NASA Performance Plan

Fiscal Year 2000

April 1999

The *NASA Fiscal Year 2000 Performance Plan* is intended for use in conjunction with the *NASA Budget Estimates, Fiscal Year 2000*. More detailed information on program content, goals, means, and strategies is contained in the Agency budget documentation. This Performance Plan provides information on only a subset of the Agency's total program.

The *NASA Performance Plan* is prepared by the Office of the Chief Financial Officer.
Questions or comments should be directed to the Resources Management Division, (202) 358-2240.

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The Government Performance and Results Act

The Government Performance and Results Act (GPRA) was passed by Congress and signed by the President in 1993. GPRA was enacted to improve the efficiency of all Federal agencies, with the following specific goals:

- Improve Federal program management, effectiveness, and public accountability
- Improve congressional decisionmaking on where to commit the Nation's financial and human resources
- Improve citizen confidence in Government performance

The Act directs Executive Branch agencies to develop a customer-focused strategic plan that aligns activities with concrete missions and goals. The first strategic plans were to be submitted in September 1998 as part of the Fiscal Year (FY) 1999 budget process. These budget submissions were to support, in a relatable manner, the goals expressed in the agency strategic plans. The Act also directs agencies to manage and measure results to justify congressional appropriations and authorizations. Six months after the completion of the fiscal year, agencies will report on the degree of success in achieving the goals and evaluation measures defined in the strategic and performance plans. The first such report will be furnished to the Congress in March 2000, covering the performance in FY 1999.

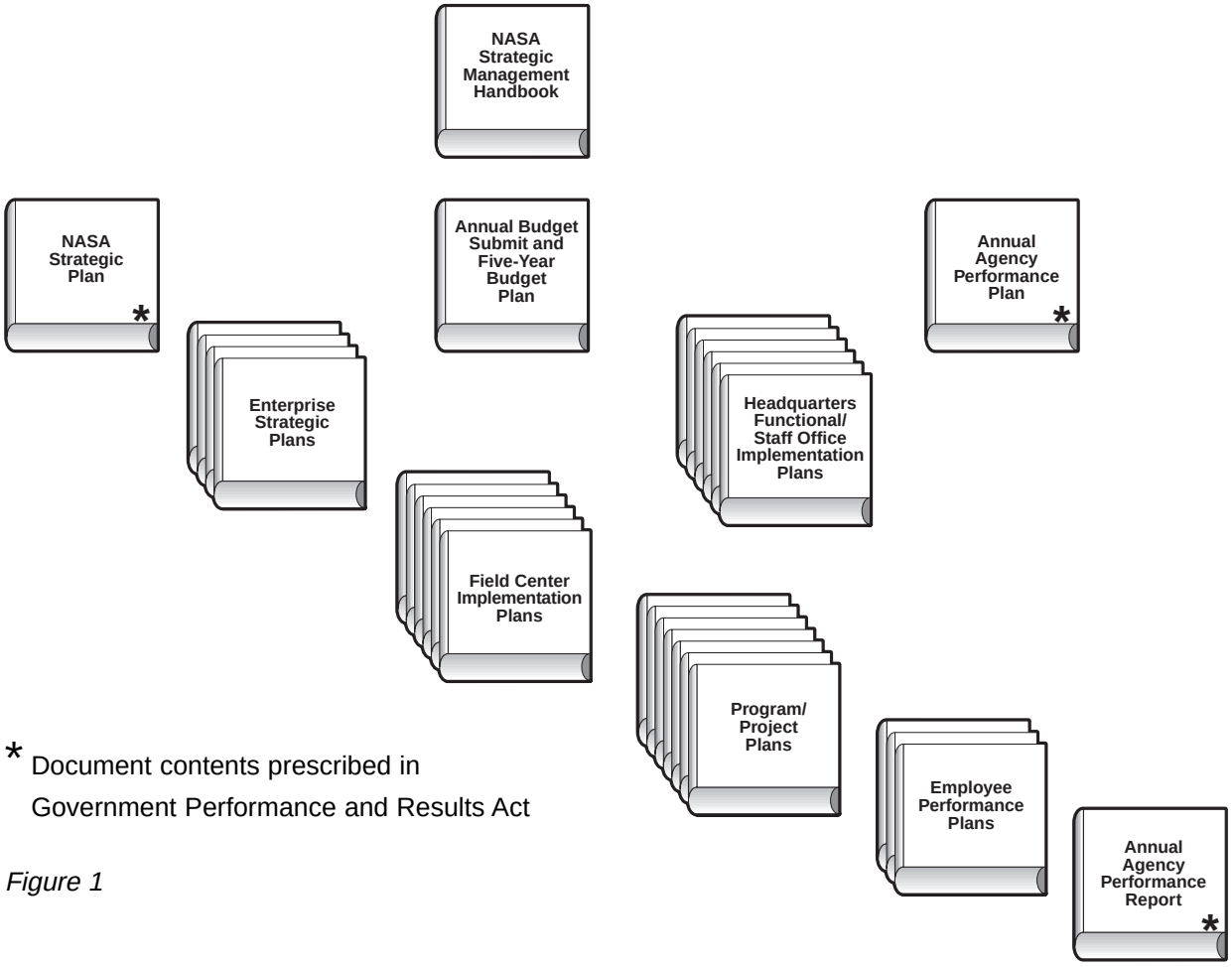
NASA's Strategic Management System

Processes within NASA's Strategic Management System provide the information and results for GPRA's planning and reporting requirements. The system is defined in the NASA Strategic Management Handbook (NASA Procedures and Guidelines 1000.2). Figure 1 illustrates the hierarchy of documentation for the Strategic Management System; Figure 2 provides the system's roadmap.

The NASA Strategic Plan (NASA Policy Directive 1000.1) defines the vision, mission, and fundamental questions of science and research that provide the foundation of the Agency's goals. The Strategic Plan describes the four Strategic Enterprises that manage the programs and activities to implement our mission, answer the fundamental questions, and provide service to identified customers. These Strategic Enterprises are the **Space Science, Earth Science, Human Exploration and Development of Space,** and **Aero-Space Technology.** The support systems for the Strategic Enterprises, defined as Crosscutting Processes, are also defined in the Strategic Plan. These Crosscutting Processes are **Manage Strategically, Provide Aerospace Products and Capabilities, Generate Knowledge,** and **Communicate Knowledge.**

Interested readers may access these Strategic Management System documents through the Internet.

Consistent with the directions in Office of Management and Budget (OMB) Circular A-11, "Preparation and Submission of Budget Estimates," an interim update to the NASA FY 1999 Strategic Plan is included as a separate section of this document. These changes to the Strategic Plan respond to requests that NASA (1) tie our strategic goals and objectives to the National Space Policy (1996), (2) more clearly identify synergy with other Federal agencies, and (3) identify the technology development initiatives in each of the Enterprises.



* Document contents prescribed in Government Performance and Results Act

Figure 1

NASA's Strategic Management System Roadmap

Vision, Mission, Questions, Roadmap and Goals, and Contributions to National Priorities

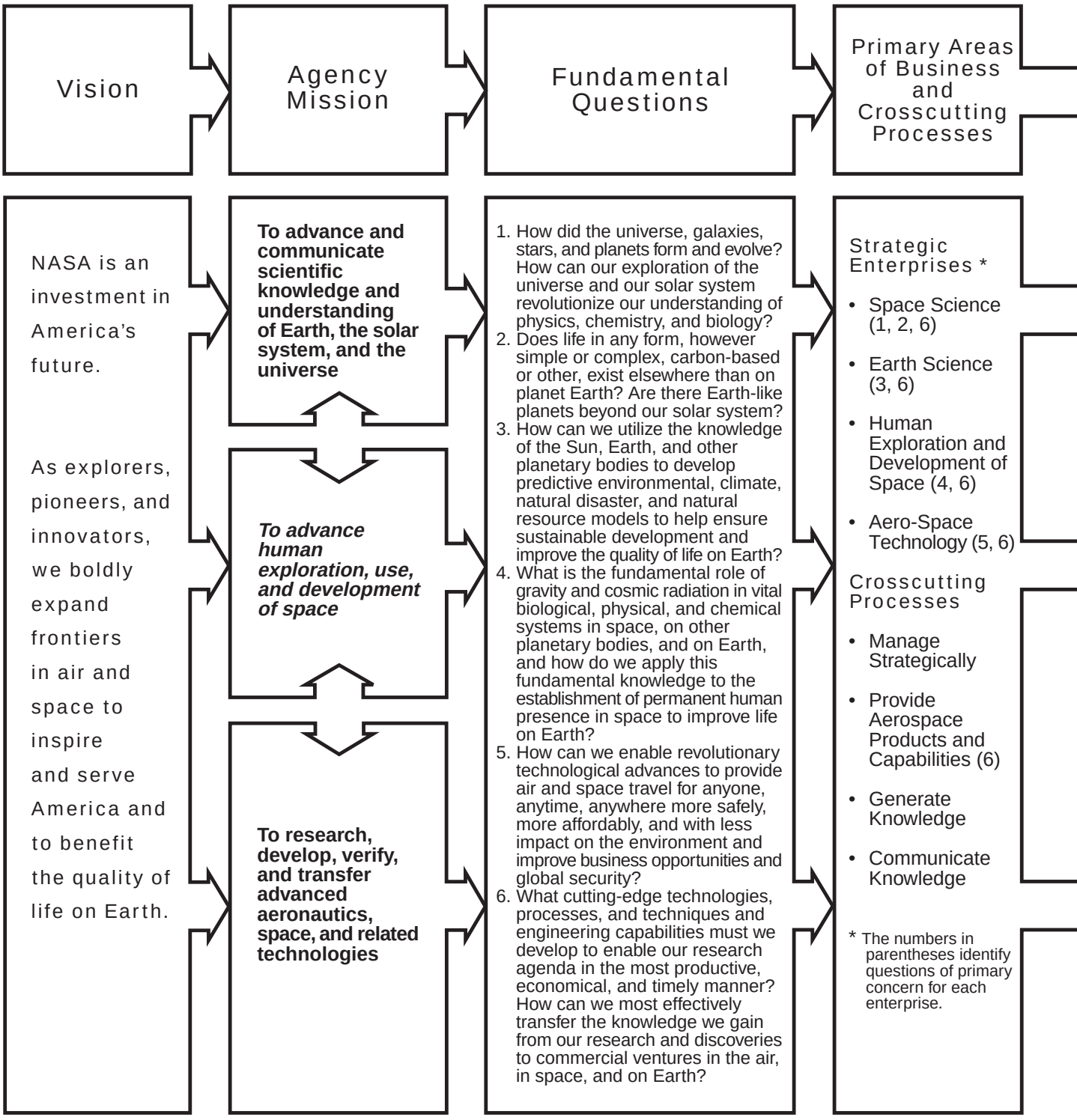
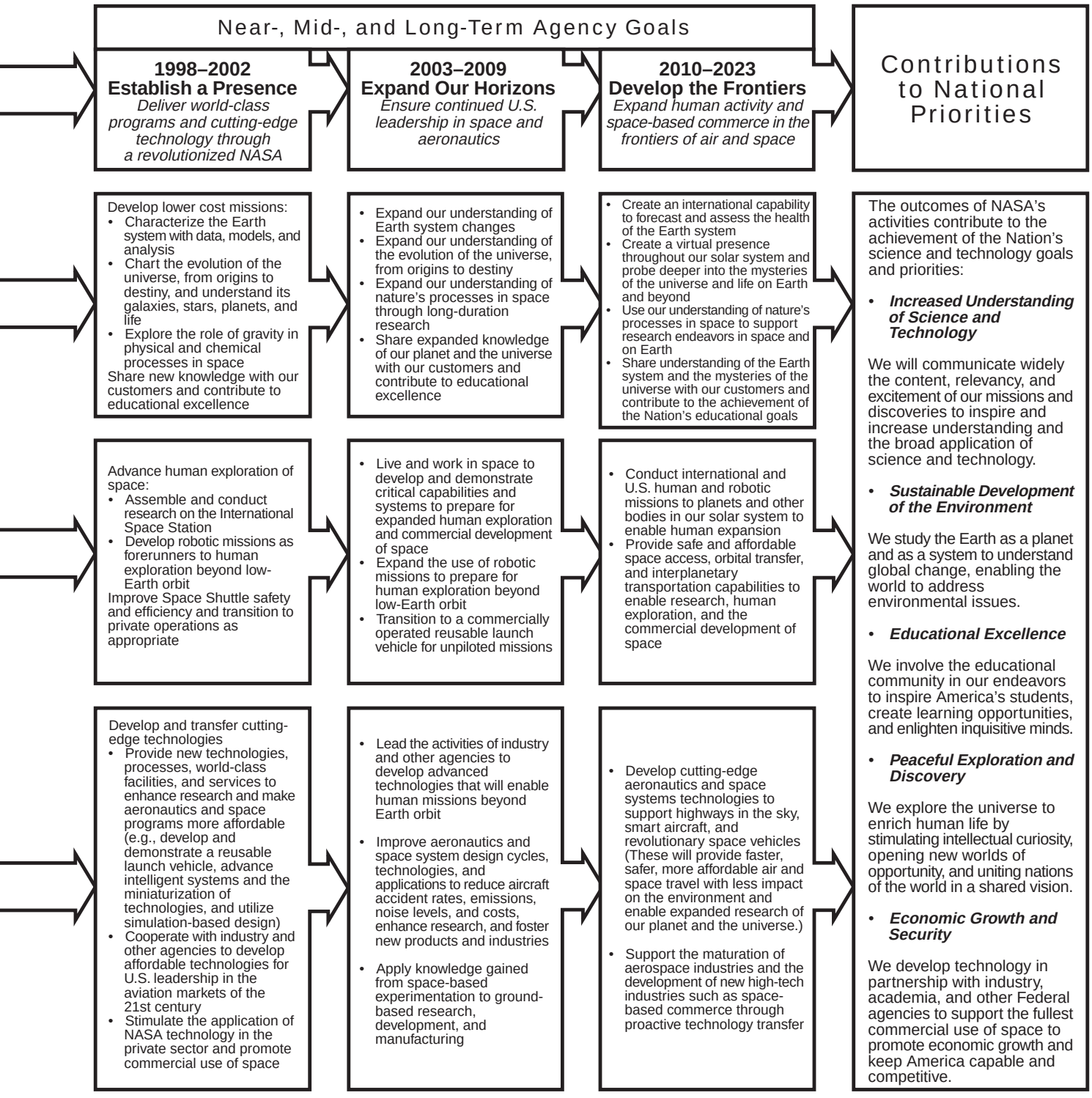


Figure 2


Near-, Mid-, and Long-Term Agency Goals
1998–2002
Establish a Presence
Deliver world-class programs and cutting-edge technology through a revolutionized NASA
2003–2009
Expand Our Horizons
Ensure continued U.S. leadership in space and aeronautics
2010–2023
Develop the Frontiers
Expand human activity and space-based commerce in the frontiers of air and space
Contributions to National Priorities
Develop lower cost missions:
• Characterize the Earth system with data, models, and analysis
• Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life
• Explore the role of gravity in physical and chemical processes in space
Share new knowledge with our customers and contribute to educational excellence
• Expand our understanding of Earth system changes
• Expand our understanding of the evolution of the universe, from origins to destiny
• Expand our understanding of nature's processes in space through long-duration research
• Share expanded knowledge of our planet and the universe with our customers and contribute to educational excellence
• Create an international capability to forecast and assess the health of the Earth system
• Create a virtual presence throughout our solar system and probe deeper into the mysteries of the universe and life on Earth and beyond
• Use our understanding of nature's processes in space to support research endeavors in space and on Earth
• Share understanding of the Earth system and the mysteries of the universe with our customers and contribute to the achievement of the Nation's educational goals
Advance human exploration of space:
• Assemble and conduct research on the International Space Station
• Develop robotic missions as forerunners to human exploration beyond low-Earth orbit
Improve Space Shuttle safety and efficiency and transition to private operations as appropriate
• Live and work in space to develop and demonstrate critical capabilities and systems to prepare for expanded human exploration and commercial development of space
• Expand the use of robotic missions to prepare for human exploration beyond low-Earth orbit
• Transition to a commercially operated reusable launch vehicle for unpiloted missions
• Conduct international and U.S. human and robotic missions to planets and other bodies in our solar system to enable human expansion
• Provide safe and affordable space access, orbital transfer, and interplanetary transportation capabilities to enable research, human exploration, and the commercial development of space
Develop and transfer cutting-edge technologies
• Provide new technologies, processes, world-class facilities, and services to enhance research and make aeronautics and space programs more affordable (e.g., develop and demonstrate a reusable launch vehicle, advance intelligent systems and the miniaturization of technologies, and utilize simulation-based design)
• Cooperate with industry and other agencies to develop affordable technologies for U.S. leadership in the aviation markets of the 21st century
• Stimulate the application of NASA technology in the private sector and promote commercial use of space
• Lead the activities of industry and other agencies to develop advanced technologies that will enable human missions beyond Earth orbit
• Improve aeronautics and space system design cycles, technologies, and applications to reduce aircraft accident rates, emissions, noise levels, and costs, enhance research, and foster new products and industries
• Apply knowledge gained from space-based experimentation to ground-based research, development, and manufacturing
• Develop cutting-edge aeronautics and space systems technologies to support highways in the sky, smart aircraft, and revolutionary space vehicles (These will provide faster, safer, more affordable air and space travel with less impact on the environment and enable expanded research of our planet and the universe.)
• Support the maturation of aerospace industries and the development of new high-tech industries such as space-based commerce through proactive technology transfer
The outcomes of NASA's activities contribute to the achievement of the Nation's science and technology goals and priorities:
• Increased Understanding of Science and Technology
We will communicate widely the content, relevancy, and excitement of our missions and discoveries to inspire and increase understanding and the broad application of science and technology.
• Sustainable Development of the Environment
We study the Earth as a planet and as a system to understand global change, enabling the world to address environmental issues.
• Educational Excellence
We involve the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds.
• Peaceful Exploration and Discovery
We explore the universe to enrich human life by stimulating intellectual curiosity, opening new worlds of opportunity, and uniting nations of the world in a shared vision.
• Economic Growth and Security
We develop technology in partnership with industry, academia, and other Federal agencies to support the fullest commercial use of space to promote economic growth and keep America capable and competitive.

In the NASA Strategic Plan, the vision and mission statements of the Agency are articulated. We reprint them here for the convenience of the reader.

NASA Vision Statement

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.

NASA Mission Statement

- ***To advance and communicate scientific knowledge and understanding of Earth, the solar system, and the universe and use the environment of space for research***
- ***To advance human exploration, use, and development of space***
- ***To research, develop, verify, and transfer advanced aeronautics, space, and related technologies***

Outcomes of NASA's Activities

Government investment decisions on funding for space and aeronautics research and technology cannot be made knowing in advance the full benefits ("outcomes") that will accrue from making the investments. Nor can the timetable be known as to when these benefits will be realized. However, we can identify how the outcomes of NASA's activities contribute significantly to the achievement of America's goals in four key areas:

- **Increased Understanding of Science and Technology**—NASA widely communicates the content, relevancy, and excitement of our discoveries to both inspire and increase understanding and the application of science and technology.
- **Sustaining Development of the Environment**—NASA studies Earth as a planet and as a system to understand global climate change, enabling the world to address environmental issues.
- **Educational Excellence**—NASA involves the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds.
- **Peaceful Exploration and Discovery**—NASA explores the universe to enrich human life by stimulating intellectual curiosity, opening new worlds of opportunity, and uniting nations of the world in this quest.
- **Economic Growth and Security**—NASA conducts aeronautics and space research and develops technology in partnership with industry, academia, and other Federal agencies to keep America capable and competitive.

NASA Fiscal Year 2000 Budget Request

The NASA FY 2000 budget request reaffirms the President's commitment to support NASA's space and aeronautics program (Figure 3). This budget will support the Agency's priorities as directed by the National Space Policy and the President's Goals for a National Partnership in Aeronautics Research and Technology. NASA's priorities include a commitment to safety for human aeronautics and space flight, the assembly of the International Space Station (ISS), and the development of the Next Generation Launch Vehicle. The budget also provides support for an aggressive space science program, a program of long-term observation, research and analysis of Earth from space, and revolutionary advancements that will sustain global U.S. leadership in civil aeronautics and space.

The successful execution of NASA's strategic goals and objectives is contingent on receiving the requested appropriations, as well as the provision of funds, materials, or services that have been committed to the cooperative agreements or partnerships that are referenced in this document. The parties to these agreements include foreign governments, other Federal agencies or departments, and commercial entities.

Under the FY 2000 appropriations structure, the Mission Support appropriation carries a portion of the direct support required to execute the Enterprise goals and objectives, notably Research and Operations Support and civil service salaries and travel. As NASA moves into the era of full-cost management, the budget for these supporting elements will be directly allocated to the programs and projects. The remaining direct costs, such as for the mission-unique information technology support, are already incorporated in the program and project budgets; thus they are not identified as separate contributions.

For informational purposes, the Enterprise sections of this plan will display the civil service staffing levels assigned to the Enterprise. There are also tables in each of the sections that provide

Fiscal Year 2000 Estimates
(In millions of Real Year Dollars)

	FY 99	FY 00	FY 01	FY 02	FY 03	FY04
NASA Total Budget $M	13,665	13,578	13,752	13,757	13,750	13,751
Space Science	2,119	2,197	2,347	2,439	2,634	2,852
Earth Science	1,414	1,459	1,463	1,421	1,373	1,424
Human Exploration and Development of Space	6,309	6,390	6,301	6,024	5,574	5,362
Aero-Space Technology	1,339	1,006	950	982	1,014	999
Mission Support, Academic Programs, Inspector General, and others	2,484	2,526	2,692	2,892	3,155	3,114
Civil Servant Full-Time Equivalents	18,755	18,180	17,993	17,906	17,852	17,784

For the purposes of performance evaluation, Human Exploration and Development of Space (HEDS) includes elements from both the Science, Aeronautics, and Technology appropriation and the Mission Support appropriation. These include the Life and Microgravity Science, Mission Communications, and Space Communications budgets.

Figure 3

the reader with a crosswalk among the performance targets, the strategic objectives, and the appropriate budget line item.

Additional detail on the means and strategies for accomplishing these performance targets is included in the separate NASA FY2000 Budget; in the spirit of efficiency, this information is not repeated in this document. The NASA FY 2000 Budget is available through the NASA Home Page at the following Internet address: *http://ifmp.nasa.gov/codeb/budget2000/*

Fiscal Year 2000 President's Budget Performance Goals

The President's Budget Request for FY 2000 highlights specific Governmentwide Performance Goals. The NASA performance goals called out for this Government Performance Plan are provided below.

Space Science

- NASA Space Science will successfully launch its three planned spacecraft—the Thermosphere, Ionosphere, and Mesosphere Energetics and Dynamics (TIMED) mission; the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE); and the High Energy Solar Spectroscopic Imager—within 10 percent of their schedules and budgets.
- NASA Space Science will develop innovative new technologies to reduce the cost of future spacecraft by delivering the first engineering model of a standard, miniaturized integrated avionics system, to be used for the Europa Orbiter and future missions.
- The NASA Advisory Council will rate all near-term Space Science objectives as being met or on schedule.

Earth Science

- NASA Earth Science will successfully launch its three planned spacecraft—the Advanced Cavity Radiometer Irradiance Monitor (ACRIM) mission; the Vegetation Canopy Lidar (VCL) mission; and a technology validation mission to reduce the costs of future Landsat missions (EO-1)—within 10 percent of their schedules and budgets.
- NASA Earth Science will double the volume of precipitation, land surface, and climate data it archives from its missions compared to 1998, increase the number of products delivered from its archives by 10 percent, and make the data available to users within 5 days.
- The NASA Advisory Council will rate all near-term Earth Science objectives as being met or on schedule.

Human Exploration and Development of Space

- On the International Space Station, NASA will deploy the U.S. Laboratory Module, initiate Station-based extravehicular activity capability, and activate a Station-based external robotic manipulator within performance, schedule, and budget targets.
- NASA will ensure that Space Shuttle safety, reliability, availability, and cost will improve by achieving seven or fewer flight anomalies per mission, successful on-time launches 85 percent of the time, and a 12-month flight manifest preparation time.
- NASA will expand human presence and scientific resources in space by initiating continuous three-person crew presence on the International Space Station.

Aero-Space Technology

- The X-33 program will begin flight testing in 2000 to demonstrate technologies that are traceable to the mass fraction and operability required for future reusable launch vehicles (including 48-hour surge turnarounds and 7-day routine turnarounds with a 50-person ground crew).
- The X-34 program will continue flight testing in 2000 to demonstrate technologies key to the operational requirements of future reusable launch vehicles, including high flight rates (including a flight rate of 25 flights in 1 year).

NASA Performance Plan

This document, as required by the GPRA, describes performance measures and service levels for program activities requested in the FY 2000 budget. Performance goals are defined for NASA's Strategic Enterprises and for the Crosscutting Processes. The *NASA FY 2000 Performance Plan* should be used in conjunction with the *NASA Strategic Plan* (NPD 1000.1) and the *NASA Budget Estimates, Fiscal Year 2000* to obtain a complete understanding of the entire body of work being undertaken by the Agency in Fiscal Year 2000. The *NASA Budget Estimates, Fiscal Year 2000* document provides the complete description of program activities, budget requirements, and performance measures. The NASA Performance Plan provides detail for only a subset of the information provided in the Budget Estimates publication. The NASA budget may be found on the NASA Chief Financial Officer's Home Page at the following address: *http://ifmp.nasa.gov/codeb/budget2000/*

Each section of the Performance Plan includes the following:

- A description of the mission/goal(s) of the Enterprise or Crosscutting Process
- The budget and civil service personnel required to support the Enterprise for FY 1999–2004
- A description of the measurement and the performance targets for FY 2000 (where applicable, prior year performance data will be provided)
- A tabular display of the strategic goal, strategic objectives, and performance targets
- A crosswalk relating the performance targets to both the goals of the Strategic Plan and the NASA budget structure

In the Enterprise and Crosscutting Process sections that follow, the goals, objectives, and specific performance targets are identified. The budgetary resources identified for each Enterprise are consistent with the NASA budget presentation for FY 2000. The civil service staffing for the Enterprises is also provided. In the Enterprise sections, the performance targets differ in significance. In some cases, a performance target represents a major event for the program or project; in other cases, the performance target enables the next major event or critical step in another objective. The performance targets of greater significance are identified in ***bold italic fonts*** in each of the Enterprise sections of this document.

The Performance Evaluation Process: Verification and Validation

NASA uses a process of extensive internal and external reviews to evaluate our progress against established plans. These reviews provide an opportunity to verify and validate the performance data that are provided by the implementing organizations.

Internally, there are standard monthly and quarterly project- and program-level reviews at the NASA Field Installations, at contractor installations, and at NASA Headquarters. There are regular reviews for functional management activities, such as procurement, finance, facilities, personnel, information resources management, and so forth. There are reviews of science, engineering, and technology plans and performance. The NASA Inspector General conducts independent reviews and provides recommendations for corrective actions.

NASA has established management councils, as described in the NASA Strategic Management Handbook, that conduct internal oversight reviews. Throughout the year, Program Management Councils at Headquarters and the Centers assess program schedules, cost, and technical performance against established programmatic commitments. The Senior Management Council brings together both Headquarters and Field Installation Directors to conduct assessment reviews twice a year of the progress being made in meeting the Enterprise and Crosscutting Process performance targets.

NASA's extant management review processes provide appropriate forums for internal reporting and reviewing of project and program performance data. The recent streamlining of Agency processes provide confidence that new data collection and oversight processes need not be created for compliance with the GPRA. Our mission-oriented organizational structure and established management processes are well suited to the assessment of this type of performance evaluation.

There is also a significant *external* review process in place. One of its key elements is the peer review process. NASA uses panels of outside scientific experts to ensure that science research proposals are selected strictly on the merits of the planned research. This process takes into account past performance for selection and/or continued funding.

External reviews are conducted by a number of organizations. An independent accounting firm annually audits NASA's financial statements, including program and functional performance parameters, which leads to the publication of the NASA Accountability Report. NASA requests assistance from other Federal agencies to provide expert advice and council. In some cases, the organizations are advisory bodies of experts from the public and private sectors that work with NASA to establish priorities in particular scientific disciplines. In other cases, reviews are conducted by such organizations as the NASA Advisory Council, the Aerospace Safety Advisory Panel, the National Academy of Sciences, and the General Accounting Office, which share responsibility for oversight of the Agency. The Occupational Safety and Health Administration and the Environmental Protection Agency will also provide reviews of performance unique to their agencies during the fiscal year.

The use of these external reviews allows NASA to receive a report card on whether we are making the anticipated progress toward accomplishing the priorities established by the Administration, Congress, and our advisory bodies. When necessary, these external assessments result in the revision of either implementation plans or strategic plans.

The GPRA Performance Evaluation and Report Process

For the purposes of the GPRA performance reporting process, NASA intends to use its own advisory committees as the critical input. These committees already opine on NASA's Strategic Plan, individual Enterprise Strategic Plans, and budgetary priorities. NASA furnishes program performance status information, and, in turn, the committees render advice and counsel. It is this process that NASA will employ to generate an independent "scorecard" report on our annual performance.

NASA has historically been one of the most open Federal agencies in terms of performance measurements. Public attention is drawn quickly to program successes—and particularly to program failures. Press conferences on the scientific results and program technical status are commonplace. The technical measurement of program progress is a management imperative because of the heavy emphasis on development programs and, within the programs, the specific projects. Flight programs such as the International Space Station compile thousands on thousands of technical performance metrics, schedule milestones, and cost performance.

However, the GPRA requires a heavier focus on *outcome* metrics rather than NASA's ubiquitous input and output metrics. Similar to other Federal agencies engaged in science and technology, NASA has difficulty in quantifying *outcomes* and, especially, relating current outcomes to current fiscal expenditures. This is particularly the case because NASA development programs are multi-year in character. In some cases, the past expenditures began more than a decade ago, such as the Hubble Space Telescope, which entered into development in the mid-1970's. More recently, NASA has focused on programs and projects with much shorter development periods, on the order of 3 to 5 years. Yet, the science outcomes depend on scientists analyzing the information gathered in the years after launch.

The stated objectives of programs within NASA's Enterprises are long term in character. This is exemplified by considering a Space Science performance objective: "Solve mysteries of the universe." Annual performance evaluations assess whether appropriate progress is being made, perhaps actually solving individual "mysteries" to the satisfaction of the scientific community or providing additional insights to the eventual solution of other mysteries. The assessment process requires a multifaceted judgment that takes into account the nature of the challenge of solving the mystery, the level of resources available to be applied, and the actual scientific achievements of the past year.

It is particularly important, in our view, to avoid evaluating actual output performance in research and development (R&D) organizations by counting the number of planned events for the year with the number that actually occurred. The "bean count" approach is more appropriate to a known manufacturing environment. In the high-performance, high-risk R&D environment that characterizes NASA's programs, it is inadvisable to "incentivize" on-time performance and thereby deemphasize *safety, quality, high performance, and appropriate risk-taking.*

NASA has worked hard to maintain the highest emphasis on maintaining *safety;* this value applies not only to the safety of personnel but also to the preservation of high-value facilities, equipment, experimental hardware, and related capabilities. *Quality* goes hand in hand with safety, but extends

well beyond it. For example, taking credit for completing a critical design review (CDR) for a spacecraft is only appropriate when the CDR process has been thorough, complete, and meets performance standards. Great care must be taken that quality does not suffer when contract fee incentives call for a milestone payment upon completion of the CDR. Other examples abound, and they give rise to our constant vigilance to avoid rushing to launch to achieve a given date.

It is possible, of course, to emphasize safety and quality and achieve little of lasting significance or have the achievement take an inordinate amount of time. Building spacecraft that do not test new designs, but rely only on proven designs, is appropriate for operational, mission agencies or commercial entities. It is not appropriate for an R&D environment. Conducting basic and applied research involves experimentation. The exploration of new methods and new technologies in expanding the frontiers of space and aeronautics is an explicit role for NASA. In these *high-performance ventures*, it is acceptable to take risks, to push the envelope, and to fail. The tolerance of failure puts NASA and other R&D agencies into a different category than other Federal agencies involved in the delivery of services to the public. Note, however, that this does not translate into an acceptance of failures that result from taking an inappropriate level of risk. The level of *appropriate risk* is tailored to the environment. The distinction is critical, particularly in high-value, high-cost environments, such as human space flight, the maintenance of the Hubble Space Telescope, and the launch of the Cassini spacecraft. The risk of failure in those venues is limited by all practicable means.

