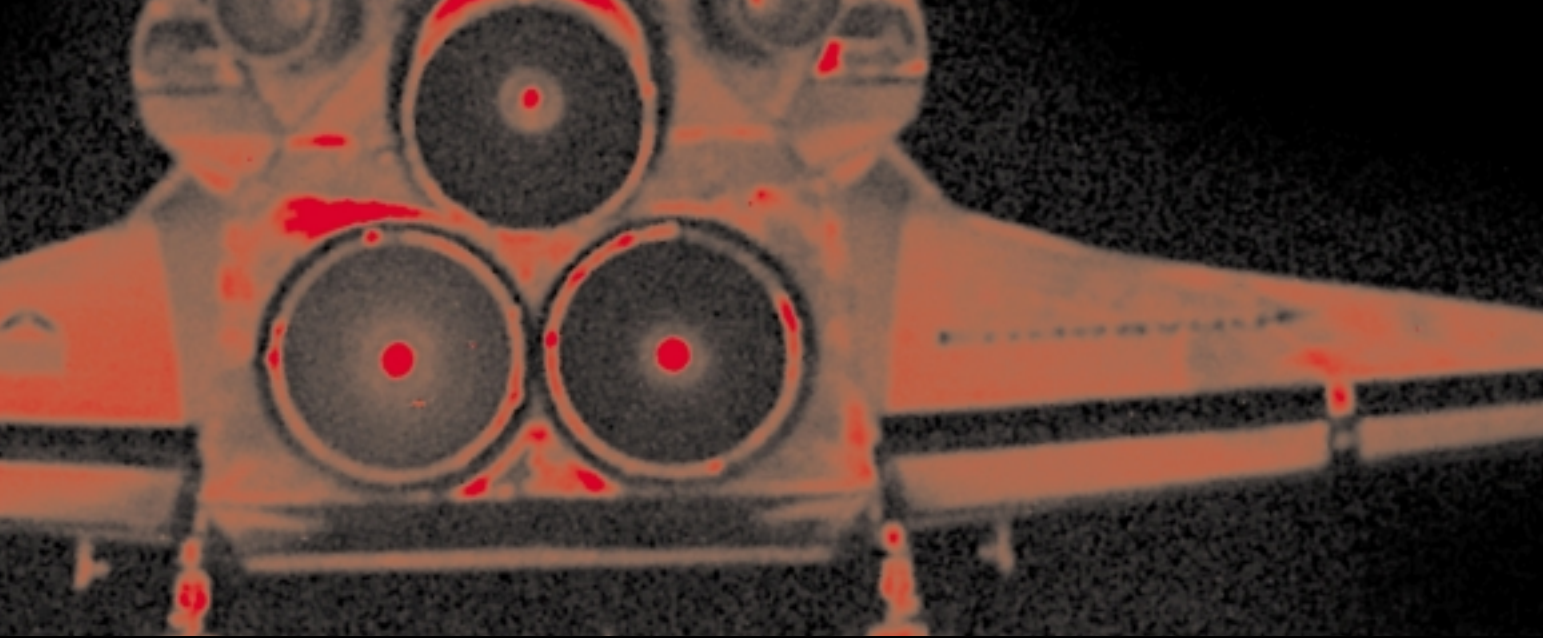
Manage Strategically

Managing NASA physical and human resources effectively and efficiently is critical to achieving the programmatic goals and objectives contained in the strategic, implementation, and performance plans. By integrating general management practices with the strategic process, all parts of the Agency can proceed together coherently, comprehensively, and expeditiously toward achieving a single set of strategic goals. To do this successfully, NASA must leverage limited resources; standardize processes where it makes sense; streamline processes for timely results; and ensure rapid, reliable, and open exchange of information.

Strategic Goal and Objectives

The goal and related objectives of the Manage Strategically process for FY 2001 were as follows:

- Ensure that the Agency meets its responsibilities safely and effectively, as it allocates its resources to support NASA's strategic, implementation, and performance plans:



- Assess, document, communicate, and mitigate the programmatic and technical risks associated with NASA programs and projects; focus special attention on addressing and mitigating safety and health risks presented by our work environment and our projects.
- Improve the effectiveness and efficiency of Agency acquisitions through the increased use of techniques and management that enhance contractor innovation and performance.
- Optimize Agency investment strategies and systems to align human, physical, and financial resources with customer requirements while ensuring compliance with applicable statutes and regulations.
- Ensure that information technology provides an open and secure exchange of information, is consistent with Agency technical architectures and standards, demonstrates a projected return on investment, reduces risk, and directly contributes to mission success.

Highlights of Performance and Accomplishments

Detailed discussion of FY 2001 performance measures is included in the FY 2001 Performance Report at *http://ifmp.nasa.gov/codeb/library/library.htm*. Highlights of the performance and accomplishments are discussed below.

Goal: Ensure that the Agency meets its responsibilities safely and effectively as it allocates its resources to support NASA's strategic, implementation, and performance plans.

Objective: Assess, document, communicate, and mitigate the programmatic and technical risks associated with NASA programs and projects; focus special attention on addressing and mitigating safety and health risks presented by our work environment and our projects.

Continuous Risk Management (CRM), developed in conjunction with Carnegie-Mellon University, is NASA's process for managing risks associated with the Agency's programs and projects. CRM is in use throughout NASA to identify, analyze, plan (for the way risks are handled), track, control, document, and communicate programmatic and technical risks.

NASA's most important core value is the safety of its workforce and high-value equipment and property. The Agency Safety Initiative is aimed at reducing the occurrence of injury and occupational illnesses in the workplace. In the past year, NASA continued its success in reducing injuries with a rate of 0.75 occurrences per 100 workers, well below the goal specified by the President's direction arising from the Federal Worker 2000 Presidential Initiative. That initiative requires executive agencies to reduce the overall occurrence of injuries due to occupational injury or illness by 3 percent per year from the FY 1997 baseline, which, for NASA, was 1.27 occurrences per 100 workers. To continue this positive trend, Centers are working to be certified under the Occupational Safety and Health Administration's Voluntary Protection Program (VPP). NASA has a goal for all its Centers to be VPP-certified by the end of FY 2002. By the end of FY 2001, 2 of the 10 Centers had been certified.

Each year since FY 1999, the Agency has gauged both management's and employees' perception of the effectiveness of its safety and health program through a survey known as the Performance Evaluation Profile. Scores derived from this survey have been increasing steadily during this period and indicate that there is a shift in the NASA culture to one of increased management and employee participation in mishap prevention. Finally, a number of Critical Facilities Safety Projects contracts were awarded to reduce safety risks and reinforce the commitment to zero mishaps.

Objective: Improve the effectiveness and efficiency of Agency acquisitions through the increased use of techniques and management that enhance contractor innovation and performance.

NASA continues to enhance its procurement processes to improve system access to users and expand the base of qualified competitors. The percentage of contract dollars obligated to Performance Based Contracts (PBC) has steadily increased. Numbers of contract awards and dollars, however, do not accurately reflect the total effort at improving procurement systems because the small business program is supported in a number of outstanding ways in addition to contract awards. A no-cost, three-day intensive training program for small businesses on ways to market and perform for NASA and its prime contractors is regularly offered. NASA also offers aeronautics and science forums enabling small businesses to present their capabilities to Center technical and management representatives.

The Minority Business Resource Advisory Committee and the NASA/Prime Contractor Roundtable assist in ensuring that small businesses are integrated into programs to the maximum extent practicable. NASA continues to aggressively pursue opportunities to expand the aerospace industrial base needed to support missions by awarding over 19 percent of the Agency's contract dollars to small disadvantaged businesses, including women-owned businesses, historically Black colleges and universities, and other minority educational institutions.

Objective: Optimize Agency investment strategies and systems to align human, physical, and financial resources with customer requirements while ensuring compliance with applicable statutes and regulations.

NASA's focus on the restructure and revitalization of the workforce involves a human capital management strategy centered on the following:

- attracting and retaining a high-caliber, high-tech, and diverse workforce whose skills and competencies are aligned with mission objectives;

- investing in technical training and career development of this critical resource;

- cultivating a continued pipeline of talent to meet future science, math, and technology needs; and

- ensuring that the workforce represents the country's diverse population.

After years of downsizing, Centers are reestablishing recruitment networks and rebuilding the once-extensive Co-operative Education Program. The Agency also will continue to use the Presidential Management Intern Program and student employment programs as sources for entry-level hires.

In December 2000, Federal agencies were given the authority to establish their own Federal Career Intern Program (FCIP) to recruit individuals into developmental positions at the GS-5, -7, or -9 levels. NASA designed FCIP plans that promote flexible and expeditious recruitment processes, thereby enabling it to compete more successfully with streamlined hiring practices in the private sector. It was one of the first Federal agencies to hire individuals under this program and, based on initial success, anticipates that it will be a useful tool for hiring "fresh-out" (i.e., newly graduated) engineers and scientists. In May, the National Recruitment Initiative was established to develop strategies to attract and hire a highly technical science and engineering (S&E) workforce, focusing on "fresh-outs" to counterbalance the aging of the current workforce. This initiative leverages partnerships and alliances with universities and coordinates recruitment opportunities and outcomes. Beginning in August, NASA was the first to implement a new Federal program whereby agencies were able to begin repaying student loans to attract or retain employees. The Automated Staffing and Recruitment System (NASA STARS), a pathfinder project under the Integrated Financial Management Program, was also initiated in FY 2001. NASA STARS is an automated résumé management process that uses a computer-assisted rating and referral system which simplifies and expedites hiring, allows applicants to apply online, and enables the creation of a skills database.

Considerable emphasis is placed on training and development of the workforce. "Just-in-time" training opportunities for project leaders and team members are emphasized to improve project team competencies. New FY 2001 online, desktop-based training products included 11 new online courses on NASA's Site for Online Learning and Resources; the development of an interactive Project Management simulation based on the first of the "Faster, Better, Cheaper" missions (Mars Pathfinder); and the initiation of an online journal (*Academy Sharing Knowledge*) that shares lessons learned in Project Management. Additional resources were devoted to development of new leadership (Global Leadership Program and the NASA Business Education Program) and engineering courses (Concurrent Design Exercises, Comprehensive Systems Skills Initiative, NASA Engineering Training Design Exercise, and Mastering Process Improvement). The NASA Fellowship Program was redesigned to align it more closely with NASA strategic plans, further strategic objectives, and ensure that development experiences are leveraged on reentry into the workplace. NASA also updated its leadership model specifying the latest cutting-edge skills and behaviors required for effective leadership. The model is linked to the Strategic Plan and defines skill requirements for team leaders through senior executives. The new Global Leadership program provides an international perspective and skills for management in an increasingly global environment. Partnerships were established with

academia to provide opportunities in leadership and project management development, including a partnership with the Massachusetts Institute of Technology in project management and another with the Darden Business School of the University of Virginia to develop a business education program.

NASA continues to look for ways to help ensure a future pipeline of talent from which it and others can draw. The new Agencywide Undergraduate Student Research Program provides students with opportunities for participating in research and gaining experience in their chosen disciplines. It was developed to extend and strengthen NASA's commitment to educational excellence and university research and to highlight the critical need to increase the Nation's undergraduate and graduate science, engineering, mathematics, and technology skill base.

Although NASA did not achieve the workforce diversity levels hoped for in FY 2001, it has consistently increased representation of women and minorities since FY 1999. Representation of individuals with targeted disabilities has remained about the same since FY 1999.

In FY 2001, NASA totally restructured its Integrated Financial Management (IFM) program after terminating the Agency's contract with the incumbent system developer. Management reaffirmed the critical need for a new integrated financial management system and initiated a new planning effort based on benchmarks in the commercial and Federal sectors. The original plan for a large-scale implementation approach was abandoned in favor of individual smaller scale projects for specific functions based on the availability of commercial software applications. A best-of-suite strategy was adopted, in which Core Financial System (CFS) requirements would drive the selection of an Enterprise Resource Planning application and key software selection criteria included the ability of that application to be extended to fill a number of other requirements, as well as past performance.

An Agency-level project team is now in place at MSFC, the lead Center for the IFM project, and the CFS design phase began in February 2001. The CFS module of the IFM system will be delivered to MSFC and then rolled out to Headquarters and each of the remaining Centers in three "waves." Each Center will receive the full functionality of the CFS as its "wave" is rolled out. Full implementation of CFS will be complete by mid-FY 2004.

In addition, three "pathfinder" projects will test the new processes and technical requirements for implementation of new administrative systems for Travel, Résumé, and Position Description Management.

Objective: Ensure that information technology provides an open and secure exchange of information, is consistent with Agency technical architectures and standards, demonstrates a projected return on investment, reduces risk, and directly contributes to mission success.

NASA's strategic focus areas for Information Technology (IT) are 1) cost-effective common infrastructure and services, 2) safety and security, 3) transfer of innovative technology into the infrastructure, and 4) emerging IT areas. In FY 2001, the Chief Information Officer also identified the Outsourcing Desktop Management Initiative (ODIN) and IT Security as areas of special focus. NASA made significant achievements in IT service, support, security, and training. It substantially improved IT support while maintaining customer ratings of "satisfied" to "very satisfied" and held or substantially reduced costs per resource unit to the baseline.

To attain a trained workforce of users, managers, system/network administrators, and IT Security Managers, IT

Security Awareness training was made available to civil service employees, civil service managers, and civil service system administrators. Web-based training modules were developed and implemented that enable employees to take IT Security training at their desks, require that employees pass a test as part of the training, and allow management to track who has passed the course.

All Centers detected and reduced systems vulnerabilities. The Vulnerability Reduction Program was expanded to include complex vulnerabilities requiring hands-on verification. This added level of vulnerability reduction targets a list of high-risk exploits identified by outside experts as well as the in-house IT security community.

Step-by-step guidelines were acquired for securely configuring major operating systems to improve user authentication and data protection. A public key infrastructure was developed for digital signature, authentication, and encryption in support of secure electronic messaging, IFM activity, and electronic commerce initiative. The IT community identified functions required to protect information and data from disclosure and began a program to ensure that employees have the capability to protect information and data.

NASA initiated a number of programs to effectively detect and thwart intrusion attempts, including a Critical Infrastructure Protection Program integrated into the IT Security Program to focus on ensuring that adequate security is provided for Minimum Essential Infrastructure assets. NASA began implementing Secure E-mail Plug-in—a software program that enables users to send secure e-mail with digital signature over the Internet.

The Chief Information Office funded a number of pilot projects targeted at improving IT practices. Some examples include projects addressing directory-enabled networking, Public Key Infrastructure (PKI), remote control of vulnerability scanning devices, and PKI-based strong authentication and granular authorization within the NASA Acquisition Internet Service.

With an understanding of the essential role that software systems play in mission success, NASA specialists developed a wide variety of notable scientific/engineering applications during FY 2001. Some examples include the Internet-based Global Differential GPS (IGDG) for real-time positioning and orbit determination, the Control Designer's Unified Interface for the rapid modeling and analysis of flight control systems for new aircraft, and the Numerical Propulsion System Simulation for aerospace system design and analysis.

Provide Aerospace Products and Capabilities

The Provide Aerospace Products and Capabilities (PAPAC) process is the means by which NASA's Strategic Enterprises and their Centers deliver systems (ground, aeronautics, and space), technologies, data, and operational services to customers. Through the use of Agency products and capabilities, customers can conduct research, explore and develop space, and improve life on Earth. This process is conducted by the five Strategic Enterprises and their Centers and enables them to deliver products and services to customers more effectively and efficiently.

Strategic Goal and Objectives

PAPAC's goal and related objectives for FY 2001 were as follows:

- Enable NASA's Strategic Enterprises and their Centers to deliver products and services more effectively and efficiently while extending the technology,

research, and science benefits broadly to the public and commercial sectors:

- Reduce the cost and development time for delivering products and operational services.
- Improve and maintain NASA's engineering capability.
- Capture and preserve engineering and technological process knowledge to continuously improve NASA's program/project management.
- Facilitate the insertion of technology into all programs and proactively transfer technology, form commercialization partnerships, and integrate all innovative approaches to strengthen U.S. competitiveness.

Highlights of Performance and Accomplishments

Detailed discussion of FY 2001 performance measures is included in the FY 2001 Performance Report at *http://ifmp.nasa.gov/codeb/library/library.htm*. Highlights of the performance and accomplishments are discussed below.

Goal: Enable NASA's Strategic Enterprises and their Centers to deliver products and services more effectively and efficiently while extending the technology, research, and science benefits broadly to the public and commercial sectors.

Objective: Reduce the cost and development time for delivering products and operational services.
Overall, costs and schedules for the development and upgrade of major scientific facilities and capital assets were not reduced to the planned average percentage of cost and schedule estimates. Some schedule delays resulted from a diminishing opportunity of some projects, such as X-37, being launched on the Space Shuttle, as originally planned. Other instances of spacecraft and instrument technical challenges in software and assembly had an impact on original baseline estimates for cost and schedule on projects such as X-38 development, the Space Infrared Telescope Facility Program, and the Relativity Mission/Gravity Probe B. And while independent review teams concluded that the ISS onorbit capability is extraordinary, the ISS experienced both cost and schedule problems due to underestimating.

Objective: Improve and maintain NASA's engineering capability.

Minimal unscheduled downtime in FY 2001 reflects the effectiveness of NASA's engineering capability as demonstrated by the over-99-percent availability of spacecraft and major ground facilities.

Objective: Capture and preserve engineering and technological process knowledge to continuously improve NASA's program/project management.

One of NASA's challenges is to improve efficiency and effectiveness in executing programs and projects. Major revisions to NPG 7120.5, NASA Program and Project Management Processes and Requirements, provide more extensive description, clarification, and guidance on processes involved in program and project management. The revisions include lessons learned, including NASA Integrated Action Team (NIAT) recommendations. The NIAT action plans represent a systems solution to continually improve NASA's ability to effectively execute its programs and projects. This involves a comprehensive set of practices that focus on the objectives of well-prepared people, sound decisionmaking, and effective communications. Emphases include more rigorous program and project formulation, balance of scope and resources, continuous evaluation of mission risk profile, and inclusion of management and stakeholders in the mission risk acceptance process. Additional areas of improvement include software development and assurance, the inte-

grated review process, surveillance, verification and validation, and knowledge management. Implementation of the NIAT Action Plans, which are in process, and the initiation of the requirement for earlier and more rigorous life-cycle cost estimating for all major projects will also improve program and project management.

Objective: Facilitate the insertion of technology into all programs and proactively transfer technology, form commercialization partnerships, and integrate all innovative approaches to strengthen U.S. competitiveness.

NASA contributed over 16 percent of its R&D investments in commercial partnerships. By relating technology goals to anticipated mission needs, additional innovative approaches to technology challenges will be stimulated and more cooperative programs with outside partners who share common goals will be promoted. This should increase the transfer of NASA-sponsored technology into non-aerospace applications, resulting in an even greater return on investment.

Generate Knowledge

The Generate Knowledge process is the process by which new scientific and technological knowledge is acquired from exploring the Earth system, the solar system, and the universe; from researching biological, chemical, and physical processes in the space environment; and from performing aeronautics and aerospace activities. Missions and programs offer opportunities to conduct research using unique platforms such as aircraft, spacecraft, and sounding rockets. Information acquired from our research is useful to scientists, engineers, technologists, natural resource managers, policymakers, educators, and the general public. Generating knowledge is central to the mission and is the primary means through which we seek answers to our fundamental questions.

Strategic Goal and Objectives

The goal and related objectives of the Generate Knowledge process for FY 2001 were as follows:

- Extend the boundaries of knowledge of science and engineering to capture new knowledge in useful and transferable media and to share new knowledge with customers.

  The objectives have been established to improve the efficiency with which we:
  - acquire advice from diverse communities;
  - plan and set research priorities;
  - select, fund, and conduct research programs;
  - archive data and publish, patent, and share results; and
  - collaborate with old and new partners.

Highlights of Performance and Accomplishments

Detailed discussion of FY 2001 performance measures is included in the FY 2001 Performance Report at *http://ifmp.nasa.gov/codeb/library/library.htm*. Highlights of the performance and accomplishments are discussed below.

Goal: Extend the boundaries of knowledge of science and engineering to capture new knowledge in useful and transferable media and to share new knowledge with customers.

Objective: Acquire advice from diverse communities.

NASA acquires advice from diverse communities to ensure that its research programs are at the forefront of the various scientific disciplines it funds. This advice is gathered by two principal methods—through the Enterprises'

Federal Advisory Committee Act (FACA)-chartered advisory committees for each of the science Enterprises and through external reviews by organizations such as the National Research Council. The Enterprises have continued to acquire advice through their advisory committees, all of which met on schedule and collectively submitted letters of advice as planned.

Objective: Plan and set research priorities.

The recommendations of the diverse communities are used to help plan and set research priorities documented in the Enterprises' strategic plans. These plans are updated periodically to ensure that programs' research directions follow the latest scientific priorities. The SSE and ESE released updated Strategic Plans in December 2000. The plans may be accessed at *http://spacescience.nasa.gov/admin/pubs/strategy/2000/index.html* and *http://www.earth.nasa.gov/visions/stratplan/index.html*, respectively. The newly formed BPRE and the HEDS Enterprise plans were not released as planned during FY 2001. The HEDS completed plan was released in November 2001. The new strategic plan for the BPRE was delayed due to restructuring of the ISS research program and will be released in the fall of 2002.

Objective: Select, fund, and conduct research programs.

The directions outlined in the strategic plans guide the solicitation and peer review of research proposals. Only the most meritorious peer-reviewed research is selected and funded. In aggregate, these funded grants form the core of NASA's research programs. The Agency has continued to select and fund its research via merit review. For the third year in a row, at least 80 percent of its research funds for the science codes were subjected to peer review. In addition, the Agency increased the number of Principal Investigators funded by the science codes.

Objective: Archive data and publish, patent, and share results.

NASA ensures that the public and other nonscientific communities are kept abreast of the latest discoveries by maintaining data archives and Web sites. The process does not include research of a proprietary industrial nature or research for which conduct or dissemination is limited for reasons of national security.

Space flight data are unique and missions are expensive; therefore, data archival is an important issue. SSE and ESE make science data widely accessible as soon as possible after receipt and maintain these data in open archives. The BPRE has continued the archival of their life sciences research publications. This online, searchable bibliographic database, named Spaceline, is a valuable resource of information to the research community and is of extreme importance because the life sciences community relies on published literature as the primary source of knowledge for its disciplines.

Research is validated scientifically when published in refereed journals and when it is subsequently cited by other researchers; this is how the scientific community signals which discoveries are both relevant and rigorously evaluated in the continuous search for knowledge. In the annual review by *Science News* in the second quarter of FY 2001, which reflects the accomplishments of calendar year 2000, the research programs of the SSE, ESE, BPRE, and HEDS accounted for over 8 percent of the 150 "most important stories."

