

NASA Performance Plan



Fiscal Year 1999

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Introduction

The Government Performance and Results Act (GPRA) passed by Congress and signed by the President in 1993 provides a new tool to improve the efficiency of all Federal agencies. The goals of GPRA are to:

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

The Act directs Executive Branch agencies to develop a customer-focused strategic plan that aligns activities with concrete missions and goals. The first plans were submitted in September 1998 as part of the Fiscal Year 1999 (FY99) budget process. These budget submissions were expected to support 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 plans required by GPRA have been submitted to the Office of Management and Budget (OMB) and to Congress. Copies of NASA plans are available from the Office of Policy and Plans at NASA Headquarters and can be accessed on the Internet web sites identified in the Appendix.

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.

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 Plan describes four Strategic Enterprises that manage the programs and activities to implement our mission, answer the fundamental questions, and provide service to identified customers. The support systems for the Strategic Enterprises, defined as Crosscutting Processes, are also defined in the Strategic Plan.

The NASA Performance Plan outlines selected measurements to evaluate progress the Agency intends to make in FY99 toward the achievement of its goals. To be submitted annually, the Plan provides NASA managers, OMB, and Congress with an improved capability to assess our success in fulfilling our commitments. The Government-wide Performance Plan submitted by OMB with the President's FY99 budget request to Congress included a subset of measurements from an earlier draft of the Performance Plan. This final version contains modifications to selected measures that appear in the Government Plan. These modifications reflect changes that have taken place since the performance measurements were submitted in the fall of 1997.

As with the Strategic Plan, NASA intends to revise and improve the content of future editions of this document. Agency managers will validate the performance measures in consultation with customers, employees, and stakeholders in the Administration, Congress, and other agencies. Similar consultations will be conducted with internal and external advisory committees.

NASA's Strategic Management System Documents

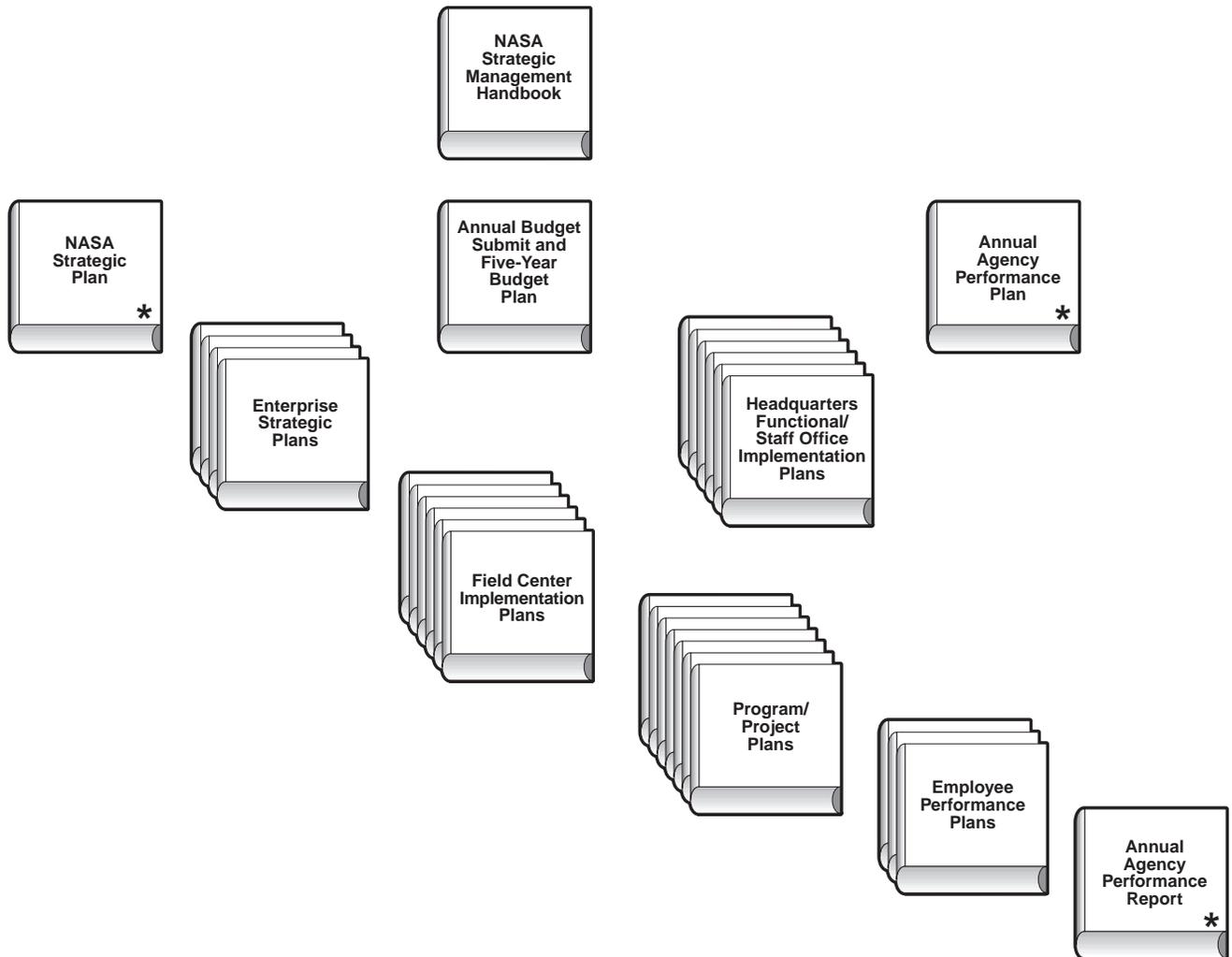


Figure 1

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 the Earth, the solar system, and the universe and use the environment of space for research;

To explore, use, and enable the development of space for human and robotic endeavors in science and commerce;

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

NASA Performance Plan

This document, as required by GPRA, describes performance measures and service levels for program activities requested in the FY99 budget. Performance goals are defined for NASA's Strategic Enterprises and for Crosscutting Processes. The *NASA Budget Estimates, Fiscal Year 1999* document provides the complete description of program activities, budget requirements, and performance measures. The NASA Performance Plan provides detail for a subset of the information provided in the *Budget Estimates* publication.

NASA implements and executes its space and aeronautics programs and activities through four Strategic Enterprises. Each Enterprise has identified a unique set of goals, objectives, and strategies to meet the requirements of their primary customers. The four Enterprises are:

- Space Science
- Earth Science
- Human Exploration and Development of Space
- Aeronautics and Space Transportation Technology

Crosscutting Processes support the goals of the Agency and all four Enterprises. The Crosscutting Processes transform inputs, such as policies and resources, into outcomes, such as knowledge. The Processes are:

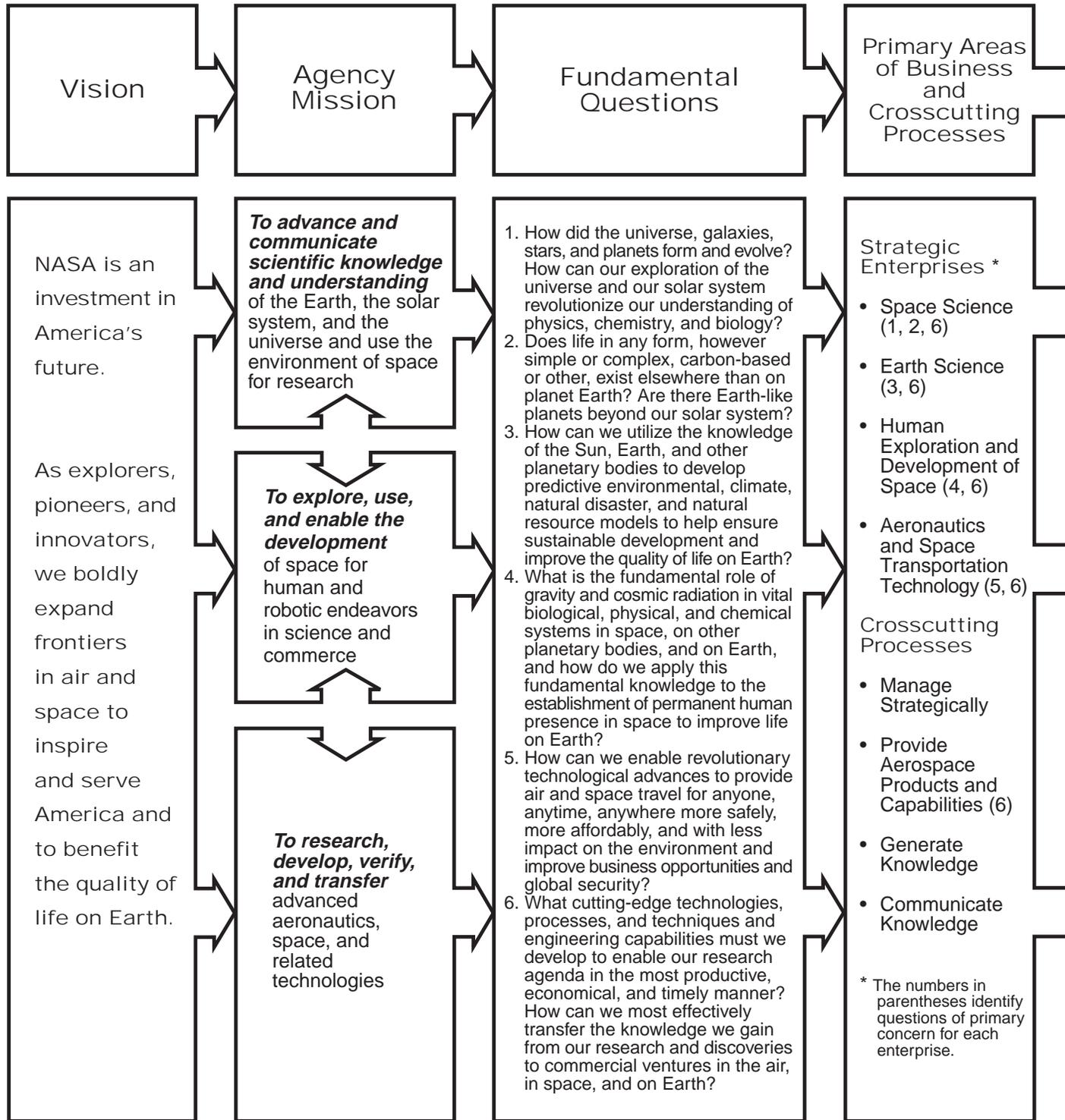
- Manage Strategically
- Provide Aerospace Products and Capabilities
- Generate Knowledge
- Communicate Knowledge

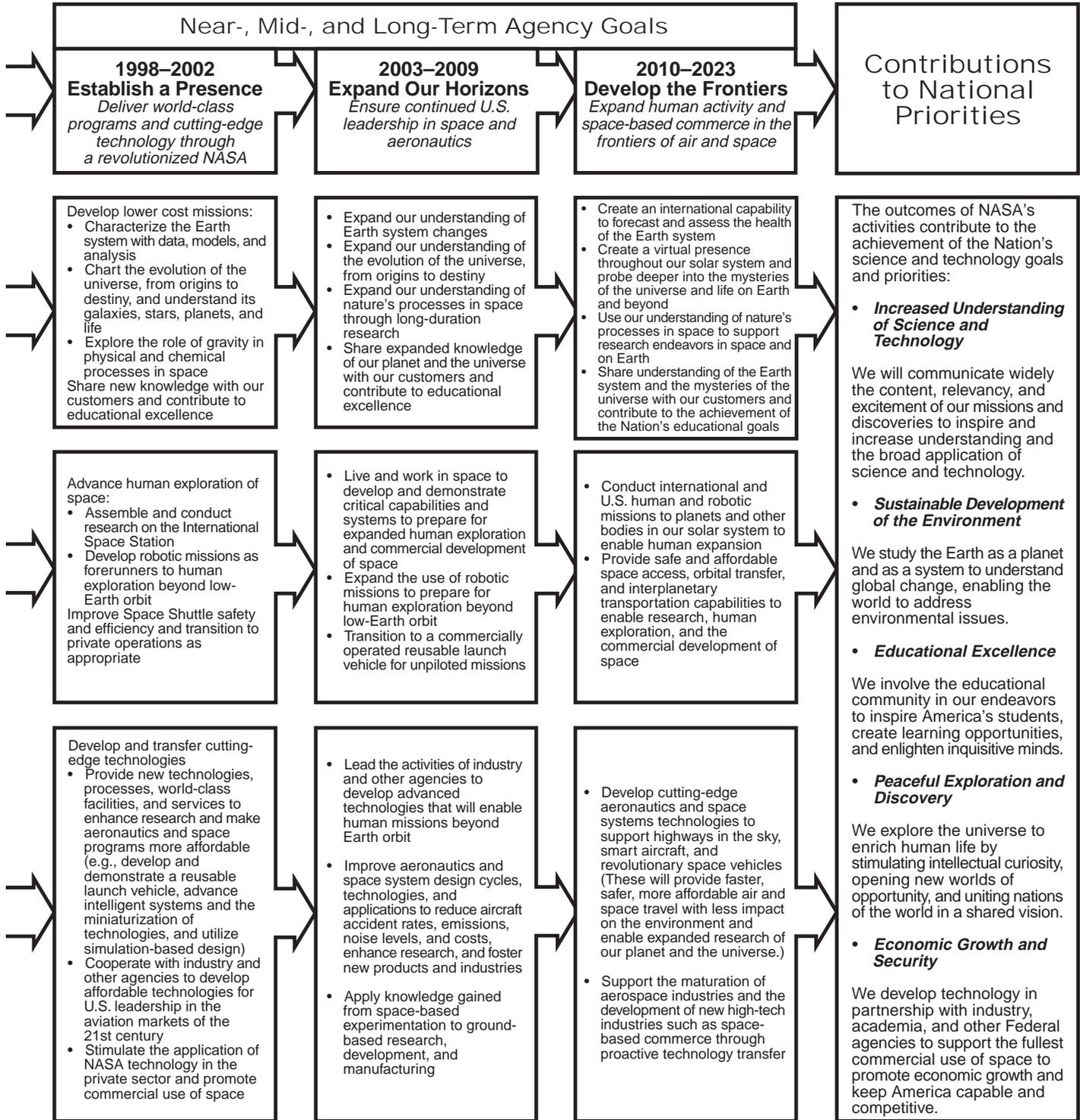
Each section of the Performance Plan includes the following:

- A description of the mission of the Enterprise or Crosscutting Process.
- The budget required to support the Enterprise for FY 99-03.
- A description of the measurement and the performance target for FY99. Where, applicable, comparison data to previous years will be provided.

NASA's Strategic Management System Roadmap

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





Performance Evaluation

Performance will be evaluated by internal and external processes. Internal reviews will be conducted by Agency management councils. Throughout the year, Program Management Councils (PMC) at Headquarters and the Centers will assess program schedules, cost, and technical performance against established baselined programmatic commitments. With membership of Headquarters' Officials-in-Charge and Center Directors, the Senior Management Council (SMC) will conduct assessment reviews twice a year. The SMC reviews will ensure sufficient progress is being made in meeting the Enterprise and Crosscutting Process performance targets.

External reviews will be conducted by organizations such as the NASA Advisory Council, the National Academy of Sciences, and the General Accounting Office. 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 Performance Report required by GPRA will be based on a combination of information from the internal and external assessments.

NASA Fiscal Year 1999 Budget Request

The NASA FY99 budget request (Figure 3) reaffirms the President's commitment to a balanced aeronautics and space program. 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, 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.

Fiscal Year 1999 Estimates (In millions of Real Year Dollars)					
	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>	<u>FY 02</u>	<u>FY 03</u>
NASA Total Budget	13465.0	13278.0	13315.0	13394.0	13435.0
Space Science	2058.4	2207.4	2308.4	2387.4	2568.4
Earth Science	1372.0	1492.0	1494.0	1449.0	1407.0
Human Exploration and Development of Space	5753.0	5569.0	5422.0	5194.0	4979.0
Aeronautics and Space Transportation Technology	1305.0	1092.0	1026.0	1057.0	1071.0
Mission Support, Academic Programs, Inspector General, and others	2976.6	2917.6	3064.6	3306.6	3409.6

Figure 3

Space Science Enterprise

Mission

The Space Science Enterprise mission is to solve mysteries of the universe, explore the solar system, discover planets around other stars, and search for life beyond Earth. Programs of the Enterprise chart the evolution of the universe from origins to destiny, and improve understanding of galaxies, stars, planets, and life. The Enterprise mission includes developing innovative technologies to support Space Science programs and making them available for other applications 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 Space Science Enterprise is developing new programs through the “faster, better, cheaper” approach. Program managers are encouraged to accept prudent risk, shorten development time of technologies and missions, explore new conceptual approaches, streamline management, and incorporate innovative methods and technologies to enhance efficiency and effectiveness. 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, continue to play a key role in the implementation strategy of the Enterprise.

The same spirit of innovation that embodies the Space Science flight programs applies to technology development. Long-term, high-risk, high-payoff

technologies are key to implementing the Space Science mission. Technologies for advanced miniaturization, intelligent systems, autonomous operations, and simulation-based design will receive special attention in FY99.

Enterprise Resource Requirements

The President has requested the following budget for FY99 to FY03 to support the accomplishment of Space Science goals:

<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>	<u>FY 02</u>	<u>FY 03</u>
2058.4	2207.4	2308.4	2387.4	2568.4

Performance Measures

To meet the near-term goals displayed in Chart 1, the following objectives will be measured:

Objective—Solve mysteries of the universe

Space Science spacecraft will chart the evolution of the universe and enhance our understanding of galaxies, stars, and planets.

- The performance target will be to successfully launch seven spacecraft, within 10 percent of budget on average.

The Hubble Space Telescope (HST) will continue its observations of the universe. HST resolution will complete a 3-year research project to determine the expansion rate of the universe (the Hubble constant), which determines its age.

- The performance target will be to measure the Hubble constant within an accuracy of about 10 percent, as compared to previous measurements that differ among themselves by a factor of two.

The Advanced X-ray Astrophysics Facility (AXAF) will record images and spectra of the Milky Way and other galaxies.

- The performance targets will be to:
 - Record 100 images and spectra at a resolution of better than an arcsecond, five to ten times sharper than images gathered earlier by the Einstein Observatory.
 - Record data on approximately 50 compact stellar objects with a sensitivity 50 times greater than the Einstein Observatory.

The Rossi X-ray Timing Explorer (RXTE) was launched in December 1995. RXTE is measuring rapid fluctuations of x-rays from cosmic sources and will conduct experiments to test the General Relativity Theory.

- The performance target will be to observe physical phenomena 25,000 times closer to the event horizon of black holes than permitted with optical wavelength measurements.

Objective—Explore the solar system

The Near-Earth Asteroid Rendezvous (NEAR) will provide high precision measurements of the shape and composition of the asteroid EROS, increasing our understanding of the early history of such bodies and the solar system.

- The performance targets will be to:
 - Orbit EROS closer than 50 kilometers, 20–30 times closer than previous asteroid flybys.
 - Measure the shape of EROS to an accuracy of 10 meters or better, about 100 times better than previous measurements of the asteroid Mathilde.
 - Complete the first direct compositional measurements of an asteroid.

The Lunar Prospector, launched in 1998, is designed to provide a complete map of the lunar surface. Research returns will also expand knowledge of the early history of the Moon.

- The performance targets will be to:
 - Map the 75 to 80 percent of the Moon's surface not accessible during the Apollo missions conducted from 1969–1972.
 - Provide definitive measurements of the weak lunar magnetic field.

The Transition Region and Coronal Explorer (TRACE) will observe energy propagation from solar disturbances beginning at the bottom of the visible solar atmosphere into the corona high above. The observations will be made at both high spatial resolution (a few arcseconds) and high time resolution (a few seconds). The analysis of this data will improve the understanding of solar activity and enhance the ability to predict its occurrence and effects in interplanetary space and on the Earth.

- The performance target will be to provide these data with spatial resolution five times better than was collected from the Yohkoh Soft X-ray Telescope.

Objective—Discover planets around other stars

NASA will connect the twin 10-meter telescopes at the Keck Observatory in Hawaii into an 85-meter-baseline interferometer. This system will provide a capability to directly detect hot planets with Jupiter-size masses and characterize clouds of dust and gases permeating other planetary systems.

- The performance target will be to assemble and lab-test the interferometer beam combiner. This state-of-the-art system will approximately double observational efficiency by using a new approach to fringe detection.

Objective—Search for life beyond Earth

The Galileo spacecraft will continue to conduct investigations of Jupiter's moon, Europa, expanding the understanding of its history. Data collected will help determine the presence and state of water, a central consideration in understanding the possibility of life on the moon. The near-infrared imaging spectrometer on Galileo will provide data on mineralogical characteristics of the observed portions of the surface, while gravitational and magnetometer measurements will yield insight about conditions below the surface.

- The performance targets will be to:
 - Complete Galileo's program of 11 encounters with Europa.
 - Bring the total multispectral mapping coverage to about one percent of the surface at 30-meter resolution and distributed over 50 percent of the surface at lower resolution.

NASA will establish a new Astrobiology Institute. The Institute will promote publication of interdisciplinary research, demonstrate investigator interactions, and foster effective public education and outreach on research on life in the universe. To stimulate and facilitate multidisciplinary research, the Institute will feature an innovative virtual organizational structure. In FY98, NASA will select the participating organizations and the Institute Director.

- The performance target will be to initiate Institute operations by linking up to eight institutions and engaging approximately 50 investigators.

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

Results from the Mars Global Surveyor (MGS) will provide a greater understanding of geological

processes of the planet. The MGS will also provide data to determine whether or not water-related minerals are present on the surface. In addition to their immediate scientific interest, MGS data will provide information on potential landing sites for missions of human exploration at a later time.

- The performance targets will be to:
 - Achieve the final science orbit.
 - Measure the topography with 10-meter precision, about 100 times more accurate than previous measurements.
 - Provide high-resolution 1.5-meter imaging data, 10 times more detailed than the best imaging from the 1976 Viking mission.
 - Provide the first thermal infrared spectrometry of the planet.

Objective—Improve the reliability of space weather forecasting

During FY99 the Sun will approach the most active part of its 11-year cycle. Observations of solar activity will be conducted with a series of NASA spacecraft, including Polar, Wind, the Solar and Heliospheric Observatory (SOHO), the Interplanetary Monitoring Platform-8 (IMP-8), and the Anomalous Composition Explorer (ACE). Data will also be collected from instruments on two Japanese spacecraft, Geotail and Yohkoh. Information from these combined missions will help characterize solar energetic particle emissions and will promote development of predictive tools to manage the effects of solar activity on terrestrial activity. Research on solar activity will contribute to designs for human interplanetary exploration.

- The performance target will be to achieve complete coverage (maximum and minimum) of the solar cycle, an increase from 35 percent.

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

The New Millennium Program (NMP) will develop and validate innovative technologies and capabilities that will be required for Space Science missions planned for the next decade.

- The performance target will be to demonstrate an electric ion propulsion system with specific impulse ten times greater than chemical propulsion systems.

The Micro-Arcsecond Metrology Testbed will demonstrate an improvement in positioning accuracy of optical surfaces. This accuracy is important for the development of high-performance interferometers.

- The performance target will be to demonstrate an improvement in positioning accuracy to the picometer (millionth-millionths of a meter) range, ten times better than previously achieved.

The Mars 98 Lander will demonstrate technologies to reduce mass and power consumption and increase instrument reach and dexterity.

- The performance target will be to demonstrate an advanced robotic manipulator with improved performance of an order of magnitude compared to the manipulator used on Viking in 1976.

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:
 - Account for four percent of the 150 “most important science stories” in the annual review by *Science News*.
 - Account for no less than 25 percent of total contributions to the college textbook *Astronomy: From the Earth to the Universe*.
 - Each new Space Science Enterprise mission initiated in FY99 will have a funded education and outreach program.
 - The Space Science Enterprise will complete an organized network of contacts by the end of FY99 to work with educators and space scientists to formulate and implement space science education and outreach programs. This network will be available to every state in the United States.

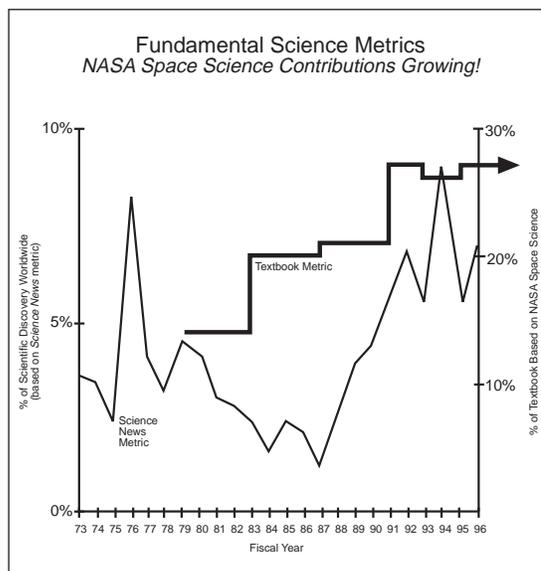


Figure 4

External Assessment

The Space Science Advisory Committee of the NASA Advisory Council will conduct an annual assessment of the Enterprise's near-term science objectives. The Committee will provide a qualitative

progress measurement (Green, Yellow, or Red). “Green” will indicate that an 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.