Thus, output measures are best used in a suitable context. For these reasons, NASA management encourages Space Shuttle program managers to shunt aside metrics dealing with launches planned versus launches achieved during a given fiscal year. If, by waiting, one less launch is achieved than planned but the result is better safety or quality or enables improved performance or reduces risk, then that latter result is what we want to incentivize.

We have met with little success in past efforts to marry conventional output measures to these other parameters to derive a quantitative performance metric. Instead, we have determined that asking independent experts to review both quantitative and qualitative measures and to come up with an integrated score is a better approach.

For the purpose of assessing NASA's overall performance, we will ask our advisory committees to evaluate accomplishments at the level of the Enterprise and Crosscutting Process objectives, integrating not only quantitative output measures but also balancing these in the context of safety, quality, high performance, and appropriate risk. The advisory committees will be asked to assign a rating of "red, yellow, or green" to measure the progress made against each of the objectives and to provide a narrative explanation. These objectives are identified in both the Strategic Plan and this Performance plan and are provided below. The advisory committees will also take into account NASA's performance against the 11 "performance goals" called out in the President's Budget Request for Fiscal Year 2000, subject to such adjustments as may be necessary by the action of Congress on the President's request.

Space Science Enterprise

- Solve mysteries of the universe
- Explore the solar system
- Discover planets around other stars
- Search for life beyond Earth
- Develop innovative technologies for Enterprise missions and for external customers
- Incorporate education and enhanced public understanding of science as integral components of Space Science missions and research

Earth Science Enterprise

- Understand the causes and consequences of land-cover/land-use change
- Predict seasonal-to-interannual climate variations
- Identify natural hazards, processes, and mitigation strategies
- Detect long-term climate change, causes, and impacts
- Understand the causes of variation in atmospheric ozone concentration and distribution
- Implement open, distributed, and responsive data system architectures
- 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
- Make major scientific contributions to national and international environmental assessments

Human Exploration and Development of Space Enterprise

- Enable human exploration through collaborative robotic missions
- Define innovative, safe, and affordable human exploration mission architectures
- Invest in enabling high-leverage exploration technologies
- In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems
- Provide safe and affordable access to space
- Deploy and operate the International Space Station to advance scientific, exploration, engineering, and commercial objectives
- Ensure and enhance the health, safety, and performance of humans in space
- Meet strategic space mission operations needs while reducing costs and increasing standardization and interoperability
- Facilitate access to space for commercial researchers
- Foster commercial participation on the International Space Station
- Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets

Aero-Space Technology Enterprise

- Contribute to aviation safety—reduce aircraft accident rate
- Affordable air travel—increase throughput
- Contribute to environmental compatibility—reduce emissions
- Contribute to environmental compatibility—reduce noise
- General aviation revitalization
- Next-generation experimental aircraft
- Next-generation design tools
- Revolutionize space launch capabilities
- Revolutionize in-space transportation
- Provide world-class aerospace research and development services, facilities, and expertise

Manage Strategically

- Optimize investment strategies and systems to align human, physical, and financial resources with customer requirements, while ensuring compliance with applicable statutes and regulations
- Improve the effectiveness and efficiency of Agency acquisitions through increased use of techniques and management that enhance contractor innovation and performance
- Improve information technology capability and services

Provide Aerospace Products and Capabilities

- Reduce the cost and development time to deliver products and operational services
- Improve and maintain NASA's engineering capability
- Capture and preserve engineering and technological best practices and process knowledge to continuously improve NASA's program/project management
- Focus on integrated technology planning and technology development in cooperation with commercial industry and other NASA partners and customers

Generate Knowledge

- Acquire advice
- Plan and set priorities
- Select and fund/conduct research and analysis programs
- Select and implement flight missions
- Analyze data (initial)
- Publish and disseminate results
- Create archives
- Conduct further research

Communicate Knowledge

- Highlight existing and identify new opportunities for NASA's customers, including the public, the academic community, and the Nation's students, to directly participate in space research and discovery
- Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs

Space Science Enterprise

Mission

The primary goal of the Space Science Enterprise is to chart the evolution of the universe from origins to destiny and improve understanding of galaxies, stars, planets, and life. Within this goal, Enterprise objectives are to solve mysteries of the universe, explore the solar system, discover planets around other stars, and search for life beyond Earth. Other Enterprise goals include developing innovative technologies to support Space Science programs and making them available for other applications that benefit the Nation. Enterprise missions and research also yield scientific information of value for future exploration programs. Knowledge and discoveries will be shared with the public to enhance science, mathematics, and technology education and increase the scientific and technological literacy of all Americans.

Implementation Strategy

The Space Science Enterprise is continuing to develop new programs through the "faster, better, cheaper" approach. Program managers are encouraged to accept prudent risk, shorten the development time of technologies and missions, explore new conceptual approaches, streamline management, and incorporate innovative methods and technologies to enhance efficiency and effectiveness. Continuing investments in long-term, high-risk, high-payoff technologies, such as advanced miniaturization, intelligent systems, autonomous operations, and simulation-based design, are key to implementing the Space Science mission. Collaborative efforts with other Federal agencies, such as the National Science Foundation, Department of Defense, and Department of Energy, as well as with international partners, play a key role in the implementation strategy of the Enterprise.

Enterprise Resource Requirements

The President has requested the budget in the table below for FY 1999 to FY 2004 to support the accomplishment of Space Science goals.

Performance Measures

While many Space Science Enterprise missions and programs address more than one goal, Chart 1 allocates each individual program to a single goal that it most directly serves. Performance will be measured for the supporting objectives in Chart 1 as follows:

Objective—Solve mysteries of the universe

The Space Science Enterprise will chart the evolution of the universe and enhance our understanding of galaxies, stars, and planets. The performance targets will be to:

- Maintain and improve Chandra X-ray Observatory (formerly Advanced X-ray Astrophysics Facility) instrument performance.
- Complete the final integration and test of the Gravity Probe-B science payload with the spacecraft.

Space Science Budget

	FY 99	FY 00	FY 01	FY 02	FY 03	FY04
NOA $M	2,119.2	2,196.6	2,346.8	2,439.4	2,634.4	2,851.8
Civil Servant Full-Time Equivalents	1,865	1,787	1,665	1,654	1,617	1,620

- Successfully install and activate three key Hubble Space Telescope upgrades during the third servicing mission: flight computer, advanced camera, and solar arrays.
- Complete the 747 Section 46 mockup test activity for the Stratospheric Observatory for Infrared Astronomy (SOFIA).
- Deliver the Space Infrared Telescope Facility (SIRTF) Infrared Array Camera (IRAC), Multiband Imaging Photometer (MIPS), and Infrared Spectrograph (IRS) instruments.
- Provide the following support for payloads and Explorer class missions: prepare data archiving center and instrument analysis software for INTEGRAL; assemble and test the breadboard cooler for Planck; integrate, functionally test, environmentally qualify, and deliver the Galaxy Evolution Explorer (GALEX) science instrument; and begin system-level environmental testing of the Microwave Anisotropy Probe (MAP) spacecraft.
- Operate the following missions: Compton Gamma Ray Observatory (CGRO), Far Ultraviolet Spectroscopic Explorer (FUSE), Solar, Anomalous, and Magnetospheric Explorer (SAMPEX), Rossi X-ray Timing Explorer (RXTE), and the X-ray Spectrometer (XRS) and X-ray Imaging Spectrometer (XIS) instruments on the Japanese Astro-E spacecraft.
- Undertake the following research and technology initiatives: complete the Next Generation Space Telescope (NGST) Developmental Cryogenic Active Telescope Testbed (DCATT) phase 1; demonstrate performance of the Superconductor-Insulator-Superconductor mixer for the heterodyne instrument on the European Space Agency's Far Infrared Space Telescope (FIRST); demonstrate the prototype instrument for the Gamma-ray Large Area Space Telescope (GLAST); successfully launch 25 sounding rocket missions, and conduct 26 science and technology demonstration balloon missions.

Objective—Explore the solar system

Space-based observations of the Sun, the rocky inner planets, the gas giant outer planets, and solar system small bodies will expand our understanding of the nature and history of our solar system. The performance targets will be to:

- Deliver the Mars 01 Orbiter and Lander science instruments.
- Meet the milestones for the Mars 03 instrument selection and initiate the implementation of the Lander mission, deliver engineering models of the radio-frequency subsystem and antennas for the radar sounder instrument to the European Space Agency for the Mars Express mission, and select the contractors for the major system elements of the Mars Surveyor 05 mission.
- Launch and operate the Thermosphere, Ionosphere, and Mesosphere Energetics and Dynamic (TIMED) mission.
- Provide the following support for payloads and Explorer-class missions: deliver the electrical qualification models for the four U.S.-provided instruments for the Rosetta Orbiter; complete the development of Cluster-II instrument analysis software for the one U.S. and five U.S.-partnered instruments before launch; deliver the High Energy Solar Spectroscopic Imager (HESSI); deliver all components for system integration and testing of the first flight system for the Two Wide-angle Imaging Neutral-atom Spectrometers (TWINS) mission; deliver, launch, and operate the Imager for Magnetopause-to Aurora Global Exploration (IMAGE); and select two Small Explorer (SMEX) missions and release a University Explorer (UNEX) Announcement of Opportunity (AO).

- Acquire calibrated observational data from the Japanese Yohkoh high-energy solar physics mission, including the U.S.-provided Soft X-ray Telescope (SXT).
- Complete Genesis spacecraft assembly and start functional testing.
- Release an AO for the next Discovery mission.
- Complete the breadboard of the imager instrument for the Comet Nucleus Tour (CONTOUR) and award the contract for the propulsion system after a Preliminary Design Review (PDR).
- Recover playback data from at least one Galileo flyby of Io.
- Operate and successfully obtain data sets from the following missions: Mars Climate Orbiter (MCO), Mars Polar Lander (MPL), Mars Global Surveyor (MGS), Near Earth Asteroid Rendezvous (NEAR), Transition Region and Coronal Explorer (TRACE), TIMED, Wind, Cassini, Ulysses, Voyager Interstellar Mission, Stardust, Fast Auroral Snapshot Explorer (FAST), Interplanetary Monitoring Platform (IMP-8), and Advanced Composition Explorer (ACE).
- Undertake the following research and technology initiatives: complete the system Critical Design Review (CDR) for the New Millennium Deep Space-4 (Champollion) project; fabricate and test 15 prototype AMTEC cells and complete the final design for a 75-watt Advanced Radioactive Power Source (ARPS); complete and deliver for testing Solar-B's four Electrical Engineering Models; complete STEREO Phase A studies; and complete a preliminary design for either the Europa Orbiter or Pluto-Kuiper Express mission, whichever is planned for earlier launch.

Objective—Discover planets around other stars

Advancements in interferometric observing will eventually enable us to detect and characterize Earth-sized planets orbiting distant stars. Toward that goal, the performance targets for FY 2000 will be to:

- Demonstrate that Remote Manipulator System optical path difference can be controlled at 1.5 nanometers with the Space Interferometry Mission (SIM) System Testbed (STB) operating in an emulated on-orbit mode.
- Complete and deliver a technology development plan for the Terrestrial Planet Finder (TPF) mission.
- Test the development of an interferometer program for connecting the twin Keck 10-meter telescopes with an array of four 2-meter-class outrigger telescopes.

Objective—Search for life beyond Earth

The Europa Orbiter will orbit Jupiter's ice covered moon to determine whether there is an underlying ocean. Possibly the only other object in our solar system with a liquid water environment, Europa is a major location for the search for extraterrestrial life. The performance targets for FY 2000 for this mission, which is in the developmental stage, will be to:

- Successfully complete a PDR.
- Begin the integration and test of the Avionics Engineering Model.

Objective—Develop innovative technologies for Enterprise missions and for external customers

Enterprise-supported technological advances provide fundamental capabilities that enable missions, reduce costs, increase safety, and open up new opportunities. Important technology development activities that are focused on specific objectives have been listed above with other

performance targets for those objectives. Other Enterprise technology programs are more widely applicable. The performance targets for these programs will be to:

- Demonstrate the search, discovery, and fusion of multiple data products at a major science meeting, accomplish and document the infusion of five information systems research and technology efforts into flight projects or the broad research community, and enable two interdisciplinary collaborations.
- Demonstrate software-implemented fault tolerance for science teams' applications on a first-generation embedded computing testbed for the Remote Exploration and Experimentation element of the High Performance Computer and Communications (HPCC) program.
- Deliver to the X2000 First Delivery project the first engineering model of an integrated avionics system that includes the functionality of command and data handling, attitude control, power management and distribution, and science payload interface.

Note that the following two sections repeat targets that are also identified as key parts of the science program documented in previous sections. They are called out again in these sections to highlight the fact that these missions also support the objectives and the efforts of other Enterprises.

Objective—Investigate the composition, evolution, and resources on Mars, the Moon, and small bodies

To support decisions on human exploration beyond low-Earth orbit, there will be a need for scientific information for operation on other bodies and utilization of their resources. Many Enterprise programs will also contribute valuable information; the performance targets for some of the most directly applicable programs will be to:

- Deliver the Mars 01 Orbiter and Lander science instruments.
- Meet the milestones for the Mars 03 instrument selection and initiate the implementation of the Lander mission, deliver engineering models of the radio-frequency subsystem and antennas for the radar sounder instrument to the European Space Agency for the Mars Express mission, and select the contractors for the major system elements of the Mars Surveyor 05 mission.
- Operate the following missions: MCO, MPL, MGS, and NEAR.

Objective—Improve the reliability of space weather forecasting

A human exploration program will also need scientific information about solar activity and the interplanetary radiation environment, which also has a variety of terrestrial impacts. The performance targets from some of the Enterprise scientific programs most applicable to this objective will be to:

- Operate the following missions: TRACE, Wind, IMP-8, and ACE.
- Deliver and operate HESSI and the TIMED mission.
- Complete the STEREO Phase A studies.

Objective—Incorporate education and enhanced public understanding of science as integral components of Space Science missions and research

Space Science missions and research programs make a unique contribution to education and the

public understanding of science. Providing a steady return of discoveries and new knowledge contributes to the accomplishment of this objective. The performance targets will be to:

- Each new Space Science mission will have a funded education and outreach program.
- By the end of FY 2000, 10 percent of all Space Science research grants will have an associated education and outreach program under way.
- Twenty-six States will have Enterprise-funded education or outreach programs planned or under way.
- At least five research, mission development/ operations, or education programs will have been planned/undertaken in Historically Black Colleges and Universities, Hispanic Serving Institutions, or Tribal Colleges, with at least one project under way in each group.
- At least three national and two regional educational or outreach conferences will be supported with a significant Space Science presence.
- At least three exhibits or planetarium shows will be on display.
- An online directory providing enhanced access to major Space Science-related products and programs will be operational by the end of the fiscal year.
- A comprehensive approach to assessing the effectiveness and impact of the Space Science education and outreach efforts will be under development, with a pilot test of the evaluation initiated.

Internal Assessment

The Space Science program consists of numerous diverse components whose performance must each be assessed in an appropriate way. For some program elements, such as mission development, the achievement of major milestones is easily identified through routine project management reviews. For missions in an operational phase, success can be gauged in terms of operating efficiency or major data sets returned; these can also be assessed by a straightforward analysis of mission records. For technology programs, progress can be predicted and measured in terms of technical capabilities achieved or successful laboratory or flight tests. In each of these cases, performance assessment data can be retrieved from normal project management reporting during the course of the fiscal year.

External Assessment

For the basic research in science and technology and data analysis programs, however, accurate evaluation must consider important contextual factors, such as the relative value of the research objectives, progress toward those objectives, productivity by prevailing research community standards, and impact on related research funded or performed by other agencies or focused even on different objectives. Simple quantitative measures, such as the number of grants or scientists supported, publication counts, or research citations, are not able to capture these important aspects of the evaluation requirement. The demonstrated best way to assess research programs has been demonstrated to be a peer review or visiting committee approach. Evaluators must be external to the Agency, and they must be recognized experts in the areas concerned, with due attention to potential bias and conflicts of interest. The Enterprise will employ this mechanism, conducted by an independent entity such as the National Research Council, to qualitatively assess progress on a regular basis in all its programs in basic research and data analysis. The reviews will be formally structured and will determine whether these

investigation programs are fully effective, are not as strong as desired but have returned results of significant value, or are not scientifically or technologically competitive. The review process will also identify those programs that have produced important unexpected results or have contributed to an unanticipated degree to other research. The performance target for each of these programs assessed in this way will be to:

- Earn a rating of “Fully Effective” against stated program goals by an independent program assessment.

Space Science Enterprise FY 2000 Performance Plan—Chart 1

Space Science Enterprise Strategic Goals	Objectives	Enterprise FY 2000 Performance Plan	00#
Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life	• Solve mysteries of the universe	• ***The Chandra X-ray Observatory (formerly AXAF) instrument will meet nominal performance expectations, and science data will be taken with 70% efficiency with at least 90% of science data recovered on the ground.***	0S1
		• Complete final integration and test of the Gravity Probe-B science payload with the spacecraft in August 2000.	0S3
		• ***Successfully install and activate three key Hubble upgrades during the third servicing mission: flight computer, advanced camera, and solar arrays. Maintain an average on-target pointing efficiency of 35% during FY00 operations before they are interrupted for the third servicing mission, presently scheduled for May 2000.***	0S4
		• Complete the SOFIA 747 Section 46 mockup test activity during June 2000 with no functional test discrepancies that would invalidate CDR-level designs and cause significant design rework with attendant cost and schedule impact.	0S43
		• ***Deliver the SIRTF Infrared Array Camera (IRAC), Multiband Imaging Photometer (MIPS), and Infrared Spectrograph (IRS) instruments during April 2000. The instruments shall perform at their specified levels at delivery.***	0S5
		• Prepare the INTEGRAL Science Data Center (ISDC) for data archiving and prepare instrument analysis software for the Spectrometer on INTEGRAL (SPI) instrument within 10% of estimated cost.	0S6
		• Assemble and successfully test the breadboard cooler for ESA's Planck mission in April 2000.	0S7
		• Deliver the GALEX science instrument from JPL to the Space Astrophysics Laboratory at Caltech during April 2000 for science calibration. The instrument will be fully integrated, functionally tested, and environmentally qualified at the time of the scheduled delivery.	0S8
		• Begin system-level environmental testing of the MAP spacecraft during July 2000.	0S9
		• The baseline mission of the CGRO ended in 1996; the target for FY00 is to continue to operate those instruments not dependent on expended consumables (Oriented Scintillation Spectrometer Experiment, OSSE; Burst and Transient Source Experiment, BATSE; and Imaging Compton Telescope, COMPTEL) at an average efficiency of at least 60%.	0S11
		• ***The 3-year FUSE mission will complete at least one-third of the observations needed for its minimum science program with six of the eight instrument performance parameters being met.***	0S12
		• The prime mission of SAMPEX ended in 1995; the FY00 target is to obtain at least 60% data coverage from at least three of SAMPEX's four instruments.	0S15
		• The baseline RXTE mission ended in 1997; the target for FY00 is to operate at least three of the five instruments at an efficiency of 45% with 95% data recovery; All Sky Monitor data will be posted on the web within 7 days, and Proportional Counter Array and High-Energy X-ray Timing Experiment data will be released within 60 days.	0S2
		• ***If launched, activate the XRS and XIS instruments on the Japanese Astro-E spacecraft after launch and collect at least 90% of the XRS and XIS data.***	0S14
		• Complete the NGST Developmental Cryogenic Active Telescope Testbed (DCATT) phase 1, measure ambient operation with off-the-shelf components, and make final preparations for phase 2, the measurement of cold telescope operation with selected "flight-like" component upgrades.	0S53
		• Demonstrate performance of the Superconductor-Insulator-Superconductor (SIS) mixer to at least 8hv/k at 1,120 GHz and 10hv/k at 1,200 GHz. The U.S. contribution to the ESA FIRST is the heterodyne instrument, which contains the SIS receiver.	0S62
		• The prototype primary instrument for GLAST will demonstrate achievement of the established instrument performance level of angular resolution of 3.5 degrees across the entire 20-MeV to 100-GeV energy range.	0S63
		• Based on an overall goal of successfully launching 25 sounding rocket missions, at least 23 payloads shall successfully achieve their required altitude and orientation, and at least 21 investigators shall achieve their minimum mission success goals.	0S65
		• Based on an overall goal of conducting 26 worldwide science and technology demonstration balloon missions, at least 23 campaigns shall successfully achieve altitude and distance, and investigators' instrumentation shall function as planned for at least 19 missions.	0S66
	• Explore the solar system	• ***Deliver the Mars 01 Orbiter and Lander science instruments that meet capability requirements by June 1, 2000; prelaunch Gamma Ray Spectrometer (GRS) tests shall determine abundances in known calibration sources to 10% accuracy.****	0S29
		• Assuming the Mars Surveyor program architecture is confirmed, meet the milestones for the Mars 03 instrument selection and initiate implementation of the lander mission. Deliver engineering models of the radio-frequency subsystem and antennas for the radar sounder instrument to ESA (if ESA approves the Mars Express mission), and select the contractors for the major system elements of the Mars Surveyor 05 mission.*	0S30
		• The Rosetta project will deliver the electrical qualification models for the four U.S.-provided instruments to ESA in May 2000 for integration with the Rosetta Orbiter.	OS20
		• ***The TIMED mission will be delivered on time for a planned May 2000 launch, within 10% of the planned development budget.***	OS18

Space Science Enterprise FY 2000 Performance Plan—Chart 1 (continued)

Space Science Enterprise Strategic Goals	Objectives	Enterprise FY 2000 Performance Plan	00#
Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life	• Explore the solar system	• Complete the development of the Cluster-II instrument analysis software for the one U.S. and five U.S.-partnered instruments before launch and, if launch occurs in FY00, activate and verify the wideband data and U.S. subcomponents after launch.	0S21
		• ***HESSI will be delivered in time for a planned July 2000 launch, within 10% of the planned development budget.#***	0S22
		• ***Assuming launch and normal checkout, HESSI operations will return data to achieve at least the primary science objectives, with at least 80% coverage of the time allowed by orbit.***	0S23
		• Deliver to the Los Alamos National Laboratory in March 2000 all components for system integration and testing of the first flight system for the TWINS mission.	0S25
		• IMAGE will be delivered on time for a planned February 2000 launch and deliver the program within 10% of the planned development budget.	0S26
		• If launched, IMAGE will acquire critical measures at minute time scales, returning 85% real-time coverage of Earth's magnetospheric changes.	0S27
		• Select two Small Explorer (SMEX) missions and release a University Explorer (UNEX) Announcement of Opportunity (AO).	0S28
		• Acquire calibrated observational data from the Japanese Yohkoh high-energy solar physics mission (including the U.S.-provided SXT) for at least 75% of the time permitted by tracking coverage.	0S24
		• Complete Genesis spacecraft assembly and start functional testing in November 1999.	0S31
		• Release an AO for the next Discovery mission.	0S32
		• Successfully complete the breadboard of the imager instrument for CONTOUR and award the contract for the propulsion system after a PDR that confirms the design and maintains 15% margins for mass and power.	0S42
		• The baseline Galileo mission ended in 1997; the target for FY00 is to recover at least 90% of playback data from at least one Galileo flyby of Io.	0S45
		• ***The Mars Climate Orbiter (MCO) will aerobrake from its initial insertion orbit into a near-polar, Sun-synchronous, approximately 400-km circular orbit and will initiate mapping operations no later than May 2000, acquiring 70% of the available science data and relaying to Earth 70% of the data transmitted at adequate signal levels by the Mars Polar Lander (MPL).****	0S40
		• ***MPL will successfully land on Mars in December 1999 and operate its science instruments for the 80-day prime mission with at least 75% of planned science data returned.***	0S41
		• ***The Mars Global Surveyor (MGS) will acquire 70% of science data available, conduct at least two 5-day atmospheric mapping campaigns, and relay to Earth at least 70% of data transmitted at adequate signal levels by the Deep Space-2 Mars microprobes.****	0S46
		• NEAR will successfully orbit 433 Eros and meet primary scientific objectives while not exceeding projected mission cost by more than 10%.*	0S16
		• Collect pixel-limited images in all Transition Region and Coronal Explorer (TRACE) wavelength bands, operating 24-hour schedules for sustained periods over 8 months.#	0S17
		• If successfully launched, the TIMED mission will acquire global data in the mesosphere and lower thermosphere/ionosphere region globally (all the latitudes) for at least 90 days at the required spatial resolution, coverage, and accuracy and for all local solar times.#	0S19
		• Collect 85% of data acquired from the International Solar-Terrestrial Physics Program (ISTP) spacecraft and successfully execute the Wind trajectory plan.	0S33
		• Continue Cassini operations during the quiescent cruise phase without major anomalies, conduct planning for the Jupiter gravity-assist flyby, and explore early science data collection opportunities. The following in-flight activities will be completed: Instrument Checkout #2; uplink Articulation and Attitude Control Subsystem (AACS) software update with Reaction Wheel Authority capability; Command and Data Subsystem Version 8; and Saturn tour designs for selection by the Program Science Group.	0S34
		• Capture at least 90% of available Ulysses science data. These data will be the only data observed from outside-of-the-ecliptic plane.	0S35
		• Average 12 hours of Voyager Interstellar Mission data capture per day per spacecraft to characterize the heliosphere and the heliospheric processes at work in the outer solar system as well as the transition from the solar system to interstellar space	0S36
		• Continue Stardust spacecraft cruise operations without major anomalies and perform interstellar dust collection for at least 36 days.	0S37
		• FAST will return simultaneous data from high-latitude, low-altitude magnetosphere locations in the Sun-Earth connected system through solar maximum at the required resolution and accuracy with at least 85% efficiency.	OS38
		• Collect and process data from the Interplanetary Monitoring Platform (IMP-8, launched in 1973), making data from at least six instruments available within 15 months and the magnetic field and plasma data available within 2 months.#	OS39

Space Science Enterprise FY 2000 Performance Plan—Chart 1 (continued)

Space Science Enterprise Strategic Goals	Objectives	Enterprise FY 2000 Performance Plan	00#
Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life	• Explore the solar system	• ACE will measure the composition and energy spectra of heavy nuclei in at least eight solar energetic particle events. Maintain real-time solar wind data transmissions at least 90% of the time; measure the isotopic composition of a majority of the "primary" galactic cosmic ray elements from carbon to zinc; and provide browse parameters within 3 days for 90% of the year.#	0S48
		• ***Complete the system CDR for the New Millennium Deep Space-4 (Champollion) project before the end of FY00, including successful completion of the avionics subsystem CDR and the mechanical subsystem CDR.***	0S47
		• The Advanced Radioactive Power Source (ARPS), which is a partnership with the Department of Energy to develop small, robust, highly efficient radioisotope power sources, will accomplish the following five objectives on time and within budget in 2000: fabricate and test 15 prototype AMTEC cells by January; complete the final design of the AMTEC cells by March; complete the final design for a 75-watt ARPS by April; begin the prototype AMTEC four-cell lifetime test by April; and begin qualification unit fabrication by September.	0S58
		• Complete and deliver for testing Solar-B's four Electrical Engineering Models in September 2000.	0S60
		• Complete STEREO Phase A studies by June 2000, including the release of an AO for investigations with specific instruments and selection of the formulation phase payload.#	0S61
		• ***Successfully complete a preliminary design for either the Europa Orbiter or Pluto-Kuiper Express mission (whichever is planned for earlier launch) that is shown to be capable of achieving the Category 1A science objectives with adequate cost, mass, power, and other engineering margins.***	0S64
Develop new critical technologies to enable innovative and less costly mission and research concepts	• Explore the solar system	• The first engineering model (EM-1) of the X2000 First Delivery will be delivered in September 2000. Successful development includes the integration of all EM-1 hardware, the functional verification of delivered hardware and software, and the ability to support ongoing testing, hardware integration, and software verification for delivered software.	0S70
Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life	• Discover planets around other stars	• The Space Interferometry Mission (SIM) System Testbed (STB) will demonstrate, in May 2000, that Remote Manipulator System optical path difference can be controlled at 1.5 nanometers, operating in an emulated on-orbit mode.	0S52
		• ***Complete and deliver a technology development plan for the Terrestrial Planet Finder (TPF) mission by June 2000. This infrared interferometer mission is projected for a 2010 launch and requires the definition of technologies that will not be developed or demonstrated by precursor missions.***	0S54
		• ***Development of the interferometer program for connecting the twin Keck 10-meter telescopes with an array of four 2-meter class outrigger telescopes will be tested by detecting and tracking fringes with two test siderostats at 2- and 10-micron wavelengths***	0S55
	• Search for life beyond Earth	• The Europa Orbiter project will successfully complete a PDR in March 2000 and will begin the integration and test of the Avionics Engineering Model in July 2000.	0S56
Develop new critical technologies to enable innovative and less costly mission and research concepts	• Develop innovative technologies for Enterprise missions and for external customers	• Information systems R&T will demonstrate the search, discovery, and fusion of multiple data products at a major science meeting. Accomplish and document the infusion of five information systems R&T efforts into flight projects or the broad research community. Space science data services shall be acknowledged as enabling for two interdisciplinary collaborations.	0S49
		• The Remote Exploration and Experimentation element of the HPCC program will demonstrate software-implemented fault tolerance for science teams' applications on a first-generation embedded computing testbed, with the applications' sustained performance degraded by no more than 25% at fault rates characteristic of deep space and low-Earth orbit.	0S50
		• ***In April 2000, the Center for Integrated Space Microelectronics will deliver to the X2000 First Delivery project the first engineering model of an integrated avionics system that includes the functionality of command and data handling, attitude control, power management and distribution, and science payload interface. The system will be used on the Europa Orbiter and other missions.***	0S57
Contribute measurably to achieving the science, math, and technology education goals of our Nation, and share widely the excitement and inspiration of our missions and discoveries	• Incorporate education and enhanced public understanding of science as integral components of Space Science missions and research	• ***Successful achievement of at least seven of the following eight objectives will be made. (1) Each new Space Science mission will have a funded education and outreach program. (2) By the end of FY00, 10% of all Space Science research grants will have an associated education and outreach program under way. (3) Twenty-six states will have Enterprise-funded education or outreach programs planned or under way. (4) At least five research, mission development/operations, or education programs will have been planned/undertaken in Historically Black Colleges and Universities, Hispanic Serving Institutions, or Tribal Colleges, with at least one project under way in each group. (5) At least three national and two regional educational or outreach conferences will be supported with a significant Space Science presence. (6) At least three exhibits or planetarium shows will be on display. (7) An online directory providing enhanced access to major Space Science-related products and programs will be operational by end of the fiscal year. (8) A comprehensive approach to assessing the effectiveness and impact of the Space Science education and outreach efforts will be under development, with a pilot test of the evaluation initiated.***	0S67
Support all goals	• Support all objectives	• Conduct research and analysis.	0S68
		• Conduct data analysis.	0S69

* Dual support to the objective—Investigate the composition, evoluion, and resources on Mars, the Moon, and small bodies.
\# Dual support to the objective—Improve the reliability of space weather forecasting.

Space Science Enterprise FY 2000 Budget—Chart 1a

Strategic Objective	Budget Category: Chandra (formerly AXAF)	GPB	SOFIA	TIMED	SIRTF	Payloads	Explorers	Mars Surveyor	Discovery	Operating Missions	SR&T	R&PM	COF	Environmental	Education & Minority	SBIR	Performance Target Item # (Chart 1)	Other Objectives Addressed by Target (List)*
Solve mysteries of the universe	X																0S1	
		X															0S3	
										X							0S4	ESS, DPO
										X							0S11	
			X														0S43	ESS, DPO
					X												0S5	
						X											0S6, 0S7	
							X										0S8, 0S9	
										X							0S2, 0S12	
						X											0S14	
											X						0S62, 0S63	TCH
											X						0S65, 0S66	ESS, TCH
										X							0S15	ESS
											X						0S53	DPO
Explore the solar system				X													0S18	
						X											0S20, 0S21, 0S24	
							X										0S22, 0S25, 0S26	HDS
								X									0S40, 0S41, 0S30, 0S29	HDS
										X							0S33, 0S23	HDS
										X							0S45	SLB
										X							0S17, 0S27, 0S39, 0S48	SMU, HDS
									X								0S31, 0S32, 0S42	
							X										0S28	SMU
										X							0S34	SLB
										X							0S46	SLB, HDS
										X							0S35, 0S37, 0S38	
										X							0S16	HDS
											X						0S64, 0S57, 0S58	SLB, TCH
											X						0S60, 0S61	HDS, TCH
										X							0S19	
										X							0S36	
											X						0S47	TCH
Discover planets around other stars											X						0S52, 0S44, 0S54, 0S55	TCH
Search for life beyond Earth											X						0S56	ESS, TCH
Investigate the composition, evolution, and resources on Mars, the Moon, and small bodies																		
Improve the reliability of space weather forecasting																		

Space Science Enterprise FY 2000 Budget—Chart 1a (continued)

Strategic Objective	Budget Category: Chandra (formerly AXAF)	GPB	SOFIA	TIMED	SIRTF	Payloads	Explorers	Mars Surveyor	Discovery	Operating Missions	SR&T	R&PM	COF	Environmental	Education & Minority	SBIR	Performance Target Item # (Chart 1)	Other Objectives Addressed by Target (List)*
Develop innovative technologies for Enterprise missions and for external customers											X						0S49, 0S50	
											X						0S59	SMU, ESS
											X						0S68, 0S69	All
Incorporate education and enhanced public understanding of science as integral components of Space Science missions and research														X			0S67	

Note: X=primary contribution; Y=secondary contribution.
* SMU—Solve mysteries of the universe; ESS—Explore the solar system; DPO—Discover planets around other stars; SLB—Search for life beyond Earth; TCH—Technology; and HDS—Human exploration and development of space.