NASA disseminates the results of its research in a number of ways. (More information can be found in the Communicate Knowledge section of this Report.) In FY 2001, all Enterprises updated their Web sites, making it easier for the public to have a complete view of all activ-

ities taking place. The mission Web sites maintained at Goddard Space Flight Center (GSFC), JPL, and the Science@NASA Web site (supported by MSFC) disseminated results of research to a diverse population of users via the Internet. SSE, ESE, and BPRE maintain and periodically update publicly accessible Web sites for active missions. The SSE Web site, *http://spacescience.nasa.gov/missions/index.htm*, is a central location with links to active and upcoming missions. The ESE Web site, *http://www.earth.nasa.gov/missions/index.html*, is the location with links to all active and future missions funded by the Enterprise. BPRE has payloads flying on the ISS. The Web site *http://spaceresearch.nasa.gov/news.html* maintains an updated account of the results of those experiments, as well as other news of general interest.

Objective: Collaborate with old and new partners.

NASA continuously collaborates with old and new partners. Because of the cost and uniqueness of space flight missions, SSE, ESE, and BPRE have diligently worked with other Federal agencies to leverage resources, design better missions, and reduce duplication of effort. NASA's unique resources are used by a variety of Agencies to accomplish crosscutting programs. In FY 2001, BPRE finalized a Memorandum of Understanding (MOU) with the U.S. Department of Agriculture and renewed eight MOUs. The Earth Science Enterprise signed an MOU with the Federal Emergency Management Agency, as well as an interagency agreement for the National Oceanographic Partnership Program. In FY 2001, NASA concluded over 80 international agreements with 30 countries and international organizations in support of the Enterprises, either for space education activities or to establish a framework for subsequent arrangements. These include MOUs for significant international cooperation and Letters of Agreement for visiting researchers, data analysis, ground-based projects, and other cooperation with foreign entities.

Communicate Knowledge

The Space Act of 1958 provides a unique charter for the widest practicable and appropriate dissemination of information concerning activities and results. During the past four decades, the results of the Agency's scientific activities and discoveries have proven to be extremely important to the American people and the world. The Communicate Knowledge process seeks to increase understanding of science and technology, advance its broad application, and inspire achievement and innovation. The process augments the transfer of technology performed within the normal course of conducting research, performing missions, and executing programs and projects. This process ensures that knowledge derived from the public's investment is presented and transmitted to meet the specific needs and interests of the public, educators, and other constituency groups.

Strategic Goal and Objectives

The goal and related objectives of the Communicate Knowledge process for FY 2001 were as follows:

- Ensure that information derived from NASA's research efforts is distributed in a useful, timely, and reliable manner:
  - Highlight existing and identify new opportunities for NASA's customers, including the public, the academic community, and the Nation's students, to participate directly in space research and discovery.
  - Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.

Highlights of Performance and Accomplishments

The Agency has significantly improved its communication of the knowledge it generates based upon performance in the areas of providing education, transferring technology, assisting customers in locating and using technical information, and providing a historical context for NASA's activities and achievements. Children, industry, and the public in general now have easier access to more relevant information than in the past. Detailed discussion of FY 2001 performance measures is included in the FY 2001 Performance Report at *http://ifmp.nasa.gov/codeb/library/library.htm*. Highlights of the performance and accomplishments are discussed below.

Goal: Ensure that information derived from NASA's research efforts is distributed in a useful, timely, and reliable manner.

Objective: Highlight existing and identify new opportunities for NASA's customers, including the public, the academic community, and the Nation's students, to participate directly in space research and discovery.

NASA has shared the experience of expanding the frontiers of air and space with the public and other stakeholders. It provided over 1,900 portable exhibits and supported over 600 events in FY 2001. Participation in nontraditional venues such as State fairs and conventions brings NASA's message to a public that may otherwise be uninformed about or unaware of its programs. In addition, exhibits are used for educational purposes in schools, encouraging students to study math and science. All Centers have online resources and are either introducing more exhibits for the public or enhancing and upgrading existing exhibits. Some Centers partner with online Center programs, as in the partnership between KSC and SSC. KSC's Display Management Team (DMT), made up of representatives from all NASA Directorates, supports events, symposia, and conferences with static displays, pop-ups, graphics, and handout materials. SSC's outreach efforts are primarily focused on the visitor center, StenniSphere. All exhibit resources and staffing support this frequently visited facility.

The public has been able to view the NASA Art Program more than ever before. Stories in newspapers such as the *Wall Street Journal*, on networks such as Cable News Network (CNN), and on programs such as *Fox News* have generated considerable interest in NASA's art initiatives and exposed the art program to television audiences. Highlights included Artrain USA, the Nation's only traveling art museum on a train (Figure 38). Artrain

Figure 38: Artrain USA

is currently featuring the Artistry in Space exhibition, highlighting works of art from NASA that chronicle almost four decades of NASA history. Artrain plans to reach over 40 States by the end of 2002 and then travel to Canada for a year. Public attendance and participation in the NASA Art Program has increased as it has visited more locations, including those with populations not often exposed to NASA programs.

For FY 2001, NASA Image eXchange (NIX) now accesses thousands of images held in databases and millions of images not in databases that are on NASA Web pages.

A number of new historical publications were produced chronicling and placing its activities and achievements in perspective for the American public. Some examples include the following:

- Rumerman, Judy A., and Stephen J. Garber, compilers. *A Chronology of Space Shuttle Flights, 1981–2000.* (NASA HHR-70, October 2000).
- Burrows, William E. *The Infinite Journey: Eyewitness Accounts of NASA and the Age of Space.* (Discovery Publishing, October 2000).
- Portree, David S.F. *Humans to Mars: Fifty Years of Mission Planning, 1950–2000.* (NASA SP-2001-4520, February 2001).

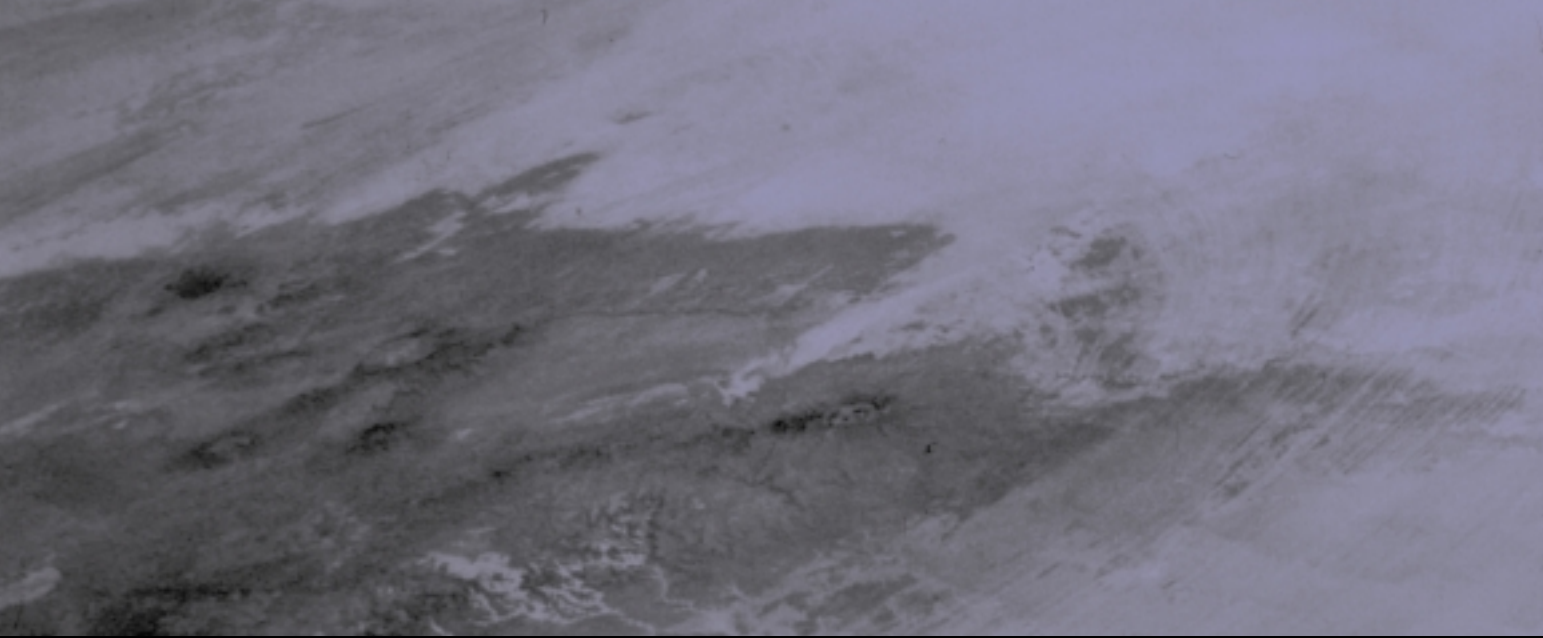
Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.

During FY 2001, NASA provided publications that communicated technologies available for commercial use. Online distribution and paper copies were published of the following resources: *Aerospace Technology Innovation*, *Spinoff*, and NASA Tech Briefs.

Special editions of *Aerospace Technology Innovation* were published to promote sensor technologies to targeted industry groups and educational initiatives in aerospace, the solar system, and Earth to the education community.

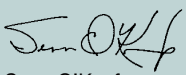
Over three million teachers, faculty, and students participated in NASA Education Programs in FY 2001. NASA increased the number of sites that offer precollege Science, Engineering, Mathematics, and Aeronautics Academy curricula. For each $100,000 of funding provided through the Minority University Research and Education Program, over three refereed papers were produced.

Management Controls, Challenges, and Legal Compliance



Management Controls, Challenges, and Legal Compliance

In response to the recommendation of NASA's Internal Control Council (ICC), I have chosen to report one material weakness for corrective action as prescribed by the Federal Managers' Financial Integrity Act (FMFIA). I have agreed with the ICC that internal control deficiencies of NASA's International Space Station (ISS) meet the criteria for identification of the ISS area as a material weakness. The description of the ISS in this Report provides a summary of corrective actions already taken and those scheduled for continuing reviews and corrective action. With reasonable assurance, I certify that other NASA systems of accounting and internal controls are in compliance with the internal control objectives in OMB's Bulletin Number 01-02, as amended. With the exception of the ISS, these other systems of accounting and internal controls provide reasonable assurance that the Agency is in compliance with provisions of the FMFIA. Therefore, NASA submits a qualified statement of assurance for the reporting period for FY 2001.



Sean O'Keefe
NASA Administrator

Federal Managers' Financial Integrity Act

The FMFIA requires agencies to provide an annual statement of assurance regarding management controls and financial systems. In FY 2001, NASA reports progress in strengthening its overall management controls, although one material weakness has been identified and corrective action is underway. The International Space Station (ISS), which appeared as a significant area of concern in the FY 2000 Accountability Report, has been designated a material weakness in FY 2001 by the Internal Control Council. The ISS Management Team has developed a corrective action plan and schedule.

All Centers and Headquarters have obtained third-party International Organization for Standardization (ISO) certification to the ISO 9001 standard for quality management systems. In 2001, the ISO standard was updated,

and three Centers have obtained certification to the new and improved standard. The establishment of ISO quality management systems continues to represent a major management control initiative and provides for work process documentation, quarterly audits, and ongoing preventive and corrective action. Customer satisfaction is a major emphasis of the new ISO standard, and NASA is measuring customer feedback and "raising the bar" to make continual improvements in customer products, services, and relations. Agency financial management controls and systems, taken as a whole, provide reasonable assurance that accounting systems comply with appropriate Federal requirements. This conclusion is based on the review and consideration of a wide variety of evaluations, internal analyses, reconciliations, reports, and other information, including quality assurance evaluations, General Accounting Office (GAO) and Office of Inspector General (OIG) audits, and an independent public accountant's opinion of our financial statements and reports on the internal control structure and compliance with laws and regulations.

NASA's conclusion is that reasonable controls are in place across the Agency. However, audits, internal reviews, and other evaluations have revealed management weaknesses in individual systems. These weaknesses have been identified by NASA as "significant areas of concern," and we are aggressively correcting identified weaknesses. An increased level of effort has been applied to previously reported significant areas of concern, one of which has been raised to a material weakness. Two new significant areas of concern, described below, have been added.

Material Weakness

International Space Station. Due to continued rising cost and cost-estimating deficiencies within the International Space Station Program, the cost con-

cerns warrant identification of the program as a material weakness. The recent ISS Management and Cost Evaluation (IMCE) Task Force noted much of this cost growth as "a consequence of underestimating cost and a schedule erosion of 4+ years." The Task Force further stated that while "the risk in design and development of the vehicle has been largely retired," cost-estimating deficiencies still remain on the program. The material weakness is in financial and cost management of the program; program management in the areas of safety and technical performance have been extraordinary. To date, there have been 23 missions, including assembly and logistics/utilization. All have been successful, with no major anomalies. The program has enabled early research capability with a three-person permanent crew, and keystone elements of three of the five international partners have been successfully deployed.

The ISS Program is committed to fiscal responsibility and working to achieve high-priority ISS objectives within funding limitations established by the Administration and Congress. Actions to improve cost-estimating ability, institute management efficiencies, and refocus staff for maximum accountability and performance have been documented in an FY 2002 Program Management Action Plan and have been initiated. NASA agrees with the recommendations provided by the IMCE and is in the process of identifying, documenting, and implementing a more comprehensive set of corrective actions necessary to resolve the material weakness and reduce overall programmatic cost to achieve the President's FY 2002 budget projection for the "U.S. core complete," a solution developed by OMB and NASA senior management based on the principles of establishing permanent human presence in orbit, conducting world-class research, and accommodating international elements.

Status of Existing Significant Areas of Management Concern

Financial Management Systems. Because NASA uses individual, nonintegrated systems at Headquarters and its Centers to meet statutory and regulatory reporting requirements, the Agency reports its financial management systems as a significant area of management concern. While financial management systems are not integrated, compensating policies and procedures have been implemented that provide appropriate assurance regarding the fundamental completeness and integrity of internal accounting and administrative controls related to the financial statements.

NASA has made significant strides in implementing a Core Financial System (CFS) using commercial off-the-shelf financial software. In FY 2001, the design phase for the CFS was completed and implementation at the pilot Center, Marshall Space Flight Center, began. Pilot Center activities will be completed in FY 2002, and the system will be implemented at remaining Centers in FY 2003. Until the CFS is in place, NASA will continue to report its financial systems as a significant area of management concern.

Information Technology Security. NASA has made significant strides in IT security in the past three years by establishing an IT Security Program that sets clear goals, associates performance metrics with those goals, carefully measures progress against major milestones, and manages the program by means of the metrics. The NASA IT Security Program places ownership of IT Security actions in the hands of program and project managers, under the leadership and guidance of the Chief Information Officer. Within this framework, the approach to assessing IT security risk has been to adopt a stringent risk management methodology and assign responsibility for execution to the line manager responsible for operation of the system.

A strict project management approach has been applied to the IT Security planning and monitoring process, and substantial improvements have been made in such areas as training, vulnerability reduction, policy standardization, and intrusion detection. New technologies such as public key infrastructure (PKI), virtual private networks (VPN), remote intrusion detection and monitoring, and prediction analyses using artificial intelligence techniques are also being deployed to further protect systems from being compromised. Specific examples of these successes include the following:

- Implementing a Web-based online program that trained NASA civil service employees in IT awareness;
- Reducing the percentage of hostile probes that resulted in a successful system compromise from 11 percent in 1999 to well under 2 percent in 2001;
- Reducing the occurrence of specific vulnerabilities on systems to less than 0.1 vulnerabilities per system; and
- Reorganizing and refocusing the IT Security incident reporting structure into an award-winning organization.

Together, these achievements represent a major advance in NASA's IT security capabilities. Despite this progress, NASA considers IT security to be an area of management concern because NASA's program in this area is not yet fully mature, and the attendant risks are still higher than desired. For example, the audit of the FY 2001 financial statements identified reportable conditions in the area of IT security controls. NASA management will continue to give special attention to IT security as we track progress in the program.

Decommissioning of Plum Brook Reactor Facility. A revised decommissioning plan has been submitted to the Nuclear Regulatory Commission (NRC), and NASA is awaiting comment and approval. Funding is included in the FY 2003 budget request. Until the NRC approves the decommissioning project plan, NASA will continue to report the decommissioning of the Plum Brook Reactor Facility as a significant area of management concern.

National Environmental Policy Act (NEPA). NEPA requires evaluation of potential environmental impacts of proposed Federal actions as early as possible in the program and project planning process. Changes to NPG 7120.5 on NASA program and project management have been made, and training classes have been initiated to ensure greater visibility and more consistent implementation of the NEPA process. This area will continue to be monitored to test whether the NEPA process is being implemented at the program and project level.

New Significant Areas of Management Concern

Cost Estimating and Risk Analysis. Most NASA programs have the unique characteristics of being one-of-a-kind and highly dependent on timely access to leading-edge technology. These characteristics, particularly in the early stages of formulation and development, militate against having a high confidence in program and project cost estimates and a firm understanding of attendant cost uncertainties. This is generally acknowledged and understood by decisionmakers in the Administration and Congress. These decisionmakers should be armed, however, with the best available information on project and program estimates and assessed risks as they make funding and policy decisions. This should include having independent evaluations to complement baselined estimates. The availability of such evaluations is vitally important, particularly as the Agency strives to undertake challenging missions in a cost-constrained environment. Recent performance in this area on highly visible programs indi-

cates that a concerted effort to remedy current shortcomings is urgently needed.

Efforts toward that end place responsibility on the Office of the Chief Financial Officer to lead the improvement in this key discipline. Using the Independent Program Assessment Office as a center of competence, the CFO will work with the Enterprises and Centers to build expertise in cost estimating. The Office of the CFO will lead an Agencywide working group to improve the cost-estimating methodology, competence, and processes used to support and review programs. The CFO will work to restore adequate civil service staffing for cost estimating and—particularly in the interim—access to external cost-estimating resources. In addition to these efforts, aimed at effectively compensating for the loss of skills during downsizing, the Agency will enhance the thoroughness of its decisionmaking processes to ensure consideration of credible program cost estimates and cost uncertainty analyses in program management and budgeting.

Access to NASA Facilities and Technology. NASA began increasing its security and counterintelligence capabilities in early 2000 in response to events at other Federal agencies. In August 2001, the Administrator elevated security and counterintelligence responsibility to the "direct report" level and appointed an Associate Administrator for Security Management and Safeguards. The terrorist attacks on America increased the urgency of enhancements to security and counterterrorism programs. These improvements include increasing security personnel and their training, increasing antiterrorism defenses, conducting threat and vulnerability assessments at all Centers, and accelerating deployment of the NASA Secure Network. For FY 2002, NASA has received $108.5 million in emergency funding to cover increased security expenses since September 11th and to fund enhanced security countermeasures.

Commitment to Strong Management Controls

The reporting of corrective actions for significant areas of concern does not provide a full account of the management control improvements undertaken. NASA is committed to continuously improving the management of programs and related controls independently, as well as part of Governmentwide reengineering and reinventing processes, and to removing unnecessary, burdensome requirements and controls while evaluating streamlined processes to ensure that reasonable controls remain in place. NASA is committed to improving every aspect of management.

Inspector General's Assessment of NASA's Most Serious Management and Performance Challenges

As required by the Reports Consolidation Act of 2000, the Inspector General's assessment of the most serious management and performance challenges facing NASA are included as Appendix 1.

The Inspector General Act Amendments

The Inspector General (IG) Act (as amended) requires semiannual reporting on IG audits and related activities, as well as Agency followup. Agency followup reporting is included in this Accountability Report, and, as required by Section 106 of the IG Act Amendments (Public Law 100-504), it includes statistics on audit reports with disallowed costs and recommendations that propose that funds be put to better use as agreed to by management decision for FY 2001 (Appendix 2). It also provides information on the status of audit and inspection reports pending final action (Appendix 3).

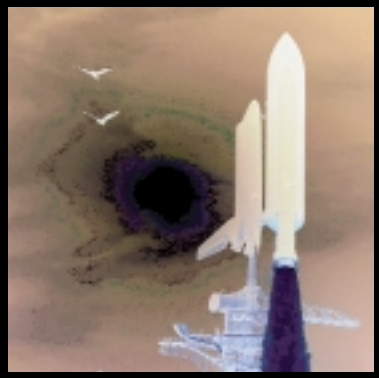
Audit Followup and Internal Management Controls

Effective audit followup and internal management controls are a high priority for all levels of management. The Management Assessment Division of the Office of Management Systems continues to improve the audit resolution and followup process. It is strengthening the Agency's virtual team of Audit Liaison Representatives (ALR) with improved automation and communication and working with the OIG to resolve and close audit issues. Also, the Division is discussing the management of audit resolution and closure with other Federal agencies to further enhance NASA's processes.

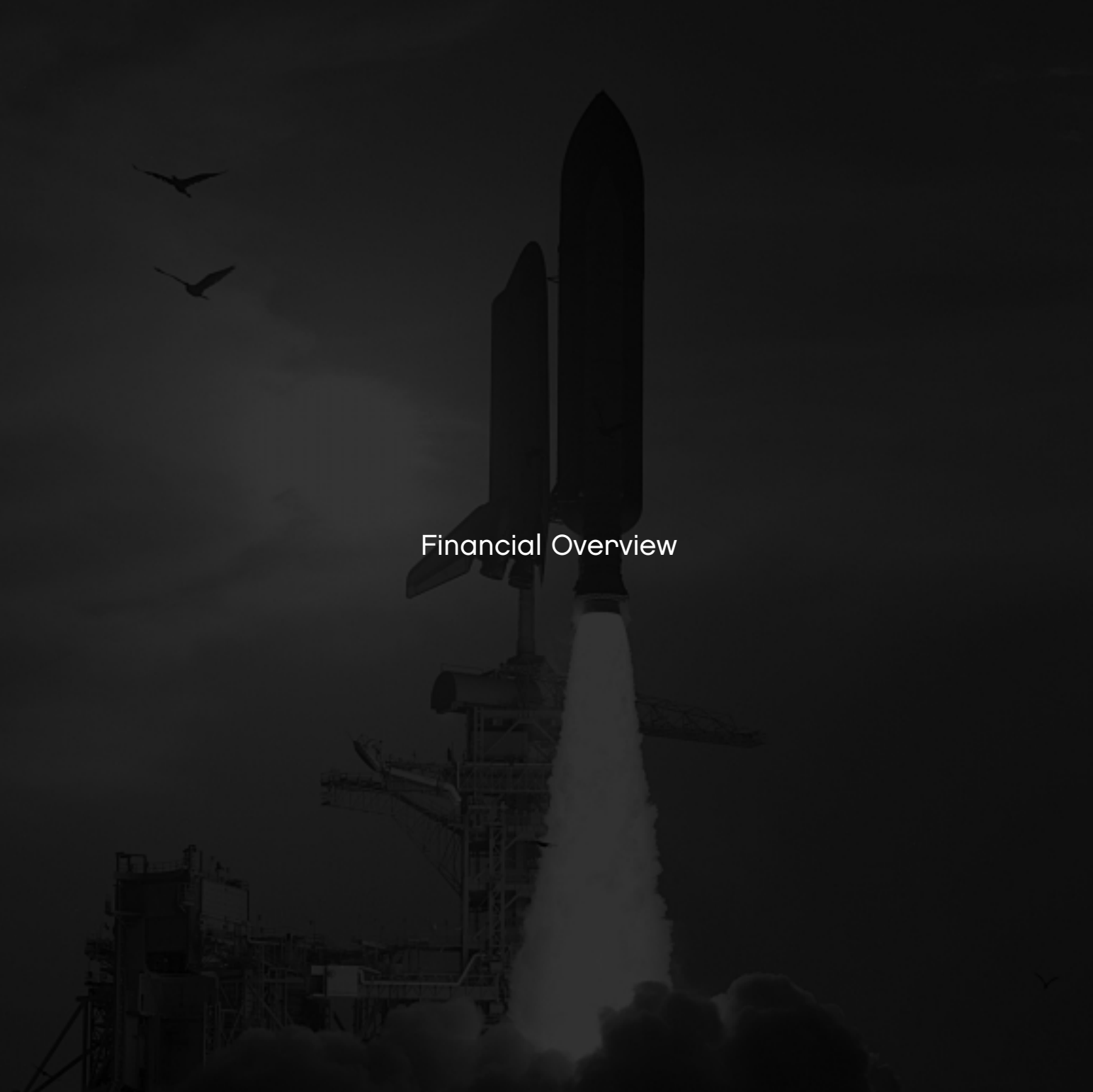
The number of open OIG recommendations has increased again this year. The IG and NASA Audit Followup Official (AFO) met to discuss new processes designed to reduce the backlog of open recommendations for both audits and inspections. These processes, which will be implemented in February 2002, will increase communication and coordination and will minimize future unresolved and open recommendations. The Management Assessment Division has placed an increased emphasis on this area to reduce the number of open recommendations. The Division is working with the OIG to reconcile audit-tracking data in order to produce accurate and current Agencywide metrics for more focused management attention. Electronic dissemination of audit and inspection information to the widest possible audience provides effective and efficient communication between management and the OIG.