Space Science—Chart 1

Agency Near-Term Goals	Space Science Near-Term Goals	Objectives	Performance Targets
<p>Develop lower cost missions: Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life</p>	<p>Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life</p>	<ul style="list-style-type: none"> Solve mysteries of the universe Explore the solar system Discover planets around other stars Search for life beyond Earth 	<ul style="list-style-type: none"> Successfully launch at least seven spacecraft, within 10 percent of budget on average. Complete Hubble Space Telescope 3-year project and measure the Hubble constant within an accuracy of approximately 10 percent. The Advanced X-ray Astrophysics Facility (AXAF) will record 100 images and spectra of galaxies at a resolution of better than an arcsecond and record data on approximately 50 compact stellar objects. The Rossi X-ray Timing Explorer (RXTE) will observe physical phenomena 25,000 times closer to the event horizon of black holes than permitted with optical wavelength measurements. The Near-Earth Asteroid Rendezvous (NEAR) will orbit EROS at a distance closer than 50 kilometers, measure its shape to an accuracy of 10 meters (or better), and complete the first direct compositional measurements of an asteroid. The Lunar Prospector will map the 75 to 80 percent of the Moon's surface not accessible during the Apollo missions and provide definitive measurements of the weak lunar magnetic field. The Transition Region and Coronal Explorer (TRACE) will observe energy propagation from solar disturbances beginning at the bottom of the visible solar atmosphere into the corona high above with a spatial resolution five times better than previous capabilities. Assemble and lab-test the interferometer beam combiner connecting the twin 10-meter telescopes at the Keck Observatory in Hawaii. The Galileo spacecraft will complete 11 encounters with Jupiter's moon, Europa, conducting investigations that will help determine the presence and state of water, a central consideration in understanding the possibility of life on the moon. Initiate the Astrobiology Institute's operations by linking up to eight institutions and engaging approximately 50 investigators to promote publication of interdisciplinary research and foster effective public education and outreach on research on life in the universe.
<p>Advance human exploration of space by successfully conducting robotic missions</p>	<p>Use robotic missions as forerunners to human exploration beyond low-Earth orbit</p>	<ul style="list-style-type: none"> Investigate the composition, evolution, and resources of Mars, the Moon, and small bodies Improve the reliability of space weather forecasting 	<ul style="list-style-type: none"> The Mars Global Surveyor (MGS) will achieve the final science orbit, measure the topography with 10-meter precision, provide high-resolution 1.5-meter imaging data, and provide the first thermal infrared spectrometry of the planet. Conduct solar activity observations with a series of NASA spacecraft to achieve complete coverage (maximum and minimum) of the solar cycle, an increase from 35 percent.
<p>Develop and transfer cutting-edge technologies</p>	<p>Develop new critical technologies to enable innovative and less costly mission and research concepts</p>	<ul style="list-style-type: none"> Develop innovative technologies for Enterprise missions and for external customers 	<ul style="list-style-type: none"> The New Millennium Program (NMP) will demonstrate an electric ion propulsion system with specific impulse ten times greater than chemical propulsion systems. The Micro-Arsecond Metrology Testbed will demonstrate an improvement in positioning accuracy to the picometer (millionth-millionths of a meter) range, ten times better than previously achieved. The Mars 98 Lander will demonstrate an advanced robotic manipulator with improved performance of an order of magnitude compared to the manipulator used on Viking in 1976.
<p>Share new knowledge with our customers and contribute to educational excellence</p>	<p>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</p>	<ul style="list-style-type: none"> Incorporate education and enhanced public understanding of science as integral components of Space Science missions and research 	<ul style="list-style-type: none"> Account for 4 percent of the 150 "most important science stories" in the annual review by <i>Science News</i>. Account for no less than 25 percent of total contributions to the college textbook <i>Astronomy: From the Earth to the Universe</i>. Each new Space Science Enterprise mission initiated in FY99 will have a funded education and outreach program. The Space Science Enterprise will complete an organized network of contacts by the end of FY99 to work with educators and space scientists to formulate and implement space science education and outreach programs.

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. 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. 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 development time of technologies and missions, explore new conceptual approaches, streamline management, and incorporate innovative methods to enhance efficiency and effectiveness. Programs of the Enterprise contribute to the U.S. Global Change Research Program and are conducted in collaboration with other Federal agencies, such as the National

Oceanic and Atmospheric Administration. Cooperative research programs with 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 following budget for FY99 to FY03 to support the accomplishment of Earth Science goals:

<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>	<u>FY 02</u>	<u>FY 03</u>
1372.0	1492.0	1494.0	1449.0	1407.0

Performance Measures

To meet the near-term goals displayed in Chart 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 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 due to the activity of phytoplankton.

- The performance targets will be to:
 - Refresh the global archive of 30m land imagery from Landsat 7, three to four times per year. A single global archive has not been constructed since the late 1970's. Landsat 7 also includes a 15m panchromatic band, where previous spacecraft in the series were limited to 30m.
 - 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.
 - Collect near-daily global measurements of ocean color (an index of ocean productivity from which calculations of ocean update of carbon are made.)

Objective—Predict seasonal-to-interannual climate variations

In FY99 the Earth Science Enterprise will continue to monitor key climate anomalies such as El Niño. The Tropical Rainfall Measuring Mission (TRMM), launched in 1997, will gather information on rainfall in the tropics where two-thirds of global precipitation falls. This is the key to the hydrological cycle, one of the three major processes driving climate change, and the global heat balance which drives seasonal change.

- The performance target will be to begin the second of a three-year sequence of instantaneous measurements of rainfall rates and monthly accumulations in the global tropics. This will be the first-ever measurement of global tropical rainfall. Current uncertainty in global tropical rainfall estimates is 50 percent; TRMM data will reduce this uncertainty to 10 percent, an 80 percent improvement.

The QuikScat spacecraft, planned for launch in FY99, joins TRMM and the Ocean Topography

Experiment/Poseidon (TOPEX/Poseidon) as a major El Niño tracking asset. QuikScat will replace the NASA Scatterometer instrument that was lost in the failure of Japan's ADEOS spacecraft launched in 1997.

- The performance target will be to provide 25km resolution wind speed and direction measurements over at least 90 percent of the ice-free global oceans every two days. This represents a resolution increase of a factor of two, and a 15 percent increase in coverage over previous measurements.

Objective—Identify natural hazards, processes, and mitigation strategies for floods, droughts, and volcanoes

In FY99 the Earth Science Enterprise will provide the technology and instruments to allow collection of interferometric Synthetic Aperture Radar (SAR) data. This will enable the first consistent global topography data record collected from space, and will have a variety of applications including flood hazard assessment, laying out new roadways and pipelines, and providing airline operators with detailed elevation data for remote areas.

- The performance target will be to provide instruments sufficient to create the first digital topographic map of 80 percent of the Earth's land surface—everything between 60°N and 56°S.

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

In FY99 information on global and regional studies of temperature and precipitation drivers will be collected to measure the solar radiation reaching the 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 impact the Earth's energy balance. The Moderate Resolution Imaging Spectroradiometer (MODIS), the

Multi-Angle Imaging Spectroradiometer (MISR), and the Advanced Spaceborne Thermal Emission and Reflection Radiometer instruments will collect measurements on the EOS AM-1 spacecraft. This data 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 the Earth and its atmosphere. The current uncertainty in the Earth's radiation balance is about $5\text{W}/\text{m}^2$ monthly mean over $100 \times 100\text{km}$ areas.

- The performance targets for these instruments will be to:
 - Conduct daily observations of cloud properties such as extent, height, optical thickness, and particle size.
 - Map aerosol formation, distribution, and sinks over the land and oceans.
 - Achieve a 40 percent reduction in the uncertainty in the Earth's radiation balance.

Objective—Understand the causes of variation in ozone concentrations and distribution in the upper and lower atmosphere

The Enterprise will continue to collect and analyze data to contribute to the goals of the U.S. Global Change Research Program. NASA's contribution is to fly instruments that will map the fluctuations in ozone and related constituent gas in the atmosphere.

The Total Ozone Mapping Spectrometer (TOMS) will collect information of the ozone content as the total column of the Earth's atmosphere.

- The performance target will be to use new retrieval methods to collect and analyze three new data products, including surface UV, tropospheric aerosols, and, in certain regions, tropospheric columns. Together with SBUV/2 data, there will now be a continuous 20 data set for total ozone that will measure the ultimate effec-

tiveness of the Montreal Protocol on substances that deplete the ozone layer. These data are also useful in routing aircraft around areas of concentrated volcanic dust.

The Stratospheric Aerosol and Gas Experiment III (SAGE III) will be launched to provide measurements of the distribution of trace constituents, temperature, aerosols, and cloud presence.

- The performance targets will be to improve the collection and analysis of measurements provided by SAGE II. These improvements include: lunar occultation capability allowing for new nitrogen trioxide (NO_3) and chlorine dioxide (OCIO) measurements; additional wavelength sampling providing direct measurements and ability to retrieve aerosols throughout the troposphere; and appreciably higher spectral resolution allowing significantly improved distributions of water vapor and ozone in the upper troposphere and lower stratosphere. This represents approximately a two-thirds reduction in error in near-tropopause water vapor measurements, and extension of ozone measurements into mid-troposphere with 10 to 15 percent errors.

Measurements will be collected and analyzed from other atmospheric ozone programs.

- The performance targets will be to:
 - Complete the major model-measurement inter-comparison for atmospheric chemistry/transport models, emphasizing treatment of transport in two- and three-dimensional models.
 - Complete the detailed multi-aircraft study of troposphere chemistry over the tropical Pacific Ocean, especially the contribution of long-range transport of air from South America and Africa to otherwise unpolluted areas.
 - Measure surface levels of chlorine- and bromine-containing chemical compounds

addressed under the Montreal Protocol to document the decreasing concentrations of the regulated compounds and the rising concentrations of their replacements to quantify the decrease in total halogen abundance in the lower atmosphere.

Objective—Improve dissemination of Earth Science research results

The dissemination of information resulting from Earth Science research is accomplished through the Earth Observing System Data and Information System (EOSDIS), and will be a high priority in FY99. 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:
 - Make available data on prediction, land surface, and climate to users within five days.
 - Double the volume of data archived compared to FY97.
 - Increase the number of distinct customers by 20 percent compared to FY97.
 - Increase products delivered from the Distributed Active Archive Centers by 10 percent compared to FY97.

Objective—Incorporate education and enhanced public understanding of science as an integral component of Earth Science missions and research

Earth 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 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 research grants and 20 early career fellowships in Earth Science.

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 to national and international scientific environmental assessments.

- The performance targets will be to make significant contributions to two national and two international assessments, including:
 - Atmospheric Effects of Aviation, in collaboration with the Federal Aviation Administration
 - U.S. regional/national assessment(s) in partnership with USGCRP agencies
 - World Meteorological Organization (WMO) Ozone Assessment
 - Intergovernmental Panel on Climate Change (IPCC) Assessment Report, sponsored by the United Nations Environment Programme and WHO

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

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 an 80 percent reduction in mass for future land imaging instruments.

- Demonstrate a new capability to double the calibration quality for moderate resolution land imagery.

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

- The performance target will be to establish at least five new Regional Earth Science Applications Centers.

NASA is committed to providing technical assistance and advice to companies developing the commercial remote-sensing market opportunities.

- The performance target will be to establish at least 75 commercial partnerships in “value-added” remote-sensing product development, an increase from 37 (100 percent) over FY97.

General Earth Science performance measure—Successfully launch spacecraft

- The Earth Science Enterprise will successfully launch four spacecraft, within 10 percent of budget on average.

External Assessment

The Earth Science Advisory Committee of the NASA Advisory Council will conduct an annual assessment of the Enterprise's near-term science objectives. The Committee 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.