Earth Science Enterprise

Mission

The Earth Science Enterprise mission is to understand the total Earth system and the effects of natural and human-induced changes on the global environment. The programs of the Enterprise advance the new discipline of Earth System Science, with a near-term emphasis on global climate change. Both space- and ground-based capabilities yield new scientific understanding of Earth and practical benefits to the Nation. The research results will contribute to the development of environmental policy and economic investment decisions. The Enterprise mission includes the development of innovative technologies to support Earth Science programs and make them available for solving practical societal problems in agriculture and food production, water resources, and national resource management that provide benefits to the Nation. Knowledge and discoveries will be shared with the public to enhance science, mathematics, and technology education and increase the scientific and technological literacy of all Americans.

Implementation Strategy

The Earth Science Enterprise conducts global and regional research requiring the vantage point of space. New programs will be developed and deployed through the "faster, better, cheaper" approach. Program managers are encouraged to accept prudent risk, shorten the development time of technologies and missions, explore new conceptual approaches, streamline management, and incorporate innovative methods to enhance efficiency and effectiveness. The programs of the Enterprise contribute to the U.S. Global Change Research Program and are conducted in collaboration with 10 other U.S. Federal agencies and 13 nations. Cooperative research programs with national and international partners will continue to play a key role in the implementation strategy of the Enterprise.

The same spirit of innovation that embodies the Earth Science flight programs applies to technology development. Long-term, high-risk, high-payoff technologies are key to implementing the Earth Science mission. The Enterprise priorities feature near-term product milestones on a path of long-term inquiry. Obtaining data from the private sector is an emerging feature of the Enterprise strategy. This will reduce Agency costs and encourage the growth of the commercial remote-sensing industry.

Enterprise Resource Requirements

The President has requested the budget in the table below for FY 1999 to FY 2004 to support the accomplishment of Earth Science goals.

Performance Measures

To meet the near-term goals displayed in Figure 2, the following objectives will be measured:

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

The carbon cycle is one of the major Earth system processes influencing global climate. Key elements

Earth Science Budget

	FY 99	FY 00	FY 01	FY 02	FY 03	FY04
NOA $M	1,413.8	1,459.1	1,462.8	1,420.5	1,373.0	1,424.4
Civil Servant Full-Time Equivalents	1,520	1,542	1,575	1,570	1,623	1,655

of NASA contributions are monitoring land-cover changes and measuring terrestrial processes and ocean biological processes to estimate carbon uptake. An important unknown in the carbon cycle are seasonal rates of carbon storage in the ocean, which are caused by the activity of phytoplankton, which can be monitored from space. In addition to observations, NASA invests in research, data analysis, and modeling projects toward understanding the role of marine and terrestrial ecosystems in the global carbon cycle. The performance targets will be to:

- Continue the development of a global land-cover/use change data set based on Landsat and Earth Observing System (EOS) instruments, at a seasonal refresh rate.
- Continue to collect near-daily global measurements of the terrestrial biosphere (an index of terrestrial photosynthetic processes from which calculations of carbon uptake are made) from instruments on the EOS AM-1 spacecraft.
- Continue the ocean color time series with 60-percent global coverage every 4 days—a 35-percent improvement over FY 1999.
- SIMBIOS will merge Moderate Resolution Imaging Spectrometer (MODIS) ocean color data into the global ocean color time series, which began with the Ocean Color Temperature Sensor (OCTS) and the Sea-viewing Wide Field-of-view Sensor (SeaWiFS). Use the time series to understand and predict the response of the marine ecosystem to climate change. The data set will be made available via the Goddard Space Flight Center Distributed Active Archive Center (DAAC).
- Produce near-real-time fire monitoring and impact assessments based on Landsat and EOS inventory and process monitoring. This will provide an observational foundation for monitoring change in ecosystem productivity and disturbance. Near-real-time assessments will be posted on a web site for quick access by researchers and regional authorities.

Objective—Predict seasonal-to-interannual climate variations

In FY 2000, the Earth Science Enterprise will continue to invest in observations, research, data analysis, and modeling in this area. The Tropical Rainfall Measuring Mission (TRMM), launched in 1997, will continue to gather information on rainfall in the tropics, where two-thirds of global precipitation falls. This is the key to understanding Earth's hydrological cycle, one of the three major processes driving climate change, and the global heat balance, which drives seasonal change. Current uncertainty in global tropical rainfall estimates is 50 percent; TRMM data will reduce this uncertainty to 10 percent, an 80-percent improvement. The performance targets will be to:

- Establish a benchmark for global and regional rainfall measurements by combining TRMM measurements with measurements from other sources. Maps of the diurnal cycle of precipitation will be created for the first time. The existing 10-year data set will be combined with TRMM measurements to validate climate models and demonstrate the impact of rainfall on short-term weather forecasting. The data will be distributed through the Goddard DAAC for ease of access to science and operational users.
- Develop and improve methods to couple state-of-the-art land surface and sea ice models to a global coupled ocean-atmosphere model and use them to predict regional climactic consequences of El Niño or La Niña occurrence in the tropical Pacific. The results of this research will be published in open literature and provided to

the National Oceanic and Atmospheric Administration's National Climate Prediction Center and the U.S. Navy's Fleet Numeric Prediction Center. The ultimate goal is to develop a capability to significantly improve the prediction of seasonal-to-interannual climate variations and their regional climate consequences. The main focus is on North America.

- Measure production and radiative properties of aerosols produced by biomass burning in Africa based on SAFARI 2000 (field experiment) and EOS instruments. This will include extensive international participation. This burning is estimated to contribute one-half of all global atmospheric aerosols.
- Launch the NASA-Centre Nationale d'Études Spatiales (CNES) Jason-1 mission. This follow-on to TOPEX/Poseidon is to achieve a factor-of-4 improvement in accuracy in measuring ocean basin-scale sea-level variability. This is 1 order of magnitude better than that specified for TOPEX/Poseidon.
- Generate the first basin-scale high-resolution estimate of the state of the Pacific Ocean as part of the international Global Ocean Data Assimilation Experiment (GODAE).

Objective—Identify natural hazards, processes, and mitigation strategies

The Earth Science Enterprise will use 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, commerce, and so on. The long-term objective is to apply the scientific understanding toward developing a predictive capability.

In FY 2000, the Earth Science Enterprise will continue to provide the technology and instruments to allow for the collection of interferometric Synthetic Aperture Radar (SAR) data. This will enable the first consistent global topography data record collected from space, and it will have a variety of applications, including assessing flood hazards, laying out new roadways and pipelines, and providing airline operators with detailed elevation data for remote areas. The performance targets will be to:

- Use southern California Global Positioning System (GPS) array data to understand the connection between seismic risk and crustal strain leading to earthquakes.
- Develop models to use time-varying gravity observations for the first time in space.
- Demonstrate the utility of spaceborne data for floodplain mapping with the Federal Energy Management Agency.
- Develop an automatic volcano cloud/ash detection algorithm employing EOS data sets for use by the Federal Aviation Administration.

Objective—Detect long-term climate change, causes, and impacts

In FY 2000, information on global and regional studies of temperature and precipitation drivers will continue to be collected to measure the solar radiation reaching Earth. Clouds and aerosols (suspended particles in the atmosphere such as dust, sulfate, and smoke) determine the fate of this radiation in the atmosphere and affect Earth's energy balance. The MODIS, Multi-Angle Imaging Spectroradiometer (MISR), and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instruments will collect these measurements. These data, distributed through the Goddard DAAC, combined with data from the Clouds and Earth's Radiant

Energy System, will enable NASA to estimate solar and infrared radiative fluxes, which in turn will determine the heating and cooling of Earth and its atmosphere. The current uncertainty in Earth's radiation balance is about a 15-watt-per-square-meter monthly mean over 100- by 100-kilometer areas. The performance targets will be to:

- Complete the collection of satellite data needed for the 17-year cloud climatology being developed under the International Satellite Cloud Climatology Project. These data will be used to improve understanding and modeling of the role of clouds in climate and will be available through the Goddard DAAC.
- Continue the development of the global aerosol climatology data set and analysis of this climatology in climate models. The data will be available through the Goddard DAAC.
- Provide for the continuation of the long-term, precise measurement of the total solar irradiance with the launch of EOS ACRIM.
- Acquire, through a Radarsat repeat of the Antarctic Mapping Mission conducted in September–October 1997, a second set of high-resolution radar data over all of Antarctica for comparison with the baseline data set acquired in 1997, to identify changes on the ice sheet.
- Publish the first detailed estimates of thickening/thinning rates for all major ice drainage basins of the Greenland ice sheet, derived from repeated airborne laser-altimetry surveys. These measures will represent the baseline data set to compare with early Geoscience Laser Altimeter System (GLAS) data (July 2001 launch).
- Initiate a program of airborne mapping of layers within the Greenland ice sheet to decipher the impact of past climate variation on polar regions.
- Develop a remote-sensing instrument/technique for ocean surface salinity measurements from aircraft. The goal is to improve measurement accuracy to 1 order of magnitude better than available in FY 1998. The ultimate goal is the capability to globally measure sea surface salinity from space.
- Continue to improve the design and sophistication of a global climate system model, including use of higher resolution, to make it a state-of-the-art climate system model for projecting the climatic consequences at the regional level. Evidence of improvement will be increased resolution from added computing power and better numerical representations.

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

NASA's contribution in this area is to develop and operate space-based and airborne instruments that will map the fluctuations in ozone and related constituent gas in the atmosphere. In addition, NASA has a focused research and modeling effort in this area. The Total Ozone Mapping Spectrometer (TOMS) will continue to collect information of the ozone content as the total column of Earth's atmosphere. The performance targets in FY 2000 will be to:

- Implement the Stratospheric Aerosol and Gas Experiment (SAGE III) Ozone Loss and Validation Experiment. Measurements will be made from October 1999 to March 2000 in the Arctic/high-latitude region from the NASA DC-8 and ER-2 aircraft and balloon platforms. These tools will help acquire correlative data to validate SAGE III data and assess high-latitude ozone loss.
- Complete the analysis and publication of the Particle Environment Monitor (PEM)-Tropics-B field experiment.

- Complete the Troposphere Chemistry aircraft instrument size and weight reductions (by approximately 40 percent) initiative.
- Complete the planning for major new 2001 airborne/unmanned aerospace vehicle missions that will use a smaller Troposphere Chemistry aircraft instrument.

Objective—Implement open, distributed, and responsive data system architectures

The dissemination of information resulting from Earth Science research is accomplished through the Earth Observing System Data and Information System (EOSDIS) and will continue to be a high priority in FY 2000. Distribution systems will be improved and new methods will be developed to place data in the hands of Earth Science customers in a timely manner through open, distributed, and responsive data system architectures. EOSDIS performance targets will be to:

- EOSDIS will make available data on prediction, land surface, and climate to users within 5 days.
- EOSDIS will double the volume of data archived compared to FY 1998.
- EOSDIS will increase the number of distinct customers by 20 percent compared to FY 1998.
- EOSDIS will increase products delivered from the DAAC's by 10 percent compared to FY 1998.

Objective—Increase public understanding of Earth Science through education and outreach

Earth Science missions and research programs make a unique contribution to education and the public understanding of Earth science. They provide a steady return of discoveries, and new knowledge contributes to the accomplishment of this objective. The Enterprise will continue to sponsor research awards through NASA's Graduate Student Research Program. The performance targets will be to:

- Award 50 new graduate student/education research grants and 20 early career postdoctoral fellowships in Earth Science.
- Conduct at least 300 workshops to train teachers in the use of Earth Science Enterprise education products.
- Increase the number of schools participating in Global Learning and Observations to Benefit the Environment (GLOBE) to 10,500, a 30-percent increase over FY 1999. Increase participating countries to 77 from 72 in FY 1999.

Objective—Develop and transfer advanced remote-sensing technologies

In collaboration with partners in industry and academia, the Enterprise will develop and demonstrate new technologies of value to remote-sensing research. The performance targets will be to:

- Achieve a 50-percent reduction in mass for future land imaging instruments.
- Transfer at least one technology development to a commercial entity for operational use.
- Advance at least 25 percent of funded instrument technology developments one Technology Readiness Level (TRL) to enable future science missions and reduce their total cost.

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

Because the Earth Science Enterprise addresses science questions of societal importance, the research performed also leads to practical

applications. The Enterprise 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, and urban and regional planning. The performance targets will be to:

- Have at least one Regional Earth Science Applications Center (RESAC) become self-sustaining. Continue funding for the remaining centers.
- Develop at least two new data products for routine decisionmaking by user organizations involved in Type 3 Earth Science Information Partner (ESIP) cooperative agreements and the Agriculture, Forestry and Rangeland Coop Agreements and Grants.
- Implement at least five joint applications research projects/partnerships with State and local governments in remote-sensing applications.

Objective—Support the development of a robust commercial remote-sensing industry

NASA is committed to a growing relationship with the commercial remote-sensing industry to enhance 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. The performance targets will be to:

- Focus Earth Observation Commercialization Applications Program (EOCAP) joint commercial applications research to develop 20 new market commercial products (such as oil spill containment software by EarthSat and map sheets products by ERDAS, Inc.).
- Provide three commercial sources of science data from the Scientific Data Purchase for global change research and applications.
- Develop two new validated commercial information products as a result of verification and validation partnerships with industry.

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

Because of 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 Enterprise will continue to contribute scientific knowledge and observations and modeling results to national and international scientific environmental assessments. The performance targets will be to:

- Sponsor two regional assessment studies of environmental variations and natural resources vulnerability.
- Complete the contribution to the First National Assessment of the Potential Consequences of Climate Variability and Change: provide climate scenario information, support the national synthesis, conduct several regional U.S. analyses, and provide supporting research for sector analyses. Provide information to the U.S. National Assessment Coordination Office.
- Conduct the first regional international assessment in South Africa. Quantify the effects of climate variability and management practices on the environment. Publish in open literature, and provide analyses to the Intergovernmental Panel on Climate Change (IPCC) for their 2000 assessment report.
- Provide the first global, regional, and country-by-country forest cover inventory in support of the

national and international needs of research, operational, and policy communities. Publish and provide to IPCC and the International Geosphere-Biosphere Programme for their 2000 assessment report.

General Earth Science performance measure —Successfully launch spacecraft

The Earth Science Enterprise will successfully launch three spacecraft and deliver two instruments for international launches within 10 percent of budget on average.

Internal Assessment

The Earth Science Enterprise will regularly review performance objectives as part of our existing monthly review process. Using a data base to track current performance monthly for each specific FY 2000 target will enable the Enterprise to focus on targets that need improvement. Enterprise management will institute measures to ensure improvement.

Because the Earth Science Enterprise is a scientific endeavor, many of its measures involve scientific results. These are subject to peer review, both in the selection of the science investigation and in the reporting of findings in the scientific literature. Where the metric is the production of data products, these must be archived in the Enterprise's information system, where their availability can be confirmed via an Internet query. Metrics addressing scientific assessment activities result in formal, published reports that are readily identified.

External Assessment

The Earth System Science and Applications Advisory Committee (ESSAAC) will conduct an annual assessment of the Enterprise's near-term science objectives. This committee will provide a qualitative progress measurement (Green, Yellow, or Red). "Green" will indicate that the objective was met; "Yellow" will signify a concern that an objective was not fully accomplished; and "Red" will show that events occurred that prevented or severely impaired the accomplishment of the objective. The assessment will include commentary to clarify and supplement the qualitative measures.

ESSAAC is a committee of the NASA Advisory Council under the Federal Advisory Committee Act, and it consists of outside scientific and technical experts from academia, industry, and other Government agencies. ESSAAC meets at least twice a year to review plans and progress in the Earth Science Enterprise. After the end of each fiscal year, the Enterprise will provide ESSAAC a self-assessment in each of the relevant objectives, highlighting performance against the metrics in the Performance Plan for that year. ESSAAC will deliberate internally and render its own assessment, which may confirm or modify the Enterprise's self-assessment. ESSAAC's assessment will be reported in the Performance Report for that year. This process will be repeated annually.

Earth Science Enterprise FY 2000 Performance Plan—Chart 2

Earth Science Enterprise Strategic Goals	Objectives	Enterprise FY 2000 Performance Plan	00#
Expand scientific knowledge by characterizing the Earth system	• Understand the causes and consequences of land-cover/land-use change	• ***Continue the development of a global land-cover/use change data set based on Landsat and EOS instrument, at seasonal refresh rate.***	0Y1
		• Continue to collect near-daily global measurements of the terrestrial biosphere (index of terrestrial photosynthetic processes from which calculations of carbon uptake are made) from instruments on EOS AM-1.	0Y2
		• Continue the ocean color time series with 60% global coverage every 4 days—a 35% improvement over FY99.	0Y3
		• SIMBIOS will merge MODIS ocean color data into the global ocean color time series, which began with Ocean Color Temperature Sensor (OCTS) and SeaWiFS. Use the time series to understand and predict the response of the marine ecosystem to climate change. Make the data set available via the Goddard DAAC.	0Y4
		• Produce near-real-time fire monitoring and impact assessment based on Landsat and EOS inventory and process monitoring to provide an observational foundation for monitoring change in ecosystem productivity and disturbance. Post near-real-time assessments on a web site for quick access by researchers and regional authorities.	0Y7
	• Predict seasonal-to interannual climate variations	• ***Establish a benchmark for global and regional rainfall measurements by combining TRMM measurements with measurements from other sources. Create maps of the diurnal cycle of precipitation for the first time. Combine the existing 10-year data set with TRMM measurements to validate climate models and demonstrate the impact of rainfall on short-term weather forecasting. Distribute through the Goddard DAAC for ease of access to science and operational users.***	0Y9
		• Develop/improve methods to couple state-of-the-art land surface and sea ice models to a global coupled ocean-atmosphere model and use to predict regional climactic consequences of El Niño or La Niña occurrence in the tropical Pacific. Results of research will be published in the open literature and provided to NOAA's National Climate Prediction Center and the U.S. Navy's Fleet Numeric Prediction Center. Ultimate goal: develop a capability to significantly improve the prediction of seasonal-to-interannual climate variations and their regional climate consequences. The main focus is on North America	0Y10
		• Measure production and radiative properties of aerosols produced by biomass burning in Africa based on SAFARI 2000 (field experiment) and EOS instruments. Includes extensive international participation. This burning is estimated to contribute one-half of global atmospheric aerosols.	0Y11
		• ***Launch the NASA-CNES Jason-1 mission. This follow-on to TOPEX/Poseidon is to achieve a factor-of-4 improvement in accuracy in measuring ocean basin-scale sea-level variability. This is 1 order of magnitude better than that specified for TOPEX/Poseidon.***	0Y12
		• Generate the first basin-scale high-resolution estimate of the state of the Pacific Ocean as a part of the international Global Ocean Data Assimilation Experiment (GODAE).	0Y47
	• Identify natural hazards, processes, and mitigation strategies	• Use southern California GPS array data to understand the connection between seismic risk and crustal strain leading to earthquakes.	0Y37
		• Develop models to use time-varying gravity observations for the first time in space.	0Y38
		• ***Demonstrate the utility of spaceborne data for floodplain mapping with the Federal Emergency Management Agency.***	0Y39
		• Develop an automatic volcano cloud/ash detection algorithm employing EOS data sets for use by the Federal Aviation Administration.	0Y40
	• Detect long-term climate change, causes, and impacts	• Complete the collection of satellite data needed for the 17-year cloud climatology being developed under the International Satellite Cloud Climatology Project. Data will be used to improve the understanding and modeling of role of clouds in climate. Data will be available in the Goddard DAAC.	0Y13
		• Continue the development of the global aerosol climatology data set and analysis of this climatology in climate models. Data will be available in the Goddard DAAC.	0Y14
		• Provide for the continuation of the long-term, precise measurement of the total solar irradiance with the launch of EOS ACRIM.	0Y15
		• ***Acquire, through a Radarsat repeat of Antarctic Mapping Mission conducted in September–October 1997, a second set of high-resolution radar data over all of Antarctica for comparison with the baseline data set acquired in 1997, to identify changes on the ice sheet.***	0Y16
		• Publish the first detailed estimates of thickening/thinning rates for all major ice drainage basins of the Greenland ice sheet, derived from repeated airborne laser-altimetry surveys. Measures represent the baseline data set to compare with early GLAS data (July 2001 launch).	0Y17
		• Initiate a program of airborne mapping of layers within the Greenland ice sheet to decipher the impact of past climate variation on polar regions.	0Y18
		• Develop a remote-sensing instrument/technique for ocean surface salinity measurements from aircraft. Goal: to improve measurement accuracy to 1 order of magnitude better than available in FY98. The ultimate goal is the capability to globally measure sea surface salinity from space.	0Y19
		• Continue to improve the design and sophistication of a global climate system model, including use of higher resolution, to make it a state-of-the-art climate system model for projecting the climatic consequences at the regional level. Improvement will be manifested in increased resolution from added computing power and better numerical representations.	0Y20

Earth Science Enterprise FY 2000 Performance Plan—Chart 2 (continued)

Earth Science Enterprise Strategic Goals	Objectives	Enterprise FY 2000 Performance Plan	00#
Expand scientific knowledge by characterizing the Earth system	• Understand the causes of variation in atmospheric ozone concentration and distribution	• Implement the SAGE III Ozone Loss and Validation Experiment. Measurements will be made from October 1999 to March 2000 in the Arctic/high-latitude region from the NASA DC-8, ER-2, and balloon platforms. Will acquire correlative data to validate SAGE III data and assess high-latitude ozone loss.	0Y22
		• Complete the analysis and publication of the PEM-Tropics-B field experiment.	0Y23
		• Complete the Troposphere Chemistry aircraft instrument size and weight reductions (by ~40%) initiative.	0Y24
		• Complete the planning for major new 2001 airborne/unmanned aerospace vehicle mission that will use a smaller Troposphere Chemistry aircraft instrument.	0Y25
Disseminate information about the Earth system	• Implement open, distributed, and responsive data system architectures	• ***EOSDIS will make available data on prediction, land surface, and climate to users within 5 days.***	0Y26
		• EOSDIS will double the volume of data archived compared to FY98.	0Y27
		• EOSDIS will increase the number of distinct customers by 20% compared to FY98.	0Y28
Expand scientific knowledge by characterizing the Earth system	• Implement open, distributed, and responsive data system architectures	• EOSDIS will increase products delivered from the DAACs by 10% compared to FY98.	0Y29
Disseminate information about the Earth system	• Increase public understanding of Earth Science through education and outreach	• Award 50 new graduate student research grants and 20 early career fellowships in Earth Science.	0Y30
		• ***Conduct at least 300 workshops to train teachers in the use of Enterprise education products.***	0Y31
		• Increase the number of schools participating in GLOBE to 10,500, a 30% increase over FY99; increase participating countries to 77 (from 72).	0Y32
Enable the productive use of Earth Science and technology in the public and private sectors	• Develop and transfer advanced remote-sensing technologies	• ***Achieve a 50% reduction in mass for future land imaging instruments.***	0Y33
		• Transfer at least one technology development to a commercial entity for operational use.	0Y34
		• Advance at least 25% of funded instrument technology developments one TRL to enable future science missions and reduce their total cost.	0Y35
	• Extend the use of Earth Science research for national, State, and local applications	• At least one Regional Earth Science Applications Center (RESAC) becomes self-sustaining. Continue funding for the remaining centers.	0Y41
		• Implement at least five joint applications research projects/partnerships with State and local governments in remote-sensing applications.	0Y43
	• Support the development of a robust commercial remote-sensing industry	• ***Focus EOCAP joint commercial applications research to develop 20 new market commercial products (e.g., oil spill containment software by EarthSat and map sheets products by ERDAS, Inc.).***	0Y44
		• Provide three commercial sources of science data (from the data buy) for global change research and applications.	0Y45
		• Develop two new validated commercial information products as a result of verification and validation partnerships with industry.	0Y46
	• Make major scientific contributions to national and international environmental assessments	• Sponsor two regional assessment studies of environmental variations and natural resources vulnerability.	0Y48
		• Complete the contribution to the First National Assessment of the Potential Consequences of Climate Variability and Change: provide climate scenario information, support the national synthesis, conduct several regional U.S. analyses, and provide supporting research for sector analyses. Provide information to the U.S. National Assessment Coordination Office.	0Y5
		• Conduct the first regional international assessment in South Africa: quantify the effects of climate variability and management practices on the environment, publish in open literature, and provide analyses to IPCC for their 2000 assessment report.	0Y6
		• Provide the first global, regional, and country-by-country forest cover inventory in support of national and international needs of research, operational, and policy communities. Publish and provide to IPCC and the International Geosphere-Biosphere Programme for their 2000 assessment report.	0Y8
Expand scientific knowledge by characterizing the Earth system	• Successfully launch spacecraft	• Earth Science will successfully launch three spacecraft and deliver two instruments for international launches within 10% of budget on average.	0Y36

Earth Science Enterprise FY 2000 Budget—Chart 2a

Strategic Objective	Budget Category: EOS	Earth Probes	Operating Missions	Science (including R&A)	GLOBE	R&PM	Performance Target Item # (Chart 2)	Other Objectives Addressed by Target (List)
Understand the causes and consequences of land-cover/land-use change	Y			X			0Y1	
	X						0Y2	
	X		Y				0Y3	
	X		Y	Y			0Y4	
	X			Y			0Y7	
Predict seasonal-to-interannual climate changes	Y		Y	X			0Y9	
				X			0Y10, 0Y11, 0Y47, 0Y12	
	X						0Y12	
Identify natural hazards, processes, and mitigation strategies for floods, droughts, and volcanoes		Y		X			0Y37,0Y38, 0Y39, 0Y40	
Detect long-term climate change, causes, and impacts	X						0Y13, 0Y14	
	X						0Y15	
				X			0Y16, 0Y17, 0Y18, 0Y19, 0Y20	
Understand the causes of variations in ozone concentrations and distribution in the upper and lower atmosphere				X			0Y22, 0Y23, 0Y24, 0Y25	
Improve the dissemination of Earth Science results	X						0Y26, 0Y27, 0Y28, 0Y29	
Incorporate education and enhanced public understanding of science as an integral component of Earth Science missions and research				X			0Y30	
					X		0Y31, 0Y32	
Make major scientific contributions to national and international environmental assessments				X			0Y5, 0Y6, 0Y8, 0Y48	
Develop innovative technologies for Enterprise missions and for transfer to external customers	X						0Y33	
Extend the use of Earth Science research for national, State, and local applications				X			0Y41, OY42, 0Y43, 0Y44, 0Y45, 0Y46, 0Y48	
Successfully launch spacecraft	X	X					0Y36	
Note: X=primary contribution; Y=secondary contribution.								

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, understanding, and using space to enable the development of space and expand human experience into the far reaches of space. This mission includes the development of innovative technologies to support HEDS programs and to make them available for other applications that provide benefits to the Nation. Knowledge and discoveries will be shared with the public to inspire inquisitive minds, enhance science, mathematics, and technology education, and increase the scientific and technological literacy of all Americans.

Implementation Strategy

Two program offices—the Office of Space Flight and the Office of Life and Microgravity Sciences and Applications (OLMSA)—implement the HEDS Enterprise strategy.

The Office of Space Flight strategy to contribute to the HEDS mission consists of three major components: safe, reliable, and affordable access to space; the assembly and operations of the International Space Station (ISS); and the provision of the space communications infrastructure. Safety and performance upgrades provide for the modifications and improvements of ground facilities and Space Shuttle capabilities, the replacement of obsolete systems, and the expansion of safety and operating margins. Investments in Space Shuttle operations include hardware production, ground processing, launch and landing operations, flight crew operations, training, logistics, and sustaining engineering. The implementation strategy for the ISS begins with Phase II of the program, which began with the scheduled launch of the U.S.-owned/Russian-launched Functional Cargo Block (FGB) and concludes with the launch of the Airlock on Flight 7A.

The OLMSA strategy to contribute to the HEDS mission also consists of three components. OLMSA supports fundamental research driven by an emphasis on expanding scientific knowledge. Its focus on mission-driven research improves knowledge and technology for human space flight. The application-driven research of OLMSA seeks to transfer knowledge, expertise, and technology from HEDS missions to other uses that provide benefits to the Nation.

Enterprise Resource Requirements

The President has requested the budget in the table below for FY 1999 to FY 2004 to support the accomplishment of HEDS goals.

Performance Measures

Note: The goals and objectives of the HEDS Enterprise are undergoing revision.

HEDS Budget

	FY 99	FY 00	FY 01	FY 02	FY 03	FY04
NOA $M	6,309.3	6,390.2	6,300.6	6,023.5	5,574.3	5,362.0
Civil Servant Full-Time Equivalents	6,220	5,964	5,867	5,727	5,617	5,496

Objective—Expand human exploration through collaborative robotic missions

HEDS and the Space Science Enterprise will cooperate in developing mission objectives and technology requirements for robotic exploration of the solar system. This cooperation will help determine the feasibility and need for human missions of solar system exploration. Specific performance targets for this objective will be to:

- Complete the integration and testing of the Mars In-situ Propellant Production Precursor (MIP) flight unit for the 2001 Mars Surveyor mission.
- Complete the Radiation Research Instrument for the Mars 01 mission to study transit, orbital, and surface radiation effects and conduct three workshops to define and prioritize research tasks in subjects such as radiation shielding materials, in situ resource utilization, and fluids management and heat transfer technology. Complete the science definition of granular flows, flight, and dust management experiments to begin gathering research data to alleviate critical problems of dust buildup, habitat foundation engineering, and rover performance during planetary exploration.

Objective—Define innovative, safe, and affordable human exploration mission architectures

HEDS will continue studying options for potential human exploration in support of decisions to be made after the ISS experience. This will be accomplished through a small cadre of civil service employees from NASA Field Centers, along with our partners from industry and other countries. The performance target will be to:

- Complete the development and initiate the implementation of a comprehensive technology investment strategy to support future human exploration that includes critical capability developments for increasing self-sustainability, decreasing transit times, developing commercial opportunities, reducing cost and risk, increasing knowledge, and increasing operational safety.

Objective—Invest in enabling high-leverage exploration technologies

Investments will be made in technologies to enable significant improvements in cost reduction, supportability, and operations of human missions. These technologies include propulsion, power, life support, automation and robotics, communication, and navigation, and they will apply to the exploration of the Moon, Mars, and asteroids. A key element of these efforts will be the development of scientific partnerships and international cooperation. The performance target will be to:

- In coordination with other Enterprises, develop and implement tests and demonstrations of capabilities for future human exploration in the areas of advanced space power, advanced space transportation, information and automation systems, and sensors and instruments.

Objective—In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems

The microgravity environment affords substantially reduced buoyancy forces, hydrostatic pressures, and sedimentation rates, allowing gravity-related phenomena and phenomena masked by gravity on Earth to be isolated and controlled. This environment allows measurements to be made with an accuracy that cannot be obtained on Earth. In

partnership with the science community, HEDS identifies promising areas for space biological and physical science research. This partnership also supports technologies to improve U.S. competitiveness in these areas of research. Specific performance targets for this objective will be to:

- Support an expanded research program of approximately 935 investigations, an increase of approximately 17 percent over FY 1999. Publish 100 percent of science research progress in the annual OLMSA Life Sciences and Microgravity Research Program Task Bibliographies and make this available on the Internet.
- Using suborbital rockets, complete one combustion experiment on the flame spread of liquid fuels to better control Earth/space-based fire hazards, and conduct one investigation to test theories of fundamental physics properties and physical laws of fluids to provide key data for Earth and space-based processing materials. Report the results.
- Complete data reduction from the STS-95 Research Module mission. Begin to explore new cooperative efforts with the National Institutes of Health in the area of aging and transfer space-derived research for industry development of a new drug to treat Chagas' disease.