Federal Financial Management Improvement Act

The Federal Financial Management Improvement Act (FFMIA) requires agencies to report on their substantial compliance with Federal financial management system requirements, applicable Federal accounting standards, and the U.S. Government Standard General Ledger at the transaction level. Based on OMB guidance, NASA believes it is in substantial compliance with the requirements of FFMIA.



Financial Overview and Statements, and Auditors' Reports



Financial Overview

Financial Overview

Summary of Financial Results, Position, and Condition

NASA's financial statements were prepared to report the financial position and results of operations of the Agency. The principal financial statements include the 1) Consolidated Balance Sheet, 2) Consolidated Statement of Net Cost, 3) Consolidated Statement of Changes in Net Position, 4) Combined Statement of Budgetary Resources, and 5) Combined Statement of Financing. Additional financial information is also presented in the required supplementary schedules (pages 127 through 136).

The Chief Financial Officer's Act of 1990 requires that agencies prepare financial statements to be audited in accordance with Government Auditing Standards. While the financial statements were prepared from the books and records of NASA in accordance with formats prescribed by the Office of Management and Budget (OMB), they are in addition to financial reports, prepared from the same books and records, used to monitor and control budgetary resources. The statements should be read with the realization that NASA is a component of the U.S. Government, a sovereign entity.

The following paragraphs briefly describe the nature of each required financial statement and its relevance. Significant account balances and financial trends are discussed to help clarify their impact upon operations.

The **Consolidated Balance Sheet** on page 107 is presented in a comparative format providing financial information for FY 2001 and FY 2000. It presents assets owned by NASA, amounts owed (liabilities), and amounts that constitute NASA's equity (net position). The Consolidated Balance Sheet reflects total assets of $41.2 billion and liabilities of $4.8 billion for FY 2001. Unfunded liabilities reported in the statements cannot be liquidated without legislation that provides resources to do so.

Almost 73 percent of the assets are Property, Plant, and Equipment (PP&E), with a book value of $30.0 billion. PP&E is property located at the Centers, in space, and in the custody of contractors. Almost 70 percent of PP&E consists of assets held by NASA, while the remaining 30 percent represents property in the custody of contractors. The book value of Assets in Space, various spacecraft operating above the atmosphere for exploration purposes, constitutes $14.8 billion, or 70 percent of NASA-owned and -held PP&E.

The beginning of operations aboard the International Space Station (ISS) impacted NASA's balance sheet for FY 2001. As these assets became operational, they began to be capitalized and depreciated. Amounts previously shown as work-in-process were capitalized when the ISS was inhabited.

During Fiscal Year 2001, NASA directed contractors to reclassify $1.2 billion, previously reported as contractor-held equipment, as Materials and Spares in order to better reflect the nature of these property items. Included in the items were Shuttle and ISS spare parts, External Tanks, Solid Rocket Boosters, and ISS engines.

Beginning in FY 2000, OMB requested new procedures for deposit funds, requiring NASA to deposit these funds into appropriation accounts, thus rescinding NASA's exemption. Advances from others are included in other liabilities in the financial statements.

Cumulative Results of Operations represents the public's investment in NASA, akin to stockholder's equity in private industry. The public's investment in NASA is valued at $33.0 billion. The Agency's $36.4-billion net position includes $3.3 billion of unexpended appropriations (undelivered orders and unobligated amounts or funds provided, but not yet spent). Net position is presented on both the Consolidated Balance Sheet and the Consolidated Statement of Changes in Net Position.

The **Consolidated Statement of Net Cost** on page 108 presents the "income statement" (the annual cost of programs) and distributes fiscal year expenses by programmatic category. A chart depicting the distribution of expenses can be found under the heading "Appropriations Used (Costs Expensed by Enterprise)" contained in this overview. The Net Cost of Operations is reported on the Consolidated Statement of Net Cost and also on the Combined Statement of Financing.

NASA makes substantial research and development investments on behalf of the Nation. These amounts are expensed as incurred in determining the net cost of operations. Total Program Expenses are reported on the Consolidated Statement of Net Cost and also on the Required Supplementary Stewardship Information statement regarding Stewardship Investments: Research and Development. Research and Development (R&D) includes all direct, incidental, or related costs resulting from, or necessary to, performance of R&D, regardless of whether the R&D is performed by a Federal agency or by individuals and organizations under grant or contract. R&D investments identified by program on the Required Supplementary Stewardship Information statement regarding Stewardship Investments: Research and Development relates back to program expenses shown on the Consolidated Statement of Net Cost.

These investments are categorized by basic research, applied research, and development. The objective of basic research is to gain fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind. The objective of applied research is to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met. Development is the systematic use of the knowledge or understanding gained from research directed toward the production of useful materials, devices, systems, or methods, including design and development of prototypes and processes. It excludes quality control, routine product testing, and production.

The NASA Strategic Plan establishes a framework for making management decisions by separating the Agency's programs into five Strategic Enterprises through which we implement our mission and communicate with external customers. These Enterprises are Space Science, Earth Science, Biological and Physical Research, Human Exploration and Development of Space, and Aerospace Technology.

Funds are allocated by appropriation and then translated into programs. The Consolidated Statement of Net Costs distributes fiscal year expenses by programmatic category (budget line item) (Figure 38).

In Fiscal Year 2001, the Human Exploration and Development of Space (HEDS) Investment and Support program was initiated. This initiative includes human space exploration and development activities emphasizing highly innovative technologies, advances in science, and enabling synergistic commercial space development.

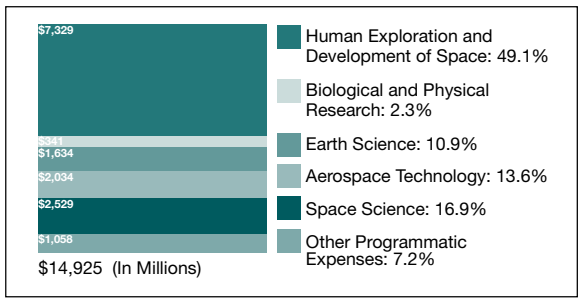


Figure 38: Appropriations Used (Costs Expensed by Enterprise)

NASA established a new enterprise, Biological and Physical Research, during Fiscal Year 2001. This action transferred programs, specifically Life and Microgravity, previously reported in Human Exploration and Development of Space, to Biological and Physical Research.

The **Consolidated Statement of Changes in Net Position** displayed on page 109 identifies appropriated funds used as a financing source for goods, services, or capital acquisitions. This Statement presents the accounting events that caused changes in the net position section of the Consolidated Balance Sheet from the beginning to the end of the reporting period.

The **Combined Statement of Budgetary Resources** on page 110 highlights budget authority for the Agency and provides information on budgetary resources available to NASA for the year and the status of those resources at the end of the year (Figure 39). Detail regarding amounts reported on the Combined Statement of Budgetary Resources is included in Required Supplementary Information: Combined Schedule of Budgetary Resources. Outlays reported in this statement reflect cash disbursements for the fiscal year by the U.S. Department of the Treasury for NASA (Figure 40).

For FY 2001, Congress provided total appropriations of $14.3 billion to NASA. Budget Authority is the authority provided by Federal law to incur financial obligations that will eventually result in outlays or expenditures. Specific forms of gross budget authority for NASA are appropriations and spending authority from offsetting collections. NASA's share of Federal operations is illustrated in Figure 41.

Funding was received and allocated through the following appropriations:

- Human Space Flight—This appropriation provided for the International Space Station and Space Shuttle programs,

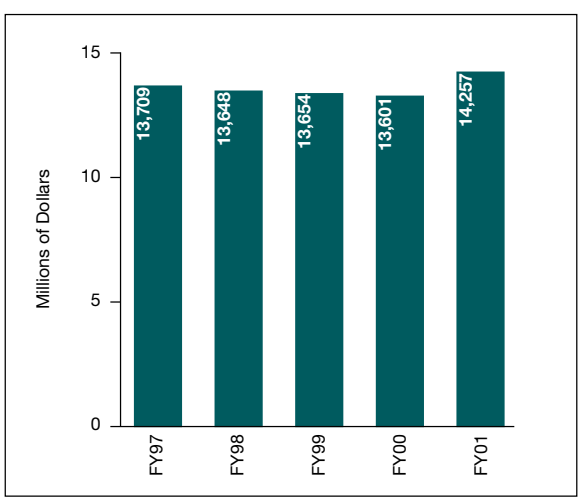


Figure 39: Trend of NASA Budget

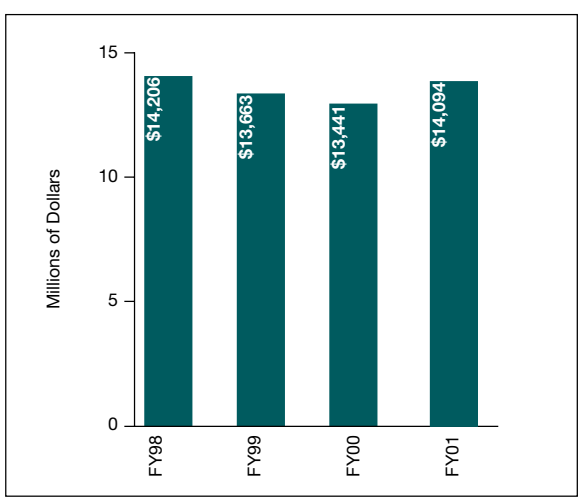


Figure 40: Total Outlays

including the development of research facilities for the ISS; continuing safe, reliable access to space through augmented investments to improve Space Shuttle safety; support of payload and expendable launch vehicle (ELV) operations; and other investments including innovative technology development and commercialization.

- Science, Aeronautics, and Technology—This appropriation provided for NASA's research and development activities, including all science activities, global change research, aeronautics, technology investments, education programs, space operations, and direct program support.

- Mission Support—This appropriation provided for NASA's civil service workforce, safety and quality assurance activities, and facilities construction activities to preserve NASA's core infrastructure.

- Inspector General—This appropriation provided for the workforce and support required to perform audits, evaluations, and investigations of programs and operations.

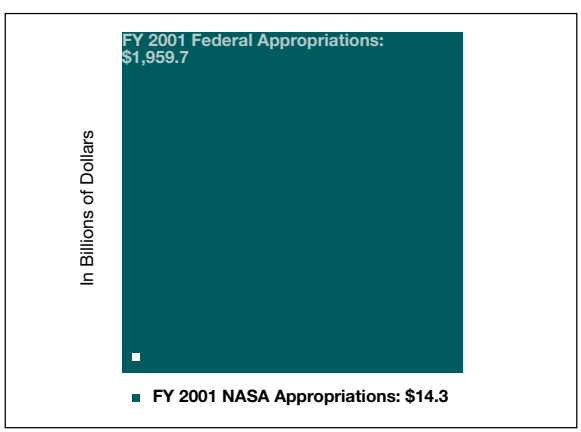


Figure 41: FY 2001 Federal Appropriations vs. FY 2001 NASA Appropriations

The **Combined Statement of Financing** on page 111 provides a reconciliation between the obligations incurred to finance operations and the net costs of operating programs. Costs that do not require resources include depreciation.

Costs capitalized on the Consolidated Balance Sheet are additions to capital assets made during the fiscal year. Obligations Incurred include amounts of orders placed, contracts awarded, services received, and similar transactions that require payment during the same or a future period. Obligations Incurred links the Combined Statement of Budgetary Resources to the Combined Statement of Financing.

Required Supplementary Stewardship Information

Required Supplementary Stewardship Information (RSSI) is included to provide information (financial and nonfinancial) on resources and responsibilities that cannot be measured in traditional financial reports.

RSSI—Heritage Assets are properties, plant, and equipment that possess historical or natural significance; cultural, educational, or aesthetic value; or significant

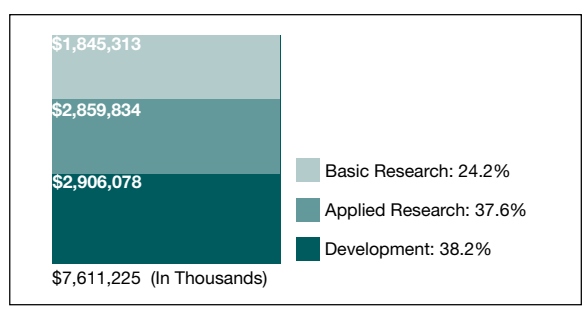


Figure 42: Research and Development

architectural characteristics. Heritage assets are reported in terms of physical units because their existence is of primary relevance. For FY 2001, NASA reported 1,504 heritage assets.

RSSI—Stewardship Investments (R&D)—Stewardship Investments are NASA-funded investments that yield long-term benefits to the general public. Investments in research are shown in this statement as basic research, applied research, and development (Figure 42).

In FY 2001, R&D expenses totaled approximately $7.6 billion and included activities to extend knowledge of Earth, its space environment, and the universe; and to invest in new aeronautics and advanced space transportation technologies that support the development and application of technologies critical to the economic, scientific, and technical competitiveness of the United States. The R&D and non-R&D expenses identified by program on the RSSI statement regarding Stewardship Investments: Research and Development tie back to the related program expenses found on the Consolidated Statement of Net Cost.

Required Supplementary Information

Required Supplementary Information (RSI) is included to present a complete picture of financial results, position, and condition. This information comprises intragovernmental activities, deferred maintenance, and budgetary resources. Intragovernmental Activities are transactions that occur between Federal agencies. Deferred Maintenance is maintenance that was not performed when it should have been or was scheduled to be performed and delayed until a future period. For FY 2001, a Combining Schedule of Budgetary Resources is included as an RSI rather than as a note disclosure (Footnote 14 in FY 2000).

Change in Appropriation Structure for FY 2002

Under the FY 2001 appropriation structure, the Mission Support appropriation includes a portion of the direct support required to execute Enterprise programs. This includes research and operations support, civil service salaries, and travel. Under the appropriation structure established for FY 2002, NASA is moving to full cost management; the budget for these supporting elements is to be directly allocated to programs and projects. The budget for FY 2002 is reflected in three appropriations: Human Space Flight (HSF); Science, Aeronautics and Technology (SAT); and the Inspector General.

The budget for FY 2002 includes both near-term priorities, such as flying the Space Shuttle safely and building the ISS, and longer term investments in America's future, such as developing more affordable, reliable means of access to space and conducting cutting-edge scientific and technological research. The budget draws on strengths in engineering and science and reflects the revolutionary insights and capabilities on the horizon in areas such as biotechnology, nanotechnology, and information technology. It describes the vision for expanding air and space frontiers, serving America, and improving life on Earth. The President's NASA budget request for FY 2002 supports these goals.

Financial Statements

Introduction to Financial Statements

The Chief Financial Officer's Act of 1990 requires that agencies prepare financial statements to be audited in accordance with Government auditing standards. These financial statements reflect the overall financial position of offices and activities, including assets and liabilities, and the results of operations, pursuant to the requirements of 31 U. S. C. 3515(b). The statements have been prepared from NASA's books and records.

These statements are in addition to separate financial reports prescribed by the Office of Management and Budget (OMB) and the U.S. Department of the Treasury (Treasury) that are used to monitor and control budgetary resources prepared from the same books and records. The statements should be read with the understanding that they are for a component of the U.S. Government, a sovereign entity. For example, Treasury, another Federal agency, holds NASA's Fund Balance. Also, NASA has no authority to pay liabilities not covered by budgetary resources. Liquidation of such liabilities requires enactment of an appropriation by Congress.

National Aeronautics and Space Administration
Consolidated Balance Sheet
As of September 30
(In Thousands)

Assets (Note 9):	**2001**	**2000**
Intragovernmental Assets:		
Fund Balance With Treasury (Note 2)	$ 6,320,749	$ 6,189,464
Investments (Note 3)	16,728	16,727
Accounts Receivable, net (Notes 4 and 9)	72,119	119,135
Advances and Prepaid Expenses	22,033	22,704
Total Intragovernmental Assets	6,431,629	6,348,030
Accounts Receivable, net (Notes 4 and 9)	9,138	6,881
Advances and Prepaid Assets	267	–
Materials and Supplies (Note 5)	4,705,362	2,679,418
Property, Plant, and Equipment, net (Notes 6 and 10)	30,019,927	25,470,264
Total Assets	**$ 41,166,323**	**$ 34,504,593**
Liabilities:		
Intragovernmental Liabilities:		
Accounts Payable	$ 160,418	$ 187,390
Other Liabilities (Notes 7 and 8)	89,662	72,663
Total Intragovernmental Liabilities	250,080	260,053
Accounts Payable	2,719,115	2,749,097
Other Liabilities (Notes 7 and 8)	429,752	346,349
Environmental Cleanup Costs (Notes 1 and 8)	1,345,869	1,021,076
Actuarial FECA Liability (Notes 1 and 8)	69,672	61,581
Total Liabilities	**4,814,488**	**4,438,156**
Commitments and Contingencies (Notes 1, 7, and 8)		
Net Position:		
Unexpended Appropriations (Note 11)	3,325,591	3,192,042
Cumulative Results of Operations	33,026,244	26,874,395
Total Net Position	**36,351,835**	**30,066,437**
Total Liabilities and Net Position	**$ 41,166,323**	**$ 34,504,593**

The accompanying notes are an integral part of this statement.

National Aeronautics and Space Administration
Consolidated Statement of Net Cost
For the Fiscal Years Ended September 30
(In Thousands)

Program/Operating Expenses by Enterprise:	**2001**	**2000**
Human Exploration and Development of Space:		
Space Shuttle	$ 3,653,998	$ 3,303,230
Space Station	2,740,366	2,754,089
U.S./Russian Cooperative	358	22,124
Investment and Support	116,150	–
Space Operations	600,706	457,582
Payload Utilization and Operations	217,792	419,452
Total Human Exploration and Development of Space	7,329,370	6,956,477
Space Science:		
Space Science	2,527,843	2,443,934
Planetary Exploration	1,157	33,289
Total Space Science	2,529,000	2,477,223
Earth Science:		
Earth Science	1,633,633	1,644,371
Biological and Physical Research:		
Biological and Physical Research	341,206	321,283
Aerospace Technology:		
Aerospace Technology	1,721,101	1,134,278
Space Access and Technology	123,145	512,409
Commercial Development and Technology Transfers	189,948	177,815
Total Aerospace Technology	2,034,194	1,824,502
Total Enterprise Program Costs	**13,867,403**	**13,223,856**
Costs Not Assigned to Enterprises:		
Academic Programs	138,544	111,377
Other Programs	194,546	165,401
Trust Funds	1,406	1,271
Reimbursable Expenses	723,073	737,498
Total Costs Not Assigned to Enterprises	**1,057,569**	**1,015,547**
Total Program Expenses	**14,924,972**	**14,239,403**
Costs Not Assigned to Programs:		
Change in Unfunded Expenses (Note 12)	439,203	(72,949)
Depreciation Expense	2,555,245	2,257,134
Funded Changes in Capitalized Property and Inventory	(8,459,996)	(4,604,770)
Total Costs Not Assigned to Programs	**(5,465,548)**	**(2,420,585)**
Less: Earned Revenues Not Attributed to Programs	(724,076)	(738,499)
Net Cost of Operations (Note 13)	**$ 8,735,348**	**$ 11,080,319**

The accompanying notes are an integral part of this statement.

National Aeronautics and Space Administration
Consolidated Statement of Changes in Net Position
For the Fiscal Year Ended September 30, 2001
(In Thousands)

Net Cost of Operations	$ (8,735,348)
Financing Sources:	
Appropriations Used	14,097,100
Donations	35,192
Imputed Financing	106,097
Transfers In	15,740
Transfers Out	(3,357)
Other	25
Net Results of Operations	5,515,449
Prior Period Adjustment (Note 1)	636,400
Net Change in Cumulative Results of Operations	6,151,849
Change in Unexpended Appropriations	133,549
Change in Net Position	6,285,398
Net Position—Beginning of Period	30,066,437
Net Position—End of Period	**$ 36,351,835**

The accompanying notes are an integral part of this statement.

National Aeronautics and Space Administration
Combined Statement of Budgetary Resources
For the Fiscal Years Ended September 30
(In Thousands)

Budgetary Resources (Note 15):	**2001**	**2000**
Budget Authority	$ 14,288,917	$ 13,654,160
Unobligated Balances—Beginning of Period	700,471	864,342
Spending Authority from Offsetting Collections	748,128	705,619
Adjustments	43,672	(39,550)
Total Budgetary Resources	**$ 15,781,188**	**$ 15,184,571**
Status of Budgetary Resources:		
Obligations Incurred	$ 14,907,247	$ 14,484,100
Unobligated Balances—Available	797,657	616,935
Unobligated Balances—Not Available	76,284	83,536
Total Status of Budgetary Resources	**$ 15,781,188**	**$ 15,184,571**
Outlays:		
Obligations Incurred	$ 14,907,247	$ 14,484,100
Less: Spending Authority from Offsetting Collections and Adjustments	(849,862)	(797,676)
Obligations Incurred, Net	**14,057,385**	**13,686,424**
Obligated Balance, Net—Beginning of Period	5,497,957	5,253,158
Less: Obligated Balance, Net—End of Period	(5,460,861)	(5,497,957)
Total Outlays	**$ 14,094,481**	**$ 13,441,625**

The accompanying notes are an integral part of this statement.