Earth Science—Chart 2

Agency Near-Term Goals	Earth Science Near-Term Goals	Objectives	Performance Targets
<ul style="list-style-type: none"> Develop lower cost missions: Characterize the Earth system with data, models, and analysis 	<p>Expand scientific knowledge by characterizing the Earth system</p>	<ul style="list-style-type: none"> Understand the causes and consequences of land-cover/land-use change Predict seasonal-to-interannual climate variations Identify natural hazards, processes, and mitigation strategies for floods, droughts, and volcanoes Detect long-term climate change, causes, and impacts Understand the causes of variation in ozone concentrations and distribution in the upper and lower atmosphere 	<ul style="list-style-type: none"> Successfully launch four spacecraft, within 10 percent of budget on average. Refresh the global archive of 30m land imagery from Landsat 7. Collect near-daily measurements of the terrestrial biosphere. Collect near-daily measurements of ocean color. Begin the second of a three-year sequence of instantaneous measurements of rainfall rates and monthly accumulations in the global tropics. The QuikScat spacecraft will provide wind speed and direction measurements over at least 90 percent of the ice-free global oceans every two days. The Enterprise will provide the technology and instruments to collect Synthetic Aperture Radar (SAR) data, which will provide data sufficient to create a digital topographic map of 80 percent of the Earth's land surface. Conduct daily observations of cloud properties such as extent, height, optical thickness, and particle size. Map aerosol formation, distribution, and sinks over the land and oceans. Achieve a 40 percent reduction in the uncertainty in the Earth's radiation balance. TOMS will use new retrieval methods to collect and analyze three new data products. SAGE III will provide measurements of the distribution of trace constituents, temperature, aerosols, and cloud presence. Complete the major model-measurement intercomparison for atmospheric chemistry/transport models. Complete the detailed multi-aircraft study of tropospheric chemistry over the tropical Pacific Ocean. Measure surface levels of chlorine- and bromine-containing chemical compounds addressed under the Montreal Protocol.
<ul style="list-style-type: none"> Develop and transfer cutting-edge technologies Share new knowledge with our customers and contribute to educational excellence 	<ul style="list-style-type: none"> Disseminate information about the Earth System 	<ul style="list-style-type: none"> Improve dissemination of Earth Science research results Incorporate education and enhanced public understanding of science as an integral component of Earth Science missions and research 	<ul style="list-style-type: none"> Make available data on prediction, land surface, and climate users within five days. Double the volume of data archived compared to FY97. Increase the number of distinct customers by 20 percent. Increase products delivered from the DAACs by 10 percent. Award 50 new graduate student research grants. Award 20 early career fellowships in Earth Science.
<ul style="list-style-type: none"> Stimulate the application of NASA technology in the private sector and promote commercial use of space 	<ul style="list-style-type: none"> Enable the productive use of Earth Science and technology in the public and private sectors 	<ul style="list-style-type: none"> Make major scientific contributions to national and international environmental assessments Develop innovative technologies for Enterprise missions and for transfer to external customers Extend the used Earth Science research to national, state, and local applications 	<ul style="list-style-type: none"> Contribute to the Atmospheric Effects of Aviation. Contribute to the U.S. regional/national assessment(s) in partnership with USGCRP agencies. Contribute to the World Meteorological Organization Ozone Assessment. Contribute to the Intergovernmental Panel on Climate Change Report. Achieve an 80 percent reduction in mass for a future land imaging instruments. Demonstrate a new capability to double the calibration quality for moderate resolution land imagery. Establish at least five new Regional Earth Science Applications Centers. Establish 75 commercial partnerships in "value-added" remote sensing product development.

Human Exploration and Development of Space Enterprise

Mission

The Human Exploration and Development of Space (HEDS) Enterprise mission is to open the space frontier by exploring, using, and enabling the development of space to expand human experience into the far reaches of space. The Enterprise mission includes the development of innovative technologies to support HEDS programs and make them available for other applications 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 HEDS Enterprise strategy is implemented by two program offices: the Office of Space Flight (OSF) and the Office of Life and Microgravity Sciences and Applications (OLMSA).

The OSF strategy to contribute to the HEDS mission consists of three major components: safety and performance upgrades; Space Shuttle operations; and initiating the assembly of the International Space Station (ISS). Safety and performance upgrades provide for the modifications and improvements of ground facilities and Space Shuttle capabilities, replacement of obsolete systems, and 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 ISS begins with Phase II of the program. This phase begins with the scheduled launch of the U.S.-owned/ Russian-launched functional cargo block

(FGB) in 1998 and concludes with the launch of the Airlock on Flight 7A in 1999.

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 following budget for FY99 to FY03 to support the accomplishment of HEDS goals:

<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>	<u>FY 02</u>	<u>FY 03</u>
5753.0	5569.0	5422.0	5194.0	4979.0

Performance Measures

To meet the near-term goals displayed in Chart 3, the following objectives will be measured:

Objective—Enable the research community to use gravity as an experimental variable

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 to maintain competitiveness for space biological and physical science research. This partnership also supports technologies to improve U.S. competitiveness in these areas of research. Examples include glasses, ceramics, polymers, and biologically inspired “smart” materials.

- The performance targets will be to:
 - Expand the number of sponsored investigations to 795, a 9 percent increase over 1998.
 - Publish at least 90 percent of the research data sponsored by HEDS and make it accessible on the Internet.

NASA will establish a new National Center for Evolutionary Biology. The Center will lead a national research effort on the evolution of mechanisms that sense gravity, and developmental mechanisms by which multicellular organisms orient themselves with respect to gravity. The Center will also focus on the study of the interaction of gravity with the evolution of life. The Life Sciences Division of the Office of Life and Microgravity Sciences and Applications will lead this effort and will involve the Office of Space Sciences and the Office of Earth Sciences so NASA will assume a national leadership role in evolutionary biology that is clearly integrated and coordinated among different program offices.

- The performance target will be to establish an integrated NASA-wide program in evolutionary biology led by the National Center for Evolutionary Biology with participation of at least 5 research institutions and engaging at least 20 investigators

NASA and the National Institutes of Health (NIH) selected a series of space flight experiments to use the microgravity environment to investigate fundamental aspects of the nervous system in a microgravity environment, and to advance our understanding of changes in the nervous system function in space. Designated the Neurolab program, this work is part of the Federal Government's activities for the Decade of the Brain (1990–1999) and will lay the groundwork for NASA-NIH cooperative research on the ISS.

The Neurolab will be launched on the Space Shuttle in 1998 on STS-90, and will perform

international research in brain function and behavior. Experiments will include studies on blood pressure control; sleep and wake cycles regulation; posture, balance, and coordination; and developmental neurobiology. New experimental technologies will be introduced to support this research. The Neurolab program will contribute to improving the clinical diagnosis of balance disorders and sleep abnormalities in addition to providing new fundamental knowledge of how the nervous system develops, processes information, and changes in response to stimuli.

- The performance targets will be to:
 - Demonstrate and utilize, for the first time in space, state-of-the-art techniques on Neurolab to understand the function of the nervous system.
 - Compare responses of at least three different biological models to understand the influence of gravity on the normal development of the nervous system.
 - Define the time course of adaptations in the balance system to altered gravitational environments.

One of the goals of the Shuttle-Mir Research Program is to conduct peer-reviewed, precursor scientific research in preparation for the ISS. Research conducted on Mir missions will increase the understanding necessary to develop effective countermeasures that may be implemented on the ISS. Mir experience indicates the current countermeasures were not effective in maintaining crew bone and muscle.

The Mir radiation project indicated the South Atlantic Anomaly (SAA) moved 250 miles north and west since the early 1970's. The research showed flight crews received 90 percent of the radiation doses during the short time the spacecraft is in the SAA.

Mir plant research demonstrated that some species of plants can successfully grow and develop in microgravity. In a Mir plant growth unit, a radish-type plant grew from a seed, produced new seeds, and new plants were grown from the space-produced seeds.

The Mir missions have also provided insight into long-duration cell tissue culturing, and has proven novel technologies to increase the number of protein crystal samples which can be accommodated in a standard growth chamber by up to a factor of 30.

- The performance targets will be to:
 - Analyze data from Mir to achieve:
 - a one crew year “jump-start” for ISS biomedical and countermeasures research.
 - a one crew year “jump-start” for ISS fundamental biology and regenerative life support research.
 - a three crew year “jump-start” for cell culture and protein crystal growth research.
 - Analyze radiation research data from Mir and incorporate findings into planning for EVA activities on the ISS to minimize crew exposure.

The Microgravity Science Laboratory (MSL-1) and MSL-1 reflight carried major NASA-developed instruments for research in combustion science and fluid physics, and utilized German-developed hardware to conduct research in materials science. Analysis of the mission has produced revolutionary data to improve our understanding of combustion and soot formation processes. This understanding is important because 85 percent of U.S. energy is produced through combustion processes. Combustion is also a major contributor to pollution which affects health.

One major problem in foundry technology is controlling the microstructure of a casting by controlling

the rate of new solid particles (nucleation rate) formation as the liquid metal cools and subsequently freezes. Experiments processed in MSL-1’s unique, German-developed levitating furnace facility yielded the first measurements of specific heat and thermal expansion of glass-forming metallic alloys. These measurements—never taken on Earth before—are fundamental measurements necessary for modeling industrial materials systems needed to manufacture new and better products. The Physics of Hard Sphere experiment, which examined changes that occur during transition of a substance from liquid to solid and solid to liquid, offered insights into phenomena which could improve the design of metallic alloys and processing techniques. Questions addressed by the Physics of Hard Sphere experiment include:

- What is the volume fraction at which dispersions of hard spheres freeze, melt, and become glasses?
- What is the equilibrium structure associated with each phase?
- What are the dynamics of Brownian fluctuations within each phase?
- What are the kinetics of the nucleation and growth of the crystalline phase?

- The performance targets will be to:
 - Improve our predictive capabilities of soot processes by at least 50 percent through the analysis of MSL-1 data.
 - Use the MSL-1 results to eliminate one of the three primary fluid flow regimes (laminar) from consideration by casting engineers for enhancing nucleation rate to form castings with a finer microstructure (which provides the basis for such desired properties as strength and toughness).
 - Use the data obtained by fluid physics experiments on suspensions of colloidal particles on MSL-1 to answer fundamental questions in

condensed matter physics regarding the transition between liquid and solid phases.

- Publish the data to update physics textbooks.

Objective—Improve Space Shuttle program operations by safely flying the manifest and aggressively pursuing a systems upgrade program

The Space Shuttle program will continue the Safety and Performance Upgrades program. Phase 1 upgrades are designed to improve safety and performance that 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.

- The performance targets will be to:
 - Achieve seven or fewer flight anomalies per mission.

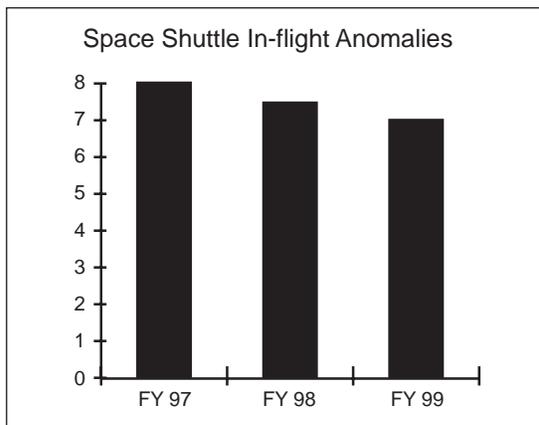


Figure 5

- Achieve 85 percent on-time, successful launches (excluding the risk of weather).

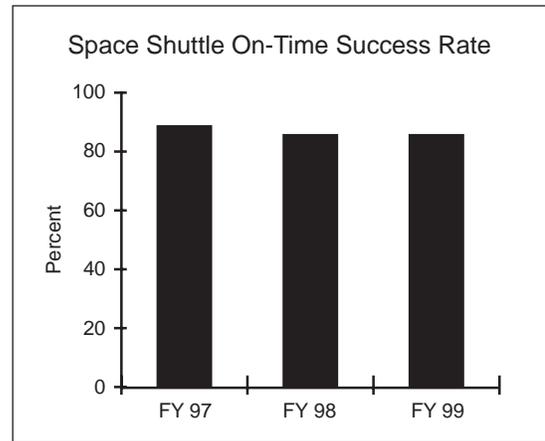


Figure 6

- Achieve a 13-month flight manifest preparation time.

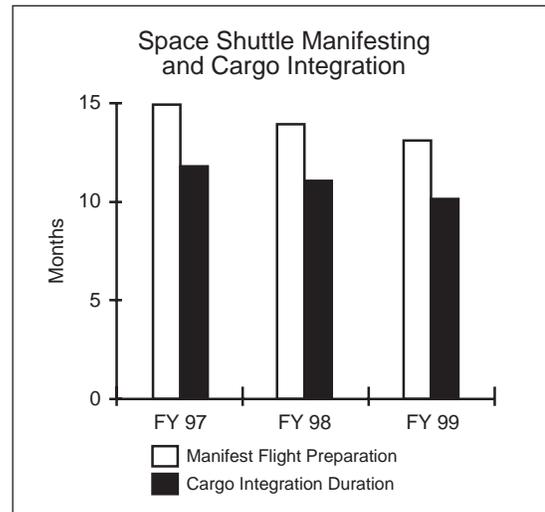


Figure 7

- Achieve a 60 percent increase in predicted reliability of the Space Shuttle over 1995.