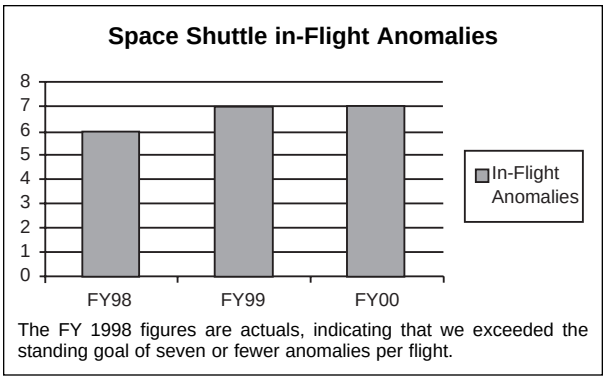


Figure 4

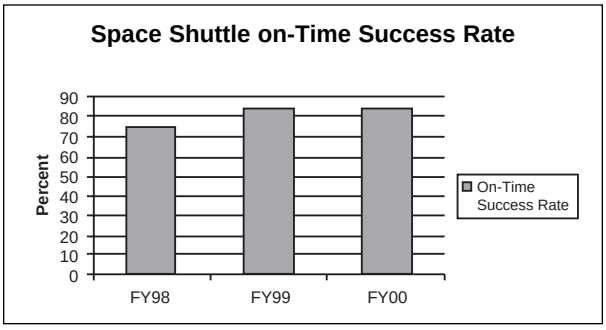


Figure 5

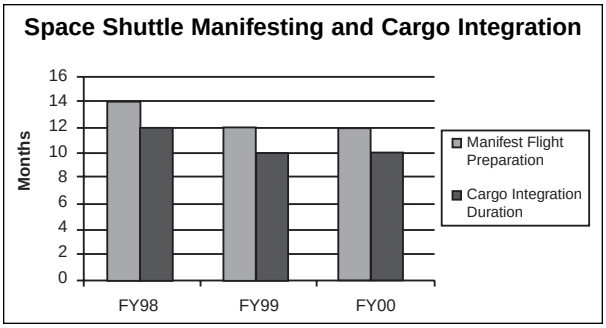


Figure 6

Objective—Provide safe and affordable access to space

The Space Shuttle program will continue the Safety and Performance Upgrades program. Phase 1 upgrades are designed to improve safety and performance, which will enable the Space Shuttle to achieve the orbital inclination and altitude of the ISS. HEDS will also implement a variety of process improvements to enhance Shuttle safety and reliability and reduce costs. Specific performance targets for this objective will be to:

- Have in place a Shuttle upgrade program that ensures the availability of a safe and reliable Shuttle system through the ISS era.
- Achieve seven or fewer flight anomalies per mission (Figure 4).
- Achieve 85 percent on-time, successful launches, excluding the risk of weather (Figure 5).
- Achieve a 12-month flight manifest preparation time (Figure 6).

Objective—Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives

The ISS will provide the world with a permanent international research facility in low-Earth orbit. The facility will provide unprecedented space-based opportunities for conducting long-duration scientific research and technology demonstrations, as well as capabilities for the commercial development of space. ISS laboratories will allow crews to learn to live and work in space and to demonstrate technologies for potential missions of human exploration beyond low-Earth orbit. The performance targets will be to:

- Deploy and activate the U.S. Laboratory Module to provide a permanent on-orbit laboratory capability.
- Deploy and activate the Canadian-built Space Station Remote Manipulator System to provide an ISS-based remote manipulating capability for maintenance and assembly.
- Deploy and activate the Airlock to provide an ISS-based extravehicular activity (EVA) capability.
- Deliver to orbit the first of three Italian-built Multi-Purpose Logistics Modules to provide a reusable capability for delivering payload and systems racks to orbit.
- Conduct operations with a three-person human presence on the ISS.
- Complete preparations for the initial ISS research capability through the integration of the first rack of the Human Research Facility (HRF-1), five EXPRESS Racks with small payload research, and the Microgravity Science Glovebox.
- Complete the production of the X-38 first space flight test article in preparation for a Shuttle test flight in 2001.

Objective—Ensure and enhance the health, safety, and performance of humans in space

The human body has evolved over millennia to survive within a narrow range of temperatures, atmospheric pressure, oxygen concentrations, radiation levels, and accelerations. When humans travel in space, we seek to bring much of our native environment with us, but we cannot faithfully reproduce the environment of Earth, especially with respect to gravity. Space travelers experience an environment that is completely novel in the 4-billion-year history of life as we know it. The body begins to adapt almost immediately. Muscles and bones shrink, fluids shift upward in the body, immune system functioning may be suppressed, and more. HEDS seeks to understand and control the effects of space travel. We seek to improve spacecraft environments and optimize safety and performance within them. Our work to ensure the health and safety of the NASA workforce on the ground is integral to ensuring safety for space travelers. Specific performance targets for this objective will be to:

- Develop medical protocols and test the capability of the Crew Health Care System as integrated in the ISS U.S. Laboratory.
- Evaluate and develop for flight testing a minimum of three major research protocols intended to protect bone, muscle, and physical work capacity, and prepare a minimum of 10 biomedical research experiments (utilizing the capabilities of the Space Shuttle and ISS HRF) to study human responses to the gravitational environment.
- Complete the first phase (including outfitting three test chambers) of the Advanced Life Support System Integration Testbed facility, which will provide the capability to conduct a

series of long-duration, human-in-the-loop, advanced technology tests over the next 6 years. Demonstrate key technology capabilities for human support, such as advanced techniques for water processing using microbes, waste processing using biological degradation and fluidized bed incineration, a no-expendable trace gas contaminant control system, solid waste processing, and the flight test of a miniature mass spectrometer.

- Provide training to the appropriate NASA supervisors with specific emphasis on actions to prevent injury and illness on the job. Increase employee participation in the wellness program by at least 25 percent over the FY 1997 baseline. In coordination with the Office of Safety and Mission Assurance, achieve a 10-percent reduction in workers' compensation claims over the FY 1998 baseline.

Objective—Meet strategic space mission operations needs while reducing costs and increasing standardization and interoperability

NASA is pursuing a capability to transfer the operation of the Space Shuttle and the ISS to the private sector. The Space Flight Operations Contract is the initial focus of this objective. In a similar vein, the ISS program is developing processes and plans to facilitate commercial use and to highlight issues and advantages of commercial operations. The performance targets will be to:

- Promote privatization of Space Shuttle operations and reduce civil service resource requirements for operations by 20 percent (from the FY 1996 FTE levels) in FY 2000.
- Promote privatization and commercialization of Space Shuttle payload operations through the transition of payload management functions (payload integration managers, payload officers, and so on) by FY 2000.
- Within policy limitations and appropriate waivers, pursue the commercial marketing of Space Shuttle payloads by working to allow the Space Flight Operations Contractor to target two reimbursable flights, one in FY 2001 and one in FY 2002.
- Reduce the space communications budget submit for FY 2000 by 30 to 35 percent from the FY 1996 congressional budget submit.
- Increase the expenditures for commercial services to 10 percent of the total space communications budget by FY 2000.

Objective—Facilitate access to space for commercial researchers

HEDS facilitates industry's use of space to develop competitive products that contribute to the Nation's economic growth. This program, which combines NASA and industry research and development capabilities, is implemented through the Commercial Space Centers (CSC) located throughout the country. CSC's are multidisciplinary consortia that work with industry, academia, and Government to facilitate the use of space for commercial products and services. Industry participation is an essential element of the program. Industry provides funding to pay for CSC-provided services, as well as in-kind industry personnel, equipment, and materials to facilitate commercial space research. Specific performance targets for this objective will be to:

- Invest 25 percent of the space communications technology budget by FY 2000 in projects that could enable space commercial opportunities, including leveraging through a consortium of industry, academia, and Government.

- Establish up to two new CSC's.
- Foster the establishment of a telemedicine hub in Western Europe. NASA and CNES will develop an international telemedicine program to incorporate and connect existing medical informatics capabilities into a user-friendly commercial electronic telemedicine hub and apply lessons learned to human space flight.

Objective—Foster commercial participation on the International Space Station

Working with the commercial sector, we will establish mechanisms for substantial commercial research activity on the ISS. The performance target for this objective will be to:

- Utilize at least 30 percent of Space Shuttle and ISS FY 2000 capabilities for commercial investigations, per the U.S. Partner Utilization Plan.

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

HEDS will implement the ISS outreach and education plan, support NASA educational activities, maintain information pages on the Internet, and conduct annual ISS videoconferences for students and professional audiences. HEDS will contribute education and outreach support by developing appropriate curricula for the National Science Teachers Association (NSTA), the National Council of Teachers of Mathematics (NCTM), and the International Technology Education Association (ITEA) national conferences and assist in revisions of textbooks as appropriate. The performance target will be to:

- Through the NASA-sponsored National Space Biomedical Research Institute, conduct an open symposium relaying the results of space-oriented research activities focusing on up to 10 ground-related applications, with the participation of interested investigators, and publish the results in a conference proceedings report.

Internal Assessment

Interim evaluation and monitoring performance targets will be conducted as an element on the regular meeting schedules of the Office of Space Flight and HEDS Management Boards and the Board of Directors of OLMSA. As a matter of NASA policy, HEDS performance targets are included in the Performance Plan submitted to the Administrator by either the Associate Administrator for Life and Microgravity Sciences and Applications or the Associate Administrator for Space Flight.

Final data collection, reporting, and verification for inclusion in the Annual Performance Report will rely on several different processes, depending on the particular performance target. Wherever possible, a specific tangible product has been identified for individual performance targets to strengthen the validation process.

For many HEDS performance targets (such as Space Shuttle on-time success rates and ISS assembly sequence milestones), the verification of performance is straightforward, and progress is monitored through regular management channels and reports. For targets that include references, investigators, and/or peer-reviewed publications, HEDS publishes, and makes available online, an annual "Task Book and Bibliography," which includes lists of investigators, publications, and research results. This data base will be an essential source of data for evaluating performance against several targets.

External Assessment

To assist in evaluating those performance goals that are more difficult to associate with specific tangible products, HEDS will employ an annual external assessment process. HEDS has asked the Life and Microgravity Sciences and Applications Subcommittee of the NASA Advisory Council to review and evaluate performance on specific targets in late October on an annual basis. Responsible managers will present their progress, and the NASA Advisory Council will score performance and record the score in its minutes. The first such review was conducted in October 1998.

HEDS Enterprise FY 2000 Performance Plan—Chart 3

HEDS Enterprise Strategic Goals	Objectives	Enterprise FY 2000 Performance Targets	00#
Expand the frontier (Office of Space Flight and OLMSA)	• Enable human exploration through collaborative robotic missions	• Complete the integration and testing of the Mars-In-situ Propellant Production Precursor (MIP) flight unit for the 2001 Mars Surveyor mission.	0H35
		• Complete the Radiation Research Instrument for the Mars 01 mission to study transit, orbital, and surface radiation effects and conduct three workshops to define and prioritize research tasks in subjects such as radiation shielding materials, in situ resource utilization, and fluids management and heat transfer technology. Complete the science definition of granular flows, flight, and dust management experiments to begin gathering research data to alleviate critical problems of dust buildup, habitat foundation engineering, and rover performance during planetary exploration.	0H33
	• Define innovative, safe, and affordable human exploration mission architectures	• ***Complete the development and initiate the implementation of a comprehensive technology investment strategy to support future human exploration that includes capability development for increasing self-sustainability, decreasing transit times, developing commercial opportunities, reducing cost and risk, and increasing knowledge and operational safety.***	0H36
	• Invest in enabling high-leverage exploration technologies	• In coordination with other Enterprises, develop and implement tests and demonstrations of capabilities for future human exploration in the areas of advanced space power, advanced space transportation, information and automation systems, and sensors and instruments.	0H38
Expand scientific knowledge (OLMSA)	• In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems	• ***Support an expanded research program of approximately 935 investigations, an increase of ~17% over FY99. Publish 100% of science research progress in the annual OLMSA Life Sciences and Microgravity Research Program Task Bibliographies and make this available on the Internet.***	0H1
		• Using suborbital rockets, complete one combustion experiment on the flame spread of liquid fuels to better control Earth/space-based fire hazards, and conduct one investigation to test theories of fundamental physics properties and physical laws of fluids to provide key data for Earth and space-based processing materials; report the results.	0H11
		• Complete data reduction from the STS-95 Research Module mission. Begin to explore new cooperative efforts with the National Institutes of Health in the area of aging and transfer space-derived research data for industry development of a new drug to treat Chagas' disease.	0H9
Enable and establish a permanent and productive human presence in Earth orbit (Office of Space Flight and OLMSA)	• Provide safe and affordable access to space	• Have in place an aggressive Shuttle program that ensures the availability of a safe and reliable Shuttle system through the ISS era.	0H15
		• ***Achieve seven or fewer flight anomalies per mission.***	0H12
		• ***Achieve 85% on-time, successful launches, excluding weather risk.***	0H13
		• Achieve a 12-month manifest preparation time.	0H14
	• Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives	• Deploy and activate the U.S. Laboratory Module to provide a permanent on-orbit laboratory capability.	0H16
		• Deploy and activate the Canadian-built Space Station Remote Manipulator System to provide an ISS-based remote manipulating capability for maintenance and assembly.	0H17
		• Deploy and activate the Airlock to provide an ISS-based EVA capability.,	0H18
		• Deliver to orbit the first of three Italian-built Multi-Purpose Logistics Modules to provide a reusable capability for delivering payload and systems racks to orbit.	0H19
		• ***Conduct operations with a three-person human presence on the ISS.***	0H61
		• Complete preparations for the initial ISS research capability through the integration of the first rack of the Human Research Facility (HRF-1), five EXPRESS racks with small payload research, and the Microgravity Science Glovebox.	0H20
		• Complete the production of the X-38 first space flight test article in preparation for a Shuttle test flight in 2001.	0H22
	• Ensure and enhance the health, safety, and performance of humans in space	• Develop medical protocols and test the capability of the Crew Health Care System as integrated in the ISS U.S. Laboratory.	0H26
		• ***Evaluate and develop for flight testing a minimum of three major research protocols intended to protect bone, muscle, and physical work capacity and prepare a minimum of 10 biomedical research experiments (utilizing the capabilities of the STS and ISS HRF) to study human responses to the gravitational environment.***	0H25
		• Complete the first phase (including outfitting three test chambers) of the Advanced Life Support System Integration Testbed facility, which will provide the capability to conduct a series of long-duration, human-in-the-loop, advanced technology tests over the next 6 years. Demonstrate key technology capabilities for human support, such as advanced techniques for water processing using microbes, waste processing using biological degradation and fluidized bed incineration, a no-expendable trace gas contaminant control system, solid waste processing, and the flight test of a miniature mass spectrometer.	0H31
		• Provide training to the appropriate NASA supervisors with specific emphasis on actions to prevent injury and illness on the job. Increase employee participation in the wellness program by at least 25% over the FY97 baseline. In coordination with the Office of Safety and Mission Assurance, achieve a 10% reduction in workers' compensation claims over the FY98 baseline.	0H60

HEDS Enterprise FY 2000 Performance Plan—Chart 3 (continued)

HEDS Enterprise Strategic Goals	Objectives	Enterprise FY 2000 Performance Targets	00#
Enable and establish a permanent and productive human presence in Earth orbit (Office of Space Flight and OLMSA)	• Meet strategic space mission operations needs while reducing costs and increasing standardization and interoperability	• ***Promote privatization of Space Shuttle operations and reduce civil service resource requirements for operations by 20% (from the FY96 FTE levels) in FY00.***	0H39
		• Promote privatization and commercialization of Space Shuttle payload operations through the transition of payload management functions (payload integration managers, payload officers, etc.) by FY00.	0H40
		• Within policy limitations and appropriate waivers, pursue the commercial marketing of Space Shuttle payloads by working to allow the Space Flight Operations Contractor to target two reimbursable flights, one in FY01 and one in FY02.	0H41
		• ***Reduce the space communications budget submit for FY00 by 30–35% from the FY96 congressional budget submit.***	0H43
		• ***Increase the expenditures for commercial services to 10% of the total space communications budget by FY00.***	0H42
Expand the commercial development of space (OLMSA)	• Facilitate access to space for commercial researchers	• ***Invest 25% of the space communications technology budget by FY00 in projects that could enable space commercial opportunities, including leveraging through a consortium of industry, academia, and Government.***	0H44
		• Establish up to two new Commercial Space Centers.	0H47
		• Foster the establishment of a telemedicine hub in Western Europe. NASA and CNES will develop an international telemedicine program to incorporate and connect existing medical informatics capabilities into a user-friendly commercial electronic telemedicine hub and apply lessons learned to human space flight.	0H49
	• Foster commercial participation on the International Space Station	• Utilize at least 30% of Space Shuttle and ISS FY00 capabilities for commercial investigations, per the U.S. Partner Utilization Plan.	0H46
Share the experience and discovery of human space flight (OLMSA)	• Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets	• The NASA-sponsored National Space Biomedical Research Institute will conduct an open symposium relaying the results of space-oriented research activities focusing on up to 10 ground-related applications with the participation of interested investigators, and publish the results in a conference proceedings report.	0H56

HEDS Enterprise FY 2000 Budget—Chart 3a

Strategic Objective / Budget Category	Space Sstation	Space Shuttle	Payload & Util. Operations	Life and Microgravity Science	Mission Communications	Space Communications	R&PM	Performance Target Item # (Chart 3)	Other Objectives Addressed by Target (List)
Enable human exploration through collaborative robotic missions				X				0H35, 0H33	
Define innovative, safe, and affordable human exploration mission architectures			X					0H36	
Invest in enabling high-leverage exploration technologies			X					0H38	
In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems		Y		X				0H1, 0H11, 0H9	
Provide safe and affordable access to space		X	Y					0H15, 0H12, 0H13, 0H14	
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial activities	X	Y						0H16, 0H17, 0H18, 0H19, 0H22, 0H61	
	X	Y		Y				0H20	
Ensure and enhance the health, safety, and performance of humans in space	Y	Y		X				0H25	
				X				0H26, 0H31, 0H60	
Meet strategic space mission operations needs while reducing costs and increasing standardization and interoperability		X						0H39, 0H40, 0H41	
					X	X		0H43	
					X			0H42	
Facilitate access to space for commercial researchers					X			0H44	
				X				0H47, 0H49	
Foster commercial participation on the International Space Station	Y			X				0H46	
Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets				X				0H56	

Note: X=primary contribution; Y=secondary contribution.

Aero-Space Technology Enterprise

Mission

The Aero-Space Technology Enterprise mission is to pioneer the identification, development, verification, transfer, application, and commercialization of high-payoff aeronautics and space transportation technologies. Research and development programs conducted by the Enterprise contribute to national security, economic growth, and the competitiveness of American aerospace companies. The Enterprise plays a key role in maintaining a safe and efficient national aviation system and an affordable, reliable space transportation system. The Enterprise 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.

Implementation Strategy

The Enterprise manages a clearly defined portfolio of technology investments to ensure alignment with national policy, Agency goals, customer requirements, and budget availability. The investment strategies are focused on issues associated with future aviation and space systems. Enterprise objectives are outcome-focused and "stretch" beyond our current knowledge base. The outcome-focused nature of the objectives project a preferred end-state within the air and space transportation systems. Designated Lead Centers have been assigned the responsibility to manage the implementation and execution phases of the technology programs. Enterprise programs are often conducted in cooperation with other Federal agencies, primarily the Federal Aviation Administration (FAA) and the Department of Defense. These partnerships take advantage of the national investment in aeronautics and astronautics capabilities and eliminate unnecessary duplication.

The Enterprise supports the maturation of technology to a level such that it can be confidently integrated into current and new systems. In most cases, technologies developed by the Enterprise can be directly transferred to the external customer.

Enterprise Resource Requirements

The President has requested the budget in the table below for FY 1999 to FY 2004 to support the accomplishment of Aero-Space Technology goals.

Performance Measures

To meet the near-term goals displayed in Figure 2, the following objectives will be measured:

Objective—Contribute to aviation safety—reduce aircraft accident rate

The worldwide commercial aviation major accident rate has been nearly constant over the past 20 years. While the rate is very low (approximately one hull loss per 2 million departures), increasing traffic over the years has resulted in the absolute

Aero-Space Technology Budget

	FY 99	FY 00	FY 01	FY 02	FY 03	FY04
NOA $M	1,339	1,006	950	982	1,014	999
Civil Servant Full-Time Equivalents	4,360	4,306	4,336	4,395	4,441	4,468

number of accidents also increasing. The worldwide demand for air travel is expected to increase even further over the next 20 years—more than doubling by 2017. Without an improvement in the accident rate, such a traffic volume would lead to 50 or more major accidents a year—a nearly weekly occurrence. To aggressively address these issues, the White House announced a national goal to reduce the fatal accident rate for aviation by 80 percent within 10 years. In close cooperation with the FAA, NASA's response to this challenge stresses the development and integration of information technologies needed to build a safer aviation system, to support pilots and air traffic controllers. The Agency also intends to provide information to assess situations and trends that might indicate unsafe conditions before they lead to accidents. The performance target will be to:

- Flight-demonstrate a conceptual aircraft flight deck integrated with evolving ground-based runway incursion avoidance technologies installed at a major airport.

Objective—Affordable air travel—increase throughput

Delays in the Air Traffic Control System currently cost U.S. operators approximately $3.5 billion per year in excess fuel burned and additional operational costs. With the number of airports experiencing 20,000 hours of delay each year projected to increase by 50 percent by 2003, more efficient and flexible routing, scheduling, and sequencing of aircraft in all weather conditions are critical to meeting these capacity demands. Working with the FAA, NASA is developing airborne and ground technology and procedures to safely reduce aircraft spacing in the terminal area, enhance air traffic management and reduce controller workload, improve low-visibility landing and surface operations, and more fully integrate aircraft and air traffic systems. The performance target will be to:

- Conclude the Terminal Area Productivity project by field demonstrations of the complete suite of technologies and procedures that enable a 12-percent increase over 1994 nonvisual operations for single-runway throughput.

Objective—Contribute to environmental compatibility—reduce aircraft emissions

Nitrogen oxides (NO_x) are a local air quality issue, as well as being a significant greenhouse gas. The aerosols and particulates from aircraft are also suspected of producing high-altitude clouds that could adversely affect Earth's climatology. Decisions have been made within the International Civil Aviation Organization (ICAO) to increase the stringency of the NO_x standard by adopting a 20-percent reduction from the current standard. The Committee on Aviation Environmental Protection is soliciting for additional constraints to increase the NO_x stringency standard even further. Stringent NO_x limits could result in emissions fees or limited access to some countries, thereby adversely affecting U.S. airlines overseas operations. To address this challenge, NASA will work in partnership with industry and other Government agencies to ensure that safety and cost issues associated with the introduction of new technologies are understood prior to the establishment of new standards. Specifically, NASA is aggressively leading the way to demonstrate low emissions, through environmentally acceptable, durable, safer, and cost-effective engine technologies, that are required if airlines are to comply with international pressures to reduce aircraft engine emissions. The performance target will be to:

- Demonstrate, in a laboratory combustion experiment, an advanced turbine-engine combustor concept that will achieve up to a 70-percent reduction of oxides of nitrogen emissions based on the 1996 ICAO standard.

Objective—Contribute to environmental compatibility—reduce noise

Aircraft noise is an issue, both nationally and internationally, prompting airports to operate with strict noise budgets and curfews that restrict airline operations and that exacerbate congestion. Increased overall noise levels caused by growth in the number and size of new aircraft after the year 2000 require a proactive response involving the systematic development and validation of noise reduction technology in several areas-engine source noise, nacelle aero-acoustics, engine-airframe integration, airframe noise, and flight procedures to reduce airport community noise impact, all while maintaining high efficiency. The performance target will be to:

- Validate the technologies to reduce noise for large commercial transports by at least 7 decibels relative to 1992 production technology.

Objective—General aviation revitalization

Cost and reliability issues have contributed to the severe decline in the general aviation market. General aviation propulsion systems are a key element in reversing this trend. NASA formed a partnership with industry to develop and flight-demonstrate advanced propulsion systems for general aviation aircraft to address this issue. The cost-sharing partnership with Teledyne Continental Motors and Williams International is focused on the technology development of a new piston engine and a new turbofan engine that will reduce costs by 50 percent, increase the time between overhauls by 75 percent, and reduce specific fuel consumption by 25 percent. Together, these technologies will significantly improve the performance and reduce the operational cost of general aviation aircraft. The performance target will be to:

- Perform flight demonstrations of advanced general aviation piston and turbine engines at the annual Oshkosh air show.

Objective—Next-generation experimental aircraft

The Aero-Space Technology Enterprise's Industry/Government/University Environmental Research Aircraft and Sensor Technology (ERAST) Alliance is supporting future Earth Science Enterprise activities in which in situ data collection is required to complement (with greater resolution) and calibrate satellite observations. The alliance transfers new technology to U.S. industry to create new civil capability for commercial and scientific applications. The performance target will be to:

- Demonstrate improved remotely piloted aircraft science mission capability by increasing the operational deployment time from 3 weeks to 9 with minimum airfield provisions and unrestricted airspace.

The Hyper-X experimental aircraft project is demonstrating and validating technologies, experimental techniques, and computational methods and tools for design and performance predictions of a hypersonic aircraft. Designated the X-43, the test vehicle will validate performance, design, and test capabilities with flights to both Mach 7 and 10. The performance target will be to:

- Demonstrate in flight an airframe-integrated, dual-mode, scramjet-powered vehicle.

Objective—Next-generation design tools

NASA continues to advance its High Performance Computing and Communications (HPCC) networking capabilities as part of the Federal HPCC program. The Aero-Space Technology Enterprise's work on the Next Generation Internet will also improve network communications for the researchers of all disciplines. The benefits from this program include new computational advances such as this project, as well as capabilities in aeronautics, space transportation, Earth science, space science, and educational outreach. The performance targets will be to:

- Demonstrate a prototype heterogeneous distributed computing environment.

Objective—Revolutionize space launch capabilities

The X-33 is an integrated technology effort to flight-demonstrate key technologies and deliver advancements in: (1) ground and flight operations techniques that will substantially reduce operations costs for a reusable launch vehicle; (2) lighter, reusable cryogenic tanks; (3) lightweight, low-cost composite structures; (4) advanced thermal protection systems to reduce maintenance; (5) propulsion and vehicle integration; and (6) the application of New Millennium microelectronics for vastly improved reliability and vehicle health management. With flight tests beginning in 2000 and to be completed near the end of 2000, the X-33 program will demonstrate technologies that are traceable to the mass fraction (less than 10-percent empty vehicle weight) required for future reusable launch vehicles. The program will meet the following operational requirements: the validation of key aerothermodynamic environments to reduce the uncertainty of predictive models for thermal protection system requirements; flights faster than Mach 13; 48-hour and 7-day ground turnarounds; and small maintenance crews (on the order of 50 persons). The flight test results will be combined with the successes of the DC-XA, X-34, and complementary ground technology advances. The combined results will reduce the technical risk of the full-scale development of an operational reusable launch vehicle. The performance target will be to:

- Conduct the flight testing of the X-33 vehicle.

The X-34 program will demonstrate the technologies necessary for a reusable vehicle, but this will not be a commercially viable vehicle. The X-34 will be a rocket-powered, Mach-8-capable flight demonstrator testbed to close the performance gap between the subsonic DC-XA and the Mach 13 X-33. The X-34 objective is to enhance U.S. commercial space launch competitiveness through the development and demonstration of key technologies applicable to future, low-cost reusable launch vehicles. The X-34 will demonstrate flexible integration capability, high flight rate (up to 25 flights per year), autonomous flight operations, safe abort capability, landings in cross winds up to 20 knots, flights through rain and fog, and a recurring flight cost of $500,000 or less. The performance target will be to:

- Complete vehicle assembly and begin the flight test of the second X-34 vehicle.

A strong need exists to significantly reduce the cost of small payload (approximately 150 kilograms) launch capability. NASA's small payload focused launch vehicle system (Bantam) project is structured

to focus on advanced reusable technology development and system analysis leading to flight experiments as technology matures. The performance target will be to:

- Complete small payload focused technologies, and select concepts to support potential decisions on the flight demonstration of a reusable first stage.

Objective—Revolutionize in-space transportation

With the launch of Deep Space 1 in October 1998—a mission designed to validate technologies for 21st century spacecraft—ion propulsion made its debut. Though much smaller in thrust than chemical systems, the ion engine produces its thrust by accelerating electrically charged xenon atoms for thousands of hours, thereby enabling spacecraft to travel far distances at increasing speeds. This 2-year mission, under the NASA Solar Propulsion Technology Applications Readiness (NSTAR) project, includes a flyby of Mars, an asteroid, and a comet. The performance target will be to:

- Complete NSTAR Mission Profile (100-percent design life) ground testing for Deep Space-1 (concurrent, identical firing of an NSTAR engine in a vacuum chamber with the actual firing sequence of the in-flight propulsion system).

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

The Aero-Space Technology Enterprise Field Centers provide American industry and academic personnel with world-class research facilities, such as wind tunnels and advanced computational

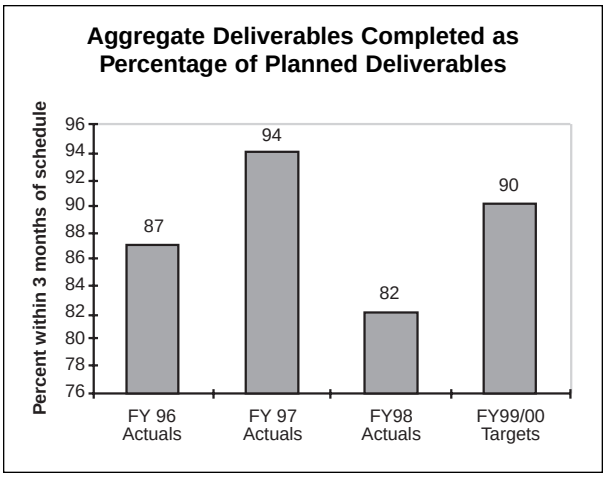


Figure 7

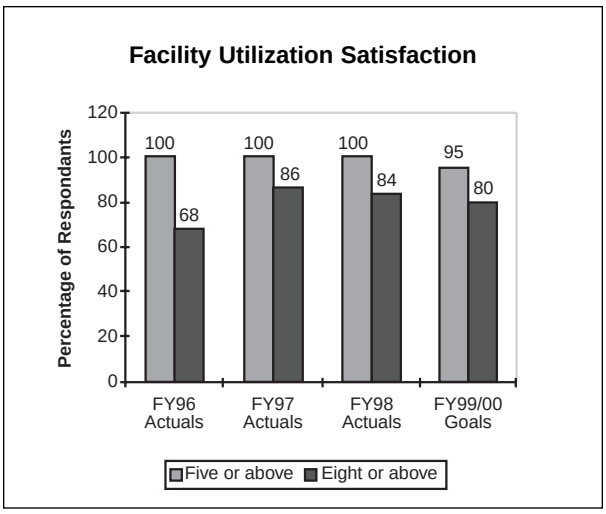


Figure 8

devices. The Office of Aero-Space Technology conducts an exit interview to determine the degree of satisfaction customers feel they received by using NASA facilities. The performance targets will be to:

- Complete 90 percent of Enterprise-controlled milestones within 3 months of schedule (Figure 7).
- Transfer at least 12 new technologies and processes to industry during the fiscal year.
- Achieve a facility utilization customer satisfaction rating of 95 percent of respondents at “5” or better and 80 percent at “8” or better, based on exit interviews (Figure 8).

Aero-Space Technology Enterprise research and technology programs provide important contributions to education and public understanding of air and space transportation. Providing a steady return of discoveries and new knowledge contributes to the accomplishment of this objective. The Enterprise will continue its outreach and education activities through several venues, including the extensive use of the Internet to share educational material in the areas of science, mathematics, and technology with teachers and students. The performance target will be:

- For all new program activities initiated in FY 2000, develop an education outreach plan, which includes and results in an educational product. This product shall be consistent with current educational standards and use program content to demonstrate or enhance the learning objectives.

Internal Assessment

The Aero-Space Technology Enterprise regularly reviews its progress on achieving its performance targets using NASA's established policies and procedures for program and project management. Evaluation is provided by the governing Program Management Council, either at the Agency-level or at the designated Lead Center, which meets at least quarterly to execute its oversight responsibilities. The Enterprise also relies on the extensive safety, quality, and reliability processes and Center organizations to ensure that performance in our facilities is maintained to standards appropriate for research and technology development operations.