National Aeronautics and Space Administration
Combined Statement of Financing
For the Fiscal Year Ended September 30
(In Thousands)

Obligations and Nonbudgetary Resources:	**2001**
Obligations Incurred	$ 14,907,247
Less: Spending Authority from Offsetting Collections and Adjustments	(849,862)
Financing Imputed for Cost Subsidies	106,097
Total Obligations as Adjusted and Nonbudgetary Resources	**14,163,482**
Resources That Do Not Fund Net Cost of Operations:	
Change In Amount of Goods, Services, and Benefits Ordered But Not Yet Received or Provided	8,231
Change in Unfilled Orders	28,101
Costs Capitalized in the Statement of Financial Position	(8,459,996)
Financing Sources That Fund Costs of Prior Periods	(3,220)
Other	1,082
Total Resources That Do Not Fund Net Cost of Operations	**(8,425,802)**
Costs That Do Not Require Resources:	
Depreciation	2,555,245
Total Costs That Do Not Require Resources	**2,555,245**
Change in Financing Sources Yet to Be Provided	**442,423**
Net Cost of Operations	**$ 8,735,348**

The accompanying notes are an integral part of this statement.

National Aeronautics and Space Administration
Notes to Financial Statements
For the Fiscal Year Ended September 30, 2001

1. Summary of Accounting Policies and Operations:

Reporting Entity

NASA is an independent agency established to plan and manage the future of the Nation's civil aeronautics and space program. NASA has five strategic enterprises—Space Science, Earth Science, Biological and Physical Research, Human Exploration and Development of Space, and Aerospace Technology—to implement the Agency's mission and communicate with external customers. These financial statements reflect all NASA activities, including those of its nine Centers, Headquarters, and NASA's Jet Propulsion Laboratory, which is a Federally Funded Research and Development Center owned by NASA but managed by an independent contractor. Financial management of NASA operations is the responsibility of Agency officials at all organizational levels. The accounting system consists of 10 distinct operations located at the Centers. Although each Center is independent of the others and has its own chief financial officer, they operate under Agencywide financial management policies. These accounting systems provide basic information necessary to meet internal and external budget and financial reporting requirements and provide fund control and accountability. All significant intra-entity activities have been eliminated.

Basis of Presentation

These financial statements present NASA's Consolidated Balance Sheet as of September 30, 2001 and 2000, the related Consolidated Statement of Net Cost and Combined Statement of Budgetary Resources for the years then ended, and the related Consolidated Statement of Changes in Net Position and Combined Statement of Financing for the fiscal year ended September 30, 2001, as required by the Chief Financial Officers Act of 1990 and the Government Management Reform Act of 1994. They were prepared from the books and records of NASA, in accordance with Generally Accepted Accounting Principles and NASA's accounting policies and practices summarized in this note. These financial statements were prepared under the accrual basis of accounting, where expenses and revenues are recorded in the period in which they are incurred or earned, respectively.

Implementation of New Accounting Standards

In Fiscal Year 2001, NASA implemented SFFAS No. 10, "Accounting for Internal Use Software," which established accounting standards for the cost of software developed or obtained for internal use. Under the provisions of this standard, internal-use software is classified as general property, plant, and equipment (PP&E). Therefore, the cost of such software must be capitalized if it meets the Agency's criteria.

Budgets and Budgetary Accounting

NASA is funded by four appropriations that require individual treatment in the NASA accounting and control system. Reimbursements to NASA's appropriations total approximately $724 and $738 million for Fiscal Years 2001 and 2000, respectively. As part of its reimbursable program, NASA launches devices into space and provides tracking and data relay services for the U.S. Department of Defense, the National Oceanic and Atmospheric Administration, and the National Weather Service.

On the Statement of Budgetary Resources, Unobligated Balances—Available represent the amounts remaining in appropriation accounts that are available for obligation in future fiscal years. Unobligated Balances—Not Available represent the amounts remaining in appropriation accounts that can only be used for adjustments to previously recorded obligations.

Use of Estimates

The preparation of financial statements in conformity with generally accepted accounting principles requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and the disclosure of contingent assets and liabilities as of the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. Actual results could differ from these estimates.

Fund Balance With Treasury

NASA's cash receipts and disbursements are processed by the Treasury. Fund Balance with Treasury includes appropriated funds, trust funds, deposit funds, and budget clearing accounts.

Investments in U.S. Government Securities

Intragovernmental non-marketable securities include the following investments:

(1) National Aeronautics and Space Administration Endeavor Teacher Fellowship Trust Fund established from public donations in tribute to the crew of the Space Shuttle Challenger.

(2) Science Space and Technology Education Trust Fund established for programs to improve science and technology education.

Accounts Receivable

Most receivables are for reimbursement of research and development costs related to satellites and launch services. The allowance for uncollectible accounts is based upon evaluation of accounts receivable, considering the probability of failure to collect based upon current status, financial and other relevant characteristics of debtors, and the relationship with the debtor. Under a cross-servicing arrangement, most accounts receivable over 180 days delinquent are turned over to the Treasury for collection (the receivable remains on NASA's books until Treasury determines that the receivable is uncollectible).

Advances to Others

Advances to others are payments made in contemplation of future performance of services, receipt of goods, and incurrence of expenditures in receipt of other assets. Most of NASA's advances are to other Federal agencies as required by Interagency Agreements.

Prepaid Expenses

Payments in advance of the receipt of goods and services are recorded as prepaid expenses at the time of prepayment and recognized as expenses when related goods and services are received.

Materials and Supplies

Materials held by Centers and contractors that are repetitively procured, stored, and issued on the basis of demand are considered Materials and Supplies.

During Fiscal Year 2001, NASA directed contractors to reclassify $1.2 billion, previously reported as contractor-held equipment, as Materials, to better reflect the nature of these property items. Included in the items were Shuttle and ISS spare parts, External Tanks, Solid Rocket Boosters, and engines.

Property, Plant, and Equipment

NASA-owned property, plant, and equipment is held by the Agency and its contractors and grantees. Property with a unit cost of $100,000 or more and a useful life of 2 years or more is capitalized; all other property is expensed when purchased. Capitalized cost includes all costs incurred by NASA to bring the property to a form and location suitable for its intended use. NASA continues to maintain physical accountability for all property, plant, and equipment regardless of cost.

During Fiscal Year 2001, the accounting methods used to account for Space Shuttles were changed. Prior to Fiscal Year 2001, the orbiter and its various component pieces were capitalized and depreciated as separate items with differing useful lives. Beginning in Fiscal Year 2001, each orbiter and its various component pieces will be capitalized and depreciated as one item with a single useful life. This change has no material effect on the financial statements and complies with accounting principles generally applicable in the United States of America.

Corrections to externally provided documentation were recorded during Fiscal Year 2001 for property transferred to NASA from another Federal agency. The property was fully depreciated; therefore, there was no effect on the Balance Sheet asset value. Land transferred from the Department of the Navy to Ames Research Center at Moffett Field was adjusted to reflect the historical cost rather than fair market value.

Under provisions of the Federal Acquisition Regulation (FAR), contractors are responsible for control over and accountability for Government-owned property in their possession. NASA's contractors and grantees report on NASA property in their custody annually.

Capitalized costs for internally developed software include the full costs (direct and indirect) incurred during the software development phase only. For purchased software, capitalized costs include amounts paid to vendors for the software and material internal costs incurred by the Agency to implement and make the software ready for use through acceptance testing.

These financial statements report depreciation expense using the straight-line method. Useful lives are 40 years for buildings, 15 years for other structures and facilities, 15 years for leasehold improvements, 15 years for space hardware, 7 years for special test equipment and tooling, 5 to 20 years for other equipment depending on its nature, and 25 years for Space Shuttles. Useful lives for assets in space are their mission lives, ranging from 2 to 20 years.

Advances from Others

Advances from Others represents amounts advanced by other Federal and non-Federal entities for goods and services to be provided and are included in other liabilities in the financial statements.

Liabilities Covered by Budgetary Resources

Accounts payable includes amounts recorded for receipt of goods or services furnished to NASA. Additionally, NASA accrues costs and recognizes liabilities based on information provided monthly by contractors on NASA Contractor Financial Management Reports (NASA Forms (NF) 533M and Q). DCAA performs independent audits to ensure reliability of reported costs and estimates. To provide further assurance, financial managers are required to test the accuracy of NASA Form 533 generated cost accruals each month, and NASA Headquarters independently analyzes the validity of the Centers' data.

Liabilities and Contingencies Not Covered by Budgetary Resources

Liabilities not covered by budgetary resources include certain environmental matters, legal claims, pensions and other retirement benefits (ORB), workers' compensation, annual leave (see discussion below), and closed appropriations.

Liabilities not covered by budgetary resources consist primarily of environmental cleanup costs as required by Federal, State, and local statutes and regulations and unfunded annual leave. Parametric models are used to estimate the total cost of cleaning up these sites

over future years. The estimates also include a five-year minimum operational period within the remedial action phase unless Centers indicate an exact number of years. In addition, a five-year monitoring period was added to the estimate for ground water, surface water/sediment, and ecological monitoring. NASA estimates the total cost of environmental cleanup to be $1.3 billion and $1 billion as of September 30, 2001 and 2000, respectively, and recorded an unfunded liability in its financial statements for these amounts. This estimate reflects an increase of $325 million from 2000 primarily due to the identification of new information used in the parametric models. This estimate could be affected in the future by changes resulting from inflation, deflation, technology, or applicable laws and regulations. Therefore, the estimated environmental liability could range from $834 million to $1.8 billion because of future changes. The estimate represents an amount that will be spent to remediate currently known sites, subject to the availability of appropriated funds. Other responsible parties that may be required to contribute to the remediation funding could share this liability. NASA received appropriations of $44 million and $37 million for the fiscal years ended September 30, 2001 and 2000, respectively, for environmental compliance and restoration. Included in the recorded liability is $28 million and $20 million for the fiscal years ended September 30, 2001 and 2000, respectively, for cleanup of current operations.

NASA is a party in various administrative proceedings, court actions (including tort suits), and claims brought by or against it. In the opinion of management and legal counsel, the ultimate resolution of these proceedings, actions, and claims will not materially affect the financial position, net cost, changes in net position, budgetary resources, or financing of NASA. Liabilities have been recorded for $2 million and $1 million for these matters as of September 30, 2001 and 2000, respectively.

Contingencies related to proceedings, actions, and claims where management believes, after consultation with legal counsel, that it is possible, but not probable, that some cost will be incurred range from zero to $30 million and zero to $133 million, as of September 30, 2001 and 2000, respectively. Accordingly, no balances have been recorded in the financial statements for these contingencies.

A liability for $85 million was recorded, as of September 30, 2001, for workers' compensation claims related to the Federal Employees' Compensation Act (FECA), administered by the U.S. Department of Labor (DOL). FECA provides income and medical cost protection to covered Federal civilian employees injured on the job, employees who have incurred a work-related occupational disease, and beneficiaries of employees whose death is attributable to a job-related injury or occupational disease. The FECA program initially pays valid claims and subsequently seeks reimbursement from the Federal agencies employing the claimants. The FECA liability includes the actuarial liability of $69 million for estimated future costs of death benefits, workers' compensation, and medical and miscellaneous costs for approved compensation cases. The present value of these estimates at the end of Fiscal Year 2001 was calculated by the DOL using a discount rate of 5.21 percent for Fiscal Year 2001 and thereafter. This liability does not include the estimated future costs for claims incurred but not reported or approved as of September 30, 2001.

NASA has approximately $45 million in accounts payable related to closed appropriations for which there is a contractual commitment to pay. These payables will be funded from appropriations that are available for obligation at the time a billing is processed, in accordance with Public Law 101-510.

Annual, Sick, and Other Leave

Annual leave is accrued as it is earned; the accrual is reduced as leave is taken. Each year, the balance in the accrued annual leave account is adjusted to reflect current pay rates. To the extent current or prior year appropriations are not available to fund annual leave earned but not taken, funding will be obtained from future financing sources. Sick leave and other types of nonvested leave are expensed as taken.

Employee Benefits

Agency employees participate in the Civil Service Retirement System (CSRS), a defined benefit plan, or the Federal Employees Retirement System (FERS), a defined benefit and contribution plan. For CSRS employees, NASA makes contributions of 8.51

percent of pay. For FERS employees, NASA makes contributions of 10.7 percent to the defined benefit plan and contributes 1 percent of pay to a retirement savings plan (contribution plan) and matches employee contributions up to an additional 4 percent of pay. For FERS employees, the Agency also contributes the employer's matching share for Social Security.

SFFAS No. 5, "Accounting for Liabilities of the Federal Government," requires Government agencies to report the full cost of employee benefits for CSRS, FERS, the Federal Employee Health Benefit (FEHB), and the Federal Employees Group Life Insurance (FEGLI) programs. NASA used the applicable cost factors and imputed financing sources from the Office of Personnel and Management Letter F-01-326 in these financial statements.

Statement of Net Cost

In Fiscal Year 2001, the Human Exploration and Development of Space (HEDS) Investment and Support program was initiated. This initiative includes human space exploration and development activities enabling synergistic commercial space development and emphasizing highly innovative technologies and advances in science.

NASA established a new enterprise, Biological and Physical Research, during Fiscal Year 2001. This action transferred programs, specifically Life and Microgravity, previously reported in Human Exploration and Development of Space, to Biological and Physical Research.

Prior Period Adjustments

Shuttle launch costs for Fiscal Year 2000 were adjusted from an estimated basis to actual costs creating a prior period adjustment.

Reclassifications

Certain reclassifications have been made to prior year amounts to conform to the current year presentation.

2. Fund Balance With Treasury:
(In Thousands)

	As of September 30, 2001			
Fund Balances:	Obligated	Unobligated Available	Unobligated Not Available	Total
Appropriated Funds	$ 5,460,673	$ 797,657	$ 58,918	$ 6,317,248
Trust Funds	188	-	3,672	3,860
Total	$ 5,460,861	$ 797,657	$ 62,590	6,321,108
Clearing and Deposit Accounts				(359)
Total Fund Balance With Treasury				$ 6,320,749

	As of September 30, 2000			
Fund Balances:	Obligated	Unobligated Available	Unobligated Not Available	Total
Appropriated Funds	$ 5,497,877	$ 616,935	$ 69,044	$ 6,183,856
Trust Funds	80	-	936	1,016
Total	$ 5,497,957	$ 616,935	$ 69,980	6,184,872
Clearing and Deposit Accounts				4,592
Total Fund Balance With Treasury				$ 6,189,464

Obligated balances represent the cumulative amount of obligations incurred, including accounts payable and advances from reimbursable customers for which outlays have not yet been made. Unobligated available balances represent the amount remaining in appropriation accounts that are available for obligation in the next fiscal year. Unobligated balances not available represent the amount remaining in appropriation accounts that can be used for adjustments to previously recorded obligations. Unobligated balances not available are the results of settling obligated balances for less than what was obligated. Unobligated trust fund balances not available represent amounts that must be apportioned by the OMB before being used to incur obligations.

Clearing accounts are used for unidentified remittances that are presumed to be applicable to budget accounts but are being held in the clearing account because the specific appropriation account is not yet known. Deposit account balances represent amounts withheld from employees' pay for U.S. Savings Bonds and State tax withholdings that will be transferred in the next fiscal year.

3. Investments:
(In Thousands)

	As of September 30, 2001			
	Par Value	Amortization Method	Discounts and Premiums, Net	Net Amount Invested
Intragovernmental Non-Marketable Securities	$ 13,706	Straight line method	$ 3,022	$ 16,728

	As of September 30, 2000			
	Par Value	Amortization Method	Discounts and Premiums, Net	Net Amount Invested
Intragovernmental Non-Marketable Securities	$ 13,583	Straight line method	$ 3,144	$ 16,727

Intragovernmental securities are non-marketable Treasury securities issued by the Bureau of Public Debt.

Interest rates range from 2.27 percent to 7.59 percent and from 4 percent to 7.59 percent for the fiscal years ended September 30, 2001 and 2000, respectively.

4. Accounts Receivable, net:
(In Thousands)

	As of September 30, 2001		
	Accounts Receivable	Allowance for Uncollectible Accounts	Net Amount Due
Intragovernmental	$ 72,120	$ (1)	$ 72,119
Governmental	10,009	(871)	9,138
Total	$ 82,129	$ (872)	$ 81,257

	As of September 30, 2000		
	Accounts Receivable	Allowance for Uncollectible Accounts	Net Amount Due
Intragovernmental	$ 119,135	$ –	$ 119,135
Governmental	7,377	(496)	6,881
Total	$ 126,512	$ (496)	$ 126,016

5. Materials and Supplies:
(In Thousands)

	As of September 30	
	2001	2000
Materials	$ 4,703,031	$ 2,676,969
Held in Reserve for Use	2,331	2,449
Total	$ 4,705,362	$ 2,679,418

These amounts are held for use in current operations. Excess, obsolete, and unserviceable items have been removed from these amounts.

During Fiscal Year 2001, NASA directed contractors to reclassify $1.2 billion, previously reported as contractor-held equipment as Materials, to better reflect the nature of these property items. Included in the items were Shuttle and ISS spare parts, External Tanks, Solid Rocket Boosters, and engines.

NASA Centers and contractors are responsible for continually reviewing materials and supplies on hand to identify items that are no longer needed for operational purposes or that need to be replaced.

6. Property, Plant, and Equipment, net:
(In Thousands)

	As of September 30, 2001		
	Cost	Accumulated Depreciation	Net Asset Value
Government-owned/Government-held:			
Land	$ 114,869	$ –	$ 114,869
Structures, Facilities, and Leasehold Improvements	5,428,770	(3,486,905)	1,941,865
Assets in Space	29,617,279	(14,865,471)	14,751,808
Equipment	1,857,987	(1,189,727)	668,260
Capitalized Leases	3,471	(401)	3,070
Internal Use Software and Development	7,771	(426)	7,345
Work-in-Process	3,623,326	–	3,623,326
Total	40,653,473	(19,542,930)	21,110,543
Government-owned/Contractor-held:			
Land	8,208	–	8,208
Structures, Facilities, and Leasehold Improvements	695,151	(439,664)	255,487
Equipment	9,031,469	(6,801,965)	2,229,504
Work-in-Process	6,416,185	–	6,416,185
Total	16,151,013	(7,241,629)	8,909,384
Total Property, Plant, and Equipment	$ 56,804,486	$ (26,784,559)	$ 30,019,927

6. Property, Plant, and Equipment, net (continued):
(In Thousands)

	As of September 30, 2000		
	Cost	Accumulated Depreciation	Net Asset Value
Government-owned/Government-held:			
Land	$ 277,880	$ –	$ 277,880
Structures, Facilities, and Leasehold Improvements	5,157,227	(3,179,885)	1,977,342
Assets in Space	20,906,360	(13,307,872)	7,598,488
Equipment	2,577,041	(1,829,533)	747,508
Capitalized Leases	16,785	(1,378)	15,407
Work-in-Process	5,166,156	–	5,166,156
Total	34,101,449	(18,318,668)	15,782,781
Government-owned/Contractor-held:			
Land	10,349	–	10,349
Structures, Facilities, and Leasehold Improvements	743,252	(472,297)	270,955
Equipment	10,486,694	(6,502,595)	3,984,099
Work-in-Process	5,422,080	–	5,422,080
Total	16,662,375	(6,974,892)	9,687,483
Total Property, Plant, and Equipment	$ 50,763,824	$ (25,293,560)	$ 25,470,264

Assets in Space are various spacecraft that operate above the atmosphere for exploration purposes. Equipment includes special tooling, special test equipment, and Agency-peculiar property, such as the Space Shuttle and other configurations of spacecraft: engines, unlaunched satellites, rockets, and other scientific components unique to NASA space programs. Structures, Facilities, and Leasehold Improvements include buildings with collateral equipment, as well as capital improvements, such as airfields, power distribution systems, flood control, utility systems, roads, and bridges. NASA also has use of certain properties at no cost. These properties include land at the Kennedy Space Center withdrawn from the public domain and land and facilities at the Marshall Space Flight Center under a no-cost, 99-year lease with the U.S. Department of the Army. Work-in-Process is the cost incurred for property, plant, and equipment items not yet completed. Work-in-Process includes equipment and facilities that are being constructed, the most significant of which are segments of the International Space Station.

7. Other Liabilities:
(In Thousands)

	As of September 30, 2001		
	Current	Non-Current	Total
Intragovernmental Liabilities:			
Advances From Others	$ 55,578	$ –	$ 55,578
Workers' Compensation	6,406	9,154	15,560
Accrued Funded Payroll	11,964	–	11,964
Accounts Payable for Closed Appropriations	–	2,989	2,989
Liability for Deposit and Clearing Funds	2,086	–	2,086
Custodial Liability	921	–	921
Other Liabilities	151	–	151
Lease Liabilities	106	307	413
Total Intragovernmental	77,212	12,450	89,662
Governmental Liabilities:			
Unfunded Annual Leave	–	139,397	139,397
Accrued Funded Payroll	101,835	–	101,835
Accounts Payable for Closed Appropriations	1,851	39,845	41,696
Advances From Others	37,610	–	37,610
Contract Holdbacks	3,120	–	3,120
Liability for Receipt Accounts	3,144	-	3,144
Contingent Liabilities	–	104,397	104,397
Lease Liabilities	418	258	676
Other Liabilities	3	–	3
Liability for Deposit and Clearing Funds	(2,126)	–	(2,126)
Total Governmental	145,855	283,897	429,752
Total Other Liabilities	$ 223,067	$ 296,347	$ 519,414

	As of September 30, 2000		
	Current	Non-Current	Total
Intragovernmental Liabilities:			
Advances From Others	$ 32,424	$ –	$ 32,424
Workers' Compensation	6,200	8,195	14,395
Accrued Funded Payroll	11,081	–	11,081
Accounts Payable for Closed Appropriations	117	9,521	9,638
Liability for Deposit and Clearing Funds	3,823	–	3,823
Liability for Receipt Accounts	717	–	717
Lease Liabilities	134	451	585
Total Intragovernmental	54,496	18,167	72,663
Governmental Liabilities:			
Unfunded Annual Leave	–	134,207	134,207
Accrued Funded Payroll	99,831	–	99,831
Accounts Payable for Closed Appropriations	3,656	34,611	38,267
Advances From Others	57,475	–	57,475
Contract Holdbacks	2,152	–	2,152
Liability for Receipt Accounts	2,539	–	2,539
Contingent Liabilities	–	1,213	1,213
Lease Liabilities	9,783	137	9,920
Liability for Deposit and Clearing Funds	745	–	745
Total Governmental	176,181	170,168	346,349
Total Other Liabilities	$ 230,677	$ 188,335	$ 419,012

The liability for Deposit and Clearing funds includes funds on deposit with the Treasury for employees' savings bonds and State tax withholdings.