Objective—Deploy and operate the ISS for research, engineering, and exploration activities

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 the conduct of long-duration scientific research, technology demonstrations, and the capabilities for the commercial development of space. Space Station 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. Assuming all partners meet their commitments, the assembly of ISS will continue on schedule in FY99.

- The performance targets will be to:
 - Deploy the Service Module.
 - Deploy the U.S. Laboratory Module.
 - Establish a 3-person human presence on the ISS.
 - Establish an initial ISS research capability.

Plans are under way to evaluate our ability to deploy payloads (such as human research, biotechnology, glovebox-type microgravity research) as early as possible during the Phase II of the ISS. Lessons learned from Phase I will be incorporated into this process. Special attention will be given to foster the commercial activities.

- The performance targets will be to:
 - Complete the integration of the first EXPRESS rack with five payloads, and prepare the rack for launch at the beginning of fiscal year 2000.
 - Complete preparations for the launch of the first rack of the Human Research Facility and the Window Observational Research Facility on the first utilization flight.

Objective—Ensure the health, safety, and performance of space flight crews

The National Space Biomedical Research Institute has been established by a consortium of seven universities to lead world-class space biomedical research to support HEDS. The Institute will undertake research on countermeasures and procedures to minimize the deleterious effects of space flight on the human body.

- The performance target will be to complete the development of countermeasure research protocols, and begin testing a minimum of three countermeasures intended to protect bone, muscle, and physical work capacity.

Objective—In partnership with the Space Science Enterprise, carry out an integrated program of robotic exploration of the solar system to characterize the potential for human exploration and development

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 to determine the feasibility and need for human missions of exploration of the solar system. In FY99 this collaboration will focus radiation and soil/dust research on robotic missions to Mars while evaluating options to increase mission efficiency for both robotic and human missions, especially options to reduce launch mass. For example, calculations have shown that *in-situ* propellant production has the potential to significantly reduce (20–25 percent) launch mass requirements. Radiation hazards to human space flight in deep space have not been quantified. New combinations of materials, each possessing favorable performance-related characteristics (shielding, structural, etc.), may markedly improve synergistic possibilities for reduced launch mass.

Understanding and controlling flow and properties of particulates and granular materials has applications, from predicting rock slides and earthquakes to designing process operation for ores and polymer pellets. It is also important for future exploration missions to the Moon and Mars for developing protective measures against the ubiquitous Martian dust, ore beneficiation, and handling of soil for *in-situ* resource utilization.

- The performance targets will be to:
 - Initiate a collaborative program to design and develop radiation and soil/dust measuring devices.
 - Plan for demonstration of *in-situ* propellant production.

Objective—Explore and invest in enabling cross-cutting technology and studies that can affordably open up the frontiers for human space exploration where there is a compelling rationale for human involvement

HEDS will continue studying options for human exploration in support of the National Space Policy. 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. 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, communication, and navigation, and will apply to 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 targets will be to:
 - Evaluate options and define the exploration technology investment plan.
 - Use ground test, the Space Shuttle, and the ISS to demonstrate advanced technologies, including a biological water processor that can dramatically reduce resupply mass (by at least one metric ton per year) and a new electronic sensor on a chip capable of real-time continuous toxicological measurements that can replace multiple chemical monitors while reducing required mass, power, and crew time by at least a factor of ten.

Objective—Promote investments in commercial assets as pathfinders in ISS commercial operations and reduce the cost of Space Shuttle operations through privatization, eventual commercialization, and flying payloads

NASA is pursuing a capability to transfer the operation of the Space Shuttle and 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:
 - Complete development of a commercialization plan for the ISS and Space Shuttle in partnership with the research and commercial investment communities and define and recommend policy and legislative changes.
 - Attract private capital (\$250M) to establish an improved logistics and research capability for the Space Shuttle.

Objective—Reduce space communications and operations costs through privatization and eventual commercialization

HEDS is committed to the commercialization of operation services as directed in the National Space Policy. HEDS will also collaborate with other Strategic Enterprises, agencies, industries, and international partners to develop commercial initiatives.

- The performance targets will be to:
 - Reduce space communications operations costs by 30 to 35 percent compared to 1995, through a consolidated space communications contract to meet established budget targets.
 - Develop options and recommendations to commercialize space communications through a Federal Government corporation.

Objective—Foster consortia of industry, academia, and government; leverage funding, resources, and expertise to identify and develop commercial space opportunities

HEDS facilitates industry's use of space to develop competitive products which contribute to the Nation's economic growth. This program, which combines NASA and industry research and devel-

opment 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, and in-kind industry personnel, equipment, and materials to facilitate commercial space research.

- The performance targets will be to:
 - Increase industry investment in space research from \$35 million in FY96 to at least \$50 million in FY99—a 40 percent increase.
 - Establish two new Commercial Space Centers: one for food technology and one for environmental systems, each with a minimum of five affiliates and with contributions from affiliates at least equal to NASA's contribution.

Objective—Involve our Nation's citizens in the adventure of exploring space and transfer knowledge and technologies to enhance the quality of life on Earth

HEDS will implement the ISS outreach and education plan, support NASA educational activities, maintain information pages on the Internet, and conduct annual ISS video conferences for students and professional audiences. HEDS will contribute education and outreach support by developing appropriate curriculum to 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 targets will be to:
 - Initiate a curriculum development program, in partnership with the ITEA, for gravity-related educational modules for national distribution which

meet the current NSTA National Standards for Science for grades K–12 and the ITEA National Standards for Technology Education scheduled to be published in June 1999.

- Expand the microgravity research program World Wide Web-based digital image archive established in 1998 by 50 percent.

HEDS research is directed toward maintaining the health and performance of space crews. Research into procedures and technologies to monitor health and provide care in remote and hostile environments is conducted. This research results in improved and efficient systems which can be easily adapted to Earth's environments.

- The performance targets will be to:
 - Conduct at least two demonstrations of the applicability of the "Telemedicine Instrumentation Pack" for health care delivery to remote areas.
 - Demonstrate the application of laser light scattering technology for early detection of eye-tissue damage from Diabetes.

External Assessment

The appropriate subcommittees of the NASA Advisory Council will conduct annual assessments of the progress made by the HEDS Enterprise in achieving its near-term objectives. These committees 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.

Human Exploration and Development of Space—Chart 3

Agency Near-Term Goals	HEDS Near-Term Goals	Objectives	Performance Targets
<p>Use the environment of space to expand scientific knowledge</p>	<ul style="list-style-type: none"> Explore the role of gravity in physical, chemical, and biological processes 	<ul style="list-style-type: none"> Enable the research community to use gravity as an experimental variable 	<ul style="list-style-type: none"> Publish at least 90 percent HEDS sponsored research data; make it accessible on the Internet. Expand the number of sponsored investigations to 795. Establish an integrated NASA-wide program in evolutionary biology led by the National Center for Evolutionary Biology. Demonstrate and utilize for the first time state-of-the-art techniques on NeuroLab to understand the function of the nervous system. Compare responses of at least three different biological models to understand the influence of gravity on the nervous system. Define the time course of adaptations in the balance system to altered gravitational environments. Analyze data from Mir to achieve: <ul style="list-style-type: none"> a one crew year "jump-start" for ISS biomedical and countermeasures research. a one crew year "jump-start" for ISS fundamental biology and regenerative life support research. a three crew year "jump-start" for cell culture and protein crystal growth research. Analyze radiation research data from Mir and incorporate findings into planning for EVA activities on ISS to minimize crew exposure. Improve our predictive capabilities of soot processes by at least 50 percent through the analysis of MSL-1 data. Use the MSL-1 results to eliminate one of three primary fluid flow regimes from consideration by casting engineers. Use the data obtained by fluid physics experiments on suspensions of colloidal particles on MSL-1 to answer fundamental questions in condensed matter physics.
<p>Enable humans to conduct unique <i>in-situ</i> research and development for scientific, engineering, and commercial applications</p>	<p>Continue to open and develop the space frontier:</p> <ul style="list-style-type: none"> Develop and assemble the International Space Station and utilize it to advance scientific, exploration, engineering, and commercial activities Provide safe and affordable human access to space 	<ul style="list-style-type: none"> Improve Space Shuttle program operations by safely flying the manifest and aggressively pursuing a systems upgrade program Deploy and operate the ISS for research, engineering, and exploration activities Ensure the health, safety, and performance of space flight crews 	<ul style="list-style-type: none"> Achieve seven or fewer flight anomalies per mission. Achieve 85 percent on-time, successful launches. Achieve a 13-month flight manifest preparation time. Achieve a 60 percent increase in predicted reliability of the Space Shuttle. Deploy the Service Module, and the U.S. Laboratory Module; establish a three-person human presence; and establish initial ISS research capability. Complete integration for the first EXPRESS rack with five payloads ready for launch at the beginning of fiscal year 2000. Complete preparations for the launch of the first rack of the Human Research Facility and the Window Observational Research Facility on the first utilization flight. Complete the development of countermeasure research protocols, and begin testing a minimum of three countermeasures intended to protect bone, muscle, and physical work capacity.

Human Exploration and Development of Space—Chart 3 (continued)

Agency Near-Term Goals	HEDS Near-Term Goals	Objectives	Performance Targets
<p>Advance human exploration of space by successfully conducting robotic missions</p>	<p>Prepare to conduct human missions of exploration</p>	<ul style="list-style-type: none"> In partnership with the Space Science Enterprise, carry out an integrated program of robotic exploration of the solar system to characterize the potential for human exploration and development Explore and invest in enabling cross-cutting technology and studies that can affordably open up the frontiers for human space exploration where there is a compelling rationale for human involvement 	<ul style="list-style-type: none"> Initiate a collaborative program to design and develop radiation and soil/dust measuring devices. Plan for demonstration of <i>in-situ</i> propellant production. Evaluate options and define exploration technology investment plan. Demonstrate advanced technologies, including a biological water processor and a new electronic sensor on a chip capable of real-time continuous toxicological measurements.
<p>Stimulate the application of NASA knowledge and technology in the private sector and promote the commercial use of space</p>	<p>Aggressively seek investment from the private sector:</p> <ul style="list-style-type: none"> Increase the affordability of space operations through privatization and commercialization Share HEDS knowledge, technologies, and assets that promise to enhance the quality of life on Earth 	<ul style="list-style-type: none"> Promote investments in commercial assets as pathfinders in ISS commercial operations and reduce the cost of Space Shuttle operations through privatization, eventual commercialization, and flying payloads Reduce space communications and operations costs through privatization and eventual commercialization Foster consortia of industry, academia, and government; leverage funding, resources, and expertise to identify and develop commercial space opportunities Involve our Nation's citizens in the adventure of exploring space and transfer knowledge and technologies to enhance the quality of life on Earth 	<ul style="list-style-type: none"> Complete development of a commercialization plan for the ISS and Space Shuttle in partnership with the research and commercial investment communities. Attract \$250M in private capital to establish an improved logistics and research capability for the Space Shuttle. Reduce space communications operations costs by 30 to 35 percent through a consolidated space communications contract. Develop options and recommendations to commercialize space communications through a Federal Government corporation. Increase industry investment in space research to \$50M in FY99. Establish two new Commercial Space Centers: one for food technology and one for environmental systems. Initiate a curriculum development program in partnership with ITEA for gravity-related educational modules. Expand the microgravity research program World Wide Web-based digital image archive established in 1998 by 50 percent. Conduct two "Telemedicine Instrumentation Pack" demonstrations. Demonstrate the application of laser light scattering technology for early detection of eye-tissue damage from diabetes.



Aeronautics and Space Transportation Technology Enterprise

Mission

The Aeronautics and Space Transportation Technology (ASTT) 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. Designated Lead Centers have been assigned the responsibility to manage the implementation and execution phases of the technology programs. Enterprise objectives are outcome-focused and “stretch” beyond our current knowledge base. The investment strategies are focused on issues associated with future aviation and space systems. The outcome-focused nature of the goals and objectives project a preferred end-state within the air and space transportation systems. Enterprise programs are often conducted in cooperation with other Federal agencies, primarily the Federal Aviation Administration and the Department of Defense. These partnerships take advantage of

the national investment in aeronautics and astronautics facilities and eliminate unnecessary duplication.