External Assessment

The Aero-Space Technology Committee of the NASA Advisory Council will conduct annual assessments of the progress made by the Enterprise in achieving its near-term technology objectives. This committee—and its nine technical subcommittees consisting of nearly 150 members from other Government agencies, industry, and academia that meet two to three times a year—will provide a qualitative progress measurement (Green, Yellow, or Red). "Green" will indicate that the objective was met; "Yellow" will indicate a concern that an objective was not fully accomplished; and "Red" will indicate that events occurred that prevented or severely impaired the accomplishment of the objective. The assessment will include commentary to clarify and supplement the qualitative measures.

Aero-Space Technology Enterprise FY 2000 Performance Plan—Chart 4

Aero-Space Technology Enterprise Strategic Goals	Objectives	Enterprise FY 2000 Performance Targets	00#
Global Aviation—Enable U.S. leadership in global civil aviation through safer, cleaner, quieter, and more affordable air travel	• Contribute to aviation safety—reduce aircraft accident rate	• ***Flight-demonstrate a conceptual aircraft flight deck integrated with evolving ground-based runway incursion avoidance technologies installed at a major airport.***	0R3
	• Contribute to environmental compatibility—reduce emissions	• ***Demonstrate, in a laboratory combustion experiment, an advanced turbine-engine combustor concept that will achieve up to a 70% reduction of oxides of nitrogen emissions based on the 1996 ICAO standard.***	0R1
	• Contribute to environmental compatibility—reduce noise	• ***Validate the technologies to reduce noise for large commercial transports by at least 7 decibels relative to 1992 production technology.***	0R2
	• Affordable air travel—increase throughput	• ***Conclude the Terminal Area Productivity project by field demonstrations of the complete suite of technologies and procedures that enable a 12% increase over 1994 nonvisual operations for single-runway throughput.***	0R4
Revolutionary Technology Leaps—Revolutionize air travel and the way in which aircraft are designed, built, and operated	• General aviation revitalization	• ***Perform flight demonstrations of advanced general aviation piston and turbine engines at the annual Oshkosh air show.***	0R7
	• Next-generation experimental aircraft	• ***Demonstrate improved remotely piloted aircraft science mission capability by increasing operational deployment time from 3 weeks to 9 with minimum airfield provisions and unrestricted airspace.***	0R11
		• ***Demonstrate in flight an airframe-integrated, dual-mode, scramjet-powered vehicle.***	0R6
	• Next-generation design tools	• ***Demonstrate a prototype heterogeneous distributed computing environment.***	0R8
Space Transportation—Enable the full commercial potential of space and expansion of space research and exploration	• Revolutionize in-space transportation	• ***Complete NSTAR Mission Profile (100% design life) ground testing for Deep Space-1 (concurrent, identical firing of an NSTAR engine in a vacuum chamber with the actual firing sequence of the in-flight propulsion system).***	0R10
	• Revolutionize space launch capabilities	• ***Complete vehicle assembly and begin the flight test of the second X-34 vehicle.***	0R12
		• ***Conduct the flight testing of the X-33 vehicle.***	0R9
		• ***Complete small payload focused technologies and select concepts for flight demonstration of a reuseable first stage (Bantam).***	0R17
Research and Development (R&D)—Enable, as appropriate, on a national basis, world-class aerospace R&D services, including facilities and expertise, and proactively transfer cutting-edge technologies in support of industry and U.S. Government R&D	• Provide world-class aerospace research and development services, facilities, and expertise	• ***Complete 90% of all Enterprise-controlled milestones within 3 months of schedule.***	0R13
		• ***Transfer at least 12 new technologies and processes to industry during the fiscal year.***	0R15
		• ***Achieve a facility utilization customer satisfaction rating of 95% of respondents at "5" or better and 80% at "8" or better, based on exit interviews***	0R14
		• ***Continue the implementation of current education outreach plans and establish new plans for all new program activities initiated in FY00.***	0R16

Aero-Space Technology Enterprise FY 2000 Budget—Chart 4a

Strategic Objective	Budget Category: RLV Flight Demo	High Speed Research	Adv. Subsonics Technology	Aviation Systems Capacity	HPCC	Aviation Safety program	Adv. Space Transportation Technology	Aeronautics R&T	Commercial Technology	R&PM	Performance Target Item # (Chart 4)	Other Objectives Addressed by Target (List)
Safety—reduce aircraft accident rate						X		Y		X	0R3	
Environmental compatability—reduce emissions								X		X	0R1	
Environmental compatability—reduce noise								X		X	0R2	
Affordable air travel—increase throughput				X						X	0R4	
General aviation revitalization								X		X	0R7	
Next-generation experimental aircraft								X		X	0R6	
								X		X	0R11	
Next-generation design tools					X					X	0R8	
Revolutionize space launch capabilities	X									X	0R12	
	X									X	0R9	
Revolutionize in-space transportation							X			X	0R10	
							X			X	0R17	
Provide world-class aerospace research and development services, facilities, and expertise	X			X	X	X	X	X		X	0R13 All program milestones contribute to meeting this target	
								X		X	0R14	
	X			X	X	X	X	X		X	0R15	
								X		X	0R16	

Note: X=primary contribution; Y=secondary contribution.

Goal

The goal of this process is to ensure that the Agency carries out its responsibilities effectively and safely and that management makes critical decisions regarding implementation activities and resource allocations that support NASA's strategic, implementation, and performance plans. For FY 2000, NASA's strategic management performance objectives (and associated performance targets) require us to make the most effective use of the abilities of our appropriated funds, "downsized" workforce, procurement processes, and information technologies.

Performance Measures

To meet the near-term goals displayed in Chart 5, the following objectives will be measured:

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

The performance targets that follow will measure our progress in increasing the cost-effectiveness of the workforce while retaining NASA's commitment to both diversity and employee health and safety. The performance targets will be to:

- Reduce the civil service workforce level to below 18,200 (Figure 9).
- Maintain a diverse NASA workforce throughout the downsizing efforts (Figure 10).
- Reduce the number of Agency lost workdays (from occupational injury or illness to NASA personnel) by 5 percent from the FY 1994–96 3-year average (Figure 11).

Functional and staff offices will continue to increase the efficiency of Agency facilities and management systems. The performance targets will be to:

- Achieve a 5-percent annual increase in costs avoided through alternative physical resource investments, such as dollars avoided Agencywide through increased energy conservation, recycling, pollution prevention, and facilities maintenance inspection (Figure 12).

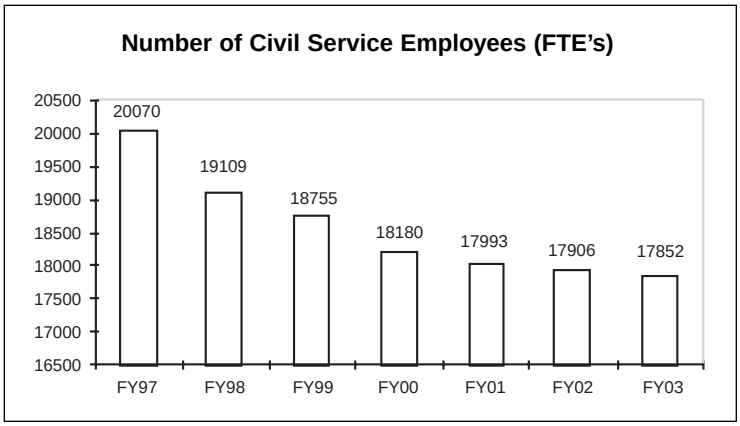


Figure 9

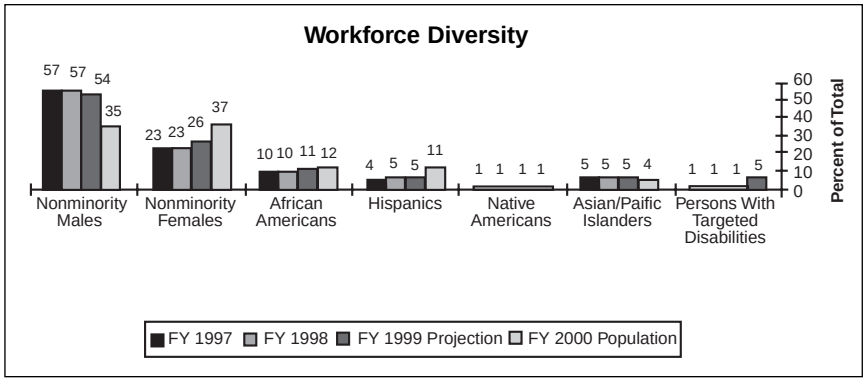


Figure 10

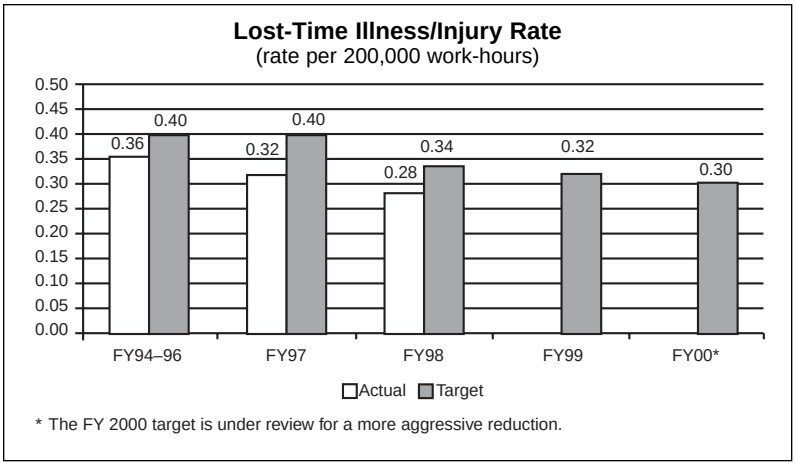


Figure 11

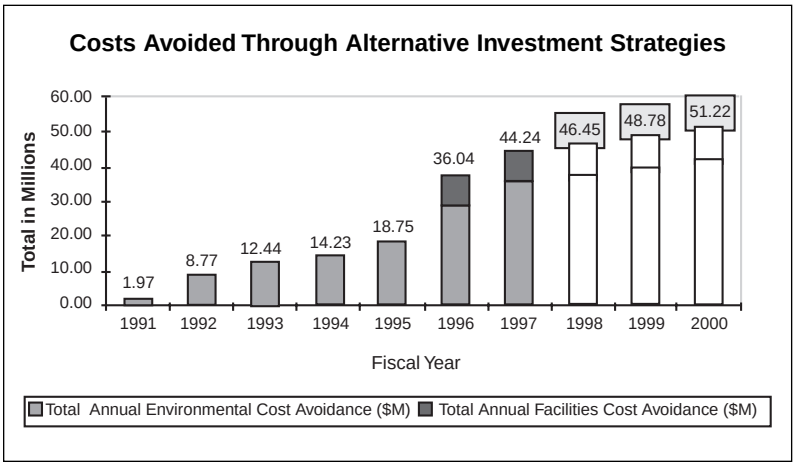


Figure 12

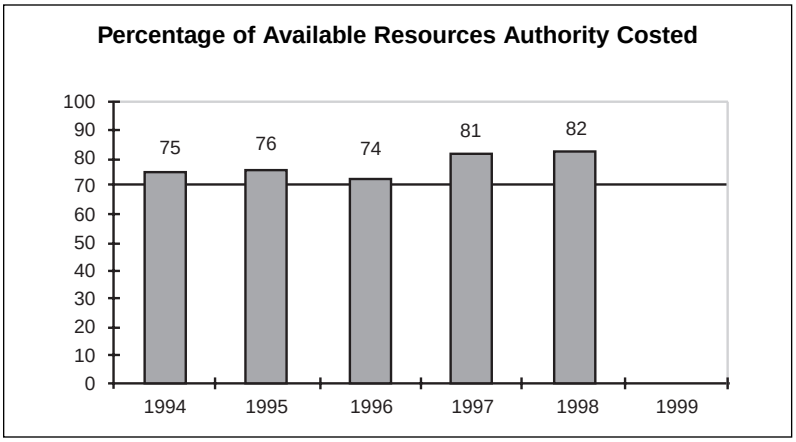


Figure 13

- Cost 70 percent or more of the resources authority available to cost within the fiscal year (Figure 13).
- Implement new financial systems and business procedures (including a new financial classification structure and full-cost budgeting and accounting procedures) through the introduction and installation of the Integrated Financial Management System (IFMS). Following the completion of system testing, the IFMS will begin to be installed at NASA Headquarters and the Field Centers.

Objective—Improve the effectiveness and efficiency of Agency acquisitions through the increased use of techniques and management that enhance contractor innovations and performance

In terms of performance-based contracting, the performance target will be to:

- Of funds available for performance-based contracts (PBC), maintain PBC obligations at 80 percent (Figure 14). "Funds available" excludes grants, cooperative agreements, actions under $100,000, the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, intragovernmental agreements, Federally Funded Research and Development Centers, and contracts with foreign governments or international organizations.

Data to support the achievement of the target performance are taken from the Financial Accounting and Contractual Status system. The Headquarters

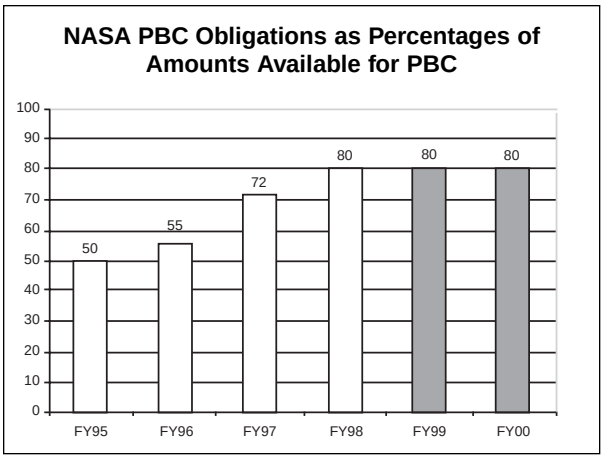


Figure 14

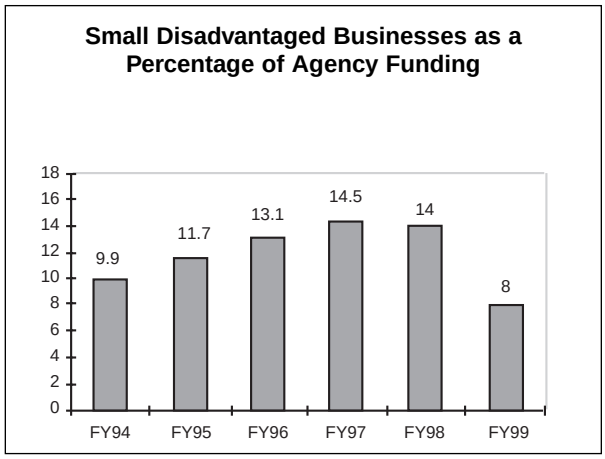


Figure 15

Office of Procurement reviews PBC performance and PBC-related activities no less frequently than quarterly. Status is reported to the NASA Administrator semi-annually, to the Office of Management and Budget quarterly, and to the NASA Senior Management Council and the Capital Investment Council as requested. PBC performance data are verified and validated through the sampling of contracts as part of periodic onsite procurement management surveys.

In terms of small disadvantaged businesses, the performance target will be to:

- Achieve at least the congressionally mandated 8-percent goal for annual funding to small disadvantaged businesses. This includes funding for prime and subcontracts awarded in support of authorized programs. Included in this measurement are small disadvantaged businesses, Historically Black Colleges and Universities, other minority institutions, and women-owned small businesses (Figure 15).

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

The performance target will be to:

- Improve information technology infrastructure service delivery to provide increased capability and efficiency while maintaining both a customer rating of "satisfactory" and costs per resource unit at the FY 1998 baseline.

Customer satisfaction (Figure 16) and unit cost metrics (Figures 17 and 18) have been established and baselined at FY 1998 levels for Agencywide information technology services—NASA ADP Consolidation Center (NACC) and NASA Integrated Services Network (NISN)—as follows:

Customer Satisfaction Rating	**Score Range**
Extremely Satisfied	4.50–5.00
Very Satisfied	4.00–4.49
Satisfied	3.00–3.99
Unsatisfied	2.00–2.99
Very Unsatisfied	1.00–1.99

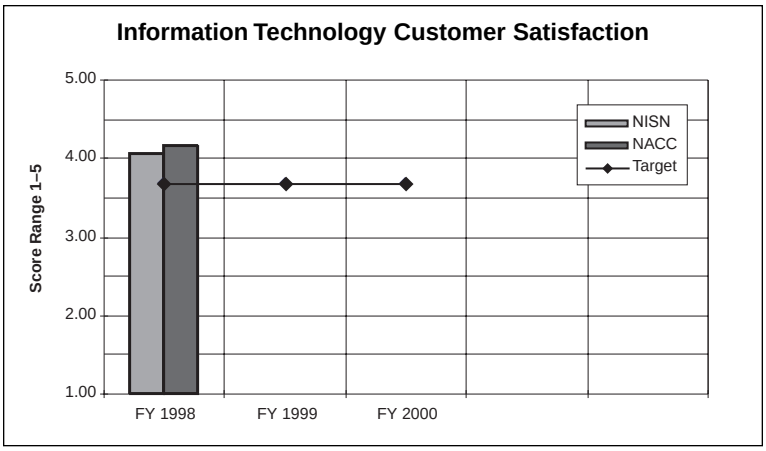


Figure 16

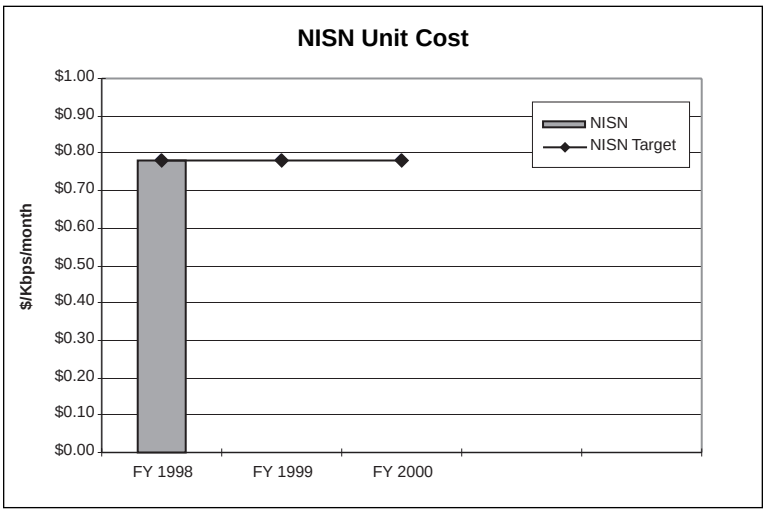


Figure 17

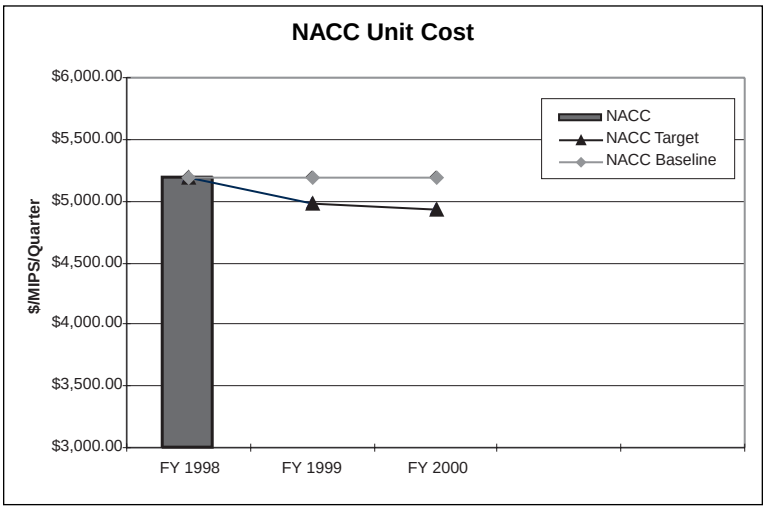


Figure 18

Manage Strategically FY 2000 Performance Plan—Chart 5

Manage Strategically Goal	Objectives	Process FY 2000 Performance Targets	00#
Provide a basis for the Agency to carry out its responsibilities effectively and safely and enable management to make critical decisions regarding implementation activities and resource allocations that are consistent with the goals, objectives, and strategies contained in NASA's Strategic, Implementation, and Performance Plans	• Optimize investment strategies and systems to align human, physical, and financial resources with customer requirements, while ensuring compliance with applicable statutes and regulations	• Reduce the civil service workforce level to below 18,200.	0MS1
		• Maintain a diverse NASA workforce throughout the downsizing efforts.	0MS2
		• Reduce the number of Agency lost workdays (from occupational injury or illness) by 5% from the FY94–96 3-year average.	0MS3
		• Achieve a 5% increase in physical resource costs avoided from the previous year through alternate investment strategies in environmental and facilities operations.	0MS12
		• Cost 70% or more of available resources.	0MS4
		• Begin the implementation at NASA installations of the Integrated Financial Management System following the completion of system testing.	0MS11
	• Improve the effectiveness and efficiency of Agency acquisitions through the increased use of techniques and management that enhance contractor innovations and performance	• Of funds available for PBC, maintain PBC obligations at 80% (funds available exclude grants, cooperative agreements, actions <$100,000, SBIR, STTR, FFRDC's, intragovernmental agreements, and contracts with foreign governments or international organizations).	0MS5
		• Achieve at least the congressionally mandated 8% goal for annual funding to small disadvantaged businesses (including prime and subcontracts, small disadvantaged businesses, HBCU's, other minority institutions, and women-owned small businesses).	0MS8
	• Improve information technology capability and services	• Improve information technology infrastructure service delivery to provide increased capability and efficiency while maintaining a customer rating of "satisfactory" and holding costs per resource unit to the FY98 baseline.	0MS10

Manage Strategically FY 2000 Budget—Chart 5a

Strategic Objective	Budget Category	HEDS	Aero-Space Technology	Space Science	Earth Science	R&PM	Safety & Mission Assurance	COF	Environmental	Education & Minority	Performance Target Item # (Chart 5)	Other Objectives Addressed by Target (List)
Optimize investment strategies and systems to align human, physical, and financial resources with customer requirements, while ensuring compliance with applicable statutes and regulations		X	X	X	X	X					0MS1, 0MS2, 0MS4, 0MS11	
						X	X				0MS3	
						X		X	X		0MS12	
Improve the effectiveness and efficiency of Agency acquistions through the increased use of techniques and management that enhance contractor innovations and performance		X	X	X	X	X					0MS5	
		X	X	X	X	X					0MS8	
Improve information technology capability and services		X	X	X	X	X					0MS10	
Note: X=primary contribution; Y=secondary contribution.												

Provide Aerospace Products and Capabilities

Goal

This 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 NASA customers. Through the use of Agency facilities, customers can conduct research, explore and develop space, and improve life on Earth. This process is used to answer the Agency fundamental question: "What cutting-edge technologies, processes, techniques, and engineering capabilities must we develop to implement our research agenda in the most productive, economical, and timely manner?" The goal of the process is to enable NASA's Strategic Enterprises and their Centers to deliver products and services to customers more effectively and efficiently. The process is also used to enable the Communicate Knowledge process to extend the technology, research, and science benefits from NASA programs broadly to the public and commercial sectors.

The following performance measures are a draft set and will be updated to reflect the results of a study currently in progress throughout the Enterprises to define a set that most accurately reflects the process. Progress on the following targets is collected and validated within the Enterprises, the Centers, and the Office of the Chief Financial Officer as a part of their management process, and that progress is then reviewed and integrated at an Agency level to report performance.

Performance Measures

Objective—Reduce the cost and development time to deliver products and operational services

NASA's role in the advancement of research and technology is conducted through the construction and operation of facilities such as telescopes, satellites, and ground-based laboratories and test facilities. The performance target will be to:

- Keep the development and upgrade of major scientific facilities and capital assets within budget. On average, the Agency will not exceed 110 percent of cost and schedule estimates.

Objective—Improve and maintain NASA's engineering capability

The performance target will be to:

- Ensure the availability of NASA's spacecraft and facilities by decreasing the downtime relative to the FY 1999 spacecraft and facility performance.

Objective—Capture and preserve engineering and technological best practices and process knowledge to continuously improve NASA's program and project management

The performance target will be to:

- Capture a set of best practices/lessons learned from each program, including at least one from each of the four Provide Aerospace Products and Capabilities subprocesses, commensurate with current program status. These data will be implemented in the improvement of this Crosscutting Process and in program and project management training.

Objective—Focus on integrated technology planning and technology development in cooperation with commercial industry and other NASA partners and customers

Technologies are some of the key enabling products provided through the Provide Aerospace Products and Capabilities Process. Leveraging NASA technology activities with those of other organizations vastly increases the total value of such activities. The performance targets will be to:

- Dedicate the percentage of the Agency's R&D budget that is established in the FY 1999 process to commercial partnerships.
- Increase the amount of leveraging of the technology budget with activities of other organizations, relative to the FY 1999 baseline that is established during the process development.

Provide Aerospace Products and Capabilities FY 2000 Performance Plan—Chart 6

Provide Aerospace Products and Capabilities Goal	Objectives	Process FY 2000 Performance Targets	00#
Enable NASA's Strategic Enterprises and their Centers to deliver products and services to customers 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 to deliver products and operational services	• Meet schedule and cost commitments by keeping the development and upgrade of major scientific facilities and capital assets within 110% of cost and schedule estimates, on average.	0P1
	• Improve and maintain NASA's engineering capability	• Ensure the availability of NASA's spacecraft and facilities by decreasing the FY99 unscheduled downtime.	0P2
	• Capture and preserve engineering and technological best practices and process knowledge to continuously improve NASA's program/project management	• Capture a set of best practices/lessons learned from each program, including at least one from each of the four Provide Aerospace Products and Capabilities subprocesses, commensurate with current program status. Data will be implemented in process improvement and program/project management training.	0P5
	• Focus on integrated technology planning and technology development in cooperation with commercial industry and other NASA partners and customers	• Dedicate the percentage of the Agency's R&D budget that is established in the FY99 process to commercial partnerships.	0P6
		• Increase the amount of leveraging of the technology budget with activities of other organizations, relative to the FY99 baseline that is established during the process development.	0P7

Provide Aerospace Products and Capabilities FY 2000 Budget—Chart 6a

Strategic Objective / Budget Category	HEDS	Aero-Space Technology	Space Science	Earth Science	R&PM	Safety & Mission Assurance	COF	Environmental	Education & Minority	Performance Target Item # (Chart 6)	Other Objectives Addressed by Target (List)
Reduce mission cost and development time to deliver products and operational services	X	X	X	X						0P1	
Improve and maintain NASA's engineering capability	X	X	X	X						0P2	
Capture and preserve engineering and technological best practices and process knowledge to continuously improve NASA's program/project management	X	X	X	X						0P5	
Focus on integrated technology planning and technology development in cooperation with commercial industry and other NASA partners and customers	X	X	X	X						0P6, 0P7	

Note: X=primary contribution; Y=secondary contribution.

Goals

NASA provides new scientific and technological knowledge gained from exploring the Earth system, the solar system, and the universe beyond, as well as from conducting the necessary supporting research and development. The Generate Knowledge Process ensures that this information is shared with scientists, engineers, and technologists in industry, academia, and other organizations. In addition, natural resource managers, policymakers, and educators benefit from this process. The goals of the Generate Knowledge Process are to extend the boundaries of knowledge of science, technology, and engineering, to capture new knowledge in useful and transferable media, and to share new knowledge with customers.

The Generate Knowledge Process is conducted by NASA's three scientific research Enterprises—the Space Science Enterprise, the Earth Science Enterprise, and OLMSA within the HEDS Enterprise. This process does not include research of a proprietary industrial nature or research whose conduct or dissemination is limited for reasons of national security.

As provided in the NASA Strategic Management Handbook, the Generate Knowledge Process is composed of eight principal subprocesses (Section 6.1.2):

1. Acquire advice
2. Plan and set priorities
3. Select and fund/conduct research and analysis programs
4. Select and implement flight missions
5. Analyze data (initial)
6. Publish and disseminate results
7. Create data archives
8. Conduct further research

Performance Measures

The performance of the Generate Knowledge Process will be assessed by analyzing performance toward the objectives of the process's constituent subprocesses. The following subprocess objectives will be measured:

Objective—Acquire advice

NASA relies on the guidance of outside customers and partners to maintain the vitality and efficacy of its research programs. This guidance is obtained through countless channels, both formal and informal. The principal vehicles for formal guidance are advisory committees chartered under the Federal Advisory Committee Act (FACA). At the conclusion of their meetings, which are conducted in conformance with the FACA statute, these committees develop and submit a letter report summarizing findings and recommendations. The Space Science Advisory Committee advises the Space Science Enterprise. The Earth Systems Science and Applications Advisory Committee (ESSAAC) provides counsel to the Earth Science Enterprise. The Life and Microgravity Sciences and Applications Advisory Committee and the Advisory Committee on the International Space Station advise OLMSA and the HEDS Enterprise. The performance target will be:

- The Space Science Enterprise, the Earth Science Enterprise, and OLMSA/HEDS will receive at least seven formal letters of advice from their FACA-chartered advisory committees.

Objective—Plan and set priorities

The Strategic Enterprises operate strategic planning systems that define their goals and objectives and support Agencywide strategic management processes. Consistent with the requirements of the GPRA of 1993, the NASA Strategic Plan must be updated every 3 years. To support this planning cycle, each of the research offices independently updates its own Strategic Plan on a periodic basis. The performance targets will be:

- The Space Science Enterprise will (1) complete a review of its in-place theme-based science and technology roadmaps, (2) conduct a programmatic integration meeting, and (3) prepare a revised draft Enterprise Strategic Plan for outside review.
- Because the Earth Science Enterprise conducts regular external assessments of the Earth Science program content through the Biennial Review process, with the next one scheduled for 1999, in 2000, the Enterprise will review its technology, education, and commercial strategies and refine the performance metrics for these areas.
- OLMSA/HEDS will release a new Strategic Plan in FY 1999, which will be used in FY 2000 to guide the implementation of programs and to develop future budgets.

Objective—Select and fund/conduct research and analysis programs

To support their broad programs of research undertaken in air and space flight, the Space Science and Earth Science Enterprises support focused science and technology research on the ground. This includes a wide range of fundamental and applied laboratory and theoretical studies directed at formulating underlying research issues and establishing the analytical and technological bases for flight research. These activities are supported by grants, contracts, and cooperative agreements with a variety of partners, including the NASA Field Centers, universities, and industrial concerns. OLMSA's solicitation process is independent of specific platforms and uses NASA Research Announcements (NRA) and Announcements of Opportunity (AO) to select flight and ground research. The performance target will be:

- For selecting and funding/conducting research and analysis and core technology projects, the Space Science Enterprise, OLMSA, and the Earth Science Enterprise will use broad Agency announcements (AO, NRA, and Cooperative Agreement Notice solicitations) to competitively award 80 percent or more of the resources in these programs based on peer review.

Objective—Select and implement flight missions

NASA's primary focus is research enabled by flight in the air and in space. The goals of these flight programs range from obtaining data that bear on fundamental cosmology to flight-testing aeronautical components and systems of commercial interest. The Space Science and Earth Science Enterprises solicit and select flight missions based on community-based planning, AO's, and peer review. OLMSA flight research is selected through the same processes as its ground-based research (see above). Flight research is generally preceded by ground research and proposals are selected for flight based on a demonstrated need for access to the space environment. The performance targets will be:

- ***To select flight missions, the Space Science Enterprise will release one Explorer and one***

Discovery AO and make selections in response to at least one AO.

- ***To select flight missions, the Earth Science Enterprise will release one Earth System Science Pathfinder AO.***
- ***To implement flight missions, the Space Science Enterprise will successfully launch and initiate operations for five Enterprise flight missions, within 10 percent of budget on average.***
- ***To implement flight missions, the Earth Science Enterprise will successfully launch one spacecraft and deliver two instruments for international launches, within 10 percent of budget on average.***
- OLMSA will complete preparations for a Space Shuttle research mission that will fly in early FY 2001.

Objective—Analyze data (initial)

Once launched, research spacecraft must be commanded, and the returned data telemetry must be processed, calibrated, and validated. These functions must be performed before the data can be used for the comparison to theoretical predictions or modeling activities that extend scientific and technical knowledge. The performance target will be:

- For the initial analysis of data, the Earth Science and Space Science Enterprises will satisfy 80 percent of their FY 2000 Enterprise performance targets in the "Operations" area.