8. Liabilities Not Covered by Budgetary Resources:
(In Thousands)

	As of September 30, 2001		
	Current	Non-Current	Total
Intragovernmental Liabilities:			
Workers' Compensation	$ 6,406	$ 9,154	$ 15,560
Accounts Payable for Closed Appropriations	–	2,989	2,989
Total Intragovernmental	6,406	12,143	18,549
Governmental Liabilities:			
Environmental Cleanup Costs	27,726	1,318,143	1,345,869
Unfunded Annual Leave	–	139,397	139,397
Actuarial FECA Liability	–	69,672	69,672
Accounts Payable for Closed Appropriations	1,851	39,845	41,696
Contingent Liabilities	–	104,397	104,397
Total Governmental	29,577	1,671,454	1,701,031
Total Liabilities Not Covered by Budgetary Resources	$ 35,983	$ 1,683,597	$ 1,719,580

	As of September 30, 2000		
	Current	Non-Current	Total
Intragovernmental Liabilities:			
Workers' Compensation	$ 6,200	$ 8,195	$ 14,395
Accounts Payable for Closed Appropriations	117	9,521	9,638
Total Intragovernmental	6,317	17,716	24,033
Governmental Liabilities:			
Unfunded Annual Leave	–	134,207	134,207
Accounts Payable for Closed Appropriations	3,656	34,611	38,267
Contingent Liabilities	–	1,213	1,213
Environmental Cleanup Costs	19,826	1,001,250	1,021,076
Actuarial FECA Liability	–	61,581	61,581
Total Governmental	23,482	1,232,862	1,256,344
Total Liabilities Not Covered by Budgetary Resources	$ 29,799	$ 1,250,578	$ 1,280,377

See Note 1 for further discussion of liabilities not covered by budgetary resources.

9. Non-Entity Assets:
(In Thousands)

	As of September 30, 2001		
Asset	Intragovernmental	Due from the Public	Total Non-Entity Assets
Accounts Receivable, net	$ 2,350	$ 1,715	$ 4,065

	As of September 30, 2000		
Asset	Intragovernmental	Due from the Public	Total Non-Entity Assets
Accounts Receivable, net	$ 1,078	$ 2,178	$ 3,256

Accounts receivable related to closed appropriations, which will be deposited in miscellaneous receipts, are included in Non-Entity Assets. These amounts are not separately identified on NASA's Statement of Financial Position as the amounts are immaterial.

10. Leases:
(In Thousands)

Entity as Lessee:
Capital Leases—
Summary of Assets Under Capital Lease:

	As of September 30 2001	2000
Equipment	$ 3,471	$ 16,785
Accumulated Amortization of Liability	(2,347)	(6,280)
	$ 1,124	$ 10,505

NASA capital leases consist of machinery with non-cancelable terms longer than one year, a fair market value of $100,000 or more, a useful life of two years or more, and agreement terms equivalent to an installment purchase.

Future Minimum Lease Payments:

Fiscal Year	
2002	$ 626
2003	332
2004	313
2005 and after	–
Future Lease Payments	1,271
Less: Imputed Interest	(147)
Net Capital Lease Liability	$ 1,124

Operating Leases—

NASA's FY 2001 operating leases are for an airplane hangar, warehouse storage, copiers and land.

Future Minimum Lease Payments:

Fiscal Year	
2002	$ 2,040
2003	1,493
2004	294
2005	178
2006 and after	–
Total	$ 4,005

Entity as Lessor:
Operating Leases—

NASA leases and allows use of its land, facilities, and equipment by the public and other Government agencies for a fee.

Future Projected Receipts:

Fiscal Year	
2002	$ 325
2003	314
2004	42
2005	33
2006 and after	29
Total	$ 743

11. Unexpended Appropriations:
(In Thousands)

	As of September 30	
	2001 Appropriated Funds	2000 Appropriated Funds
Unexpended Appropriations:		
Undelivered Orders	$ 2,469,016	$ 2,506,063
Unobligated:		
Available	797,657	616,935
Not Available	58,918	69,044
Total	$ 3,325,591	$ 3,192,042

12. Change in Unfunded Expenses:
(In Thousands)

Unfunded Expense Transaction Type	Current Fiscal Year Increase (Decrease)
Environmental Cleanup	$ 324,793
Actuarial FECA Liability	8,091
Annual Leave	5,190
Workers' Compensation	1,165
Probable Contingent Liabilities	103,184
Closed Appropriations Accounts Payable	(3,220)
Total Current Fiscal Year Change in Unfunded Expenses	$ 439,203

The change in unfunded expenses represents a net increase during Fiscal Year 2001 of the amounts estimated to be paid from future appropriations.

13. Gross Cost and Earned Revenue By Budget Functional Classification:
(In Thousands)

	2001		
Functional Classification	Gross Cost	Earned Revenue	Net Cost
General Science, Space, and Technology	$ 13,151,282	$ (671,890)	$ 12,479,392
Transportation	1,772,284	(51,183)	1,721,101
Costs Not Assigned to Programs	(5,465,548)	–	(5,465,548)
Trust Funds	1,406	(1,003)	403
Total	$ 9,459,424	$ (724,076)	$ 8,735,348

	2000		
Functional Classification	Gross Cost	Earned Revenue	Net Cost
General Science, Space, and Technology	$ 13,055,311	$ (688,955)	$ 12,366,356
Transportation	1,182,821	(48,543)	1,134,278
Costs Not Assigned to Programs	(2,420,585)	–	(2,420,585)
Trust Funds	1,271	(1,001)	270
Total	$ 11,818,818	$ (738,499)	$ 11,080,319

14. Statement of Net Cost

The Statement of Net Cost recognizes post-employment benefit expenses of $104 million and $87 million for Fiscal Years 2001 and 2000, respectively. Additionally, in Fiscal Year 2001, the Statement includes $2 million for the Judgment Fund. The expense to OPM represents NASA's share of the current and estimated future outlays for employee pensions and life and health insurance. The expense attributable to the Treasury, Judgment Fund, represents amounts paid directly from the Judgment Fund.

15. Statement of Budgetary Resources

Apportionment Categories of Obligations Incurred

The amounts of direct and reimbursable obligations incurred against amounts apportioned under Category B are displayed below:

	Direct	Reimbursable	Total
2001	$14,158,885	$ 748,362	$ 14,907,247
2000	13,782,775	701,325	14,484,100

Explanation of Material Differences Between the Statement of Budgetary Resources and the Budget of the United States Government (In millions)

A reconciliation of budgetary resources, obligations incurred, and outlays, as presented in the Combined Statement of Budgetary Resources (SBR), to amounts included in the Budget of the United States Government for the years ended September 30, 2001, and September 30, 2000, respectively, did not indicate any material differences. Budgetary resources and obligations incurred reconcile to Program and Financing Schedules, while outlays reconcile to the Analytical Perspectives of the Budget.

National Aeronautics and Space Administration
Required Supplementary Stewardship Information
Heritage Assets
For the Fiscal Year Ended September 30, 2001

Federal agencies are required to classify and report heritage assets, in accordance with the requirements of Statement of Federal Financial Accounting Standards (SFFAS) No. 8, "Supplementary Stewardship Reporting."

Heritage assets are property, plant, and equipment that possess one or more of the following characteristics: historical or natural significance; cultural, educational or aesthetic value; or significant architectural characteristics.

Since the cost of heritage assets is not relevant or determinable, NASA does not attempt to value them or to establish minimum value thresholds for designation of property, plant, or equipment as heritage assets. The useful lives of heritage assets are not reasonably estimable for depreciation purposes.

Since the most relevant information about heritage assets is their existence, they are reported in terms of physical units, as follows:

	2001	Additions	Withdrawals	2000
Buildings and Structures	28	9	0	37
Air and space displays and artifacts	393	59	(1)	451
Miscellaneous items	1,018	7	(9)	1,016
Total Heritage Assets	1,439	75	(10)	1,504

Heritage assets were generally acquired through construction by NASA or its contractors and are expected to remain in this category, except where there is legal authority for transfer or sale. Heritage assets are generally in fair condition, suitable only for display.

Many of the buildings and structures are designated as National Historic Landmarks. Numerous air- and spacecraft and related components are on display at various locations to enhance public understanding of NASA programs. NASA eliminated their cost from its property records when they were designated as heritage assets. A portion of the amount reported for deferred maintenance is for heritage assets.

In accordance with SFFAS No. 8, as amended, heritage assets whose predominant uses are in general Government operations are considered "multi-use" heritage assets. Such assets are accounted for as general property, plant, and equipment and capitalized and depreciated in the same manner as other general property, plant, and equipment. NASA has 18 buildings and structures considered to be "multi-use" heritage assets. The values of these assets are included in the property, plant, and equipment values shown in the principal financial statements.

For more than 30 years, the NASA Art Program, an important heritage asset, has documented America's major accomplishments in aeronautics and space. During that time, more than 200 artists have generously contributed their time and talent to record their impressions of the U.S. aerospace program in paintings, drawings, and other media. Not only do these works of art provide a historic record of NASA projects, but they also give the public a new and fuller understanding of advancements in aerospace. Artists are in fact given a special view of NASA through the "back door." Some have witnessed astronauts in training or scientists at work. The art collection, as a whole, depicts a wide range of subjects, from Space Shuttle launches to aeronautics research, the Hubble Space Telescope, and even virtual reality.

Artists commissioned by NASA receive a small honorarium in exchange for donating a minimum of one piece to the NASA archive, which now numbers more than 700 works of art. In addition, more than 2,000 works have been donated to the National Air and Space Museum.

National Aeronautics and Space Administration
Required Supplementary Stewardship Information
Stewardship Investments: Research and Development
For the Fiscal Years Ended September 30
(In Thousands)

Program/Application:	2001	2000	1999	1998
Space Station (a)				
Applied Research	$ –	$ –	$ 99,678	$ 137,529
Development	–	–	2,456,172	2,362,996
	–	–	2,555,850	2,500,525
Payload Utilization and Operations				
Applied Research	217,792	419,452	375,970	401,528
	217,792	419,452	375,970	401,528
Investment and Support				
Applied Research	116,150	–	–	–
	116,150	–	–	–
Space Science				
Basic	837,099	829,870	757,812	1,049,037
Applied Research	–	–	827,405	429,895
Development	1,691,901	1,647,353	992,372	857,453
	2,529,000	2,477,223	2,577,589	2,336,385
Biological and Physical Research (b)				
Basic	110,892	107,951	162,858	221,217
Applied Research	178,792	166,746	119,548	157,727
Development	51,522	46,586	14,239	20,365
	341,206	321,283	296,645	399,309
Earth Science				
Basic	560,336	494,956	358,782	331,095
Applied Research	120,889	97,018	130,625	156,835
Development	952,408	1,052,397	1,252,260	1,254,677
	1,633,633	1,644,371	1,741,667	1,742,607
Aerospace Technology				
Basic	–	144,053	356,546	438,923
Applied Research	1,721,101	906,288	910,027	937,011
Development	–	83,937	20,595	–
	1,721,101	1,134,278	1,287,168	1,375,934
Space Access and Technology				
Applied Research	123,145	512,409	569,775	678,036
	123,145	512,409	569,775	678,036
Commercial Development and Technology Transfers				
Basic	–	–	99,080	–
Applied Research	189,948	171,591	45,341	98,198
Development	–	6,224	23,510	45,788
	189,948	177,815	167,931	143,986
Space Operations				
Basic	240,282	457,582	–	–
Applied Research	150,177	–	–	–
Development	210,247	–	430,503	444,933
	600,706	457,582	430,503	444,933

National Aeronautics and Space Administration
Required Supplementary Stewardship Information
Stewardship Investments: Research and Development
For the Fiscal Years Ended September 30
(In Thousands)

Program/Application (continued):	2001	2000	1999	1998
Academic Programs				
Basic	96,704	71,504	93,339	90,468
Applied Research	41,840	39,873	19,657	19,481
Development	–	–	13,823	37,634
	138,544	111,377	126,819	147,583
Total Research and Development Expenses by Program	**$ 7,611,225**	**$ 7,255,790**	**$ 10,129,917**	**$ 10,170,826**
Non-Research and Development Expenses by Program				
Space Shuttle	$ 3,653,998	$ 3,303,230	$ 3,285,407	$ 3,369,846
Space Station	2,740,366	2,754,089	–	–
Space Communication Services	–	–	184,978	254,440
U.S./Russian Cooperative	358	22,124	151,396	152,625
Other Programs	194,546	165,401	28,922	218,109
Trust Funds	1,406	1,271	832	1,457
Reimbursable Expenses	723,073	737,498	817,810	715,407
Total Non-Research and Development Expenses by Program	**7,313,747**	**6,983,613**	**4,469,345**	**4,711,884**
Total Program Expenses	**$ 14,924,972**	**$ 14,239,403**	**$ 14,599,262**	**$14,882,710**

NASA makes substantial research and development investments for the benefit of the United States. These amounts are expensed as incurred in determining the net cost of operations.

NASA's research and development programs include activities to extend our knowledge of Earth, its space environment, and the universe, and to invest in new aeronautics and advanced space transportation technologies that support the development and application of technologies critical to the economic, scientific, and technical competitiveness of the United States.

Investment in research and development refers to those expenses incurred to support the search for new or refined knowledge and ideas and for the application or use of such knowledge and ideas for the development of new or improved products and processes with the expectation of maintaining or increasing national economic productive capacity or yielding other future benefits. Research and development is composed of the following:

Basic research: Systematic study to gain knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind;

Applied research: Systematic study to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met; and

Development: Systematic use of the knowledge and understanding gained from research for the production of useful materials, devices, systems, or methods, including the design and development of prototypes and processes.

National Aeronautics and Space Administration
Required Supplementary Stewardship Information
Stewardship Investments: Research and Development
For the Fiscal Years Ended September 30
(In Thousands)

(continued)

See Management's Discussion and Analysis elsewhere in this Accountability Report for highlighted program descriptions and performance.

(a) The OMB revised its rules in Fiscal Year 2000 and no longer considered Space Station as Investment in Research and Development, as it was in previous years. Therefore, in Fiscal Year 2000, Space Station became part of Non-Research and Development Expenses by Program.

(b) In Fiscal Year 2001, NASA established a new Enterprise—Biological and Physical Research. This initiative transferred programs, specifically Life and Microgravity, to Biological and Physical Research.

National Aeronautics and Space Administration
Required Supplementary Information
Combined Schedule of Budgetary Resources
As of September 30, 2001
(In Thousands)

	Science, Aeronautics, and Technology	Human Space Flight	Mission Support	Center	Total
Budgetary Resources:					
Budget Authority	$ 6,190,700	$ 5,462,900	$ 2,607,990	$ 27,327	$ 14,288,917
Unobligated Balances—Beginning of Period	348,140	173,688	155,115	23,528	700,471
Spending Authority from Offsetting Collections	513,166	176,977	57,982	3	748,128
Adjustments	17,372	21,798	5,377	(875)	43,672
Total Budgetary Resources	**$ 7,069,378**	**$ 5,835,363**	**$ 2,826,464**	**$ 49,983**	**$ 15,781,188**
Status of Budgetary Resources:					
Obligations Incurred	$ 6,560,018	$ 5,660,268	$ 2,661,030	$ 25,931	$ 14,907,247
Unobligated Balances - Available	472,675	170,975	148,452	5,555	797,657
Unobligated Balances - Not Available	36,685	4,120	16,982	18,497	76,284
Total Status of Budgetary Resources	**$ 7,069,378**	**$ 5,835,363**	**$ 2,826,464**	**$ 49,983**	**$ 15,781,188**
Outlays:					
Obligations Incurred	$ 6,560,018	$ 5,660,268	$ 2,661,030	$ 25,931	$ 14,907,247
Less: Spending Authority from Offsetting Collections and Adjustments	(551,140)	(221,198)	(77,307)	(217)	(849,862)
Obligations Incurred, Net	**6,008,878**	**5,439,070**	**2,583,723**	**25,714**	**14,057,385**
Obligated Balance, Net - Beginning of Period	3,045,601	1,813,384	623,441	15,531	5,497,957
Less: Obligated Balance, Net - End of Period	(3,359,961)	(1,468,499)	(622,673)	(9,728)	(5,460,861)
Total Outlays	**$ 5,694,518**	**$ 5,783,955**	**$ 2,584,491**	**$ 31,517**	**$ 14,094,481**

In Fiscal Year 2001, Congress enacted Public Law 106-154, which was a Governmentwide rescission. This rescission, or reduction of appropriation funds, was for an amount equal to 0.22 percent of the discretionary budget authority provided (or obligation limit imposed) for Fiscal Year 2001. The rescission of $31,428 for Fiscal Year 2001 included $13,620 for Science, Aeronautics, and Technology; $12,018 for Human Space Flight; $5,739 for Mission Support; and $51 for Office of Inspector General.

Cancellation of Expired Accounts included $7 million of withdrawn Science and Aeronautics Technology funds, $8 million of withdrawn Mission Support funds, and $10 million of withdrawn Human Space Flight funds. Fiscal Year 2001 was the end of the sixth year of the new appropriation structure (established in 1995) for the Human Space Flight appropriation for which funds were withdrawn. Additionally, the Fiscal Year 2001 Statement of Budgetary Resources did not include any significant cancellation of expired accounts related to the Fiscal Year 1994 and prior budget structure.

National Aeronautics and Space Administration
Required Supplementary Information
Combined Schedule of Budgetary Resources
As of September 30, 2000
(In Thousands)
(continued)

	Science, Aeronautics, and Technology	Human Space Flight	Mission Support	Other	Total
Budgetary Resources:					
Budget Authority	$ 5,608,200	$ 5,510,900	$ 2,514,758	$ 20,302	$ 13,654,160
Unobligated Balances—Beginning of Period	312,072	370,469	115,172	66,629	864,342
Spending Authority from Offsetting Collections	430,723	163,677	112,615	(1,396)	705,619
Adjustments	16,122	(19,068)	23,942	(60,546)	(39,550)
Total Budgetary Resources	**$ 6,367,117**	**$ 6,025,978**	**$ 2,766,487**	**$ 24,989**	**$ 15,184,571**
Status of Budgetary Resources:					
Obligations Incurred	$ 6,018,977	$ 5,852,290	$ 2,611,373	$ 1,460	$ 14,484,100
Unobligated Balances—Available	307,091	167,068	135,680	7,096	616,935
Unobligated Balances—Not Available	41,049	6,620	19,434	16,433	83,536
Total Status of Budgetary Resources	**$ 6,367,117**	**$ 6,025,978**	**$ 2,766,487**	**$ 24,989**	**$ 15,184,571**
Outlays:					
Obligations Incurred	$ 6,018,977	$ 5,852,290	$ 2,611,373	$ 1,460	$ 14,484,100
Less: Spending Authority from Offsetting Collections and Adjustments	(472,777)	(167,609)	(157,559)	269	(797,676)
Obligations Incurred, Net	**5,546,200**	**5,684,681**	**2,453,814**	**1,729**	**13,686,424**
Obligated Balance, Net—Beginning of Period	2,977,072	1,626,554	585,803	63,729	5,253,158
Less: Obligated Balance, Net—End of Period	(3,045,601)	(1,813,384)	(623,441)	(15,531)	(5,497,957)
Total Outlays	**$ 5,477,671**	**$ 5,497,851**	**$ 2,416,176**	**$ 49,927**	**$ 13,441,625**

In Fiscal Year 2000, Congress enacted Public Law 106-113 (STAT 1501A-303), which was a Governmentwide rescission. This rescission, or reduction of appropriation funds, was for an amount equal to 0.38 percent of the discretionary budget authority provided (or obligation limit imposed) for Fiscal Year 2000. The rescission of $51,881 for Fiscal Year 2000 included $25,805 for Science, Aeronautics, and Technology; $23,000 for Human Space Flight; and $3,076 for Mission Support.

Cancellation of Expired Accounts included $38 million of withdrawn Space Flight Control Data and Communications funds and $18 million of withdrawn Mission Support funds. Fiscal Year 2000 was the end of the fifth year of the new appropriation structure (established in 1995), and two additional appropriation funds were withdrawn (Science and Technology and Mission Support). September 30, 2000, marked the cancellation of the former appropriation known as “Research and Development.”

National Aeronautics and Space Administration
Required Supplementary Information
Intragovernmental Transactions
As of and for the Fiscal Year Ended September 30, 2001
(In Thousands)

Intragovernmental Assets:

Agency	Fund Balance with Treasury	Investments	Accounts Receivable	Advances and Prepaid Expenses
Treasury	$ 6,320,749	$ 16,728	$ 164	$ –
Air Force	–	–	28,947	152
Army	–	–	12,849	24
Commerce	–	–	8,023	2,692
Energy	–	–	1,371	–
General Services Administration	–	–	45	183
Interior	–	–	693	4
National Science Foundation	–	–	186	15,363
Navy	–	–	7,745	3,313
Defense Agencies	–	–	8,042	213
Transportation	–	–	2,524	79
Other	–	–	1,530	10
Total	**$ 6,320,749**	**$ 16,728**	**$ 72,119**	**$ 22,033**

Intragovernmental Liabilities:

Agency	Accounts Payable	Closed Accounts Payable	Workers' Compensation	Liability for Deposit and Clearing Funds
Air Force	$ 45,457	$ 1,850	$ –	$ 261
Army	25,018	45	–	(582)
Commerce	16,725	314	–	174
Energy	20,157	10	–	646
General Services Administration	4,672	–	–	(60)
Interior	6,266	4	–	8
Labor	–	–	15,560	–
National Science Foundation	5,050	35		2
Navy	20,149	452	–	67
Defense Agencies	6,283	269	–	1,433
Transportation	2,316	–	–	354
Other	8,325	10	–	(217)
Total	**$ 160,418**	**$ 2,989**	**$ 15,560**	**$ 2,086**

National Aeronautics and Space Administration
Required Supplementary Information
Intragovernmental Transactions
As of and for the Fiscal Year Ended September 30, 2001
(In Thousands)
(continued)

Intragovernmental Liabilities (continued):

Agency	Advances from Others	Lease Liabilities	Accrued Funded Payroll	Custodial Liability
Air Force	$ 17,628	$ –	$ –	$ 727
Army	12,286	–	–	(304)
Commerce	15,077	–	–	246
Energy	89	–	–	40
General Services Administration	1,571	–	–	–
Interior	1,609	–	–	–
National Science Foundation	151	–	–	10
Navy	4,675	–	–	178
Office of Personnel Management	–	–	11,964	–
Defense Agencies	724	–	–	691
Transportation	1,098	–	–	150
Treasury	–	–	–	(1,227)
Veterans Affairs	–	413	–	–
Other	670	–	–	410
Total	**$ 55,578**	**$ 413**	**$ 11,964**	**$ 921**

Agency	Other Liabilities
Air Force	$ 133
Army	2
Commerce	1
Energy	–
General Services Administration	–
Interior	–
Labor	–
National Science Foundation	–
Navy	–
Defense Agencies	15
Transportation	–
Other	–
Total	**$ 151**

Exchange Revenue	
Commerce	$ 310,482
Air Force	199,131
Other	139,337
Total Exchange Revenue	**$ 648,950**

National Aeronautics and Space Administration
Required Supplementary Information
Intragovernmental Transactions
As of and for the Fiscal Year Ended September 30, 2000
(In Thousands)

Intragovernmental Assets:

Agency	Fund Balance with Treasury	Investments	Accounts Receivable	Advances and Prepaid Expenses
Treasury	$ 6,189,464	$ 16,727	$ 154	$ -
Air Force	-	-	34,232	74
Army	-	-	14,471	3
Commerce	-	-	37,921	1,034
Navy	-	-	9,880	5,233
National Science Foundation	-	-	300	14,042
Defense Agencies	-	-	16,063	1,288
Transportation	-	-	3,440	898
Other	-	-	2,674	132
Total	**$ 6,189,464**	**$ 16,727**	**$ 119,135**	**$ 22,704**

Intragovernmental Liabilities:

Agency	Accounts Payable	Closed Accounts Payable	Workers' Compensation	Liability for Deposit and Clearing Funds
Air Force	$ 63,494	$ 9,033	$ -	$ 2,302
Army	24,816	22	-	56
Commerce	20,926	8	-	(77)
Energy	12,634	10	-	619
Labor	15	-	14,395	-
Navy	21,223	456	-	51
National Science Foundation	9,946	35	-	8
Defense Agencies	5,458	60	-	408
Transportation	4,530	-	-	73
Other	24,348	14	-	383
Total	**$ 187,390**	**$ 9,638**	**$ 14,395**	**$ 3,823**

Agency	Advances from Others	Lease Liabilities	Accrued Funded Payroll	Liability for Receipt Accounts
Air Force	$ 5,384	$ -	$ -	$ 315
Commerce	26,267	-	-	3
Energy	3	-	-	18
Office of Personnel Management	-	-	11,081	-
Defense Agencies	2	-	-	146
Transportation	355	-	-	120
Veterans Affairs	-	585	-	-
Other	413	-	-	115
Total	**$ 32,424**	**$ 585**	**$ 11,081**	**$ 717**

Exchange Revenue	
Commerce	$ 319,763
Air Force	182,108
Other	170,308
Total Exchange Revenue	**$ 672,179**

National Aeronautics and Space Administration
Required Supplementary Information
Deferred Maintenance
For the Fiscal Year Ended September 30, 2001

NASA has deferred maintenance only on its facilities, including structures. There is no significant deferred maintenance on other physical property, such as land, equipment, assets in space, leasehold improvements, or assets under capital lease. Contractor-held property is subject to the same considerations.