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

Enterprise Resource Requirements

The President has requested the following budget for FY99 to FY03 to support the accomplishment of ASTT goals:

<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>	<u>FY 02</u>	<u>FY 03</u>
1305.0	1092.0	1026.0	1057.0	1071.0

Performance Measures

To meet the near-term goals displayed in Chart 4, the following objectives will be measured:

Objective—Contribute to environmental compatibility

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 which could adversely affect the 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. Additional constraints are being solicited by the Committee on Aviation Environmental Protection (CAEP) 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 impacting 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, 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 an advanced turbine-engine combustor that will achieve up to a 50 percent nitrogen oxide reduction for large commercial engines.

Objective—Contribute to aviation safety

International attention has been focused on increasing our understanding and developing solutions to a severe icing condition which has been implicated in a number of commuter aircraft icing incidents, including fatal crashes. In FY99, NASA and Canada will collaborate to complete flight tests in severe weather conditions to build a data base on Supercooled Large Droplets (SLD). This data base is important to understand severe icing factors in extreme cold temperatures. The FAA does not have this type of information for its current certification program. The NASA-Canadian initiative will provide the FAA with data for a new certification envelope.

- The performance targets will be to collect data to:
 - Characterize the SLD icing environment.
 - Characterize the effect of SLD ice accumulation on aircraft performance.
 - Acquire data to support the development of SLD weather forecast tools.

More lives are lost to controlled flight into terrain (CFIT) than any other forms of commercial aviation accident. The list of headline examples are numerous. The typical CFIT accident scenario has no warning or indication of pilots perceiving any serious problems as they fly some segment of a land-

ing approach. Distractions or disbelief of available information have been cited as primary factors for CFIT accidents. While human error will continue to be a factor in CFIT accidents, new technologies that help with low-visibility conditions (bad weather, the darkness of night, and/or fog) will provide pilots with vital, real-time data and images. These technologies will come in “packages” that are both cost effective and well suited for several market segments. In FY99 ASTT will select and evaluate technology concepts to eliminate Controlled Flight Into Terrain (CFIT) accidents for both general aviation and transport category aircraft.

- The performance target will be to release a NASA Research Announcement for CFIT elimination concepts with early simulation and/or flight-test evaluation.

Objective—Advance high-speed research

Technology Configuration is the second of three major High Speed Research (HSR) program milestones. A complete vehicle system baseline, Technology Configuration will provide industry with a foundation to determine the technology requirements for the design and development of an environmentally compatible and economically competitive High Speed Civil Transport (HSCT). Studies indicate that over the next decade, the HSCT will result in 140,000 high-technology U.S. jobs and a \$200 billion market.

- The performance target will be to produce a complete vehicle system configuration document that includes the impact of technology validation efforts from 1990 through 1999. This document will support the evaluation of technology selection decisions for a future High Speed Civil Transport.

Objective—Revitalize general aviation

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 in FY99. The cost-sharing partnership with Teledyne Continental Motors and Williams International is focused on the development of a new piston engine that will reduce costs by 50 percent, increase the time between overhauls by 75 percent, and reduce specific fuel consumption by 25 percent, and the preflight ground test of a new turbofan engine that will 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 for the piston engine will be to:
 - Complete assembly of the first flight-ready test piston engine.
- The performance target for the turbofan engine will be to:
 - Complete pre-flight ground testing for the turbofan engine.

Objective—Develop experimental aircraft

ASTT's Industry/Government/University Environmental Research Aircraft and Sensor Technology (ERAST) Alliance supports Earth Science Enterprise activities where *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 targets will be to:
 - Conduct test flights to validate the proof-of-concept design for a solar electric remote piloted aircraft (RPA).

- Initiate the development of an RPA capable of achieving an operational altitude of 100,000 feet to complement satellite-based data. Current aircraft-based measurement capability is limited to approximately 75,000 feet.
- Initiate RPA flight demonstrations to validate the capability for science missions at 55,000 feet, which will provide the ability for extended, remote deployments to areas such as the polar regions that are not currently available due to human safety considerations.

Objective—Develop next-generation computational design tools

NASA continues to advance its High Performance Computing and Communications (HPCC) networking capabilities as part of the Federal HPCC program. ASTT's work on the Next Generation Internet will also improve network communications for the researchers of all disciplines. Benefits from this program include new computational advances such as this project, and capabilities in aeronautics, space transportation, Earth science, space science, and educational outreach.

- The performance targets will be to:
 - Demonstrate up to a 200-fold improvement over the 1992 baseline in time-to-solution for NASA's advanced applications on computational testbeds that can be increased to sustained TeraFLOPS (10^{12} floating point operations per second) capability.
 - Demonstrate communication testbeds with up to 500-fold improvement in end-to-end performance over the 1996 baseline.

Objective—Develop low-cost space launch technologies

The X-33 program is an effort to flight-demonstrate key technologies and deliver advancements in

propulsion, including a prototype engine and lighter, reusable cryogenic tanks. The program will also lead to application of New Millennium microelectronics for vastly improved reliability and vehicle health management. Improved ground and flight operations techniques will substantially reduce operations costs for a Reusable Launch Vehicle (RLV). With flight tests beginning in calendar year 1999 and to be completed by the end of FY 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 and will meet the following operational requirements: validation of key aerothermodynamic environments to reduce 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 full-scale development of an operational RLV.

- The performance target will be to complete the X-33 vehicle assembly in preparation for flight testing and demonstrate key technologies for reducing the cost of space transportation.

The X-34 program will demonstrate technologies necessary for a reusable vehicle, but will not be a commercially viable vehicle itself. 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 (25 flights per year), autonomous flight operations, safe abort

capability, landing in cross winds up to 20 knots, flights through rain and fog, and a recurring flight cost of \$500,000 or less.

- The performance targets will be to begin flight tests of the X-34 and demonstrate key technologies for reducing the cost of space transportation.

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

The ASTT Research Centers provide American industry and academic personnel with world-class research facilities, such as wind tunnels and advanced computational devices. ASTT 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 aggregate deliverables within three months of schedule.

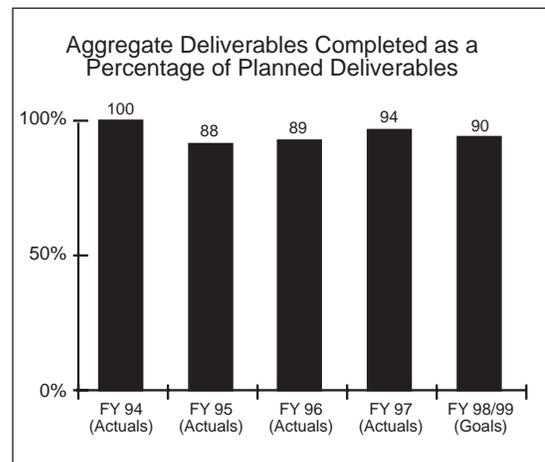


Figure 9

- Achieve a facility utilization customer satisfaction rating of 95 percent of respondents at “five” or better and 80 percent at “eight” or better based on exit interviews. (Figure 10)
- Achieve an overall Enterprise customer satisfaction rating of 90 percent of respondents at “five” or better and 30 percent at “eight” or better in the Triennial Customer Satisfaction Survey. (Figure 11)

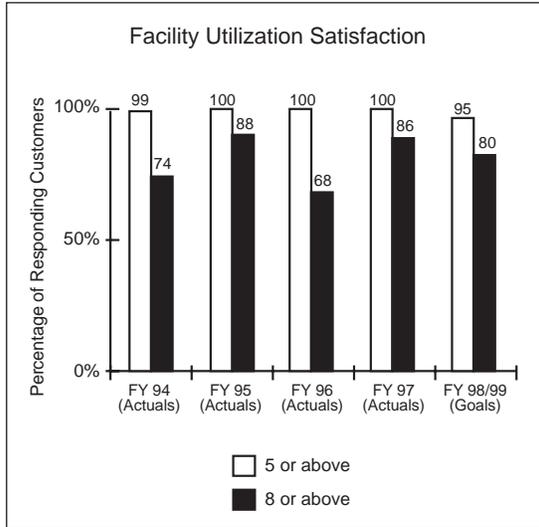


Figure 10

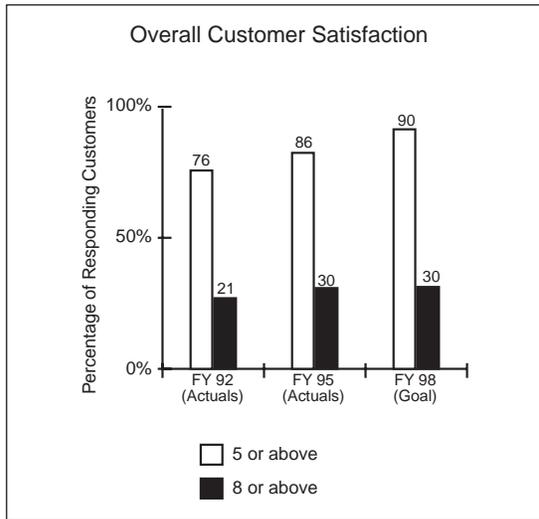


Figure 11

- Transfer at least 10 new technologies and processes to industry during the fiscal year.

ASTT 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. The Enterprise uses a Mobile Aeronautics Education Laboratory to demonstrate technology applications for education. This mobile trailer is equipped with lesson plans and software that are used at schools, conferences, and Aeronautics Research Centers. The Enterprise also makes extensive use of the Internet to share educational material in the areas of science, mathematics, and technology with teachers and students

- The performance targets will be to:
 - Facilitate the replication of the Mobile Aeronautics Education Laboratory contents in at least three new sites (educational institutions, museums, science centers, etc.) in the United States during the year.
 - For all new program activities initiated in FY99, 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.

External Assessment

The Aeronautics and Space Transportation Technology Committee of the NASA Advisory Council will conduct annual assessments of the progress made by the ASTT Enterprise in achieving its near-term technology objectives. This committee 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.

Aeronautics and Space Transportation Systems—Chart 4

Agency Near-Term Goals	ASTT Near-Term Goals	Objectives	Performance Targets
<p>Cooperate with industry and other agencies to develop affordable technologies for U.S. leadership in the aviation markets of the 21st century</p>	<p>Global Aviation—Enable U.S. leadership in global civil aviation through safer, cleaner, quieter, and more affordable air travel</p>	<ul style="list-style-type: none"> Contribute to environmental compatibility Contribute to aviation safety 	<ul style="list-style-type: none"> Demonstrate an advanced turbine-engine combustor. Characterize the Supercooled Large Droplets (SLD) icing environment performance. Acquire data to support the development of SLD weather forecast tools. Release NASA Research Announcement for Controlled Flight Into Terrain (CFIT) elimination concepts with early simulation and/or flight-test evaluation.
<p>Develop and transfer cutting-edge technologies.</p> <ul style="list-style-type: none"> Provide new technologies, processes, world-class facilities, and services and make aeronautics and space programs more affordable 	<p>Revolutionary Technology Leaps—Revolutionize air travel and the way in which aircraft are designed, built, and operated</p>	<ul style="list-style-type: none"> Advance high-speed research Revitalize general aviation Develop experimental aircraft Develop next-generation computational design tools 	<ul style="list-style-type: none"> Complete the Technology Configuration, the second of three High Speed Research program milestones. Complete assembly of the first flight-ready piston engine. Complete preflight ground testing for the turbofan engine. Conduct test flights to validate the proof-of-concept design for a solar electric remote piloted aircraft (RPA). Initiate the development of a RPA capable of achieving an operational altitude of 100,000 feet. Initiate RPA flight demonstrations to validate the capability for science missions at 55,000 feet. Demonstrate up to a 200-fold improvement over the 1992 baseline in time-to-solution for NASA's advanced applications on computational testbeds. Demonstrate communication testbeds with up to 500-fold improvement over the 1996 baseline.
<p>Develop and transfer cutting-edge technologies (e.g., develop and demonstrate an RLV)</p>	<p>Access to Space—Enable the full commercial potential of space and expansion of space research and exploration</p>	<ul style="list-style-type: none"> Develop low-cost space launch technologies 	<ul style="list-style-type: none"> Complete the X-33 in preparation for flight testing. Begin flight tests of the X-34 and demonstrate key technologies for reducing the cost of space transportation.
<p>Develop and transfer cutting-edge technologies.</p> <ul style="list-style-type: none"> Provide new technologies, processes, world-class facilities, and services 	<p>Research and Development (R&D) Services—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</p>	<ul style="list-style-type: none"> Provide world-class aerospace research and development services, facilities, and expertise 	<ul style="list-style-type: none"> Complete 90 percent of Enterprise aggregate deliverables within three months of schedule. Achieve a facility utilization customer satisfaction rating of 95 percent. Achieve an overall Enterprise customer satisfaction rating of 90 percent. Transfer at least 10 new technologies and processes to industry. Facilitate the replication of the Mobile Aeronautics Education Laboratory. For all new program activities initiated in FY99, develop an education outreach plan, which includes and results in an educational product.