Objective—Publish and disseminate results

As a recipient of public funds for public purposes, NASA disseminates the results of its research in many forms to a client base whose interest ranges from highly technical to public information and educational. The primary means for the dissemination of OLMSA, Space Science Enterprise, and Earth Science Enterprise scientific findings are refereed journals, papers presented at professional meetings, and popular scientific periodicals. For all NASA research areas, collaborations with universities ensure that the insertion of the technical knowledge in academia and educational outreach to K-12 audiences is being expanded. The performance targets will be:

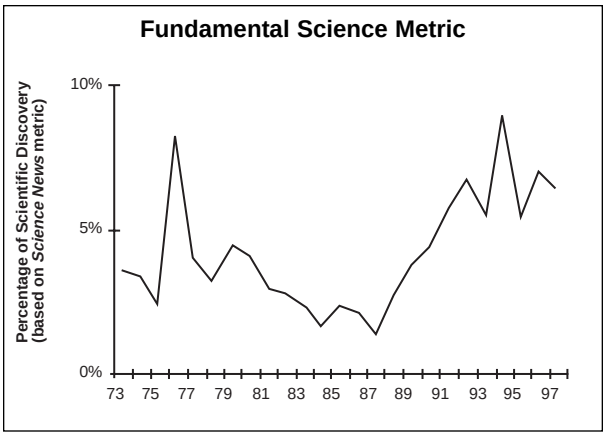


Figure 19

- For disseminating research results, the Space Science Enterprise will account for 4 percent of the 150 "most important science stories" in the annual review by *Science News.* For education and outreach, the Enterprise will meet seven of eight of its FY 2000 Enterprise Performance Plan education performance targets (Figure 19).
- ***For disseminating research results, the Earth Science Enterprise will meet all of its FY 2000 Enterprise Performance Plan disseminate information performance targets. For education and outreach, the Enterprise will meet all of its FY 2000 Enterprise Performance Plan education and outreach targets.***
- ***For disseminating research results, OLMSA will publish 100 percent of its science research progress in the annual OLMSA Life***

Sciences and Microgravity Research Program Task Bibliographies and make the information available on the Internet.

Objective—Create archives

It is NASA policy to make scientific data returned by science missions widely accessible as soon as possible after receipt and to maintain these data thereafter in openly accessible archive data bases. OLMSA, the Space Science Enterprise, and the Earth Science Enterprise support a number of data discipline-based archiving facilities and programs. The performance targets will be:

- For archiving mission data, the Space Science Enterprise will include in all AO's specific directions to investigators for archiving mission data and ensure that Enterprise flight mission data are transmitted to appropriate discipline data archives no more than 1 year after acquisition.
- ***For archiving mission data, the Earth Science Enterprise will make available data on prediction, land surface, and climate to users within 5 days. The Enterprise will double the volume of data archived compared to FY 1997.***
- OLMSA will ensure that nonhuman flight mission data are transmitted to appropriate discipline data archives no more than 2 years after the completion of an experiment.

Objective—Conduct further research

It is NASA policy to encourage the widespread use and analysis of the data and information it acquires at the public's expense. Within the Space Science and Earth Science Enterprises, the extended analysis of flight data is supported by data analysis grants programs coupled with major flight missions. OLMSA research grants include funding for the analysis of experiment results, and the results of precursor or supporting ground-based research are heavily weighted in the peer review process for selecting follow-on flight research. The performance targets will be:

- ***The Space Science Enterprise will average "fully effective" across all Enterprise data analysis programs in a yearly independent retrospective productivity assessment.***
- The Earth Science Enterprise will contribute in four of the six theme areas of the U.S. Global Change Research Program.

Generate Knowledge FY 2000 Performance Plan—Chart 7

Generate Knowledge Goal	Objectives	Process FY 2000 Performance Targets	00#
Extend the boundaries of knowledge of science and engineering, capture new knowledge in useful and transferable media, and share new knowledge with customers	• Acquire advice	• The Space Science Enterprise, Earth Science Enterprise, and OLMSA will receive at least seven formal letters of advice from their FACA-chartered advisory committees.	0GK1
	• Plan and set priorities	• The Space Science Enterprise will (1) complete a review of its in-place theme-based science and technology roadmaps, (2) conduct a programmatic integration meeting, and (3) prepare a revised draft Enterprise Strategic Plan for outside review.	0GK2
		• The Earth Science Enterprise conducts regular external assessments of the Earth Science program content through the Biennial Review process with the next one scheduled for 1999. In 2000, the Enterprise will review its technology, education, and commercial strategies and refine the performance metrics for these areas.	0GK9
		• OLMSA/HEDS will release a new Enterprise Strategic Plan in FY99; it will be used in FY00 to guide the implementation of programs and to develop future budgets.	0GK10
	• Select and fund/conduct research and analysis programs	• For selecting and funding/conducting R&A and core technology projects, the Space Science Enterprise, OLMSA, and the Earth Science Enterprise will use broad Agency announcements (AO, NRA, and CAN solicitations) to competitively award 80% or more of resources in these programs based on peer review.	0GK3
	• Select and implement flight missions	• To select flight missions, the Space Science Enterprise will release one Explorer and one Discovery AO and make selections in response to at least one AO.	0GK4
		• To select flight missions, the Earth Science Enterprise will release one Earth System Science Pathfinder AO.	0GK11
		• To implement flight missions, the Space Science Enterprise will successfully launch and initiate operations for five Enterprise flight missions, within 10% of budget on average.	0GL12
		• To implement flight missions, the Earth Science Enterprise will successfully launch one spacecraft and deliver two instruments for international launches, within 10% of budget on average.	0GK13
		• OLMSA will complete preparations for a Space Shuttle research mission that will fly in early FY01.	0GK14
	• Analyze data (initial)	• For the initial analysis of data, the Earth Science and Space Science Enterprises will satisfy 80% of their FY00 Enterprise performance targets in the “Operations” areas.	0GK5
	• Publish and disseminate results	• For disseminating research results, the Space Science Enterprise will account for 4% of the 150 “most important science stories” in the annual review by *Science News*; for education and outreach, the Enterprise will meet seven of the eight of its FY00 Enterprise Performance Plan education performance targets.	0GK6
		• For disseminating research results, the Earth Science Enterprise will meet all of its FY00 Enterprise Performance Plan “disseminate information” performance targets; for education and outreach, the Enterprise will meet all of its FY00 Enterprise Performance Plan education and outreach targets.	0GK15
		• For disseminating research results, OLMSA will publish 100% of its science research progress in the annual OLMSA Life Sciences and Microgravity Research Program Task Bibliographies and make the information available on the Internet.	0GL16
	• Create archives	• For archiving mission data, the Space Science Enterprise will include in all AO’s specific directions to investigators for archiving mission data and ensure that Enterprise flight mission data are transmitted to appropriate discipline data archives no more than 1 year after acquisition.	0GK7
		• For archiving mission data, the Earth Science Enterprise will make available data on prediction, land surface, and climate to users within 5 days; the Enterprise will double the volume of data archived compared to FY97.	0GK17
		• OLMSA will ensure that flight mission data are transmitted to appropriate discipline data archives no more than 1 year after acquisition.	0GK18
	• Conduct further research	• The Space Science Enterprise will average “fully effective” across all Enterprise data analysis programs in a yearly independent retrospective productivity assessment.	0GK8
		• The Earth Science Enterprise will contribute in four of the six theme areas of the U.S. Global Change Research Program.	0GK19

Generate Knowledge FY 2000 Budget—Chart 7a

Strategic Objective	Budget Category	HEDS	Space Science	Earth Science	R&PM	Safety & Mission Assurance	COF	Environmental	Education & Minority	Performance Target Item # (Chart 7)	Other Objectives Addressed by Target (List)
Acquire advice		X	X	X	X					0GK1	
Plan and set priorities			X		X					0GK2	
				X	X					0GK9	
		X			X					0GK10	
Select and fund/conduct R&A programs		X	X	X	X					0GK3	
Select and implement flight missions			X		X					0GK4	
				X	X					0GK11	
			X		X					0GK12	
				X	X					0GK13	
		X								0GK14	
Analyze data (initial)		X	X	X	X					0GK5	
Publish and disseminate results			X		X					0GK6	
				X	X					0GK15	
		X			X					0GK16	
Create archives			X		X					0GK7	
				X	X					0GK17	
		X			X					0GK18	
Conduct further research			X		X					0GK8	
				X	X					0GK19	

Note: X=primary contribution; Y=secondary contribution.

Goal

The Communicate Knowledge Process facilitates the distribution of information on NASA's missions and discoveries. It ensures increased public understanding of science and technology, promotes the application of NASA-generated information, and inspires achievement and innovation. The process ensures that knowledge derived from NASA research programs is available to meet the specific needs and interests of constituent groups. It begins at the inception of a research project and increases in intensity as the effort reaches maturity to ensure the appropriate delivery, archiving, and future convenient access of all research results. The goal of the Communicate Knowledge Process is to ensure that information derived from NASA's research efforts is distributed in a useful, timely, and reliable manner.

Performance Measures

In the year 2000, NASA will produce communication metrics collected by five functional offices for the four NASA Enterprises as the new Communicate Knowledge Process is being initiated. The collection of metrics from these five offices will provide a baseline for future performance measurement and will be representative of the types of Communicate Knowledge activities being undertaken NASA-wide. The collection will include the communication activities performed by organizations responsible for: (1) scientific and technical information, (2) public affairs, (3) education, (4) history, and (5) technology transfer to the private sector. To meet the near-term goals in Figure 2, goals for two objectives will be measured:

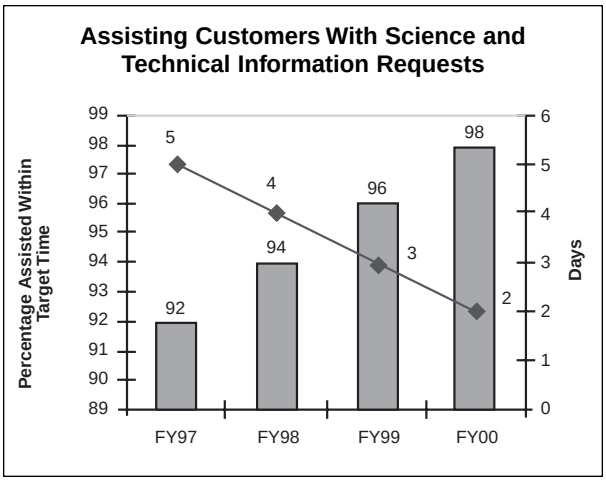


Figure 20

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

In assisting customers to locate and use NASA's scientific and technical information, NASA's performance target will be to:

- Assist customers who use the Science and Technical Information (STI) Help Desk and the NASA Image eXchange (NIX) digital image data base within a specific turnaround period (Figure 20).

Measurement tools used to gauge the success of this activity include system-generated records based on formal metrics, web usage statistics, and monthly operational reports that are all keyed to the quantitative and qualitative metrics of the program's strategic goals.

In public affairs, NASA uses an extensive exhibit program to convey knowledge to the public about NASA programs. The performance target will be to:

- Support no less than 800 portable exhibit loans, and send portable exhibits to a minimum of 175 targeted events per year. In 1999 and 2000, with reduced budgets, NASA will maintain NASA representation at this minimum number of targeted events.

In the educational community, NASA's performance target will be to:

- Maintain a level of participation involvement of approximately 3 million with teachers, faculty, and students in the education community.

The Education Data Collection and Evaluation System for metric validation of data in reaching these goals was first fully activated for 1998 data collection, which is as follows:

The total involvement in NASA education activities was 21,843,242 participants (151 education programs reporting). The education program audiences reached include: 3,108,258 in person; 6,431,900 electronically; and 13,393,084 in the general public.

In transferring NASA's technology to private industry, the NASA performance target will be to:

- Increase new opportunities to transfer technology developed at NASA to private industry from 19,600 in 1999 to 19,800. Opportunities will be made available to the public through the TechTracs data base and will be measured by monitoring a controlled data field that indicates the number of new technologies communicated to the public (Figure 21).

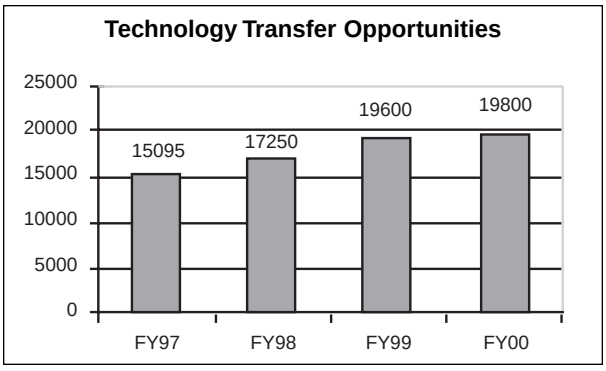


Figure 21

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

Generally, in the year 2000, all five functional offices will expand communication of NASA's knowledge to new audiences relative to the baseline established in previous years. In 2000, four of the five groups reporting metrics will target NASA information to specific new audiences. The performance targets will be as follows:

- STI plans to improve the NIX metasearch engine accessing all NASA digital image data bases. It will add QuickTime, video, animation, and browse categories on NASA's key topics of interest to customers.
- The Office of Public Affairs is acquiring the capability to provide the media with digital, high-definition video when the broadcasting industry converts to digital broadcasting in the next decade. It will also add a searchable online digital version of the NASA Headquarters photo archive to the NASA Home Page.
- A number of innovations will open NASA Public Affairs exhibits to new audiences. A series of new exhibits with updated information on the Agency's four Enterprises will begin circulation. New Internet sites to inform the public of exhibits

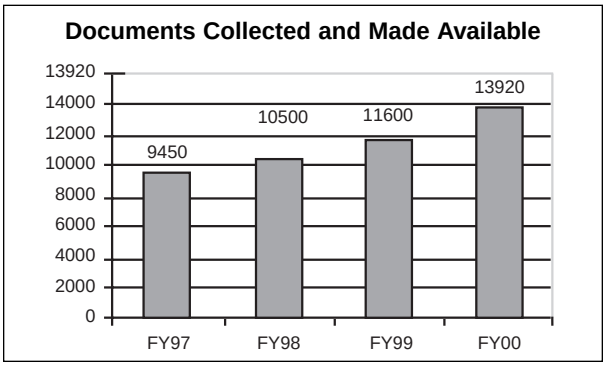


Figure 22

available for loan will expedite the loan process and attract new audiences. Two NASA Centers will create new exhibits and renovate visitor facilities to attract and accommodate additional visitors.

- The History Office will target high school students through the use of a History Day competition on "Science, Technology, and Invention." The contest is being conducted in concert with the History Day Organization, with cosponsored teacher workshops at every NASA Center.
- In terms of technology transfer, the Office of Aero-Space Technology's *Aerospace Technology Innovation* publication will be targeting medical facilities for new readership, as well as the automotive industry for new transfer opportunities, attending the Society for Automotive Engineers annual trade show in Detroit, Michigan.

As the new Communicate Knowledge Process becomes established across NASA in 2000, the Centers and Headquarters will submit entries to a new online data base. The performance target will be to:

- Provide the public with internal access to listings of (1) existing and upcoming communications events, activities, and products and (2) best communication practices within NASA.

In communicating NASA's scientific and technical information to the public, the performance targets will be to:

- Increase the NASA-sponsored, -funded, and/or -generated report documents for the scientific community and public from 11,600 to 13,920 documents (Figure 22).
- Increase the amount of nontraditional NASA-sponsored scientific and technical information available through the NIX digital image data base from 300,000 in FY 1998 to more than 470,000 in FY 2000.

NASA Public Affairs plans to use three media to improve the external constituent community's knowledge of NASA's programs, projects, and discoveries to the public during 2000.

On the Internet, the Public Affairs performance targets will be to:

- Continue to make the NASA web pages as accessible to the public as possible. In 1998, Public Affairs added the first powerful search engine to the NASA Home Page to enable the public to find information on topics of interest. The search engine currently provides comprehensive text search capability for more than 300,000 pages in NASA web space. The Public Affairs goal is to increase the number of searched pages by 5 percent per year using 1999 figures as a baseline.
- Continue to increase the capacity of the NASA Home Page to meet public demand. Figures for weekly web page downloads from the NASA Home Page were first reliably tabulated in June 1998. The resulting "baseline" is 540,000 web page downloads per week. Our goal is to provide for a 5-percent-per-year increase in download capacity using 1999 figures as a baseline.

Regarding live satellite interviews for television, the Public Affairs performance target will be to:

- Maintain a baseline for its live satellite interview program of no less than 10 live shots per month. Public Affairs periodically makes NASA astronauts, program managers, and other Agency officials available for live satellite interviews via NASA Television.

In the provision of satellite video files for television, the Public Affairs performance target will be to:

- Maintain a baseline of five video file elements per week. Public Affairs issues raw video and animation—"b-roll"—daily on NASA Television to accompany news releases on NASA programs, developments, and findings.

In communicating the historical significance of NASA activities and accomplishments, the performance target will be to:

- Produce 12 new historical publications chronicling and placing NASA's activities and achievements in perspective for the American public.

In facilitating the transfer of NASA's technology to private industry, the performance targets for 2000 will be to:

- Provide publications that will communicate its technologies available for commercial use and technologies that have been commercialized by industry. Each publication is available to the public via print and electronic media. The three principal publications with their print subscriber/distribution data are *Innovation* (12,000), *Spinoff* (50,000), and *Tech Briefs* (205,000). The effectiveness of these media will be measured by monitoring the readership and frequency of use as a source of reference.
- Publish at least one industry-specific *Aerospace Technology Innovation* issue per year.

All publications are supplemented by availability through the electronic media, which, because of budgetary constraints, will be the means for increasing circulation in the future.

Advisory Bodies

During the year 2000, NASA will be instituting a formal process for communicating NASA's knowledge to the public. Within NASA, numerous offices originate communication conveying NASA's knowledge to various publics. These include the science project offices, the technology project offices, the public affairs office, the education office, the history office, and the STI office. A full-time communication coordinator, reporting to the Center Director of each of NASA's 10 Centers across the country, will produce a communication plan for each of NASA's scientific program projects, drawing on the expertise of professionals from each of these offices as well as the libraries and records officers. A Headquarters Working Group, with representatives from each of these offices at Headquarters as well as the Enterprise offices, will integrate the Center plans with Headquarters plans into a master communication plan, thus centralizing metrics, implementing standards policy, and monitoring the progress of each NASA Enterprise. A Communicate Knowledge Headquarters Board of Directors, consisting of Associate Administrators or their deputies from each Headquarters office having communication responsibilities, will meet twice a year. They will report NASA-wide progress to NASA's Capital Investment Council.

Plans and performance will be updated at each Center and reviewed internally as the programs and projects develop. The plans and performance targets will also undergo formal bi-annual review at Headquarters by the Headquarters Working Group and the Board of Directors. Each office responsible for communicating knowledge is responsible for selecting evaluation criteria and auditable validation techniques.

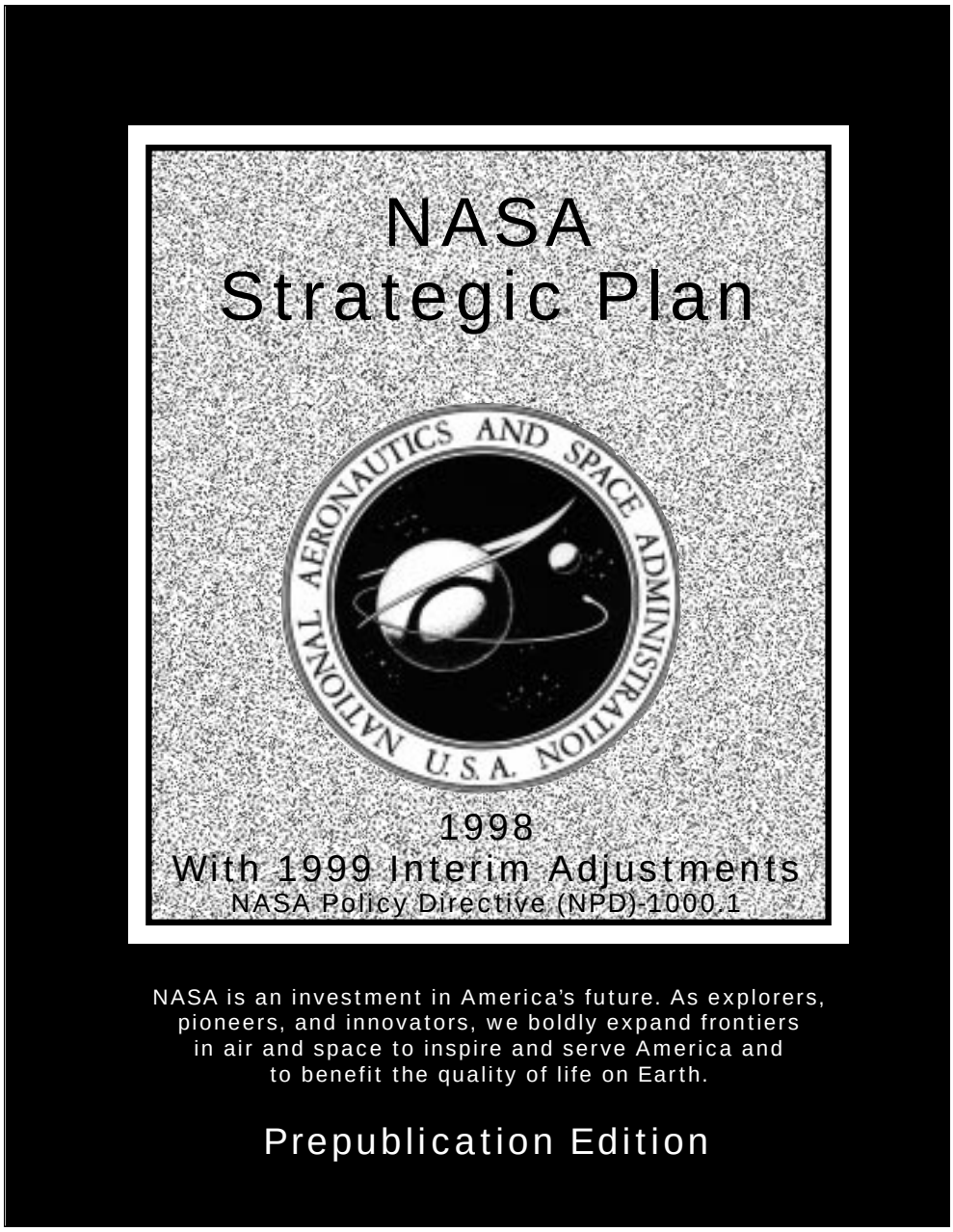
Communicate Knowledge FY 2000 Budget—Chart 8

Communicate Knowledge Goal	Objectives	Process FY 2000 Performance Targets	00#
Ensure that NASA's customers receive the information derived from NASA's research efforts that they want, in the format they want, for as long as they want it	• 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	• Assist customers who use the STI Help Desk and the NASA Image eXchange (NIX) digital image data base within a specific turnaround period.	0C10
		• Support no less than 800 portable exhibit loans and send portable exhibits to a minimum of 175 targeted events per year.	0C11
		• Seek to maintain a level of participation involvement of approximately 3 million with the education community, including teachers, faculty, and students.	0C1
		• Increase new opportunities to transfer technology to private industry from 19,600 to 19,800. These opportunities will be made available to the public through the TechTracs data base and will be measured by monitoring a controlled data field that indicates the number of new technologies communicated to the public.	0C9
	• Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs	• The Office of Scientific and Technical Information plans to improve the NIX metasearch engine accessing all NASA digital image data bases, adding QuickTime, video, animation, and browse categories on NASA's key topics of interest to customers.	0C6
		• The Office of Public Affairs is acquiring the capability to provide the media with digital, high-definition video when broadcasting industry converts to digital broadcasting in the next decade. It will also add a searchable online digital version of the NASA Headquarters photo archive to the NASA Home Page.	0C12
		• The Office of Public Affairs will open exhibits to new audiences. A series of new exhibits with updated information on the Agency's four Enterprises will begin circulation. New Internet sites to inform the public of exhibits available for loan will expedite the loan process and attract new audiences. Two NASA Centers will create new exhibits and renovate visitor facilities to attract and accommodate additional visitors.	0C13
		• The History Office will target high school students through the use of a History Day competition on "Science, Technology, and Invention." The contest is being conducted in concert with the History Day Organization, with cosponsored teacher workshops at every NASA Center.	0C14
		• The Office of Aero-Space Technology's *Aerospace Technology Innovation* publication will be targeting medical facilities for new readership, as well as the automotive industry for new technology transfer opportunities. The organization will attend the Society for Automotive Engineers annual tradeshow in Detroit, Michigan.	0C15
		• Provide the public with internal access to listings of (1) existing and upcoming communications events, activities, and products and (2) best communications practices within NASA.	0C7
		• Increase the NASA-sponsored, -funded, or -generated report documents for the scientific community and public from 11,600 to 13,920.	0C4
		• Increase the nontraditional NASA-sponsored scientific and technical information through the NIX digital image data base from 300,000 in FY98 to more than 470,000 in FY00.	0C16
		• Increase the number of searched pages in NASA web space by 5% per year, relative to the FY99 baseline.	0C17
		• Increase the capacity of the NASA Home Page to meet public demand by providing for a 5% per year increase in download capacity, using FY99 figures as a baseline.	0C18
		• Maintain a baseline for live satellite interview programs of no less than 10 live shots per month.	0C19
		• Maintain a baseline of five video file elements per week, issuing raw video and animation daily on NASA Television.	0C20
		• Produce 12 new historical publications chronicling and placing NASA's activities and achievements in perspective for the American public.	0C3
		• Provide publications that will communicate technologies available for commercial use and technologies that have been commercialized by industry to facilitate technology transfer. The three principal publications are *Innovation, Spinoff,* and *Tech Briefs,* whose effectiveness will be measured by monitoring readership and frequency of use as sources of reference.	0C21
		• Publish at least one industry-specific *Aerospace Technology Innovation* issue per year.	0C22

Communicate Knowledge FY 2000 Budget—Chart 8a

Strategic Objective	Budget Category	HEDS	Aero-Space Technology	Space Science	Earth Science	R&PM	Safety & Mission Assurance	COF	Environmental	Education & Minority	Performance Target Item # (Chart 8)	Other Objectives Addressed by Target (List)
Improve the external constituent communities' knowledge, understanding, and use of results and opportunities associated with NASA's programs		Y	Y	Y	Y	X					0C3, 0C7, 0C17, 0C18, 0C19, 0C20	
			X			X					0C4, 0C16, 0C21, 0C22	
Highlight existing and identify new opportunities for NASA's customers (the public, the academic community, and the Nation's students) to participate directly in the space and research discovery process						X				X	0C1, 0C11, 0C12 0C13, 0C14, 0C15	
			X			X					0C10, 0C9, 0C6	

Note: X=primary contribution; Y=secondary contribution.


NASA
Strategic Plan
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION U.S.A.
1998
With 1999 Interim Adjustments
NASA Policy Directive (NPD)-1000.1
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.
Prepublication Edition

Administrator's Strategic Outlook

All members of the NASA Team—our employees, contractors, academic researchers, industry, Government, and international partners—should feel a tremendous sense of pride in our many accomplishments over the past 5 years. We have looked back to the beginning of time and discovered new galaxies and planets in other solar systems. We captured the world's imagination with the remarkable achievements of the Mars Pathfinder and Hubble Space Telescope missions. We have increased our understanding of the effect of natural and human-induced activities on our home planet. Investments initiated in the past have increased the competitive posture of the aviation, space launch, and communications industries of the present. On Space Shuttle missions, we have performed experiments and technological feats that are paving the way to an era of permanent human presence in space. These achievements, and many more, are responsible for the resurgence and solidification of interest and support for NASA's activities among the Administration, Congress, and the public.

We intend to build on these accomplishments with a renewed focus on scientific research and the development and application of new cutting-edge technologies. Our unique capabilities will enable us to answer fundamental questions that have challenged humankind for centuries. Our exploration of the unknown will lead to discoveries of new worlds and generate new knowledge that stirs the soul, nourishes the mind, and enriches our lives. We will develop the tools and knowledge to help preserve our freedoms and provide hope and opportunity for future generations.

Mission success starts with safety. We will conduct our business with an enhanced fervor for safety, establishing NASA as the Nation's leader in preventing mishaps that impact the safety or health of the public, our astronauts and pilots, the NASA and contractor workforce, and the national resources under our charge. We will ensure that safety permeates everything we do at NASA. Our management team is fostering an environment that will not tolerate the occurrence of mishaps. We believe that by focusing on the safety of our missions, we will also improve quality and decrease schedule and cost. 1

In the coming years, NASA will implement programs to achieve a three-part mission encompassing Scientific Research, Space Exploration, and Technology Development and Transfer. This mission describes what we are required to do in response to policy and legislative mandates. In implementing our mission, we will pursue answers to fundamental questions of science and research

ADMINISTRATOR'S STRATEGIC OUTLOOK

1. Changes to better reflect the importance of safety

It has been recognized that technology development is not an independent business unit, but is fundamental to the successful performance of each Strategic Enterprise. Therefore, the Space Technology Enterprise has been eliminated, and technology development becomes the responsibility of the remaining four Enterprises. A new position of Chief Technologist was created to provide oversight and guidance for our technology investments. With this new structure, each Enterprise will use technology development as a means to accomplish current programs more efficiently and stimulate new programs necessary to meet our long-term goals. The goal to reduce the cost of access to space that had been associated with the Space Technology Enterprise has been added to the Aeronautics Enterprise. This expanded Enterprise was renamed Aero-Space Technology.

We have improved the level of alignment of the goals of the Agency and our Enterprise goals with the directives prescribed in two Administration policy documents. These are the National Space Policy and the Goals for a National Partnership in Aeronautics Research and Technology. We have also increased our emphasis on the need for synergy between the programs of the Enterprises and the capabilities of our partners in Government, industry, academia, and other nations. Further, we have defined the scope, goals, and objectives for four Crosscutting Processes that are critical to the success of Agency programs and activities. Finally, we have added a core value that demands safety in everything we do. 1

With the successful development of this Strategic Plan, the NASA Team must now focus on implementation. We have reached a consensus with our stakeholders, customers, and partners on our vision, mission, and roadmap to the future. We intend to implement our programs, projects, and Crosscutting Processes in a manner that enables us to deliver valuable and relevant results more effectively and efficiently. We will be relentless in our pursuit of safety and zero mishaps in all aspects of our work. 1

Each one of us—individuals who work directly on programs, as well as those who provide critical support capabilities—have an opportunity and responsibility to contribute to the development of a new NASA, the achievement of our plans, and the satisfaction of our customers. I urge all NASA employees, our stakeholders, and our customers to read this Plan and look for ways to support the accomplishment of our ambitious goals for the future.

The NASA Strategic Plan is the backbone of our new Strategic Management System. We welcome comments on the Plan and suggestions for improvement. Let me hear from you with your ideas on ways in which we can improve our ability to meet the needs of the Nation through our aeronautics and space programs.

Daniel S. Goldin
Administrator

ADMINISTRATOR'S STRATEGIC OUTLOOK

1. Changes to better reflect the importance of safety

15

The NASA Team

The goals stated in this Plan will be accomplished by a diverse group of men and women at our Headquarters, nine Centers throughout the country, and the Jet Propulsion Laboratory. We will also rely on partnerships with both large and small contractors, members of the academic community, other Federal, State, and local agencies, and other space agencies from nations around the globe.

This highly skilled team of scientists, engineers, technicians, and administrative and support professionals is dedicated to providing high-quality, technologically superior products and services in aeronautics and space. Through our dedication and professionalism, we will carry out our mission, achieve our goals and objectives, and ultimately find answers to the fundamental questions of science and research.

NASA Values

To implement this Plan, the NASA Team will strive to uphold core values related to people, excellence, and integrity.

Safety

Safety permeates everything we do at NASA, and the entire NASA workforce is committed to safety as a priority. The NASA management team is held accountable for safety. We foster an environment with zero tolerance for mishaps. We must protect the safety and health of the general public and the NASA workforce on and off the ground. By focusing on the safety of our missions, we also focus on improving quality and decreasing schedule and cost.

People

Our greatest strength is our workforce. We aggressively build a team of highly qualified individuals that is representative, at all levels, of America's diversity. We foster a culture that is built on trust, respect, teamwork, communication, creativity, and empowerment in an environment that is free of unlawful discrimination and ensures equal opportunity for all.

Excellence

We are committed to demonstrating and promoting excellence and continually improving processes, products, and services to better satisfy our customers' needs and requirements. We utilize quality-focused leadership and management, as well as scientific, engineering, and technical excellence to provide our customers with highly valued products and services in the most cost-effective, timely, and safe manner.