The condition assessment survey method is used for facilities to determine asset condition and maintenance required. Several methods are used for evaluating facility condition: 1) 100-percent inspection and condition assessment on a five-year cycle; 2) metrics to support long-term trend analyses; and 3) application of industry standards. In 1997, NASA conducted an Agencywide Facility Investment Study to identify future repairs and maintenance activities. Acceptable operating condition is in accordance with standards comparable to those used in private industry, including the aerospace industry.

There have been no changes to Agency condition assessment procedures in the past several years. NASA's estimate of its backlog of maintenance and repair is approximately $912 million. This estimate was derived from the 1997 Facility Investment Study and was adjusted as of September 30, 2001, to reflect inflation and the amounts budgeted to correct the existing facility deficiencies.

Deferred maintenance related to heritage assets is included in the deferred maintenance for general facilities. Maintenance is not deferred on assets that require immediate repair to restore them to safe working condition and have an Office of Safety and Mission Assurance Risk Assessment Classification Code 1 (see NASA STD 8719.7).

Auditors' Reports

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001

February 27, 2002

Reply to Attn of: W

TO: A/Administrator
B/Deputy Chief Financial Officer

FROM: W/Inspector General

SUBJECT: Audit of the National Aeronautics and Space Administration's Fiscal Year 2001 Financial Statements

We contracted with the independent certified public accounting firm of PricewaterhouseCoopers, LLP to audit the financial statements of NASA as of, and for the year ended, September 30, 2001. The contract required that the audit be done in accordance with generally accepted government auditing standards, Office of Management and Budget (OMB) Bulletin 01-02, *Audit Requirements for Federal Financial Statements*, and the General Accounting Office/President's Council on Integrity and Efficiency *Financial Audit Manual*.

Enclosed are three PricewaterhouseCoopers reports:

- The *Report of Independent Accountants* discusses PricewaterhouseCoopers' disclaimer on the consolidated and combined financial statements as of and for the year ended September 30, 2001. The disclaimer resulted primarily from NASA's inability to provide, in a timely manner, fully supported documentary evidence to substantiate the accuracy and the classification of amounts reported as obligations, expenses, property, plant, and equipment, and materials.

- The *Report of Independent Accountants on Internal Control* identified a material weakness[1] involving NASA's lack of adequate controls to reasonably assure that property and materials are presented fairly in the financial statements. Specifically, NASA did not provide sufficient documentation for amounts capitalized to the International Space Station, and needs to improve the controls surrounding classification and accounting treatment of contractor-held property and inventory items. In addition, PricewaterhouseCoopers identified five reportable conditions[2] involving the operational effectiveness of NASA's financial management processes, the process of estimating

[1] A material weakness is a reportable condition in which the design or operation of one or more of the internal control components does not reduce to a relatively low level the risk that errors or irregularities in amounts that would be material in relation to the financial statements being audited may occur and not be detected within a timely period by employees in the normal course of performing their assigned functions.

[2] A reportable condition is a matter that, in the auditor's judgment, should be communicated because it represents a significant deficiency in the design or operation of internal control, that could adversely affect the agency's ability to record, process, summarize, and report financial data consistent with the assertions by management in the financial statements.

environmental liability, and three conditions involving the NASA Automated Data Processing Consolidation Center: testing disaster recovery plans, access controls over security of financial management systems, and mainframe access controls.

- The *Report of Independent Accountants on Compliance with Laws and Regulations* discusses that PricewaterhouseCoopers performed tests of compliance with certain provisions of laws and regulations, noncompliance with which could have a direct and material effect on the determination of financial statement amounts. The report also discusses certain other laws and regulations specified in OMB Bulletin No. 01-02, including the requirements referred to in the Federal Financial Management Improvement Act (FMFIA). The results disclosed instances in which NASA's financial management systems did not substantially comply with FFMIA section 803(a) Federal financial management systems requirements and applicable Federal accounting standards.

In connection with the contract, we reviewed PricewaterhouseCoopers' report and selected related work papers and inquired of their representatives. Our review, as differentiated from an audit in accordance with U.S. generally accepted government auditing standards, was not intended to enable us to express, and we do not express, opinions on NASA's financial statements or conclusions about the effectiveness of internal control or conclusions on whether NASA's financial management systems substantially complied with the FFMIA or conclusions on compliance with laws and regulations. PricewaterhouseCoopers is responsible for the enclosed auditor's reports dated February 22, 2002 (see Enclosure), and the conclusions expressed in the reports. However, although our quality control review is ongoing, to date we have identified no instances where PricewaterhouseCoopers did not comply, in all material respects, with generally accepted government auditing standards.

If you have any questions, please contact Mr. Alan J. Lamoreaux, Assistant Inspector General for Audits, at (202) 358-1232, or me at (202) 358-1220.

Roberta L. Gross

Enclosures

PricewaterhouseCoopers LLP
1301 K Street, N.W. 800W
Washington DC 20005-3333
Telephone (202) 414 1000

Report of Independent Accountants

To the Inspector General of the
National Aeronautics and Space Administration:

We were engaged to audit the accompanying consolidated balance sheet of the National Aeronautics and Space Administration (NASA) as of September 30, 2001, and the related consolidated statements of net cost and changes in net position and the combined statements of budgetary resources and financing for the year then ended. These financial statements are the responsibility of NASA's management. The financial statements of NASA as of September 30, 2000, and for the year then ended were audited by other independent accountants whose report, dated February 6, 2001, expressed an unqualified opinion on those statements.

For the year ended September 30, 2001, NASA reported obligations incurred of $14.9 billion in its combined statements of budgetary resources and financing and total program expenses of $14.9 billion in its consolidated statement of net cost. To obtain reasonable assurance about whether those amounts were fairly stated, we selected for testing statistical samples of individual obligation and cost transactions from general ledger accounts comprising obligations incurred and expenses. NASA did not provide sufficient documentary evidence in support of transactions included in our samples to determine the accuracy of the reported obligations and expenses.

NASA capitalized approximately $5.8 billion in costs for the International Space Station (ISS) during the year ended September 30, 2001. NASA did not provide sufficient documentary evidence to determine the accuracy and completeness of those capitalized costs. As discussed in Note 1 to the financial statements, NASA recorded in its fiscal year 2001 consolidated statement of changes in net position a prior period adjustment, increasing the amount of costs capitalized to the ISS for space shuttle launches made during fiscal year 2000 by $636 million. NASA did not provide sufficient documentary evidence in support of this adjustment to determine if the additional amount capitalized fairly presents shuttle launch costs attributable to the ISS.

As discussed in Note 6 to the financial statements, NASA changed its accounting for certain assets held by contractors and used in the space shuttle program, reclassifying them from depreciable property, plant, and equipment to materials that will be expensed as they are consumed. This change was effected through the reporting of assets held by NASA's contractors on the annual form 1018 reports. Included among the assets reclassified are certain space shuttle components, such as engines, that generally are refurbished and reused, rather than consumed in a single mission. Thus, the acquisition costs of these components would not be attributed to the periods of their use. The information provided by NASA did not contain

sufficient documentary evidence to determine the appropriateness or the effect of this accounting change.

As of September 30, 2001, NASA reported in its consolidated balance sheet approximately $4.7 billion of NASA-owned materials that are held by contractors. The contractors reported materials using a definition that commingles the Federal Accounting Standards Advisory Board's (FASAB) definition of inventory and its definition of equipment, impairing NASA's ability to classify these assets in conformity with generally accepted accounting principles. The information provided by NASA did not contain sufficient documentary evidence to determine how much of the reported contractor-held materials balance should have been presented as materials, and how much should have been presented as property, plant, and equipment in the consolidated balance sheet as of September 30, 2001.

FASAB's Statement of Federal Financial Accounting Standards No. 4, *Managerial Cost Accounting Concepts and Standards for the Federal Government*, requires federal agencies to report within the financial statements the full cost of their programs. Office of Management and Budget (OMB) Bulletin No. 97-01, *Form and Content of Agency Financial Statements*, requires that costs incurred during a fiscal year that are capitalized on the balance sheet be reported in the statement of financing and notes that such costs do not result in expenses in the statement of net cost in that period. NASA reported $8.5 billion of capitalized costs as operating expenses of the programs, while depreciation expense of $2.5 billion was not reported as an operating expense of the programs. We believe the elimination of capitalized costs from each program's operating expenses and the allocation of depreciation expense to each program are necessary for the fair presentation of the fiscal year 2001 consolidated statement of net cost in conformity with generally accepted accounting principles.

As discussed above, NASA did not provide the sufficient evidence needed to support the accuracy and the classification of amounts reported as obligations, expenses, property, plant, and equipment, and materials in the consolidated and combined financial statements as of and for the year ended September 30, 2001, thereby limiting the scope of our work such that we are not able to express, and we do not express, an opinion on these financial statements.

The management's discussion and analysis, required supplementary stewardship information, and required supplementary information are not required parts of the financial statements but are supplementary information required by the Federal Accounting Standards Advisory Board and OMB Bulletin No. 97-01. This information has not been subjected to auditing procedures; accordingly, we express no opinion on this information.

The accountability report includes other information, in addition to the financial statements, management's discussion and analysis, required supplementary stewardship information, and required supplementary information, which is presented for the purpose of additional analysis and is not a required part of the financial statements. This information has not been subjected to auditing procedures; accordingly, we express no opinion on this information.

In accordance with *Government Auditing Standards*, we have also issued reports dated February 22, 2002, on our consideration of NASA's internal control and on its compliance with laws and regulations. Those reports, which disclose a material weakness and reportable conditions in internal control and non-compliance with the Federal Financial Management Improvement Act, are integral parts of a report prepared in accordance with *Government Auditing Standards* and should be read in conjunction with this report in considering the results of our work.

PricewaterhouseCoopers LLP

Washington, D.C.
February 22, 2002

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Report of Independent Accountants on Internal Control

To the Inspector General of the
National Aeronautics and Space Administration:

We were engaged to audit the financial statements of the National Aeronautics and Space Administration (NASA) as of and for the year ended September 30, 2001, and have issued our report thereon dated February 22, 2002, in which we disclaimed an opinion on those financial statements.

In planning and performing our work, we considered NASA's internal control over financial reporting by obtaining an understanding of NASA's internal control, determined whether internal controls had been placed in operation, assessed control risk, and performed tests of controls. We limited our internal control testing to those controls necessary to achieve the objectives described in Office of Management and Budget (OMB) Bulletin No. 01-02. We did not test all internal controls relevant to operating objectives as broadly defined by the Federal Managers' Financial Integrity Act of 1982, such as those controls relevant to ensuring efficient operations. The objective of our work was not to provide assurance on internal control. Consequently, we do not provide an opinion on internal control.

Our consideration of the internal control over financial reporting would not necessarily disclose all matters in the internal control over financial reporting that might be reportable conditions. Under standards issued by the American Institute of Certified Public Accountants (AICPA), reportable conditions are matters coming to our attention relating to significant deficiencies in the design or operation of the internal control that, in our judgment, could adversely affect the agency's ability to record, process, summarize, and report financial data consistent with the assertions by management in the financial statements. Material weaknesses are reportable conditions in which the design or operation of one or more of the internal control components does not reduce to a relatively low level the risk that misstatements in amounts that would be material in relation to the financial statements being audited may occur and not be detected within a timely period by employees in the normal course of performing their assigned functions. Because of inherent limitations in internal controls, misstatements, losses, or noncompliance may nevertheless occur and not be detected. However, we noted certain matters discussed in the following paragraphs involving the internal control and its operation that we consider to be a material weakness and reportable conditions under standards established by the AICPA and OMB Bulletin No. 01-02.

Material Weakness:

NASA Lacks Adequate Controls to Reasonably Assure that Property, Plant, and Equipment and Materials are Presented Fairly in the Financial Statements

NASA's property, plant, and equipment is comprised of several broad categories, including land, buildings and structures, assets-in-space, work-in-progress, and equipment. The most significant categories of assets include NASA-held assets-in-space and NASA-held work-in-progress and contractor-held work-in-progress. Combined, these three categories comprise $24.8 billion, or 83%, of NASA's net property, plant, and equipment at September 30, 2001.

As of September 30, 2001, NASA had capitalized approximately $8.9 billion related to the International Space Station (ISS). During our audit, we noted weaknesses in NASA's controls to ensure the validity and completeness of the amounts capitalized to the ISS during fiscal year 2001.

- NASA does not have a cost allocation policy to guide its financial and program managers in determining and documenting allocations of costs to the ISS.

- NASA was unable to provide us with a comprehensive listing of ISS costs that had been classified as capitalized assets versus amounts that had been classified as operating expenses. Thus, we were unable to determine whether all significant capital costs had been correctly included in the costs capitalized to the ISS as of September 30, 2001.

- NASA capitalized space shuttle launch costs of approximately $3.0 billion for the transportation of ISS hardware to orbit during fiscal year 2001. On a sample basis, NASA provided Contractor Financial Management Reports and vendor invoices in support of the $3.0 billion. We noted that whole or partial amounts from the Contractor Financial Management Reports and vendor invoices were allocated to the space shuttle launch costs capitalized. However, NASA did not provide sufficient documentary evidence to assess the reasonableness of the allocations.

  Related to this issue, during fiscal year 2001, NASA recorded in its consolidated statement of changes in net position a prior period adjustment, increasing the amount of costs capitalized to the ISS for space shuttle launches during fiscal year 2000 by $636 million. NASA did not provide sufficient documentary evidence in support of this adjustment to determine if the additional amounts capitalized fairly present shuttle launch costs attributable to the ISS.

- We noted that other cost allocations regarding ground processing costs, multiple element integration testing, and space launch support made to the ISS during the fiscal

year approximated $746 million. The documentation NASA provided for the sample transactions tested was not sufficient to assess the reasonableness of these allocations.

Recommendations:

- NASA should develop cost allocation policies to guide its financial and program managers in determining and documenting allocations of costs to the ISS.

- NASA should complete a review of significant ISS contracts to provide reasonable assurance that costs are being appropriately capitalized or expensed, and that an appropriate audit trail evidencing the basis for capitalization decisions is maintained.

- NASA should develop and implement an approach for determining the actual launch costs associated with each space shuttle flight so that the appropriate cost of transporting ISS components to space are capitalized, and that an appropriate audit trail evidencing the basis for capitalization decisions is maintained.

- We recommend that, as NASA addresses these recommendations related to the ISS, NASA apply these same considerations to other significant assets currently held in work-in-progress pending the beginning of their missions.

We also noted that NASA needs to improve the controls surrounding contractor-held property and the contractor reporting process to reasonably assure the accuracy of the data reported by the contractors and that data's consistency with generally accepted accounting principles. Federal Acquisition Regulations (FAR) require contractors to maintain the detail property records for the NASA-owned, contractor-held items. Annually, contractors report to NASA aggregated property, plant, and equipment and materials information to update NASA's accounting records via NASA Form 1018, *NASA Property in the Custody of Contractors*. NASA uses the 1018 reports as the basis for reporting significant materials and property, plant, and equipment balances in its financial statements. In testing these balances, as of September 30, 2001, we found:

- As of September 30, 2001, NASA reported in its consolidated balance sheet approximately $4.7 billion of NASA-owned materials that are held by contractors. The NASA FAR Supplement defines materials as "NASA-owned property held in inventory that may become a part of an end item or be expended in performing a contract. Examples include raw and processed material, parts, assemblies, small tools and supplies. Material that is part of contract work-in-process is not included." This definition, which guides contractors in preparing the 1018 report, commingles the Federal Accounting Standards Advisory Board's (FASAB) definitions of inventory and its definition of equipment, impairing NASA's ability to report these assets in conformity with generally accepted accounting principles. Under FASAB standards, equipment and inventory should be separately classified in the financial statements. In

addition, we noted that one of NASA's larger contractors had misclassified work-in-progress items as materials. Work-in-progress should be classified as property, plant, and equipment. The information reported to NASA by the contractors did not contain sufficient documentary evidence to determine how much of the reported contractor-held materials balance should have been presented as materials and how much should have been presented as property, plant, and equipment in the consolidated balance sheet as of September 30, 2001.

- Some of NASA's contractors used estimated costs instead of actual costs to assign values to completed assets. The current 1018 reporting instructions do not provide guidance to the contractors regarding the development or use of estimates to assign final values to completed assets. Lacking guidance on the use of estimates, it is difficult to assess the reasonableness of the estimates or the impact that this has on NASA's financial statements.

Recommendations:

- NASA should revise the 1018 definitions and reporting instructions so that consumable materials are reported separately from items to be built into long-lived assets, consistent with FASAB and OMB form and content reporting requirements.

- NASA should revise the form 1018 to provide additional information that would allow NASA to conduct a more rigorous analysis of the 1018 reports and better enable it to provide reasonable assurance that property, plant, and equipment and materials balances are properly aggregated and classified by the contractors. Specifically, the 1018 should provide information from the contractors regarding additions and deletions to construction-in-progress, materials, and work-in-progress as well as transfers of assets among contractors and with NASA. NASA should also obtain detailed data supporting balances reported for materials and property, plant, and equipment in the 1018 reports and use this data to validate the contractor-submitted information. In particular, NASA should conduct an analysis of contractor data on the specific items comprising the materials balances reported by the contractors to determine the proper classification of these assets within the consolidated balance sheet.

- NASA should ensure that the 1018 reporting instructions are clarified and updated regarding the use of estimated costs by the contractors. If the use of estimated costs is not permitted, then the reporting instructions should be updated to specifically preclude the use of estimates. If NASA determines that the use of estimated costs is appropriate for assigning values to finished equipment, then NASA should implement appropriate controls to determine the reasonableness of the contractor estimation techniques.

- NASA should build on its fiscal year 2001 outreach to contractors, which it undertook in response to a fiscal year 2000 reportable condition and which surfaced a number of the issues reported here, to provide regular dialogue with and monitoring of contractors to minimize the risk of errors on the 1018 reports.

Reportable Conditions:

System Constraints Impede the Operational Effectiveness of NASA's Financial Management Processes

Each of NASA's Centers uses a different financial management system. These systems were designed and implemented before the current OMB form and content requirements and Federal accounting standards became effective. The systems used by the Centers have multiple feeder systems, and most of the systems summarize individual transactions on a daily or monthly basis. Financial information from the Centers may be summarized more than once before it is uploaded into the General Ledger Accounts System (GLAS). The successive summarization of data through the various systems impedes NASA's ability to maintain an audit trail through the summary data to the detailed transaction-level source documentation. Current OMB and GAO guidance on internal control requires agencies to maintain transaction-level documentation and to make the transaction-level documentation readily available for review. NASA was unable to provide sufficient transaction-level documentation to support certain obligation and expense transactions and certain transaction-level cost allocations that we had selected for testing.

Recommendation:

NASA is currently in the process of implementing a new agency-wide financial management system. If implemented properly, the new financial management system, linked closely with operational procedures, should provide NASA with the ability to readily support transactions and significant events that impact the financial statements. Until the new system becomes operational, we recommend that NASA maintain documentation trails from summary level data recorded in the financial management systems to the detailed source documents.

Improve Controls Used to Estimate the Environmental Liability

NASA has reported a liability of approximately $1.3 billion for environmental cleanup costs for numerous NASA-owned environmental sites around the country. This liability was calculated using parametric models and other estimation techniques, including references to site-specific cleanup reports and bids received from NASA contractors to cleanup sites. Remediation managers located at each of NASA's Centers were responsible for completing the site-specific liability calculations. During our review of the documentation supporting this liability, we noted that the remediation project managers did not have clear or consistent guidance for estimating environmental remediation liabilities. Therefore, the process of

estimating site-specific liabilities varied significantly from one NASA Center to another. In addition, the initial documentation provided by NASA to support site-specific liability calculations did not support the liability calculations completed by the NASA remediation managers. During our audit, NASA made a concerted effort to update the liability calculations for a majority of the environmental cleanup sites around the country. However, control improvements are still warranted for this significant liability.

Recommendation:

NASA should develop liability calculation documentation and provide training to all of the remediation managers to ensure that environmental liabilities are calculated consistently across all of its sites. NASA should establish and implement control procedures to ensure the proper development of environmental liabilities and documentation requirements. NASA should also validate estimates against actual spending to determine the accuracy of estimates.

Perform a Comprehensive Disaster Recovery Test of Logical Partitions that Process Financially Significant Applications

Examination of the Disaster Recovery Test Plan that provides a testing history of all logical partitions revealed that the logical partitions at NASA's primary recovery site in New Jersey, which process the significant financial applications of the Space Centers have not been tested in a consolidated manner to provide comfort that the NASA Automated Data Processing Consolidation Center (NACC) could recover the data processing environments in the event of a disaster that affects the entire data center. In addition, documentation and/or contracts from all of the computer vendors were not available to provide assurance that the necessary hardware and software would be delivered to the secondary recovery site at the Johnson Space Center in a required period of time to support NACC operations and services.