Manage Strategically

Goal

This process coordinates the Strategic Management System by which the Agency develops the plans, implementation strategies, and evaluation processes to achieve NASA's goals. This process provides policy direction and implementation guidelines to NASA's organizational elements and employees as they develop, conduct, and evaluate programs central to the Agency's vision. The goal of this process is to verify that management decisions and resource allocations are aligned with national policies and statutes, Agency plans, and budget guidelines.

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 National Performance Review established a Governmentwide goal to reduce the size of the Federal workforce to the level of 1960.

- The performance targets for functions related to human resources will be to:
 - Reduce the Civil Service workforce level to below 19,000.

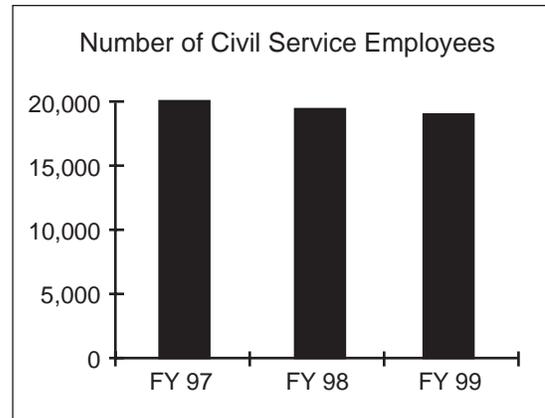


Figure 12

- Maintain a diverse NASA workforce through the downsizing efforts (Figure 13).
- Reduce the number of Agency lost workdays (due to occupational injury or illness to NASA personnel) by 5 percent from the FY94–96 3-year average.

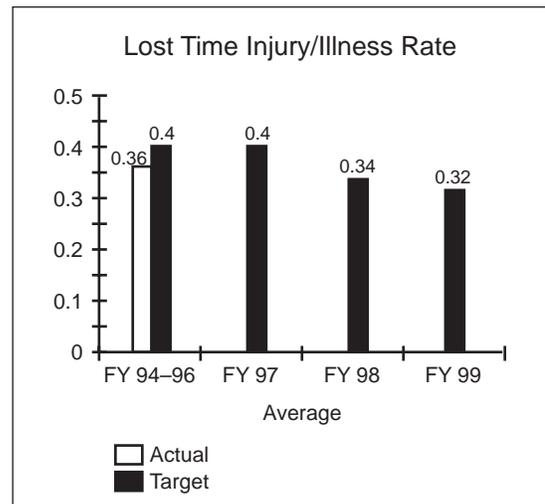


Figure 14

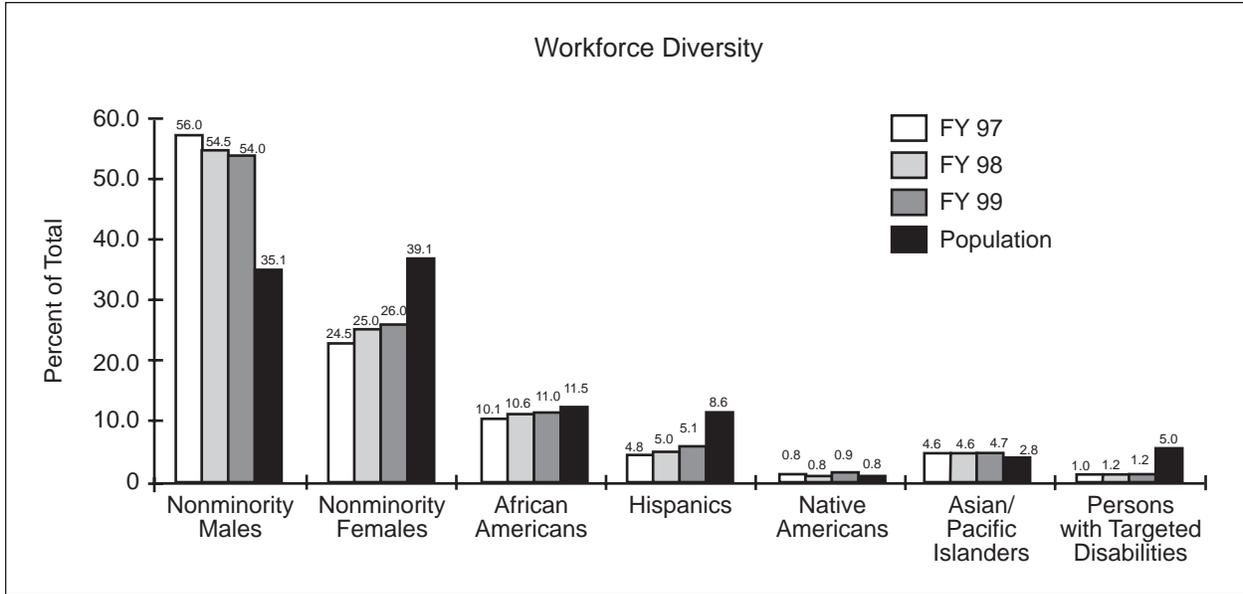


Figure 13

Functional and staff offices maintain capabilities to improve the effectiveness and efficiency of Agency management systems that contribute to the “faster, better, cheaper” approach.

- The performance targets will be to:
 - Achieve a 5 percent increase in physical resource costs avoided through alternate investment strategies from the previous year.

- Achieve 70 percent or greater of resource authority obligated within the fiscal year.

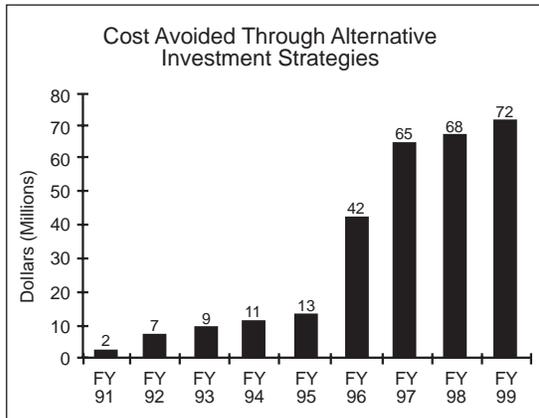


Figure 15

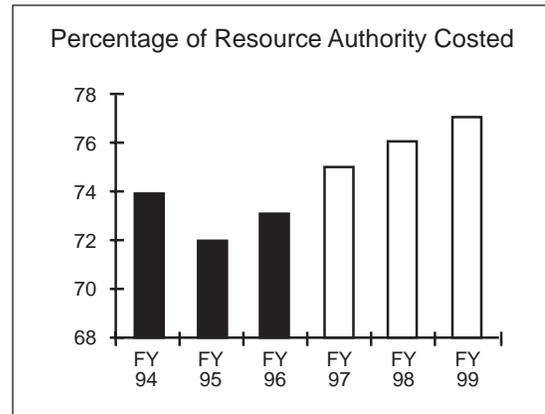


Figure 16

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

- The performance targets will be to:
 - Increase obligated funds available for Performance-Based Contracts (PBC) to 80 percent. “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.

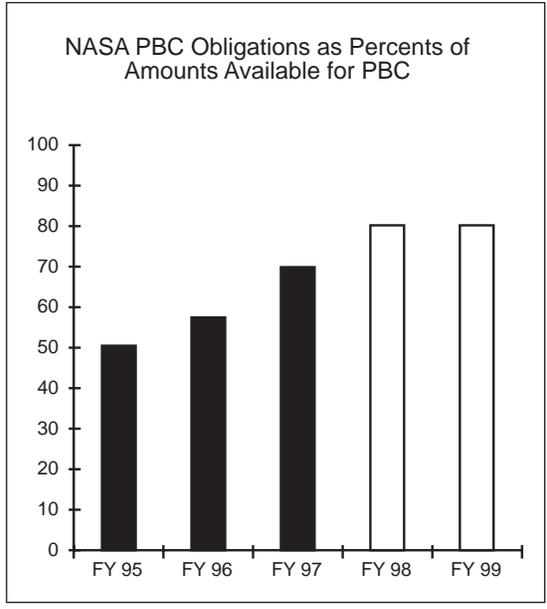


Figure 17

- 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 Historically Black Colleges and Universities, other minority institutions, and women-owned small businesses.

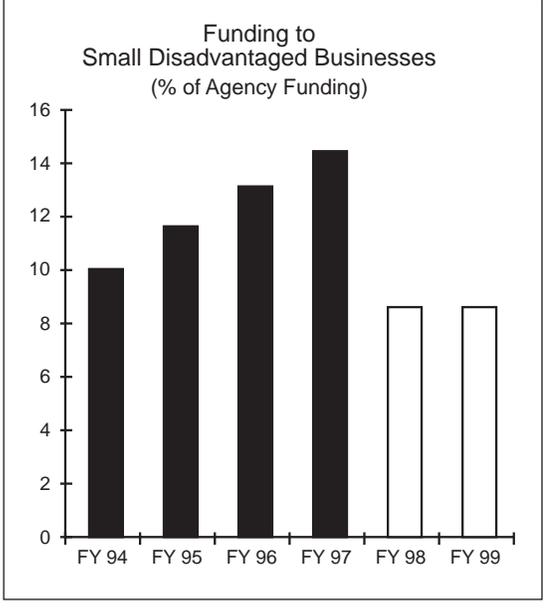


Figure 18

Objective—Improve information technology capability and services

- The performance target will be to improve Information Technology return on investment and customer satisfaction by maintaining a positive return on investment and a “Satisfactory” rating from IT customers.

Manage Strategically Process—Chart 5

<p>Manage Strategically—Goal</p>	<p>Objectives</p>	<p>Performance Targets</p>
<p>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</p>	<ul style="list-style-type: none"> • Optimize investment strategies and systems to align human, physical, and financial resources with customer requirements, while ensuring compliance with applicable statutes and regulations • Improve 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 	<ul style="list-style-type: none"> • Reduce the Civil Service workforce level to below 19,000. • Maintain a diverse NASA workforce through the downsizing efforts. • Reduce the number of Agency lost workdays by 5 percent • Achieve a 5 percent increase in physical resource costs avoided through alternate investment strategies. • Achieve 70 percent or greater of resource authority obligated. • Increase obligated funds available for Performance-Based Contracts (PBC) to 80 percent. • Achieve at least the 8 percent goal for funding to small disadvantaged businesses. • Improve Information Technology return on investment and customer satisfaction by maintaining a positive return on investment and a "Satisfactory" rating from IT customers.

Provide Aerospace Products and Capabilities

Goals

This process is the means by which NASA's Strategic Enterprises and their Centers deliver systems (ground, aeronautics, 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 extend broadly the technology, research, and science benefits from NASA programs to the public and commercial sectors.

Performance Measures

To meet the near-term goals displayed in Chart 6, the following objectives will be measured:

Objective—Meet schedule and cost commitments

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—Ensure the availability of NASA's spacecraft and facilities

- The performance target will be to keep, on average, operating time lost to unscheduled downtime for NASA spacecraft and facilities to less than 10 percent of total scheduled possible operating time.

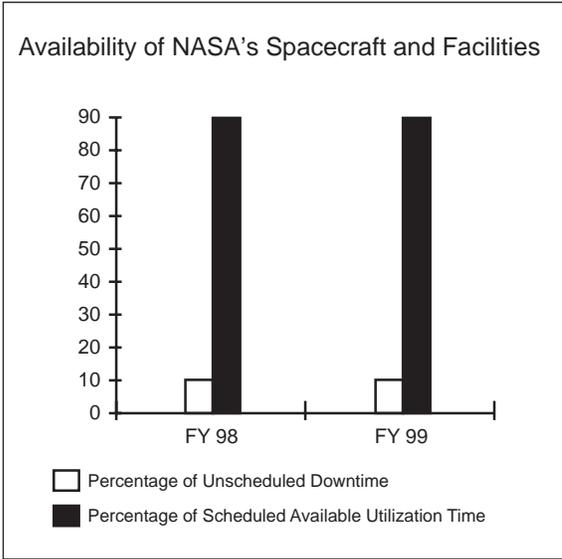


Figure 19

Objective—Reduce mission cost and development time

The “faster, better, cheaper” approach attempts to reduce spacecraft development time and costs.