Integrity

We preserve America's confidence and trust by ensuring that our missions are consistent with national goals, carefully conceived, and well executed. We deliver on our promises and are accountable for our performance. We are open and honest with one another and with our customers, and we cooperate within and across organizations to deliver the highest quality results. We are bold but prudent in confronting challenges and accepting risks. We work with integrity and are dedicated to fulfilling our vision in an environment in which adherence to fundamental ethical principles and compliance with related laws and regulations flourish.

THE NASA TEAM AND VALUES

1

1. Changes to better reflect the importance of safety

Strategies and Outcomes

The Space Science Enterprise pursues the study of origins, as well as studies of the evolution and destiny of the cosmos, by establishing a continuum of exploration and science. It creates a virtual presence in the solar system, exploring new territories and investigating the solar system in all its complexity. It simultaneously probes the universe to the beginning of time, looking ever deeper with increasingly capable telescopes, scanning the entire electromagnetic spectrum from gamma rays to radio wavelengths. It also sends probes into interstellar space, beginning a virtual presence even beyond the solar system.

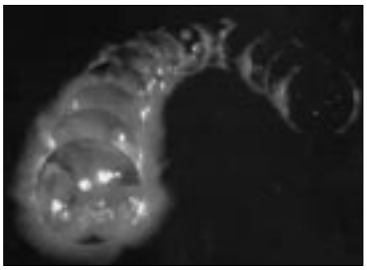
The strategy of the Enterprise is to conduct world-class research, to maximize the scientific yield from our current missions, and to develop and deploy new missions within the "faster, better, cheaper" framework of a revolutionized NASA.

Fulfilling one major commitment of previous strategic planning, the Enterprise will complete the deployment of the four "Great Observatories" with the launch of the Chandra X-ray Observatory (formerly AXAF) in 1999 and the Space Infrared Telescope Facility (SIRTF) in 2001. Complementing the discoveries of the Hubble Space Telescope and the Compton Gamma Ray Observatory launched earlier in this decade, Chandra and SIRTF are certain to add to this bounty and help unravel the mysteries of the universe.

1

Key elements of the Enterprise program will include a sustained program of robotic research, exploration, and technology development on the surface of Mars, a long-term program to obtain in situ measurements and to return samples from solar system bodies, and a progressive initiative to identify and characterize planets around other stars.

2



Changes in solar activity affect Earth in many ways. These 12 x-ray images between 1991 and 1995 demonstrate the Sun's variability.

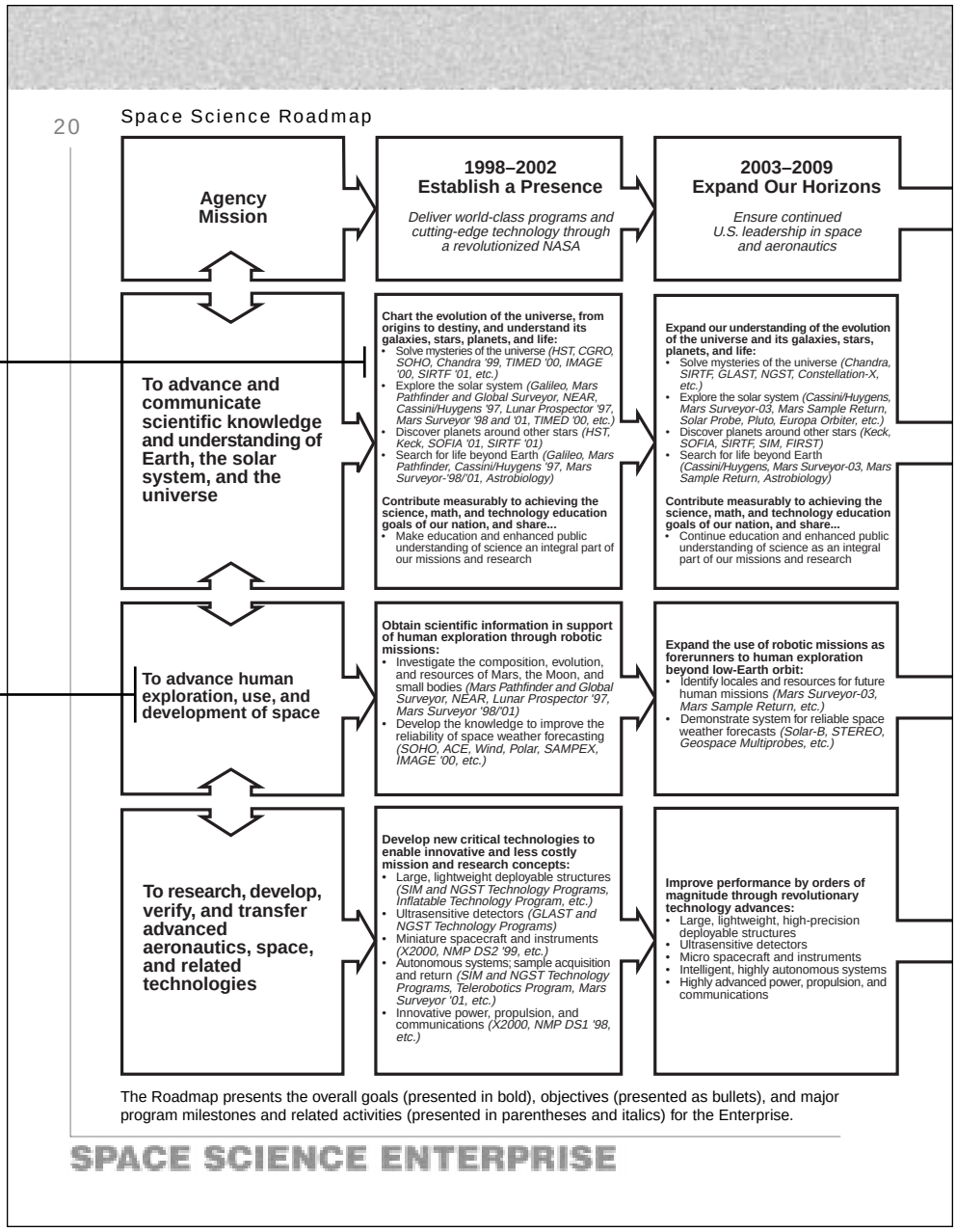
With the brilliant successes of the Mars Pathfinder, Lunar Prospector, and Transition Region and Coronal Explorer (TRACE), these Discovery and Explorer missions have visibly demonstrated that the Enterprise's "faster, better, cheaper" programs can achieve exciting results and yield superb science. The Enterprise will develop and use innovative technologies and more capable spacecraft to improve performance and lower costs of future science missions. Through programs such as Discovery and Explorer, the Enterprise will accept prudent risk, shorten development time, explore new conceptual approaches, streamline management, and make other changes to enhance efficiency and effectiveness.

3

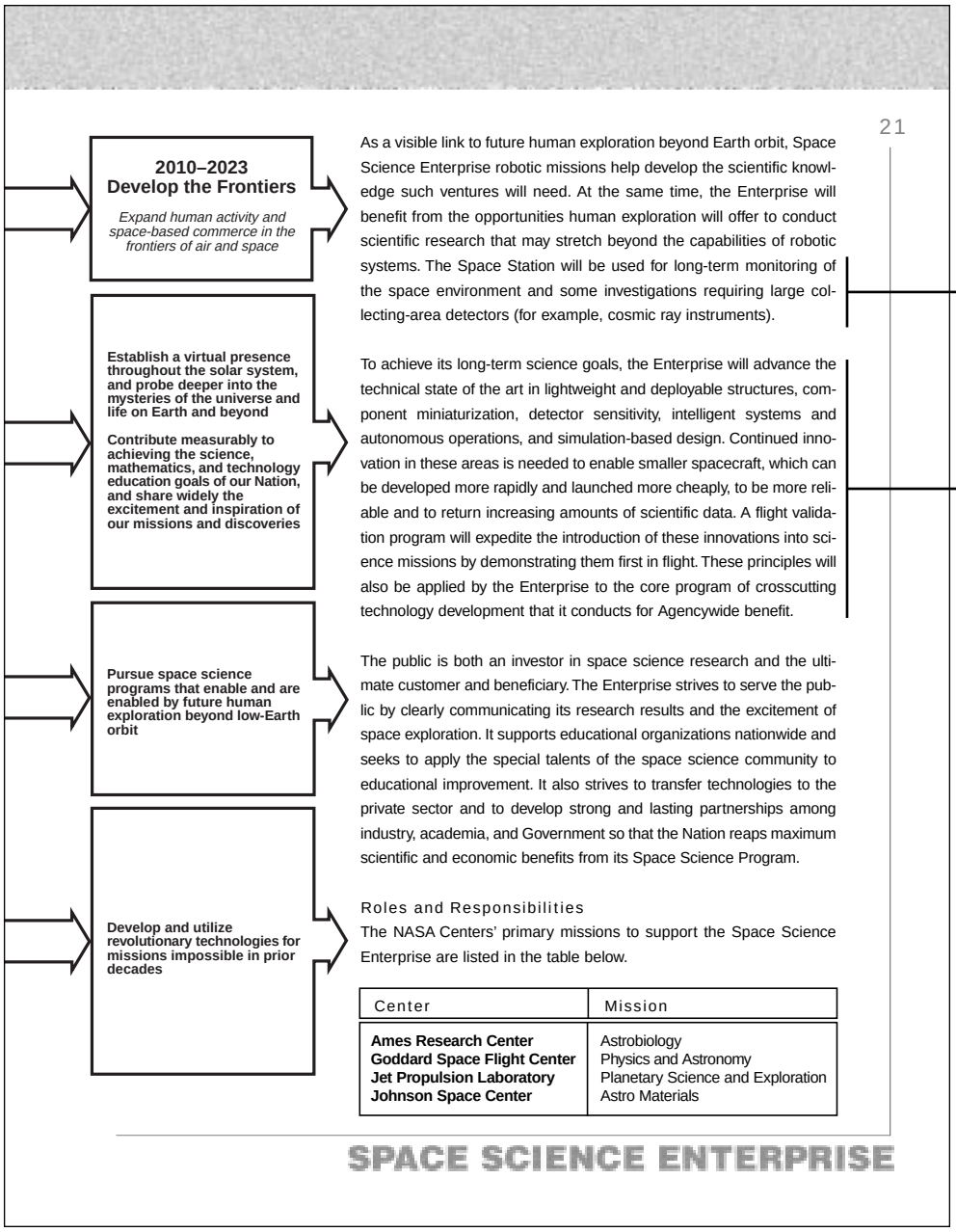
A key aspect of our strategic planning is to ensure the Enterprise acquires the advice of the external science community, and in particular the National Academy of Sciences. In addition, there is extensive collaboration with this community, international partners, and other Federal agencies, such as the National Science Foundation, Department of Defense, and Department of Energy, in the conduct of our missions and research. This collaboration is discussed more fully on page 35 of this Plan.

SPACE SCIENCE ENTERPRISE

1. Name change
2. Adds explicit reference to the National Space Policy
3. Adds discussion of technology development



1. Name change (Chandra)
2. Improved wording



21

2010–2023
Develop the Frontiers

Expand human activity and space-based commerce in the frontiers of air and space

Establish a virtual presence throughout the solar system, and probe deeper into the mysteries of the universe and life on Earth and beyond

Contribute measurably to achieving the science, mathematics, and technology education goals of our Nation, and share widely the excitement and inspiration of our missions and discoveries

Pursue space science programs that enable and are enabled by future human exploration beyond low-Earth orbit

Develop and utilize revolutionary technologies for missions impossible in prior decades

As a visible link to future human exploration beyond Earth orbit, Space Science Enterprise robotic missions help develop the scientific knowledge such ventures will need. At the same time, the Enterprise will benefit from the opportunities human exploration will offer to conduct scientific research that may stretch beyond the capabilities of robotic systems. The Space Station will be used for long-term monitoring of the space environment and some investigations requiring large collecting-area detectors (for example, cosmic ray instruments). 1

To achieve its long-term science goals, the Enterprise will advance the technical state of the art in lightweight and deployable structures, component miniaturization, detector sensitivity, intelligent systems and autonomous operations, and simulation-based design. Continued innovation in these areas is needed to enable smaller spacecraft, which can be developed more rapidly and launched more cheaply, to be more reliable and to return increasing amounts of scientific data. A flight validation program will expedite the introduction of these innovations into science missions by demonstrating them first in flight. These principles will also be applied by the Enterprise to the core program of crosscutting technology development that it conducts for Agencywide benefit. 2

The public is both an investor in space science research and the ultimate customer and beneficiary. The Enterprise strives to serve the public by clearly communicating its research results and the excitement of space exploration. It supports educational organizations nationwide and seeks to apply the special talents of the space science community to educational improvement. It also strives to transfer technologies to the private sector and to develop strong and lasting partnerships among industry, academia, and Government so that the Nation reaps maximum scientific and economic benefits from its Space Science Program.

Roles and Responsibilities

The NASA Centers' primary missions to support the Space Science Enterprise are listed in the table below.

Center	Mission
Ames Research Center	Astrobiology
Goddard Space Flight Center	Physics and Astronomy
Jet Propulsion Laboratory	Planetary Science and Exploration
Johnson Space Center	Astro Materials

SPACE SCIENCE ENTERPRISE

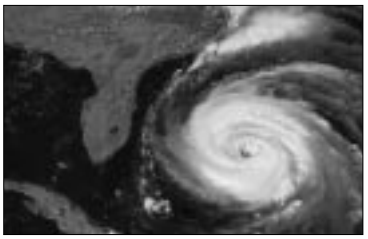
1. Adds Space Station reference
2. Adds discussion of technology development

assessments of the environment; fosters commercial use of remote-sensing data and leverages the resources of the commercial remote-sensing industry to lower the cost of acquiring data; and strengthens Earth science education and public awareness.

These goals, and the strategies that follow, implement the President's National Space Policy of September 1996. This Policy requires NASA to undertake "a program of long-term observation, research, and analysis of the Earth's land, oceans, atmosphere and their interactions, including continual measurements from the Earth Observing System. . . . In carrying out these activities, NASA will develop new and innovative space technologies and smaller more capable spacecraft to improve the performance and lower the cost of future space missions."

Through 2002, the Enterprise will deploy the first series of Earth Observing System (EOS) missions, including Landsat 7. These will join our currently operating spacecraft, such as the Tropical Rainfall Measuring Mission (TRMM). This period will also see the first launches of Earth System Science Pathfinder small satellite missions for new scientific investigations. In tandem, a strong program of aircraft and other field campaigns will validate and supplement spacecraft measurements. Modeling and assessment activities will turn the data collected into widely useful information products for research and applications. These programs are detailed in the Earth Science Strategic Enterprise Plan and supporting strategy documents.

The Enterprise is responsible for technology development needed for the next generation of Earth remote-sensing systems and is defining a science-driven strategy to guide technology investment choices. Participation in the New Millennium program is one example of the Enterprise's technology



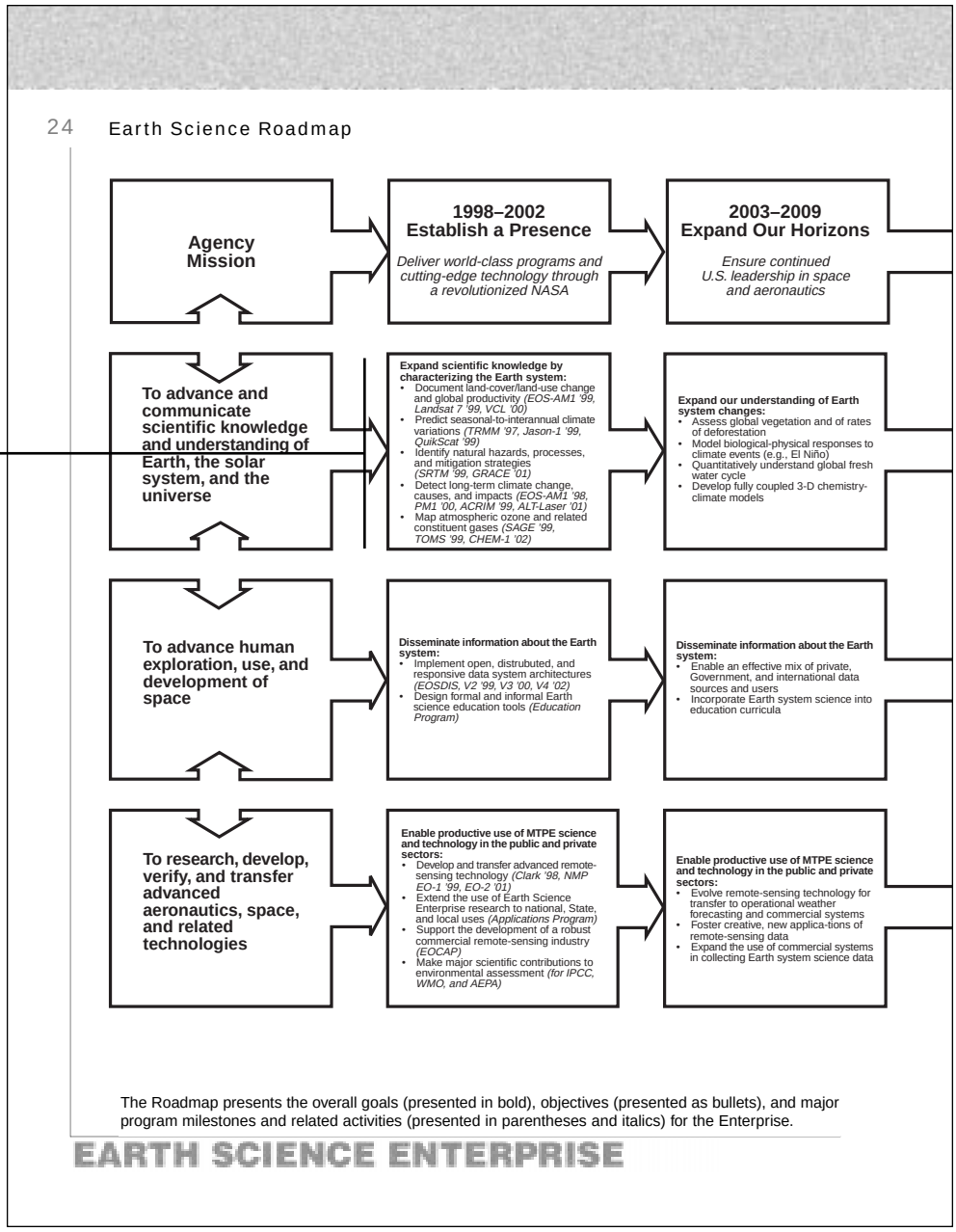
This image of Hurricane Fran was taken from the NOAA/National Weather Service's GOES-8 (Geostationary Operational Environmental Satellite) on September 4, 1996, at 1:15 p.m. EDT, less than 7 hours before the eye went ashore at Cape Fear, North Carolina. The image was enhanced and rendered at NASA's Goddard Space Flight Center, Laboratory for Atmosphere, Greenbelt, Maryland.

investment approach. In the near term, technology investments will be driven by the need for smaller, less expensive instruments to continue the EOS first series measurements and to enable key new measurement capabilities such as Light Intersection Direction and Ranging (LIDAR) for atmospheric winds. Highly distributed, advanced Internet capabilities must be developed to enable the widespread application of environmental data. In the midterm, new measurement and modeling capabilities will be pursued to enable the three-dimensional characterization of Earth's atmosphere

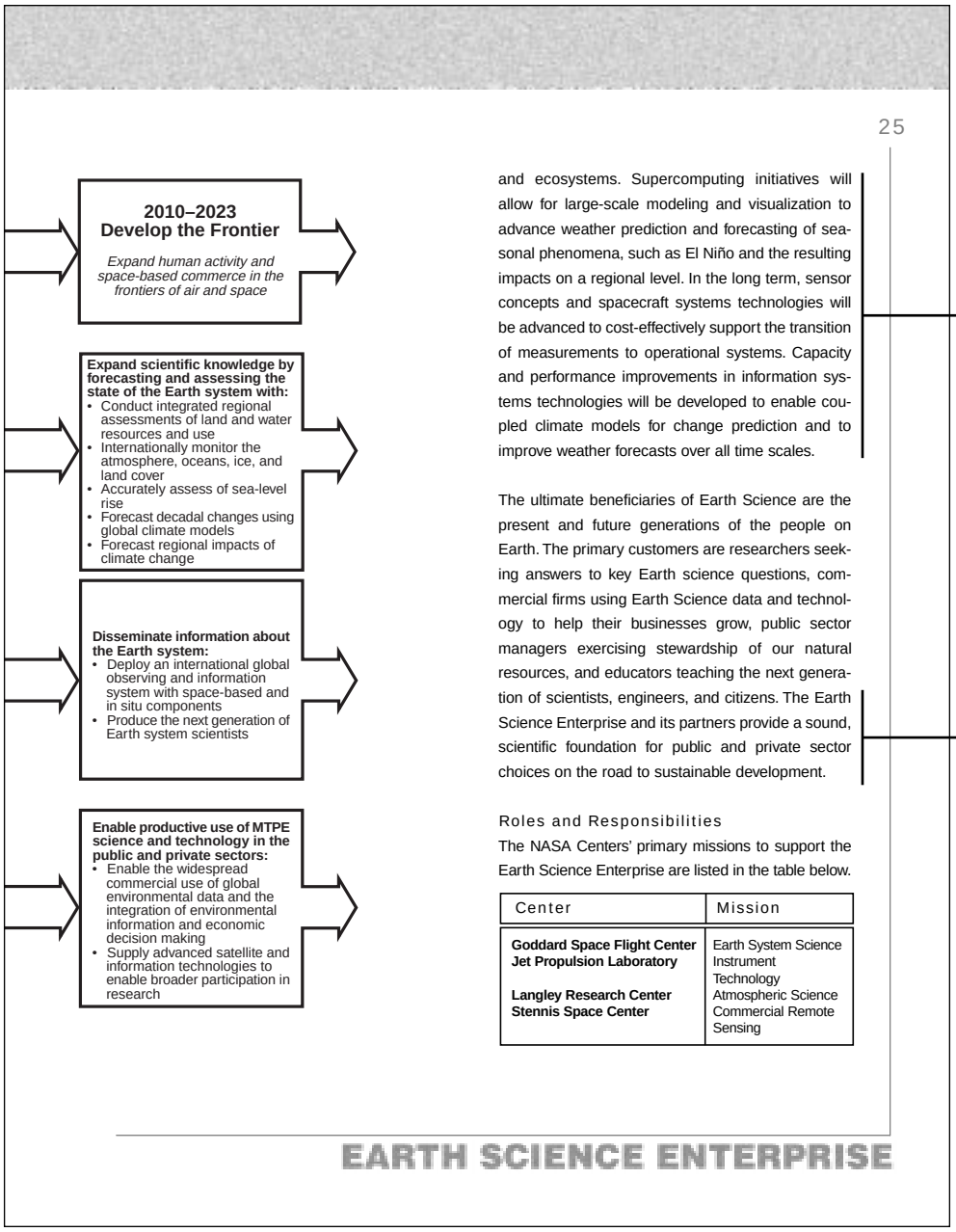
NASA's ER-2 is the country's premier high-altitude civilian research aircraft. Flying in the lower stratosphere, it allows scientists to make in situ measurements for the study of atmospheric chemistry, such as ozone breakdown. It also serves as a testbed for instruments planned for future Earth-orbiting spacecraft.

EARTH SCIENCE ENTERPRISE

1. Adds explicit reference to the National Space Policy
2. Adds discussion of technology development
3. Name change



1. Name and schedule changes



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2010–2023
Develop the Frontier

Expand human activity and space-based commerce in the frontiers of air and space

Expand scientific knowledge by forecasting and assessing the state of the Earth system with:
- Conduct integrated regional assessments of land and water resources and use
- Internationally monitor the atmosphere, oceans, ice, and land cover
- Accurately assess of sea-level rise
- Forecast decadal changes using global climate models
- Forecast regional impacts of climate change

Disseminate information about the Earth system:
- Deploy an international global observing and information system with space-based and in situ components
- Produce the next generation of Earth system scientists

Enable productive use of MTPE science and technology in the public and private sectors:
- Enable the widespread commercial use of global environmental data and the integration of environmental information and economic decision making
- Supply advanced satellite and information technologies to enable broader participation in research

and ecosystems. Supercomputing initiatives will allow for large-scale modeling and visualization to advance weather prediction and forecasting of seasonal phenomena, such as El Niño and the resulting impacts on a regional level. In the long term, sensor concepts and spacecraft systems technologies will be advanced to cost-effectively support the transition of measurements to operational systems. Capacity and performance improvements in information systems technologies will be developed to enable coupled climate models for change prediction and to improve weather forecasts over all time scales. 1

The ultimate beneficiaries of Earth Science are the present and future generations of the people on Earth. The primary customers are researchers seeking answers to key Earth science questions, commercial firms using Earth Science data and technology to help their businesses grow, public sector managers exercising stewardship of our natural resources, and educators teaching the next generation of scientists, engineers, and citizens. The Earth Science Enterprise and its partners provide a sound, scientific foundation for public and private sector choices on the road to sustainable development. 2

Roles and Responsibilities

The NASA Centers' primary missions to support the Earth Science Enterprise are listed in the table below.

Center	Mission
Goddard Space Flight Center **Jet Propulsion Laboratory** **Langley Research Center** **Stennis Space Center**	Earth System Science Instrument Technology Atmospheric Science Commercial Remote Sensing

EARTH SCIENCE ENTERPRISE

1. Continuation of technology development discussion
2. Adds reference to partners

26

Human Exploration and Development of Space Enterprise

Mission

We seek to bring the frontier of space fully within the sphere of human activity to build a better future for all humankind. Imagine new products based on space research, such as high-quality protein crystals to allow the design of new drugs for treating disease. Envision school children learning their lessons by telepresence instruction from the Moon. Imagine commerce flourishing in space, with solar power satellites, or a Martian powerplant to permit a permanent colony. These images are part of the Human Exploration and Development of Space (HEDS) Enterprise. The mission of the 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.

In exploring space, HEDS brings people and machines together to overcome challenges of distance, time, and environment. Robotic science missions survey and characterize other bodies as precursors to eventual human missions. The Space Shuttle and International Space Station (ISS) serve as research platforms to pave the way for sustained human presence in space through critical research on human adaptation. These programs also provide opportunities for research with applications on Earth. HEDS serves as a catalyst for commercial space development. We will employ breakthrough technologies to revolutionize human space flight.

Phase I of the International Space Station includes nine docking missions by the Space Shuttle to the Russian Mir *space station.*

Questions to Address

HEDS pursues the answers to myriad research and engineering questions that must be answered as we learn to live and work in space. HEDS plays an important role in pursuing answers to the questions: 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? HEDS also plays an important role working with the other Enterprises to pursue answers to other fundamental questions, including: Does life exist elsewhere than on our planet?

Goals

The goals of the HEDS Enterprise are as follows:

- Expand the space frontier;
- Expand scientific knowledge;
- Enable and establish a permanent and productive human presence in Earth orbit;
- Expand the commercial development of space; and
- Share the experience and discovery of human space flight.

1

Strategies and Outcomes

The programs of NASA's HEDS respond to the goals of the National Space Policy. Under the direction of the policy, HEDS focuses its research and developments in "space science to enhance knowledge of . . . fundamental natural and physical sciences; . . . [and] human space flight to conduct scientific, commercial, and exploration activities. . . ."

2

HUMAN EXPLORATION AND DEVELOPMENT OF SPACE ENTERPRISE

1. Restructured goals
2. Adds explicit reference to the National Space Policy

The Enterprise will contribute new scientific knowledge by studying the effects of gravity and the space environment on important biological, chemical, and physical processes. This knowledge will provide fundamental insights for new Earth-bound applications and technology. We will continue to develop biomedical knowledge and technology to allow people to thrive physically and psychologically while exploring and opening the space frontier.

The Enterprise relies on the robotic missions of the Space Science Enterprise to provide extensive knowledge of the geology, environment, and resources of planetary bodies. The Space Science Enterprise missions will also demonstrate the feasibility of utilizing local resources to "live off the land."

Pursuant to the National Space Policy, HEDS will develop and operate the ISS to support activities requiring the unique attributes of humans in space and establish a permanent human presence in Earth orbit. The ISS will support future decisions on the feasibility and desirability of conducting further human exploration activities. The ISS will be the largest multinational science and engineering program in history and will vastly expand the human experience of living and working in space. This long-duration laboratory will provide unprecedented opportunities for science, technology, engineering, and commercial investigations in the space environment.

HEDS will seek out synergies between commercial capabilities and Government needs. HEDS will also join with the private sector to stimulate opportunities for commercial development in space as a key to future settlement. Near-term efforts will emphasize joint pilot projects that provide clear benefit to Earth from the development of near-Earth space, while the long-term emphasis will be on the use of resources and environments of planetary bodies for the benefit of humankind and to sustain a human presence beyond Earth.

Artist's concept of a potential Mars mission. Here, the crew has connected two habitats together to conduct a variety of surface exploration activities.

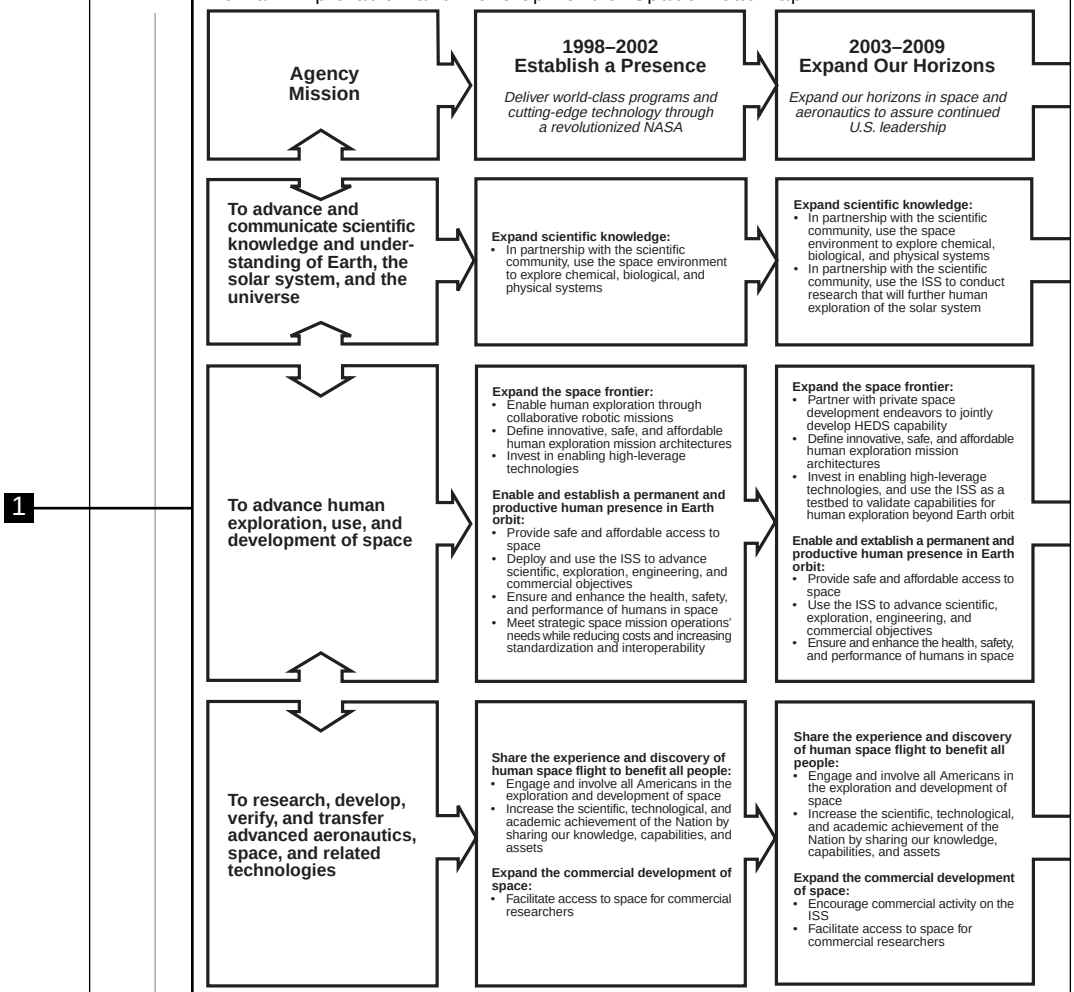
Safe, reliable, low-cost transportation is critical to the goals of the HEDS Enterprise. The National Space Policy directs the Agency to ensure safety on all space flight missions involving the Space Shuttle and the ISS. The Space Shuttle program is committed to flying safely, meeting the manifest, improving system supportability and reliability, and reducing cost—in that order of priority. HEDS will provide space operations management and communications services through commercial means while setting the stage for future investments that will be required as we explore the solar system and beyond. Per the National Space Policy, HEDS will seek to privatize or commercialize NASA's space communications operations no later than 2005.