Recommendation:

We recommend that NACC management schedule a consolidated test of the logical partitions at the primary site in the near future and ensure that contracts are in place to provide for delivery of necessary hardware and software to the secondary site.

Improve Logical Access Controls over Security of Financial Management Systems

Our testing of the LPARS that process the significant financial applications revealed a number of weaknesses in the system software and access control settings. A number of security software parameters either were incorrectly set or were not operating effectively in the mainframe and client server architecture that we tested. Below are a few examples of the control weaknesses noted:

- Emergency IDs used by authorized NACC primary and backup system programmers not suspended/revoked after resolution of emergency conditions

- Incorrect settings for the RACF and ACF2 access control software programs
- Incorrect settings for the operating system
- Weak password controls
- Inadequate monitoring of violations
- Inadequate auditing of functions supporting sensitive or critical general resources

Recommendation:

NACC staff should review the various security plans and ensure compliance with such plans. These are: 1) The NACC Security Policies and Procedures, 2) the CSC-PrISMS Security Plan, 3) the Marshall Space Flight Center (MSFC) Information Technology Security Plan, and 4) NASA's NASA Procedures and Guidelines 2810.1.1. A comprehensive review should be performed of all security parameters and these parameters should be modified accordingly to bring them in compliance with NASA's stated security program.

Access Control Weakness for the NACC Mainframe

We identified additional vulnerabilities in security over the NACC mainframe. Because of the sensitive nature of these findings, we are reporting them, together with our recommendations, in a separate limited-distribution report.

* * *

In addition, we considered NASA's internal control over required supplementary stewardship information by obtaining an understanding of NASA's internal control, determined whether these internal controls had been placed in operation, assessed control risk, and performed tests of controls as required by OMB Bulletin No. 01-02 and not to provide assurance on these internal controls; accordingly, we do not provide an opinion on such controls.

Finally, with respect to internal control related to performance measures reported in the Strategic Enterprise and Performance Highlights, we obtained an understanding of the design of significant internal controls relating to the existence and completeness assertions, as required by OMB Bulletin No. 01-02. Our procedures were not designed to provide assurance on internal control over reported performance measures; accordingly, we do not provide an opinion on such controls.

We also noted certain other matters involving internal control that we will report to the management of NASA in a separate management letter.

This report is intended solely for the information and use of the management of NASA, OMB, and Congress, and is not intended to be and should not be used by anyone other than these specified parties.

PricewaterhouseCoopers LLP

Washington, D.C.
February 22, 2002

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Report of Independent Accountants on Compliance with Laws and Regulations

To the Inspector General of the
National Aeronautics and Space Administration:

We were engaged to audit the financial statements of the National Aeronautics and Space Administration (NASA) as of and for the year ended September 30, 2001, and have issued our report thereon dated February 22, 2002, in which we disclaimed an opinion on those financial statements.

The management of NASA is responsible for complying with laws and regulations applicable to the agency. We performed tests of its compliance with certain provisions of laws and regulations, noncompliance with which could have a direct and material effect on the determination of financial statement amounts, and certain other laws and regulations specified in OMB Bulletin No. 01-02, including the requirements referred to in the Federal Financial Management Improvement Act (FFMIA) of 1996. We limited our tests of compliance to these provisions, and we did not test compliance with all laws and regulations applicable to NASA.

Under FFMIA, we are required to report whether the agency's financial management systems substantially comply with the Federal financial management systems requirements, applicable Federal accounting standards, and the United States Government Standard General Ledger at the transaction level. To meet this requirement, we performed tests of compliance with FFMIA section 803(a) requirements. The results of our tests disclosed instances, described below, which indicated that NASA's financial management systems did not substantially comply with Federal financial management systems requirements and applicable Federal accounting standards.

We found that NASA lacked adequate controls to provide reasonable assurance that materials and property, plant, and equipment are presented fairly in the financial statements as of September 30, 2001. In addition, NASA did not provide sufficient documentary evidence in support of amounts reported as obligations incurred and operating expenses in fiscal year 2001. We also noted weaknesses over the security surrounding NASA's financial management systems and the mainframe located at the NASA Automated Data Processing Consolidation Center. We believe that these matters, taken together, represent substantial noncompliance with the Federal financial management systems requirements under FFMIA. Further details on these findings, together with our recommendations for corrective action have been reported separately to NASA in our report on internal control dated February 22, 2002.

Statement of Federal Financial Accounting Standards No. 4, *Managerial Cost Accounting Concepts and Standards for the Federal Government*, requires federal agencies to report

within the financial statements the full cost of their programs. Office of Management and Budget (OMB) Bulletin No. 97-01, *Form and Content of Agency Financial Statements*, requires that costs incurred during a fiscal year that are capitalized on the balance sheet be reported in the statement of financing and notes that such costs do not result in expenses in the statement of net cost in that period. NASA reported $8.5 billion of capitalized costs as operating expenses of the programs, while depreciation expense of $2.5 billion was not reported as an operating expense of the programs. We believe the elimination of capitalized costs from each program's operating expenses and the allocation of depreciation expense to each program are necessary for the fair presentation of the fiscal year 2001 consolidated statement of net cost in conformity with generally accepted accounting principles. Thus, we believe that NASA's treatment of depreciation expense and capital expenditures in its fiscal 2001 statement of net cost represents substantial noncompliance with the Federal accounting standards requirements under FFMIA.

We believe that NASA should assign priority to corrective actions for these FFMIA related matters consistent with the requirements of OMB Circular No. A-50, Revised, on audit follow-up.

The results of our tests of compliance disclosed no other instances of noncompliance with laws and regulations that are required to be reported under *Government Auditing Standards* or OMB Bulletin No. 01-02.

Providing an opinion on compliance with certain provisions of laws and regulations was not an objective of our work; accordingly, we do not express such an opinion.

This report is intended solely for the information and use of the management of NASA, OMB, and Congress, and is not intended to be and should not be used by anyone other than these specified parties.

PricewaterhouseCoopers LLP

Washington, D.C.
February 22, 2002

Appendices

Appendix 1:
Inspector General Assessment of NASA's Most Serious Management and Performance Challenges

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001

February 4, 2002

Reply to Attn of: W

TO: A/Administrator

FROM W/Inspector General

SUBJECT: Inspector General Assessment of NASA's Most Serious Management and Performance Challenges

Pursuant to the Reports Consolidation Act of 2000, this report includes a statement that "summarizes what the Inspector General considers to be the most serious management and performance challenges facing the Agency and briefly assesses the Agency's progress in addressing those challenges." Based on the activities of my office, I have identified eleven management and performance challenges, detailed below. The Agency has recognized many of these issues as part of the Federal Managers' Financial Integrity Act process as warranting special management attention in order to better ensure mission success.

Information Technology Security

The security of NASA's information technology (IT) systems, while improving, requires more effective implementation, monitoring, and enforcement. We continue to encounter serious IT security policy and procedure deficiencies that led us to report NASA's IT security program as a material weakness for the purposes of the Federal Managers' Financial Integrity Act (FMFIA) and the Government Information Security Reform Act.

Leadership is the key to an effective IT program at NASA. Audits and inspections performed by our office have shown that data security and integrity, sharing of risk information between classified and unclassified programs, application controls, training, effective implementation of a common architecture, and communication have been negatively affected by fragmented programs and the lack of centralized leadership.

We also continue to be concerned about inadequate IT security training, inconsistent Agency programs to ensure the security of sensitive systems, and the absence of enforcement mechanisms to ensure that host and network level security policies and procedures are implemented appropriately. We find that resource requirements have not been fully identified, funding shortfalls exist, priorities are unclear, and corrective actions have been slow and incomplete. Repeat findings indicate that the Agency does not consistently communicate our recommendations to minimize security vulnerabilities to the NASA

community and that NASA management is often slow to implement corrective actions with which it has concurred.

E-Government Initiatives

As E-Government initiatives are further developed and implemented Government-wide, NASA will be challenged to increasingly use electronic means to improve its own processes and to interact with citizens, businesses, and other government entities. We will evaluate whether the Agency is allocating sufficient resources and management attention to these efforts.

Our experience has shown that expansion of the Agency's IT systems will create new security and/or privacy vulnerabilities. IT systems that support E-Government initiatives may be particularly vulnerable since they must be accessible from outside of the Agency. The OIG will audit and inspect NASA's implementation of the E-Government initiatives to ensure the Agency is implementing sufficient security, privacy, and other internal controls to ensure the availability, accessibility, integrity, legal sufficiency, and reliability of its electronic communications.

International Space Station Program Management

The International Space Station (ISS) is a technological marvel but has consistently experienced cost overruns. Our reviews have found significant concerns related to ISS cost and contingency planning, contract restructuring, spare parts costs, and procurement. Until these problems are fully resolved, the ISS will remain a management and performance challenge. We agreed with NASA management that ISS program management is a material weakness for the purposes of FMFIA.

One of our largest concerns is that ISS program management has not taken the necessary steps to contain cost growth on some of its major contracts. For example, ISS management settled requests from Boeing (the ISS prime contractor) for additional costs allegedly caused by the Government, and other potential claims without performing a sufficient analysis to show that Boeing's proposed costs were fair and reasonable. Also, ISS management did not adequately justify waiving the Federal Acquisition Regulation requirement that Boeing submit certified cost or pricing data. In addition, NASA's Office of Procurement did not exercise adequate oversight of the restructured contract, even though it was one of the most significant noncompetitive awards in fiscal year 2000.

The ISS Program management's planning for major projects within the program is another major concern. For example, one of our recent audits showed NASA attempted to implement the ISS Propulsion Module before completing acquisition planning and project documentation. The module eventually turned out to be unaffordable and was canceled. For future projects, management agreed with our recommendations to complete acquisition

planning and documentation, validate requirements, synchronize milestones, and obtain an approved justification for sole-source selections.

NASA's Integrated Financial Management System

Office of Management and Budget (OMB) Circular A-127, "Financial Management Systems," requires federal agencies to establish and maintain a single, integrated financial management (IFM) system that complies with applicable accounting principles, standards, and related requirements as defined by OMB, the Department of the Treasury, and the Agency. Currently, NASA does not have a single integrated financial system as required by A-127, but instead has nine separate systems producing information that must be consolidated at a top level through cumbersome techniques. As a result, the Agency relies on outdated systems that do not efficiently and effectively provide complete, timely, reliable and consistent financial information for NASA decision makers and the public.

NASA has been trying to implement an integrated financial system for over 10 years but has not yet been successful. Our past audits provided NASA with timely warnings of significant problems with the Agency's previous attempts to create such a system. NASA is continuing in its efforts to develop an integrated financial management system and we are continuing audit coverage in this area. Until project completion, NASA managers will not have financial visibility and insight into major programs such as the ISS and Space Shuttle. In addition, until IFM is fully implemented, NASA will have to use cumbersome alternative procedures to fully account for major programs. Finally, without an IFM, NASA will incur substantial costs to maintain legacy systems that an IFM would replace.

Safety and Mission Assurance

Completed and ongoing audits, inspections, and investigations, as well as the Agency's continued emphasis on safety, lead us to consider safety and mission assurance to be a significant management/performance challenge for NASA.

- Our audits of Shuttle safety found safety concerns that continue to require management's attention. Management concurred with most of our recommendations, but we remain concerned about United Space Alliance's controls over the use in and around the Space Shuttle orbiter of plastic films, foams, and adhesive tapes for which the characteristics of flammability resistance, electrostatic discharge rate and compatibility with rocket fuel were not known.
- Another audit found that Stennis Space Center and its three major contractors did not properly manage lifting devices and equipment. Because similar problems may exist at other Centers, the NASA Office of Inspector General (OIG) issued a safety alert to the Office of Safety and Mission Assurance for distribution to all Centers.
- Our criminal investigations continue to encounter cases, particularly those involving fraud in the testing of aerospace parts, that could potentially imperil the safety of NASA equipment and personnel.

- In our most recent evaluation of NASA's communications security, we found that NASA's early plans to command spacecraft via the Internet showed only low levels of coordination, policy development, and awareness of security vulnerabilities. NASA management's response to the evaluation was generally unsatisfactory and the Agency may yet expose its future spacecraft and payloads to unnecessary risks.

Launch Vehicles

The Space Shuttles, which are operated on a day-to-day basis by the United Space Alliance, are the world's most capable—and among the world's most expensive—launch vehicles. We continue to be concerned about NASA's plans to use Space Shuttles to launch payloads that do not require the Shuttle's unique capabilities, in possible violation of the Commercial Space Act of 1998. In addition, we believe the agency must develop consistent pricing policy for the launch of commercial or other non-NASA payloads on the Shuttle, but NASA management contends that a pricing policy is not required.

NASA also buys commercial expendable launch vehicles (ELV's) to launch spacecraft that do not require the Shuttle's unique capabilities. NASA policy is to allow non mission-critical and low-cost payloads to fly on unproven launch vehicles, but to require more expensive and critical payloads to fly only on launch vehicles with successful track records. Since launch failures can cause major disruptions in NASA programs, we will continue to monitor NASA's implementation of this policy as well as the ELV Program's performance measurement system and compliance with the Agency's risk mitigation policy for launch services.

Since the mid-1990s, NASA has funded technologies and prototypes intended to reduce the cost of access to space and eventually replace the Shuttle. NASA's current effort to develop such systems and technologies is the Space Launch Initiative (SLI). In May 2001, NASA awarded more than 25 SLI contracts totaling almost $800 million. More awards are planned for 2002. We are currently auditing planning and management of the SLI program. NASA must take care not to make the same mistakes in the new SLI that were made in the canceled X-33 and X-34 technology demonstration programs.

Security of NASA Facilities and Technology

NASA maintains highly sensitive and classified information, possesses significant world-class and unique facilities, and houses a valuable national work force that includes NASA civil servants, contractors, other partners, and numerous official visitors. In light of the September 11, 2001, attack on America, the security of NASA facilities and technologies is of greater concern than before.

Previous OIG audits and other reviews have found weaknesses related to the control and supervision of foreign national visitors at NASA facilities, the export of NASA technology, and the conduct of background checks for NASA employees. We found that controls over access to NASA Centers by foreign national visitors need to be strengthened and uniformly

applied on an Agency-wide basis. We also found that NASA needs to exercise greater diligence in the transfer or exchange of commodities, software, or technologies with foreign partners. NASA has accepted the majority of our recommendations concerning foreign visitors and exports, and we await the completion of the agency's corrective actions. Similarly, NASA management concurred with another report's recommendations to improve the efficiency and effectiveness of the background investigation process at the facility we reviewed, but we remain concerned about the Agency's overall background investigation policies and guidelines.

NASA has taken significant steps to improve security. One of NASA's major security improvements was the establishment of the Office of Security Management and Safeguards as a separate organization directly reporting to the NASA Administrator. Another positive step for NASA security was that the Agency sought and received over $100 million in supplemental funding to respond to the attacks of September 11, 2001. However, even with the new funding, the Agency's decentralized, fragmented structure will continue to impede a coordinated approach to security. For example, the Office of Security Management and Safeguards' evolving counterintelligence effort needs to establish stronger relationships with the NASA programs that conduct oversight of foreign visits and export controls, as well as with the OIG, which has wide-ranging law-enforcement authority.

Procurement

Procurement continues to be a significant management challenge for NASA. Procurement obligations typically account for about 86 percent of the Agency's total obligations. With such a large percentage of the Agency's budget expended through contracts and other procurement vehicles, effective and efficient procurement practices are critical to NASA's success in achieving its overall mission.

NASA continues to be challenged by the need to promote competition in contracting:

- In the past few years, the amount of NASA dollars available for competitive procurements has steadily decreased. Between FY 1993 and 2000, the percentage of annual obligation dollars available for competition decreased from 81 percent to less than 56 percent of the total obligations available. This situation is compounded by the fact that four NASA contractors account for nearly 60 percent of its contract dollars.
- OIG audit and inspection activities have identified multiple sole-source procurements that were not adequately justified in accordance with Federal Acquisition Regulations. A recent audit of multiple-award contracts indicated that about half of the 104 sole-source orders reviewed at two NASA centers did not provide for adequate competition as required by Federal and Agency procurement regulations.
- A series of OIG audit reports found that sole-source subcontracting by prime contractors under NASA contracts is commonplace. Improper sole-source subcontracting by prime contractors increases the cost to NASA and is not in the Government's best interest.

Contract administration also continues to be a management challenge for NASA. The U.S. General Accounting Office (GAO) consistently cites NASA for its lack of adequate systems and processes to oversee procurement activities and its inability to produce accurate and reliable management information in a timely manner. In addition to the risks cited by the GAO, NASA faces increased contract oversight and accountability issues due primarily to the emphasis on contract consolidation and bundling, and human capital issues. Human capital is a significant concern because NASA experienced a 30 percent reduction in its procurement personnel between FY 1993 and February 2001.

Cost Estimating

NASA's willingness and ability to provide accurate and credible cost and risk assessments analyses for its projects has been a concern for many years. In 1996, we reported that NASA had not fully established an independent program assessment function in accordance with the recommendations of the Report of the Advisory Committee on the Future of the U.S. Space Program (the Augustine Report). Management did not follow our recommendation that the Agency's independent cost analysis group, the Independent Program Assessment Office (IPAO), be assigned organizationally to NASA Headquarters. Our September 2001 follow-up review again found that the IPAO's effectiveness could be improved by increasing the organization's independence and enhancing its capabilities. Management agreed with some of our recommendations, but disagreed with our recommendations to assign administrative and organizational responsibility for the IPAO to Headquarters and to make improvements in the process by which the IPAO reviews programs and projects. Management also was not responsive to our recommendation to establish clearly defined criteria for conducting independent reviews throughout the various phases of programs and projects.

Particularly in light of current discussions of further contract consolidation and privatization, we are also concerned that the Agency has historically not performed cost-benefit analyses to determine cost savings from consolidating contracts. NASA did not perform a cost-benefit analysis as part of the decision-making process prior to awarding the Consolidated Space Operations Contract (CSOC) to ensure that the consolidation was the best approach for fulfilling space operations. Similarly, NASA did not perform a cost-benefit analysis prior to consolidation of Space Shuttle contracts under the Space Flight Operations Contract (SFOC). In response to our recommendations, management agreed to perform a cost-benefit analysis before further consolidation of contracts into the SFOC.

National Environmental Policy Act Implementation

The National Environmental Policy Act (NEPA) mandates that all Federal agencies consider the effects of their actions on the environment as early as possible and requires Federal agencies gather information about the environmental consequences of proposed actions, consider the environmental impacts of those actions to assist in making environmental decisions, consider alternatives that avoid or reduce adverse environmental impact, and keep the public informed. In March 2000, we reported that although NASA had established

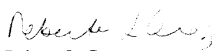
procedures for implementing NEPA, 11 (85 percent) of 13 mission-related programs/projects reviewed did not comply with NEPA requirements or NASA guidance. In addition, 2 of 9 construction-of-facilities projects we reviewed did not fully comply with NASA guidance for implementing NEPA.

NASA has initiated corrective actions in response to our audit recommendations. While we commend NASA's efforts to correct environmental management deficiencies related to NEPA, NEPA compliance will remain a significant management challenge until all of the planned actions are fully implemented and assessed as effective.

Plum Brook Reactor Decommissioning

In 1997, we recommended that NASA begin the process of decommissioning the Plum Brook reactor to save millions of dollars in future maintenance and disposal costs. Since FY 1999, NASA has reported the decommissioning of the facility as a significant area of management concern for the Agency. NASA has submitted a decommissioning plan to the Nuclear Regulatory Commission and is waiting for approval. The total estimated cost for decommissioning the reactor is $161 million.

The process of decommissioning is a NASA-wide concern that will require a coordinated effort involving several Agency components. Future decommissioning activities are particularly vulnerable to any attempts to reduce the Agency's overall budget. Because of the significant costs involved and the need to take timely action, this issue continues to warrant treatment as a significant management challenge.



Roberta L. Gross

Appendix 2:
Audits with Disallowed Costs and Recommendations That Funds Be Put to Better Use

STATISTICAL TABLE ON AUDIT REPORTS WITH DISALLOWED COSTS
OCTOBER 1, 2000, THROUGH SEPTEMBER 30, 2001

Report Category	Number of Audit Reports	Dollar Value
A. Audit reports with management decisions on which final action had not been taken at the beginning of the reporting period	0	$0
B. Audit reports on which management decisions were made during the reporting period	1	$1,048,578
C. Total audit reports pending final action during the reporting period (total of A+B)	1	$1,048,578
D. Audit reports on which final action was taken during the reporting period		
1. Value of disallowed costs collected by management	0	$0
2. Value of disallowed costs written off by management	1	$1,048,578
3. Total (lines D1+D2)	1	$1,048,578
E. Audit reports needing final action at the end of the reporting period (C-D3)	0	$0

STATISTICAL TABLE ON AUDIT REPORTS WITH RECOMMENDATIONS THAT FUNDS BE PUT TO BETTER USE
OCTOBER 1, 2000, THROUGH SEPTEMBER 30, 2001

Report Category	Number of Audit Reports	Dollar Value
A. Audit reports with management decisions on which final action had not been taken at the beginning of the reporting period	0	$0
B. Audit reports on which management decisions were made during the reporting period	5	$730,354,000
C. Total audit reports pending final action during the reporting period (Total of A+B)	5	$730,354,000
D. Audit reports on which final action was taken during the reporting period		
1. Value of recommendations implemented (completed)	3	$715,900,000
2. Value of recommendations that management concluded should not or could not be implemented or completed	1	$14,450,000
3. Total (lines D1+D2)	4	$730,350,000
E. Audit reports needing final action at the end of the reporting period (C-D3)	1	$4,000

Appendix 3:
Audit and Inspection Reports Pending Final Action

Report No.	Report Date

IG-98-028 09/08/98
Transportation Costs for Non-NASA Payloads Flown on Spacehab Models
One OIG recommendation; management concurred. Management working with OIG to close recommendation.

IG-98-030 09/14/98
Single Source Suppliers of Critical Items
Management concurred with all three recommendations. One recommendation remains open pending issuance of NASA Procedure and Guideline (NPG) 7120.5A.

IG-98-041 09/30/98
Consolidated Network Mission Operations Support Cost Savings
DCAA issued its final report and requested an OIG investigation, which is in progress.

IG-99-001 11/03/98
X-33 Funding Issues
Both recommendations were resolved during meeting with Audit Followup Official (AFO). Management conducting further reviews to determine appropriate action.

IG-99-007 01/28/99
Space Station Corrective Action Plans
Management considers audit unresolved and will refer it to AFO for final management decision.

IG-99-009 03/09/99
Space Station Contingency Planning for International Partners
The Johnson Space Center (JSC) Audit Closure Official signed documentation providing evidence that all known risks are included in the Contingency Plan. Audit considered unresolved and will be referred to AFO for final management decision.

IG-99-016 03/24/99
Advanced X-ray Astrophysics Facility
Management agreed to update NPG 7120.5 to require program managers to update Risk Management Plans.