- The performance targets will be to:
 - Reduce average spacecraft cost for Space Science and Earth Science missions to \$190M from \$590M.

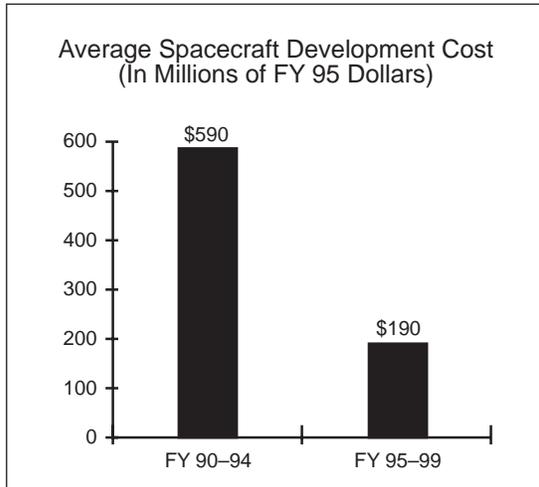


Figure 20

- Reduce the average spacecraft development time for Space Science and Earth Science to 4 years, 6 months from 8 years, 3 months.

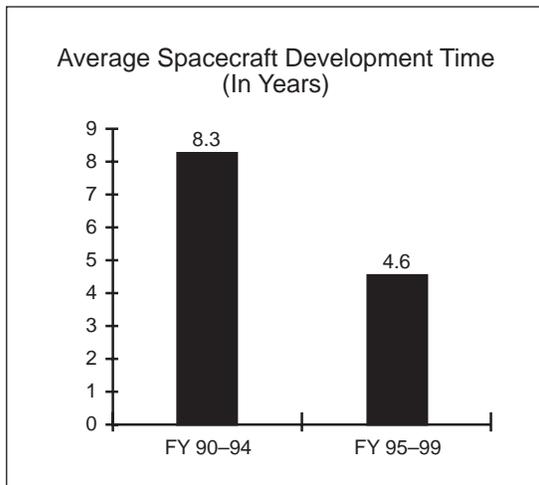


Figure 21

Objective—Leverage NASA’s research and development budget through commercial partnerships

The National Performance Review requires all Federal agencies to dedicate a certain percentage of their research and development budgets for commercial partnerships.

- The performance target will be to dedicate 10 to 20 percent of the Agency’s Research & Development budget to commercial partnerships.

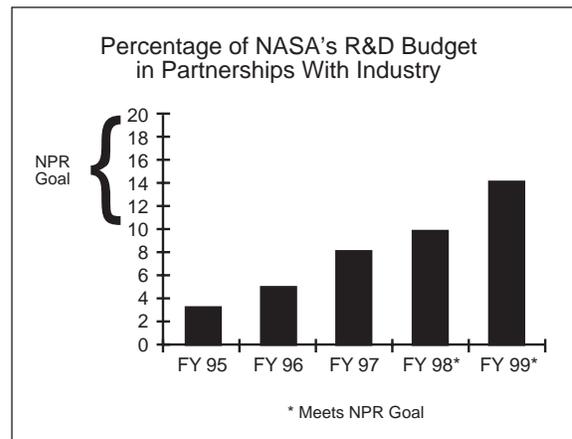


Figure 22

Provide Aerospace Products and Capabilities Process—Chart 6

PAP&C—Goal	Objectives	Performance Targets
<p>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</p>	<ul style="list-style-type: none"> • Meet schedule and cost commitments • Ensure the availability of NASA's spacecraft and facilities • Reduce mission cost and development time • Leverage NASA's research and development budget through commercial partnerships 	<ul style="list-style-type: none"> • Keep the development and upgrade of major scientific facilities and capital assets within 110 percent of budget and schedule on average. • Maintain average operating time lost to unscheduled downtime for NASA spacecraft and facilities to less than 10 percent of total scheduled possible operating time. • Reduce average spacecraft cost for Space Science and Earth Science missions to \$190M, and reduce the average spacecraft development time to 4 years, 6 months. • Dedicate 10 to 20 percent of the Agency's Research & Development budget to commercial partnerships.



Generate Knowledge

Goals

NASA provides new scientific and technological knowledge gained from exploring Earth, the solar system, and the universe, and from conducting aeronautics and astronautics research and development. This 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. This Process plays a major role in seeking answers to the fundamental questions of science and research. The goals of the Generate Knowledge Process are to extend the boundaries of knowledge of science and engineering, to capture new knowledge in useful and transferable media, and to share new knowledge with customers.

Performance Measures

To meet the near-term goals displayed in Chart 7, the following objectives will be measured:

Objective—Select research projects through peer-reviewed and merit-based competition.

- The performance target will be to submit 80 percent of Agency research projects to peer-reviewed processes. Proposals submitted to NASA for funding will be selected through a merit-based competitive process.

Objective—Provide information to the public and data to researchers.

- The performance target for prompt public information will be to provide monthly updates for all missions, and when possible, on a weekly basis.
- The performance target to validate science data will be to make available for researchers fully calibrated, verified, and validated science data products within 1 year of acquisition.

Generate Knowledge Process—Chart 7

Generate Knowledge—Goal	Objectives	Performance Targets
<p>Extend the boundaries of knowledge of science and engineering, capture new knowledge in useful and transferable media, and share new knowledge with customers</p>	<ul style="list-style-type: none"> • Select research projects through peer-reviewed and merit-based competition • Provide information to the public and data to researchers 	<ul style="list-style-type: none"> • Submit 80 percent of Agency research projects to peer-reviewed processes. • Provide monthly updates for all missions, and when possible, on a weekly basis, make available for researchers fully calibrated, verified, and validated science data products within 1 year of acquisition.

Communicate Knowledge

Goals

The Communicate Knowledge process facilitates the distribution of information on NASA's missions and discoveries. This supports the increased understanding of science and technology, promotes the application of NASA-generated information, and inspires achievement and innovation. The Process ensures that knowledge derived from the NASA research programs is available to meet the specific needs and interests of constituent groups. This process begins with 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

To meet the near-term goals displayed in Chart 8, the following objectives will be measured:

Objective—Develop educational outreach programs

NASA continually assesses the number of kindergarten through 12th grade educators participating in the NEWEST/NEWMASST educational outreach programs.

- The performance targets will be to:
 - Increase number of educators who participate annually in NEWEST/NEWMASST to 500 from 170 (Figure 23).
 - Increase the number of students reached through the program to 42,000 students from 37,000 (Figure 24).

Each year, over 1 million teachers and students participate in NASA's educational programs Agencywide.

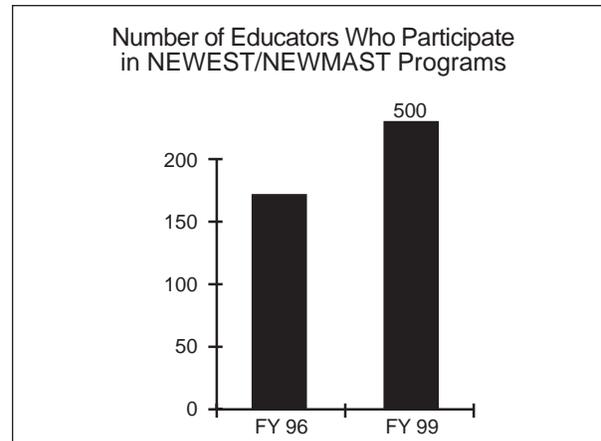


Figure 23

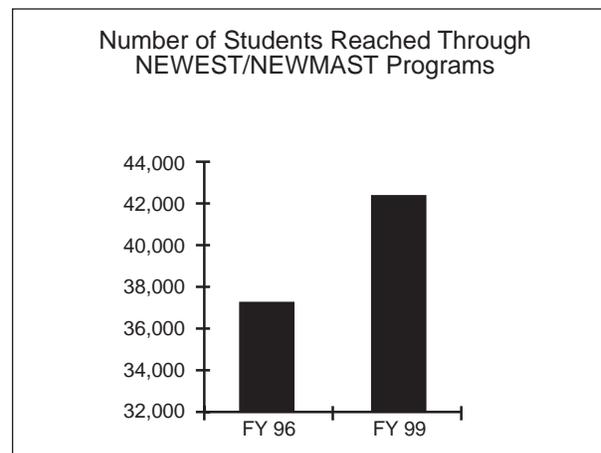


Figure 24

- The performance target for FY99 will be to:
 - Maintain the participation level in Agencywide educational programs at above 1 million teachers and students.

Objective—Increase NASA citations in independent publications

NASA surveys a collection of key, independent journals to assess the number of contributions and citations based on Agency research. Journals surveyed include *Science*, *Physics Today*, *Journal of the American Medical Association*, and *Scientific American*.

- The performance target will be to increase the number of citations of NASA research to no less than 250.

Communicate Knowledge Process—Chart 8

Communicate Knowledge—Goal	Objectives	Performance Targets
<p>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</p>	<ul style="list-style-type: none"> • Develop educational outreach programs • Increase NASA citations in independent publications 	<ul style="list-style-type: none"> • Increase the number of educators who participate in the NEWEST/NEWMMAST program to 500. • Reach 42,000 students through the educators who participate in the NEWEST/NEWMMAST program. • Maintain the participation level in Agencywide educational programs at above 1 million teachers and students. • Increase the number of citations of NASA research to no less than 250.

National Aeronautics and Space Act of 1958 and associated amendments

Available at: <http://www.hq.nasa.gov/office/codez/policy.html>

National Space Policy (1996)

Available at: <http://www.whitehouse.gov/WH/EOP/OSTP/NSTC/html/fs/fs-5.html>

Goals for a National Partnership in Aeronautics Research and Technology

Available at: <http://www.whitehouse.gov/WH/EOP/OSTP/html/aero/cv-ind.html>

NASA Strategic Management Handbook (NASA Procedures and Guidelines 1000.2)

Available at: <http://www.hq.nasa.gov/office/codez/plans.html>

NASA Performance Plan

Available at: <http://www.hq.nasa.gov/office/codez/plans.html>

Mission to Planet Earth Strategic Enterprise Plan

Available at: <http://www.hq.nasa.gov/office/mtpe/stratplan.html>

Space Science Strategic Enterprise Plan

Available at: ftp://galaxy.hq.nasa.gov/pub/OSS/Enterprise_Documents/

Human Exploration and Development of Space Strategic Enterprise Plan

Available at: <http://www.osf.hq.nasa.gov/heds/hedsplan.html>

Aeronautics and Space Transportation Technology Strategic Enterprise Plan

Available at: <http://www.hq.nasa.gov/office/aero/oasthp/library/leader.htm>

Science Policy Guide

Available at: <http://dlt.gsfc.nasa.gov/cordova/guide.html>

Government Performance and Results Act of 1993

Available at: <http://server.conginst.org/conginst/results/results.html>

NASA values the comments and recommendations of our external stakeholders, customers, partners, employees, and contractor community. For further information regarding this Performance Plan, the Strategic Plan, or NASA's four Strategic Enterprise Plans, please contact the following individuals:

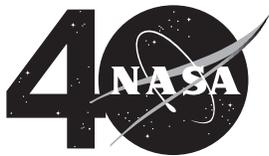
	NASA Headquarters 300 E Street, SW Washington DC 20546
NASA Strategic Plan NASA Performance Plan	Alan Ladwig Associate Administrator Office of Policy and Plans (202) 358-2096 E-mail: alan.ladwig@hq.nasa.gov
Earth Science	Dr. Ghassem Asrar Associate Administrator Office of Earth Science (202) 358-2165 E-mail: ghassem.asrar@hq.nasa.gov
Space Science	Dr. Wesley T. Huntress, Jr. Associate Administrator Office of Space Science (202) 358-2015 E-mail: wes.huntress@hq.nasa.gov
Human Exploration and Development of Space	Joe Rothenberg Associate Administrator Office of Space Flight (202) 358-1409 E-mail: joe.rothenberg@hq.nasa.gov
	Dr. Arnauld E. Nicogossian Associate Administrator Office of Life and Microgravity Sciences and Applications (202) 358-0122 E-mail: arnauld.nicogossian@hq.nasa.gov
Aeronautics and Space Transportation	Richard Christiansen Associate Administrator (Acting) Office of Aeronautics and Space Transportation Technology (202) 358-2695 E-mail: richard.christiansen@hq.nasa.gov

The NASA Performance Plan is also available on the World Wide Web at:
<http://www.hq.nasa.gov/office/codez/plans.html>



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