HEDS will pursue technology development in support of its near-, mid-, and long-term objectives. In the near term, HEDS will develop state-of-the-art research facilities for the ISS while infusing technologies to improve ISS performance. Technologies in development include microelectronic sensors for monitoring the ISS atmosphere at reduced requirements for power and crew time, biological water processing to reduce resupply requirements, advanced carbon dioxide removal systems that use specially designed, regenerable chemicals, and other

HUMAN EXPLORATION AND DEVELOPMENT OF SPACE ENTERPRISE

1. Adds explicit reference to the National Space Policy
2. Adds new emphasis on commercial synergies
3. Changes better reflect the importance of safety
4. Adds discussion of technology development

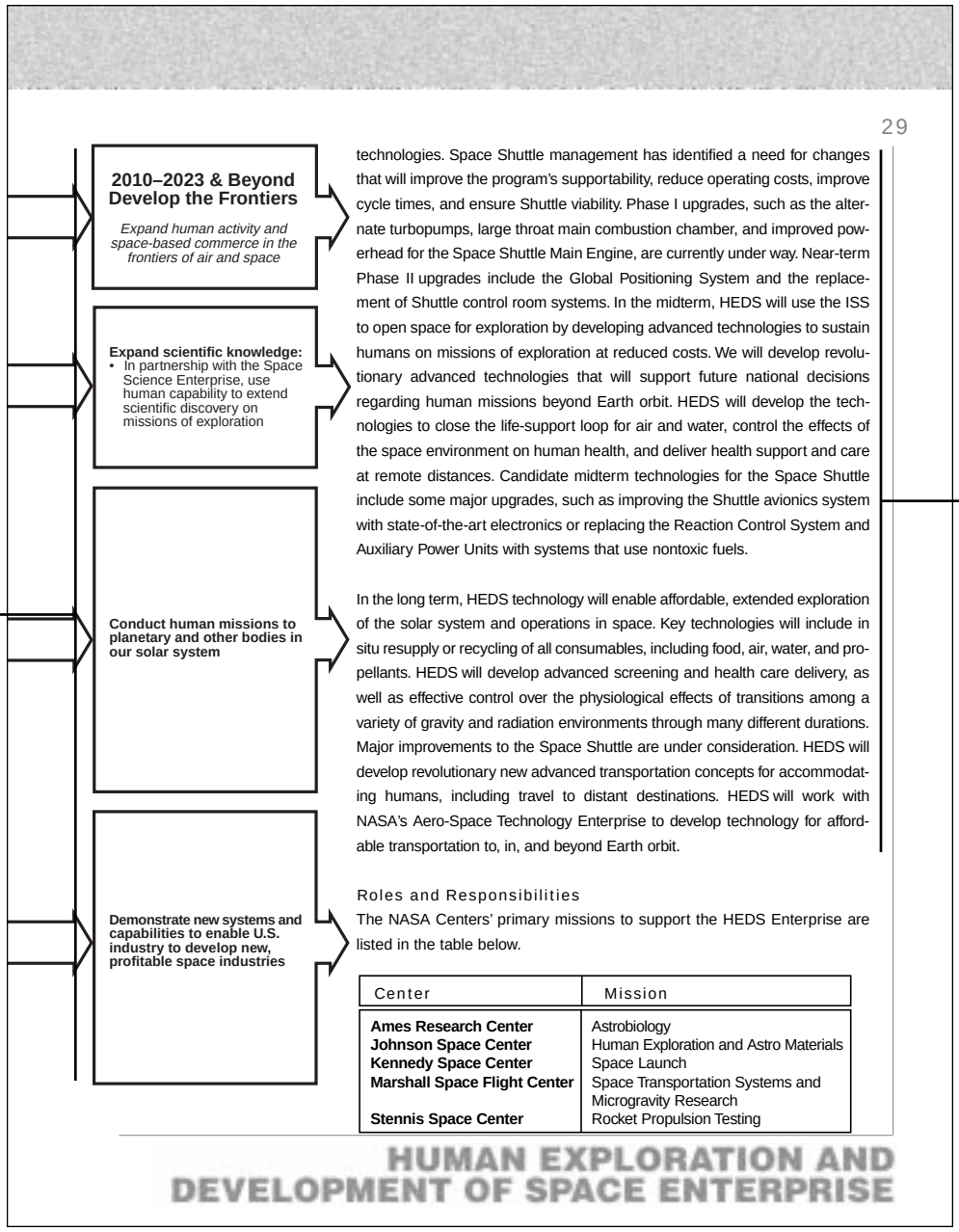
28 Human Exploration and Development of Space Roadmap



The Roadmap presents the overall goals (presented in bold), objectives (presented as bullets), and major program milestones and related activities (presented in parentheses and italics) for the Enterprise.

HUMAN EXPLORATION AND DEVELOPMENT OF SPACE ENTERPRISE

1. Changes made to reflect the splitting of the fourth HEDS goal into two separate goals, to improve clarity and, in some cases, to remove a level of detail that is more properly addressed in the Performance Plan



1. Continuation of chart with noted changes from page 95
2. Continuation of technology development discussion from page 94

1

30 Aero-Space Technology Enterprise

Mission

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, aggressive foreign competition, and launch costs that impede affordable access and utilization of space, represent formidable challenges to the Nation.

The mission of this Enterprise is to pioneer the identification, development, verification, transfer, application, and commercialization of high-payoff aeronautics and space transportation technologies. Through its research and technology accomplishments, it promotes economic growth and national security through a safe, efficient national aviation system and affordable, reliable space transportation. The plans and goals of this Enterprise directly support national policy in both aeronautics and space, documented in "Goals for a National Partnership in Aeronautics Research and Technology" and "National Space Transportation Policy." This Enterprise works in alliance with its aeronautics and space transportation customers, including U.S. industry, the university community, the Department of Defense (DoD), the Federal Aviation Administration (FAA), and the other NASA Enterprises, to ensure that national investments in aero-space technology are effectively defined and coordinated and that NASA's technology products and services add value, are timely, and have been developed to the level at which the customer can confidently make decisions regarding the application of those technologies.

The Enterprise also has Agency responsibility for technology transfer and commercialization. This function is provided as an Agency-wide service to ensure wide, rapid transfer of NASA-developed technologies to U.S. industry for the social and economic benefit of all U.S. citizens.

Questions to Address

The Aero-Space Technology Enterprise is responsible for answering the question: How do we enable revolutionary technological advances that provide air and space travel for anyone, anytime, anywhere more safely, more affordably, and with less impact on the environment and improve business opportunities and global security?

Goals

The Enterprise has three major technology goals supported by ten enabling technology objectives (detailed in the Enterprise Roadmap) and a service goal.

Technology Goals

Global Civil Aviation—Develop an environmentally friendly global air transportation system for the next century of unquestioned safety that improves the Nation's mobility.

Revolutionary Technology Leaps—Revolutionize air travel and the way in which air and space vehicles are designed, built, and operated.

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

2

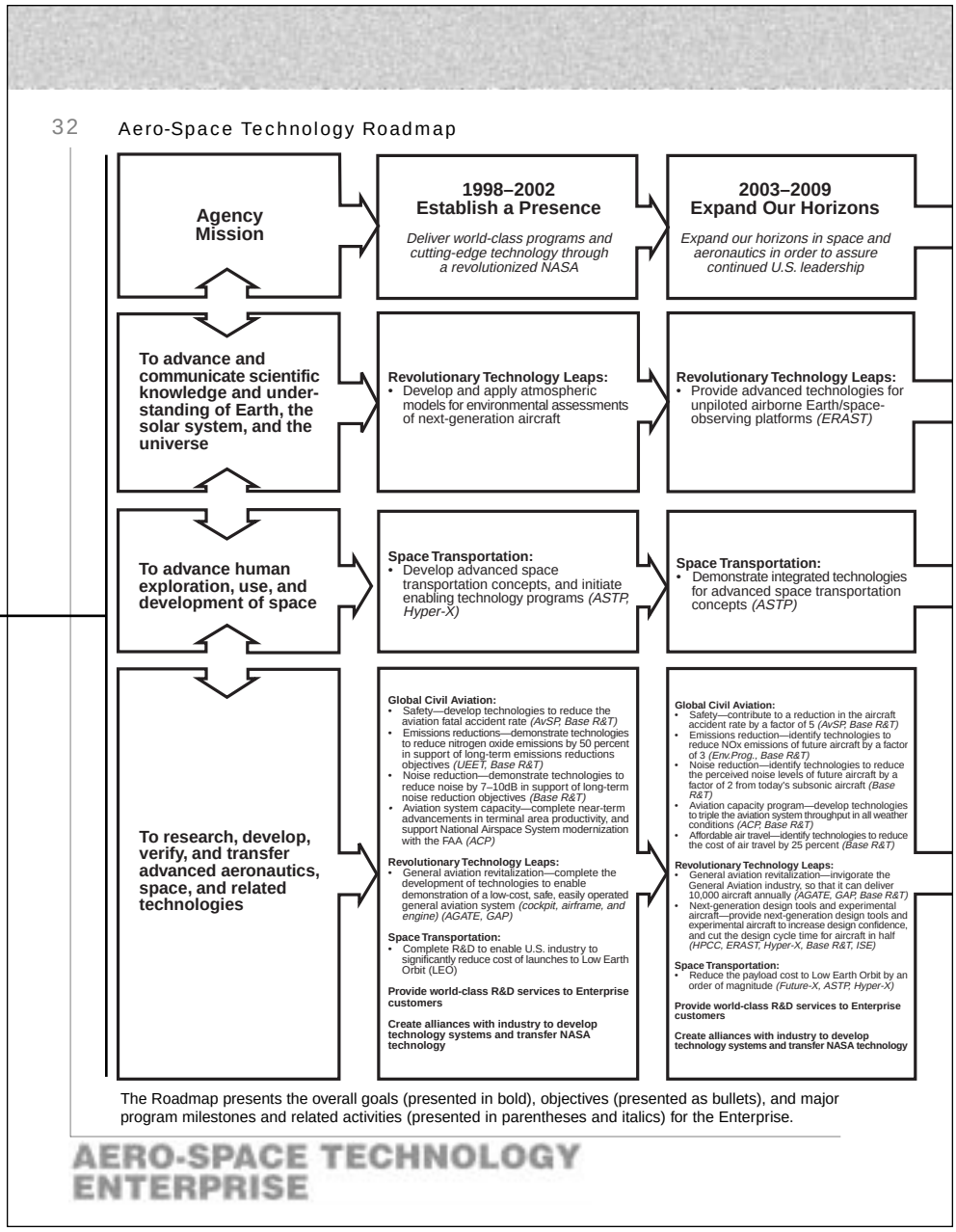
Service Goal

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.

Alliances—Create alliances with industry to develop technology systems and transfer NASA technology.

AERO-SPACE TECHNOLOGY ENTERPRISE

1. Name change
2. Improved wording



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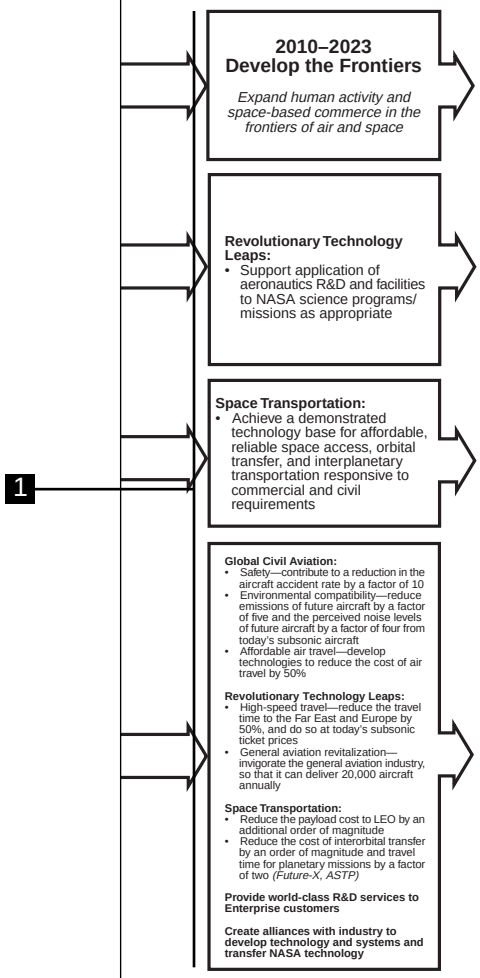
1. Changes reflect restatement of Access to Space goal, restructuring of service goals, changes to better reflect the scope of NASA impacts in some areas, reductions in Global Civil Aviation programs, and the phaseout of the High Speed Civil Transport program



1

fundamental and barrier issues. Base R&T elements will: (1) support the maturation of technology to a level that it can be confidently integrated into a Systems Technology program; (2) directly transfer technology to the external customer community as appropriate; and (3) provide the basis for new Systems Technology programs. The character of the Systems Technology programs will be to specifically target an integrated set of technologies that advance the goal/objective metrics and can be confidently developed and advanced to a level of maturity sufficient for transfer and adoption by the external customer community.

Roles and Responsibilities

The NASA Centers' primary missions to support the Aero-Space Technology Enterprise are listed in the table below.

Center	Mission
Ames Research Center	Aviation Operation Systems
Dryden Flight Research Center	Flight Research
Langley Research Center	Airframe Systems
Glenn Research Center	Aeropropulsion
Marshall Space Flight Center	Space Transportation Systems
Stennis Space Center	Rocket Propulsion Testing

AERO-SPACE TECHNOLOGY ENTERPRISE

1. Continuation of changes from page 98

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environment sought by Earth Science may help us create environments that can sustain humans on other worlds.

Synergies also exist among our Crosscutting Processes. For example, the Manage Strategically process provides information to the other processes regarding the requirements and mandates of NASA's external customers and stakeholders. This information is used to determine what knowledge to generate, what aerospace products and services are needed to meet national goals in science and technology, and what knowledge must be communicated to whom. The Generate Knowledge process provides scientific results and discoveries to the Communicate Knowledge process, which disseminates this information widely in a format that is understandable by a broad audience.

External Partnerships and Cooperation

To encourage improved efficiencies for our human and capital resources, we are also developing synergies between the programs of the Enterprises and the capabilities of other partners in Government, industry, academia, and other nations.

The Earth Science Enterprise is NASA's contribution to the U.S. Global Change Research Program, in which our research and observational priorities are coordinated with 11 other Federal agencies. NASA contributes the space-based observing capability and the analysis of remote-sensing data essential for global and regional-scale studies. Partner agencies, such as the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS), perform the bulk of the surface-based observations and analyses, and mission agencies, such as the U.S. Department of Agriculture and the Environmental Protection Agency, focus the partners on regional uses of research results. NASA and NOAA are building an integrated program of research on the El Niño-Southern Oscillation phenomenon. NASA, NOAA, and the Department of Defense (DoD) have formed the Integrated Program Office for the development of the National Polar-orbiting Operational Environmental Satellite System (NPOESS)—the next-generation U.S. weather satellites in polar orbit. NASA, NOAA, and USGS are collaborating on the Landsat 7 program, and NASA, DoD, and USGS are planning a Shuttle-based synthetic aperture radar mission to meet all three agencies' requirements for a digital terrain model of Earth's surface. NASA and the Department of Agriculture are cooperating on land-cover and land-use change research. We are also collaborating with the Federal Emergency Management Agency to conduct natural hazards research and applications.

The Space Science Enterprise vigorously pursues opportunities to collaborate with other Government agencies about the origin, evolution, and destiny of the cosmos and life. Chief among these are the National Science Foundation, the Department of Energy (DOE), and DoD. Among other activities, the National Science Foundation and NASA collaborate with the Smithsonian Institution in the search, collection, distribution, and curation of Antarctic meteorites. DOE and NASA have partnered in the provision of radioisotope thermoelectric generators for the Galileo and Cassini spacecraft. Through its Los Alamos and Lawrence Livermore Laboratories, DOE has also contributed greatly to the development of instruments and sensors needed for several space science missions. DoD has been a major developer of high-sensitivity, large-area infrared detector arrays. In addition, recently declassified critical technology for large-area deployable optical systems will be of vital importance for future large telescopes in space. The Space Science

1

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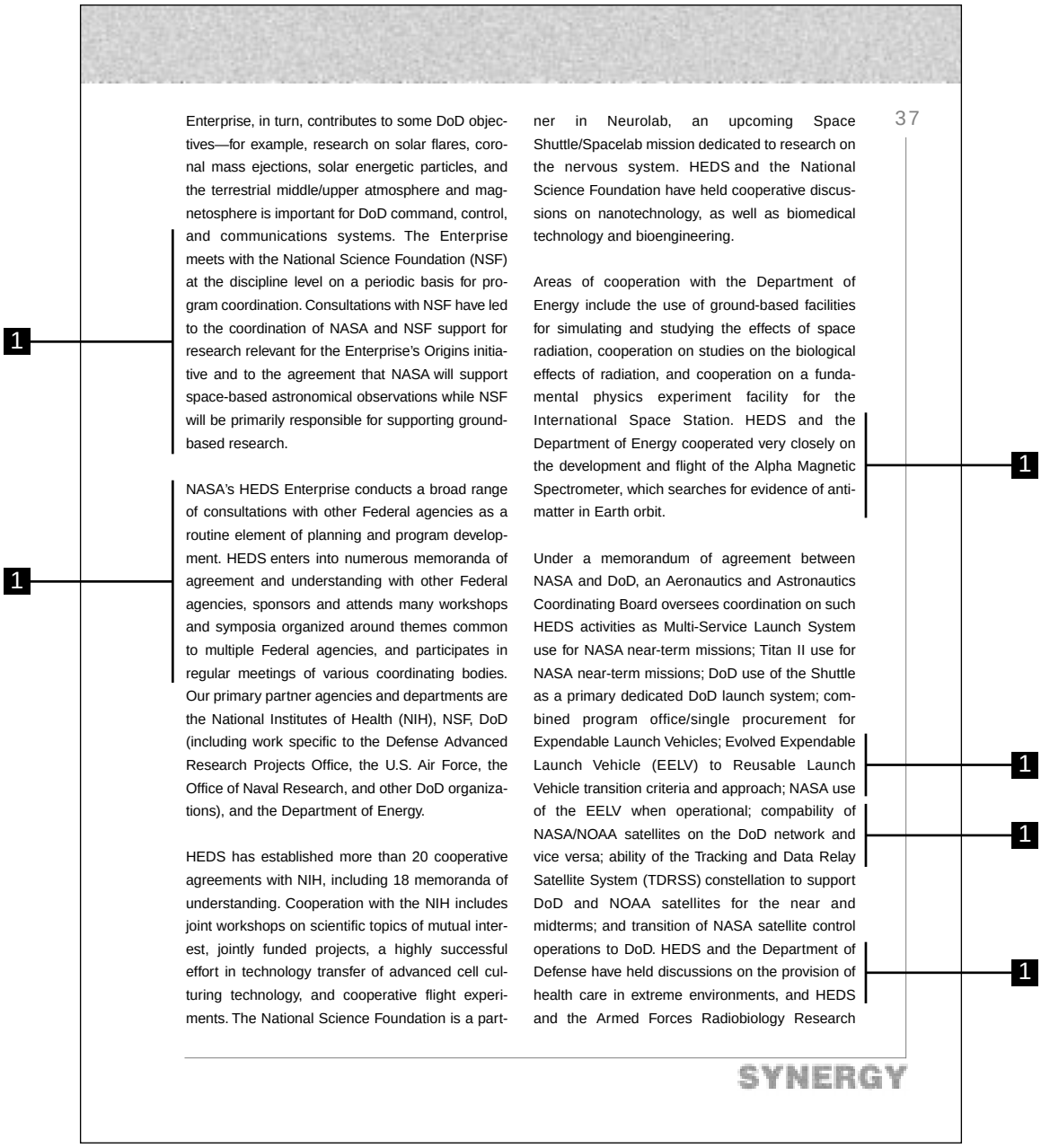
SYNERGY

1. Adds example of cooperation and partnerships



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Enterprise, in turn, contributes to some DoD objectives—for example, research on solar flares, coronal mass ejections, solar energetic particles, and the terrestrial middle/upper atmosphere and magnetosphere is important for DoD command, control, and communications systems. The Enterprise meets with the National Science Foundation (NSF) at the discipline level on a periodic basis for program coordination. Consultations with NSF have led to the coordination of NASA and NSF support for research relevant for the Enterprise's Origins initiative and to the agreement that NASA will support space-based astronomical observations while NSF will be primarily responsible for supporting ground-based research.

NASA's HEDS Enterprise conducts a broad range of consultations with other Federal agencies as a routine element of planning and program development. HEDS enters into numerous memoranda of agreement and understanding with other Federal agencies, sponsors and attends many workshops and symposia organized around themes common to multiple Federal agencies, and participates in regular meetings of various coordinating bodies. Our primary partner agencies and departments are the National Institutes of Health (NIH), NSF, DoD (including work specific to the Defense Advanced Research Projects Office, the U.S. Air Force, the Office of Naval Research, and other DoD organizations), and the Department of Energy.

HEDS has established more than 20 cooperative agreements with NIH, including 18 memoranda of understanding. Cooperation with the NIH includes joint workshops on scientific topics of mutual interest, jointly funded projects, a highly successful effort in technology transfer of advanced cell culturing technology, and cooperative flight experiments. The National Science Foundation is a partner in Neurolab, an upcoming Space Shuttle/Spacelab mission dedicated to research on the nervous system. HEDS and the National Science Foundation have held cooperative discussions on nanotechnology, as well as biomedical technology and bioengineering.

Areas of cooperation with the Department of Energy include the use of ground-based facilities for simulating and studying the effects of space radiation, cooperation on studies on the biological effects of radiation, and cooperation on a fundamental physics experiment facility for the International Space Station. HEDS and the Department of Energy cooperated very closely on the development and flight of the Alpha Magnetic Spectrometer, which searches for evidence of antimatter in Earth orbit.

Under a memorandum of agreement between NASA and DoD, an Aeronautics and Astronautics Coordinating Board oversees coordination on such HEDS activities as Multi-Service Launch System use for NASA near-term missions; Titan II use for NASA near-term missions; DoD use of the Shuttle as a primary dedicated DoD launch system; combined program office/single procurement for Expendable Launch Vehicles; Evolved Expendable Launch Vehicle (EELV) to Reusable Launch Vehicle transition criteria and approach; NASA use of the EELV when operational; compability of NASA/NOAA satellites on the DoD network and vice versa; ability of the Tracking and Data Relay Satellite System (TDRSS) constellation to support DoD and NOAA satellites for the near and midterms; and transition of NASA satellite control operations to DoD. HEDS and the Department of Defense have held discussions on the provision of health care in extreme environments, and HEDS and the Armed Forces Radiobiology Research

SYNERGY

1. Adds examples of cooperation and partnerships

38

Institute cooperate on radiation biology studies of mutual interest.

AST works in alliance with its aeronautics and space transportation customers in industry, in the university community, and through several bilateral and trilateral relationships with DoD and the FAA. For example, the NASA-FAA Coordinating Committee provides for cooperative national programs in aviation safety, airspace operations, and environmental compatibility. The NASA-DoD Aeronautics and Astronautics Coordinating Board has fostered interagency planning for programs such as rotocraft and human factors research. The Board also is addressing cooperative activities for the National Aeronautics Testing Alliance. Another example of interagency planning is the Integrated Plan for Air Traffic Management Research and Technology Development produced by a NASA-FAA integrated product team.

Each interagency program includes regular consultations among the participating agencies to identify shared goals and objectives, collaborations, and interdependencies. As part of this process, we are working to identify common metrics and success criteria for each major milestone of the interagency programs.

NASA has also developed extensive alliances with its partners in other Government agencies to improve efficiencies for our human and capital resources, leverage unique capabilities, and reduce potential functional duplications. As a member of the National Science and Technology Council, which was established by the President in 1993, NASA participates in the planning of the diverse research and development initiatives of the Federal Government and the coordination of strategies for achieving shared goals and objectives. We have also worked closely with the Office of Science and Technology Policy, as well as agencies supporting space research and development to implement the President's National Space Policy and Goals for a National Partnership in Aeronautics Research and Technology. NASA obtains substantial procurement and contract administration services from DoD rather than duplicating these capabilities. We also cooperate with DoD and the General Services Administration in developing and maintaining the uniform Federal regulation governing acquisition. In addition, NASA relies on the Department of the Treasury for processing payments to contractors, and the Agency utilizes and supports the Justice Department in criminal investigations.

International cooperation is a key element of the strategies for all four Strategic Enterprises. NASA seeks cooperation of mutual benefit with its foreign partners. Through this cooperation, global issues are addressed on a global basis. International cooperation helps meet NASA's goals and objectives by adding unique capabilities or expertise, increasing mission flight opportunities, providing access to locations outside the United States, and enhancing the scientific return. It also allows nations to share the cost of implementing space and aeronautics programs. For example, the Space Science Enterprise has cooperatively established an International Mars Exploration Working Group to coordinate planning for robotic Mars exploration; discussions are under way to include European-provided communications components as critical elements of future missions in NASA's Mars Surveyor program. NASA has extensive cooperation with Canada, Europe, Japan, and Russia. NASA also has expanding cooperation with developing spacefaring nations. NASA is working with other nations to identify new opportunities for cooperation consistent with the goals of the Agency. 1

SYNERGY

1. Adds example of cooperation and partnerships

evaluate, and report the results. As each part of the organization completes its measurement process, data are used to validate that performance meets or exceeds planned goals, objectives, and performance targets. In those situations where performance does not meet the plan, opportunities for continuous improvement and reengineering are identified.

On a semiannual basis, NASA's Senior Management Council will review performance against the goals and objectives contained in this Plan, the Enterprise Strategic Plans, and the Annual Performance Plan. These reviews will take place in March and September of each year. To assess progress in meeting the Agency's general goals, we will review performance goals and measures that relate to the near-term objectives of our Enterprises and of our Crosscutting Processes. Examples of the relationships between Agency goals and performance goals include:

- Reducing development cycle time and cost and increasing launch rates for NASA spacecraft. This relates to the Agency goals to develop lower cost missions to characterize the Earth system and chart the evolution of the universe and solar system and to improve Shuttle safety and efficiency;
- Increasing the accessibility and use of science and research data. This addresses NASA's goals to characterize the Earth system and chart the evolution of the universe and solar system, to explore nature's processes in space, and to facilitate and stimulate the productive use of science and technology in the public and private sectors; and
- Increasing leverage of NASA's research and development investments in commercial partnerships with industry. This relates to our goals to develop new technologies and processes to enhance research and make aeronautics and space programs more affordable and to develop affordable technologies for U.S. leadership in aviation growth markets.

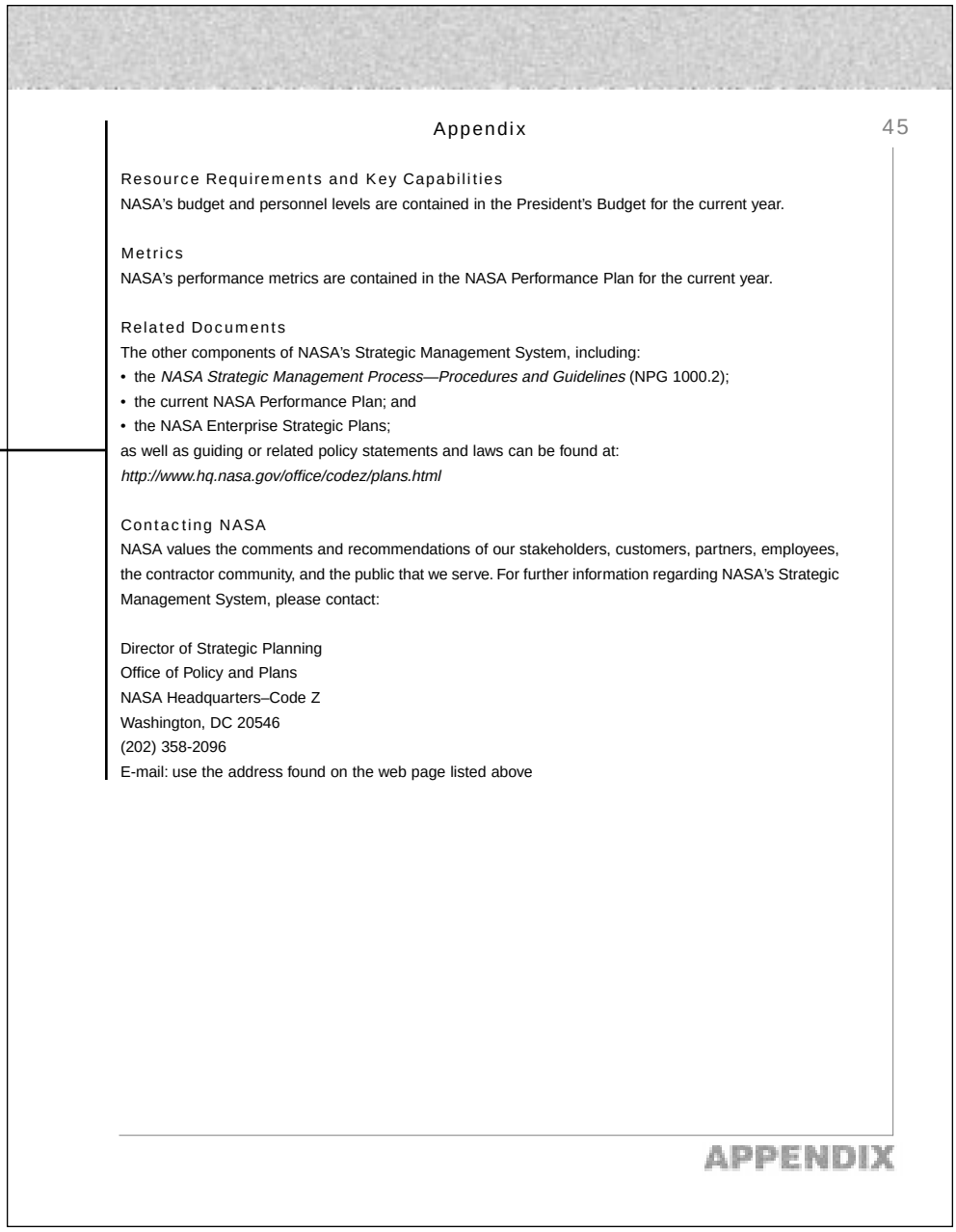
These measures will be included in the Agency's Annual Performance Plan and associated Performance Report. (Appendix 2 provides a summary of Enterprise and Crosscutting Process objectives and associated measures.)

At the program level, NASA's Program Management Council will continue to conduct reviews prior to initiation and throughout a program's life to confirm compliance with cost, schedule, and performance targets. In addition, NASA's Capital Investment Council will continually reaffirm that our investment decisions support overall program and institutional goals and that outcomes remain relevant and provide valuable contributions to the Nation's needs. To effectively manage our financial resources and evaluate Agency, Enterprise, and program-level performance, NASA is developing and implementing a new integrated financial management system. The integration of this system, and other initiatives such as full-cost accounting, will enable performance improvements to our financial and resource management.

NASA maintains a broad and diverse system of advisory committees under the Federal Advisory Committee Act, which includes the Aerospace Safety Advisory Panel and the NASA Advisory Council, its 7 standing committees, 20 standing subcommittees, and various task forces. The Agency extensively uses these advisory committees to obtain external input to its strategic and performance plans as well as to evaluate Agency performance. 1

CROSSCUTTING PROCESSES

1. Adds a description of the role of advisory committees in assessing performance



Appendix 45

Resource Requirements and Key Capabilities

NASA's budget and personnel levels are contained in the President's Budget for the current year.

Metrics

NASA's performance metrics are contained in the NASA Performance Plan for the current year.

Related Documents

The other components of NASA's Strategic Management System, including:

- the *NASA Strategic Management Process—Procedures and Guidelines* (NPG 1000.2);
- the current NASA Performance Plan; and
- the NASA Enterprise Strategic Plans;

as well as guiding or related policy statements and laws can be found at:

http://www.hq.nasa.gov/office/codez/plans.html

Contacting NASA

NASA values the comments and recommendations of our stakeholders, customers, partners, employees, the contractor community, and the public that we serve. For further information regarding NASA's Strategic Management System, please contact:

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(202) 358-2096
E-mail: use the address found on the web page listed above

APPENDIX

1. Updated Appendix to eliminate duplication of other publications and to move references to the World Wide Web to prevent information from becoming outdated