IG-99-020 03/31/99
NASA Control of Export-Controlled Technologies
Audit resulted in six recommendations. Recommendations open pending issuance of NPG 2190.

Report No.	Report Date

IG-99-032 06/23/99
Disaster Recovery Planning at Ames Research Center's (ARC's) Numerical Aerospace Simulation Facility
ARC concurred with report's recommendation and provided OIG with Disaster Recovery Plan. Full implementation and training underway.

IG-99-036 09/20/99
X-38 Crew Return Vehicle (CRV) Operational Testing
Management concurred with recommendation and included human-rated testing in the risk assessment database, with tentative plans for human-rated testing in 2005, and closed recommendation. OIG did not agree with closing prior to actual testing or development of a completed test plan. Implementation of recommendation is budget-dependent.

IG-99-037 09/10/99
Audit of Earned Value Management at NASA EOSDIS Core System (ECS) Performance Measurement Baseline
OIG made three recommendations to management; one closed. Management revising policies to implement remaining open recommendations.

IG-99-047 09/22/99
Safety Considerations at GSFC
OIG made five recommendations; three open. Management finalizing policies to close remaining open recommendations.

IG-99-052 09/24/99
X-33 Cost-Estimating Processes
Audit resulted in four recommendations; three closed. Remaining recommendation unresolved and scheduled to go to AFO for final management decision.

IG-99-053 09/27/99
Management of Contractor Acquired Facilities at MSFC
Management concurred with audit's five recommendations; requested reviews of leases in question by DCAA. Two recommendations open, pending completion of DCAA review and management action.

IG-99-058 9/30/99
Earned Value Management at NASA
Audit resulted in three recommendations; all open and resolved. Management implementing corrective actions.

Report No.	Report Date

IG-99-059 09/30/99
Matching Disbursements to Obligations
OIG made three recommendations; one remains open pending OIG determination that FMM requirement adequately implemented.

IG-00-005 02/09/00
X-38/Crew Return Vehicle Project Management
Management concurred with recommendation to develop and document major characteristics, criteria, and strategy for progressing through major Project phases; identified four major milestones; provided timeline through development phase. However, all milestones contingent on funding in FY 2002 budget.

IG-00-007 02/16/00
Performance Management of the International Space Station Contract
OIG made 14 recommendations; one open. Closure dependent upon completion of DCAA review under another audit (A0003900).

IG-00-009 02/23/00
Staffing of the Expendable Launch Vehicle Program Office at KSC
Two of OIG's four recommendations closed upon issuance of final report. Implementation of remaining two recommendations dependent upon completion of Agency directive.

IG-00-014 03/15/00
UNIX Operating System Security and Integrity of the Checkout and Launch Control System at KSC
Audit resulted in 12 recommendations to management; two closed upon issuance of final report. Management completed corrective action on all remaining open recommendations and provided closure documentation to OIG. Audit closed October 17, 2001, after end of reporting period.

IG-00-017 03/21/00
General Controls at JSC's Mission Control Center
OIG made 14 recommendations in final report. Five recommendations closed. Of 9 remaining open, 1 unresolved. Management working with OIG on closure and resolution of all recommendations.

IG-00-018 03/23/00
NASA Oversight of Contractor Exports of Controlled Technologies
Management implementing corrective actions on report's two recommendations.

Report No.	Report Date

IG-00-023 03/29/00
H. Larry Jordan Review of SSC Exchange Financial Statements for FY Ended September 30, 1998
Audit resulted in three recommendations; two closed. Management taking corrective action for remaining recommendation.

IG-00-024 03/29/00
UNIX Operating System Security and Integrity of the Small Explorer Mission Operations Center at GSFC
OIG made 10 recommendations in final report. Management taking corrective action on all recommendations.

IG-00-029 03/30/00
X-34 Technology Demonstrator
OIG report made 16 recommendations. Eight recommendations closed and management implementing corrective actions on remaining 8 recommendations.

IG-00-030 03/21/00
Compliance with the National Environmental Policy Act
Two of the OIG's nine recommendations closed. Management implementing corrective actions on remaining recommendations.

IG-00-034 05/12/00
Foreign National Visitors at NASA Centers
OIG made four recommendations to strengthen controls over access to Centers by foreign national visitors. All recommendations open. Management completed corrective action on one recommendation and is revising policies to implement the remaining three recommendations.

IG-00-035 06/05/00
Contract Safety Requirements at KSC & MSFC
OIG made three recommendations; management concurred. Two closed. Management completed action on remaining recommendation and prepared closure documentation.

IG-00-036 07/17/00
Summary Report on Disaster Recovery Planning Audits
Audit resulted in two recommendations. One recommendation closed. Management working with OIG to close remaining recommendation.

Report No.	Report Date

IG-00-037 07/17/00
Review of Research Flight Operations at Glenn Research Center (GRC)
OIG made four recommendations; management concurred. Management implementing corrective actions.

IG-00-038 07/17/00
NASA's Organizational Structure for Implementing the Clinger-Cohen Act
Management concurred with recommendations. Recommendation 1 closed; recommendations 2 and 3 open pending completion of agreed-to actions.

IG-00-043 09/20/00
Consolidated Space Operations Contract—Cost-Benefit Analysis and Award Fee Structure
Audit resulted in seven recommendations. Three recommendations open, one of which is unresolved. Unresolved recommendation to go to AFO for final management decision. Management working on corrective actions for remaining two recommendations.

IG-00-044 09/14/00
Transfer of External Tank Display to KSC Visitor Complex
OIG made three recommendations with which management disagreed. On October 2, 2001, AFO made final management decision resolving and closing all recommendations.

IG-00-045 09/20/00
Review of NASA's Independent Cost-Estimating Capability
OIG made five recommendations; management nonconcurred with three. Unresolved recommendations scheduled to go to AFO for final management decision. Corrective action on two remaining recommendations in process.

Report No.	Report Date

IG-00-048 09/19/00
Contractor Exports of Controlled Technologies
OIG made two recommendations with which management agreed. Management implementing corrective actions.

IG-00-055 09/28/00
System Information Technology Security Planning
Audit resulted in 10 recommendations; management concurred with all. Management closed 7 recommendations. Corrective action on 3 remaining recommendations in process .

IG-00-056 09/28/00
Review of Information Assurance Controls for Headquarters Windows NT 4.0 Systems
OIG made 18 recommendations; all resolved. Corrective action completed on majority of recommendations. Management preparing closure documentation.

IG-00-057 09/28/00
NASA's Planning and Implementation for Presidential Decision Directive 63-Phase I
OIG made three recommendations; management concurred with all. Management has taken corrective actions to implement recommendations and is preparing closure documentation.

IG-00-058 09/29/00
Virtual Memory Systems Operating Systems Security and Integrity Controls
Management concurred with all recommendations and is taking corrective actions.

IG-00-059 09/28/00
Software Assurance
Audit resulted in two recommendations. Management concurred and is implementing corrective actions.

INSPECTION REPORTS

Report No. / Report Date

G-99-001 04/28/00
NASA's Badging Program and Physical Access Controls at the MSFC
Three recommendations resolved and open. Management taking corrective actions on all recommendations.

G-99-007 08/06/99
Assessment of the NASA Automated Systems Incident Response Capability
Management completed corrective action on six recommendations and is implementing corrective actions for remaining five.

G-99-009 08/31/00
Headquarters Computer Support Contract Inspection
OIG made six recommendations; all open and resolved. Corrective actions completed; management preparing closure documentation.

G-99-010 07/21/00
ISS Command and Control Communications Security
Review resulted in five recommendations. Management concurred with recommendations and is taking corrective action.

G-99-010A 08/11/00
Portable Computer Systems and the Data Display Process
OIG made 11 recommendations. Eight recommendations unresolved; all open. Management and OIG working on resolution and closure.

Report No. / Report Date

G-99-014 05/26/00
NASA's Badging Program and Physical Access Controls at the Wallops Flight Facility (WFF)
OIG made six recommendations. All resolved; one remains open. Closure dependent upon resolution of jurisdictional issues involving Department of Justice and Commonwealth of Virginia.

G-99-016 9/29/2000
GRC Exchange Activities
Audit resulted in 12 recommendations. One remains open. Management implementing corrective action.

G-99-018 07/21/00
IPA Assignments to NASA
Two of three recommendations unresolved; all open. Management taking action to resolve issues with OIG.

G-00-004 07/14/00
NASA's Badging Program and Physical Access Controls at the GSFC
OIG made 17 recommendations. All resolved; 10 closed. Corrective action underway to implement remaining 7 recommendations.

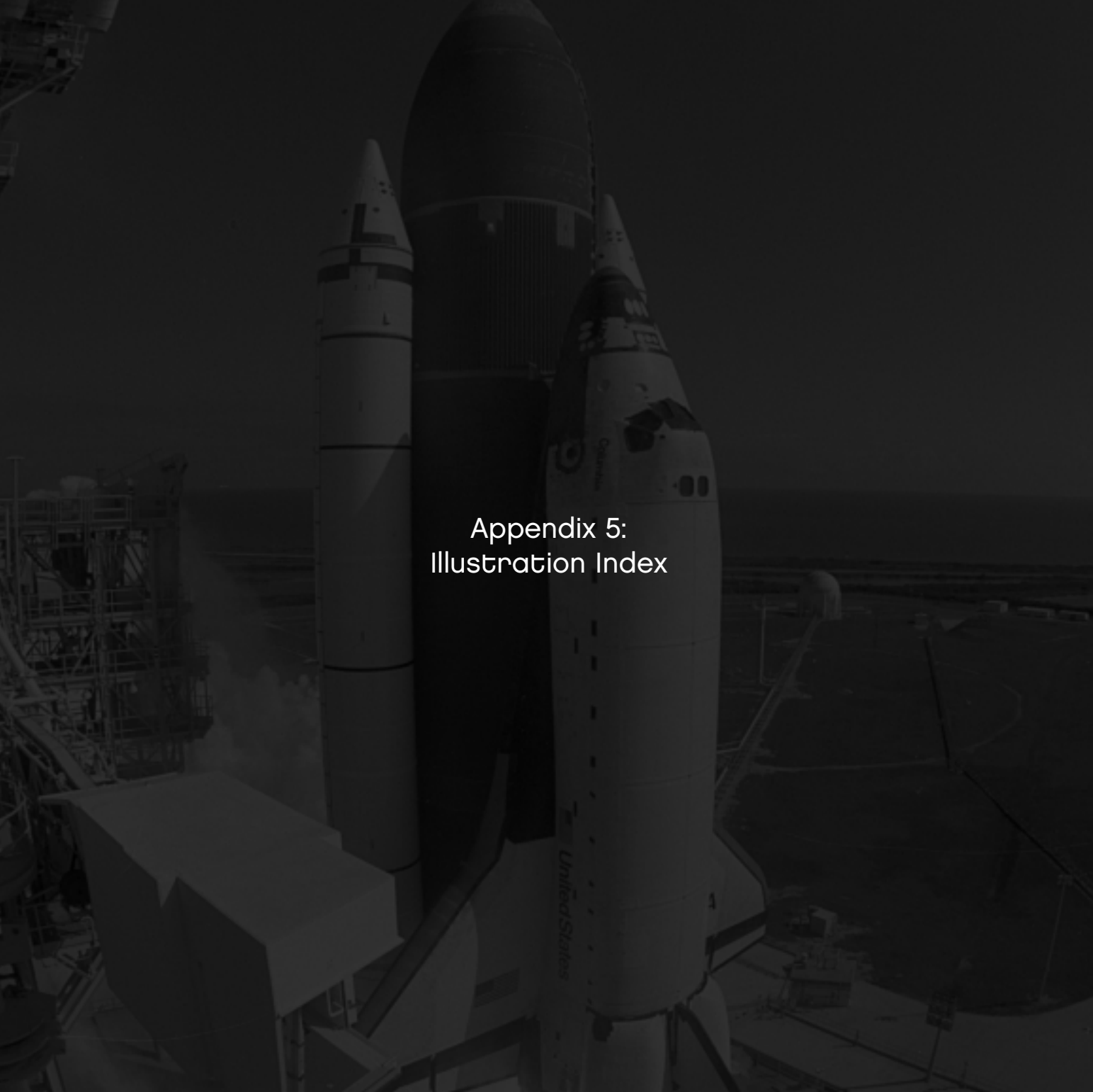
There are no disallowed costs or better use of funds associated with any of these audit and inspection reports. This Appendix reflects data from the Agency's corrective action tracking system. Currently, management and the OIG are reconciling report and recommendation status between the OIG and Agency tracking systems.

Appendix 4: Acronyms

AFO	Audit Followup Officer
AHMS	Advanced Health Management System
ALR	Audit Liaison Representative
ARC	Ames Research Center
AST	Aerospace Technology (Enterprise)
BPRE	Biological and Physical Research Enterprise
CAN	Cooperative Agreement Notice
CAP	Collaborative Arrival Planner
CAU	Cockpit Avionics Upgrade
CBSE	Center for Biophysical Sciences and Engineering
CD	Compact Disc
CERES	Clouds and Earth's Radiant Energy System
CFO	Chief Financial Officer
CFS	Core Financial System
CO_2	Carbon Dioxide
CRM	Continuous Risk Management
CRSP	Commercial Remote Sensing Program
CRV	Crew Return Vehicle
CSOC	Consolidated Space Operations Contract
CSRS	Civil Service Retirement System
CXO	Chandra X-Ray Observatory
DAAC	Distributed Active Archive Center
DC	District of Columbia
DCAA	Defense Contract Audit Agency
DOL	Department of Labor
DMT	Display Management Team (at Kennedy Space Center)
ECS	EOSDIS Core System
ELV	Expendable Launch Vehicle
EO-1	Earth Observing 1
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EOS-Terra	Earth Observing System Terra Satellite
E/PO	Education and Public Outreach
ERAST	Environmental Research Aircraft and Sensor Technology
ESE	Earth Science Enterprise
FAA	Federal Aviation Administration
FACA	Federal Advisory Committee Act
FAR	Federal Acquisition Regulation
FASEB J	*Federation of American Societies for Experimental Biology Journal*
FCIP	Federal Career Intern Program
FECA	Federal Employees' Compensation Act
FEGLI	Federal Employees' Group Life Insurance
FEHB	Federal Employees' Health Benefits
FERS	Federal Employees Retirement System
FFMIA	Federal Financial Management Improvement Act
FFRDC	Federally Funded Research and Development Centers
FMFIA	Federal Managers' Financial Integrity Act
FY	Fiscal Year
GAO	General Accounting Office
GOES-M	Geostationary Operational Environmental Satellite-M
GPRA	Government Performance and Results Act
GPS	Global Positioning System
GRC	Glenn Research Center
GS	General Schedule
GSFC	Goddard Space Flight Center
HBCU	Historically Black Colleges and Universities
HEDS	Human Exploration and Development of Space

HSI	Hispanic-Serving Institution
HST	Hubble Space Telescope
HTCI	HEDS Technology and Commercialization Initiative
ICC	Internal Control Council
IFM	Integrated Financial Management
IG	Inspector General
IGDG	Internet-Based Global Differential GPS
IMCE	ISS Management and Cost Evaluation
IPA	Independent Public Accountant
IPAO	Independent Program Assessment Office
ISO	International Standards Organization
ISS	International Space Station
ISTP	International Solar-Terrestrial Physics Program
IT	Information Technology
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
KSC	Kennedy Space Center
LEO	Low-Earth Orbit
MAP	Microwave Anisotropy Probe
MDI	Michelson Doppler Imager
MGS	Mars Global Surveyor
MIP	Mars In-situ Propellant Production Precursor
MISR	Multi-Angle Imaging Spectrometer
MLG	Main Landing Gear
MODIS	Moderate Resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NASA STARS	NASA's Automated Staffing and Recruitment System
NEPA	National Environmental Policy Act
NEXT	NASA Exploration Team
NIAT	NASA Integrated Action Team
NIX	NASA Image EXchange
NEAR	Near-Earth Asteroid Rendezvous
NMP	New Millennium Program
NOAA	National Oceanic and Atmospheric Administration
NO_x	Nitrogen Oxide
NPD	NASA Policy Directive
NPG	NASA Procedures and Guidelines
NRC	Nuclear Regulatory Commission
NSF	National Science Foundation
ODIN	Outsourcing Desktop Management Initiative
OIG	Office of Inspector General
OMB	Office of Management and Budget
ORB	Other Retirement Benefits
PAPAC	Provide Aerospace Products and Capabilities
PBC	Performance-Based Contracting
PKI	Public Key Infrastructure
PP&E	Property, Plant and Equipment
ProSEDS	Propulsion Small Expendable Deployer System
R&D	Research and Development
RLV	Reusable Launch Vehicle
RSI	Required Supplementary Information
RSSI	Required Supplementary Stewardship Information
RVF	Rift Valley Fever
S&E	Science and Engineering
SAC-C	Satelite de Aplicanciones Cientificas-C

SATS	Small Aircraft System
SCIGN	Southern California Integrated Global Positioning System Network
SeaWiFS	Sea-Viewing Wide Field-of-View Sensor
SEEDS	Space Exposed Experiment Developed for Students
SF	Standard Form
SFFAS	Statement of Federal Financial Accounting Standards
SFOC	Space Flight Operations Contract
SIM	Space Interferometry Mission
SLI	Space Launch Initiative
SOHO	Solar and Heliospheric Observatory
SRR	Strategic Resources Review
SSE	Space Science Enterprise
SSC	Stennis Space Center
STS	Space Transportation System
SVS	Synthetic Vision System
SWAS	Submillimeter Wave Astronomy Satellite
TCU	Tribal Colleges and Universities
TOPEX/Poseidon	Ocean Topography Experiment
TPF	Terrestrial Planet Finder
TRACE	Transition Region and Coronal Explorer
TRACE-P	Transport and Chemical Evolution over the Pacific
TRMM	Tropical Rainfall Measuring Mission
U.S.	United States (of America)
USAF	United States Air Force
USC	United States Code
VPN	Virtual Private Network
VPP	Voluntary Protection Program
WFF	Wallops Flight Facility



Appendix 5:
Illustration Index

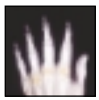


Figure 23
Bone Loss Research

Figure 24
Study of Antibiotic Production in Space

Figure 25
Space Shuttle *Discovery*

Figure 26
STS-98 Spacewalk

Figure 27
Solar Arrays

Figure 28
The International Space Station

Figure 29
Space Station and
Robotic Arm—Canadarm2

Figure 30
The U.S. Airlock Quest

Figure 31
Expedition Crews 2 and 3

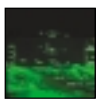


Figure 32
Synthetic Vision Display

Figure 33
Airframe and Engine Source Noise Testing

Figure 34
Helios Prototype Aircraft

Figure 35
Hyper-X Release from B-52 Carrier Aircraft

Figure 36
Linear Aerospike Flight Engine Test

Figure 37
Artrain USA

Figure 38
Appropriations Used
(Costs Expensed by Enterprise)

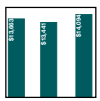


Figure 39
Total Outlays

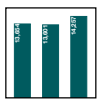
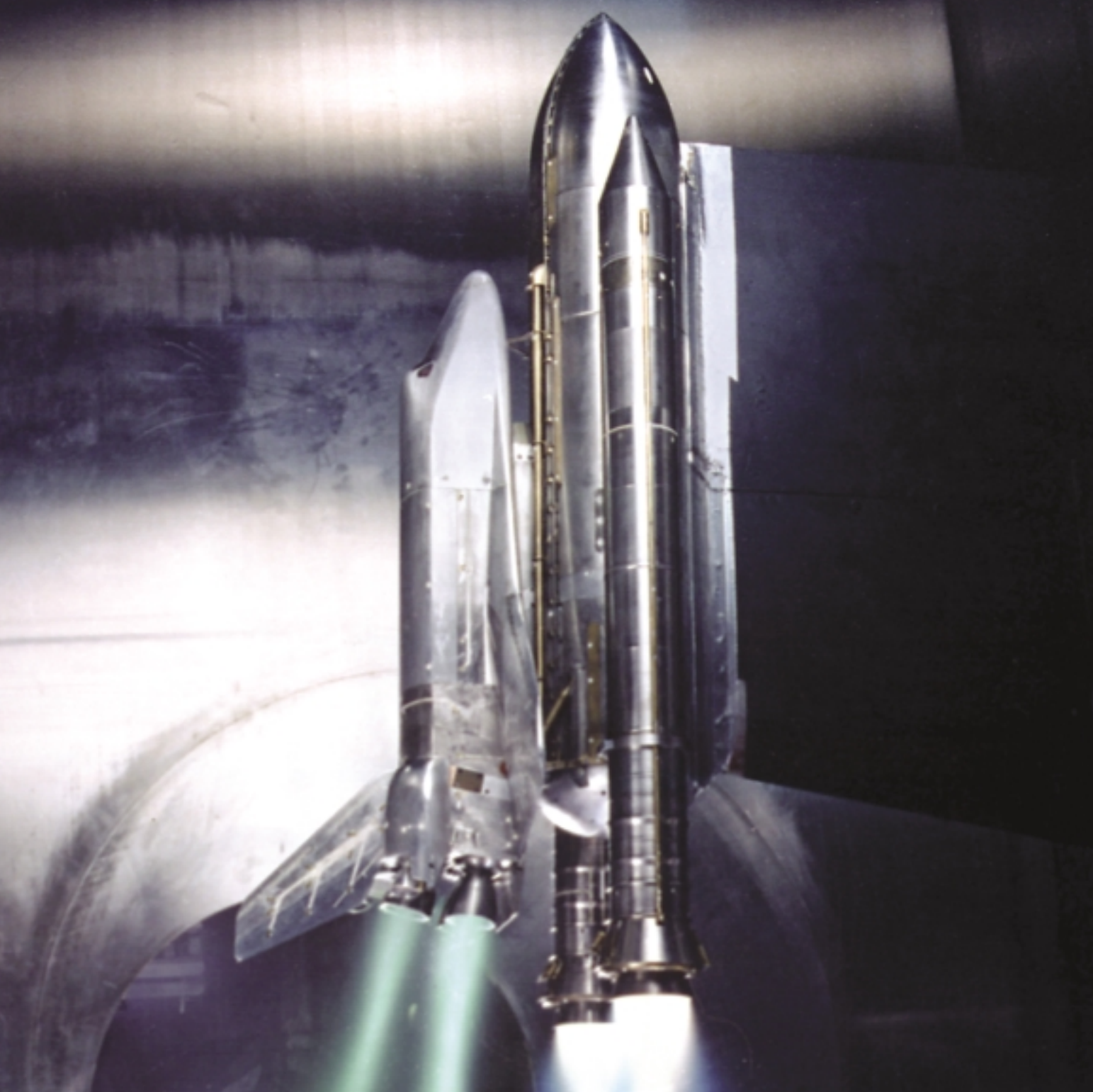


Figure 40
Trend of NASA Budget

Figure 41
FY 2001 Federal Appropriations
vs. FY 2001 NASA Appropriations

Figure 42
Research and Development



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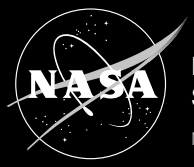

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Space Administration

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