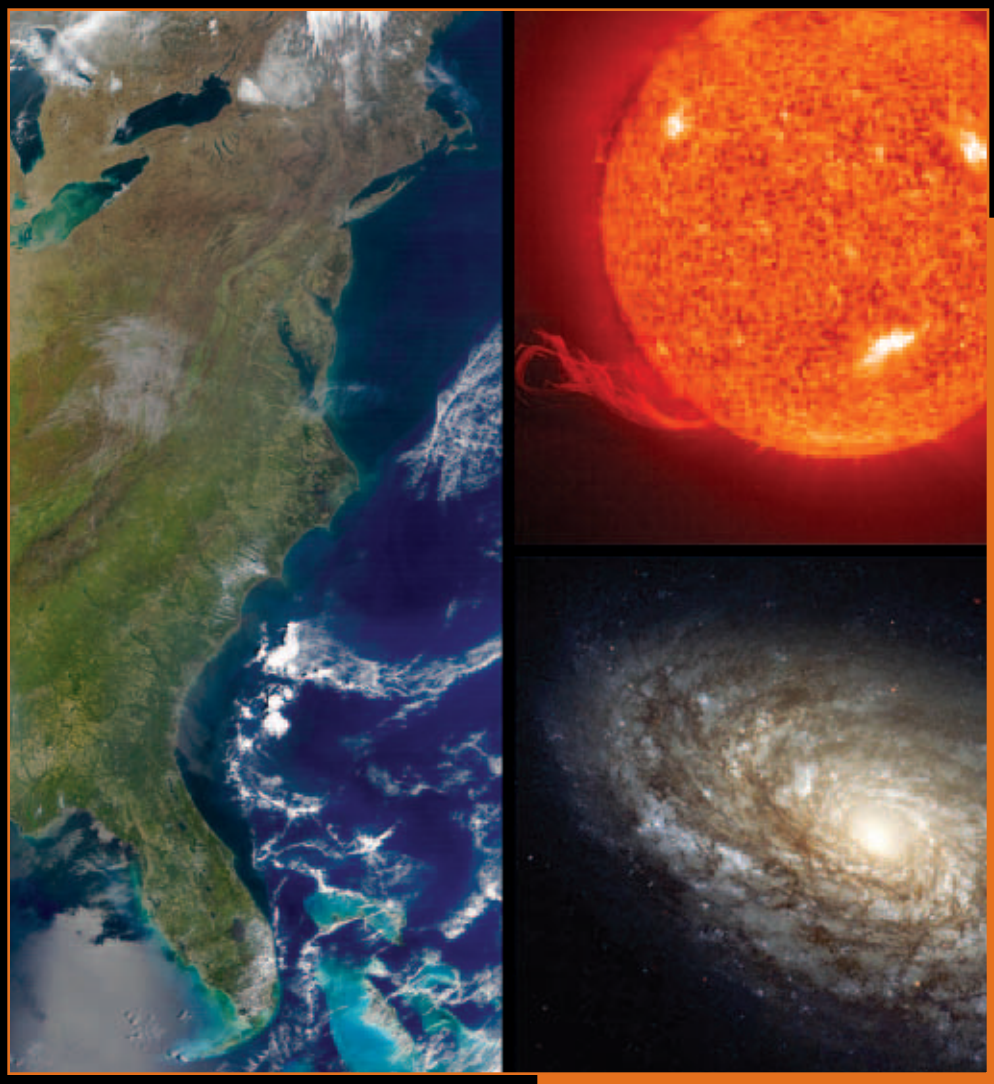


National Aeronautics and
Space Administration

Goddard Space Flight Center
FY2004 Implementation Plan

On the cover:
Left - MODIS image showing the eastern United States, April 14, 2003

Top Right - SOHO image of a huge eruptive prominence on the sun

Lower Right - Hubble Space Telescope view of the magnificent spiral galaxy, NGC 4414

Annual Update to the Goddard FY2004 Implementation Plan

Goddard Space Flight Center Public Homepage
http://www.gsfc.nasa.gov/
is a source of general information about Goddard, its mission, and links to other NASA Web sites.

Goddard Space Flight Center Internal Homepage
http://internal.gsfc.nasa.gov/
is the intranet starting point to Goddard information and documentation.
Click on "Reports and Plans" for documents related to the Center's planning activities.

Introduction to the *FY 2004 Goddard Implementation Plan*

Within the NASA center structure, the Goddard Space Flight Center's role has traditionally focused on NASA's scientific mission areas to "Understand and protect our home planet" and "Explore the universe and search for life." As a science Center, the breadth and diversity of our responsibilities and contributions is reflected in that we have a principal role in five of the Agency's seven science themes and make important contributions to the other two science themes as well. Our space exploration literally spans the universe to the beginning of time, and our Earth exploration is engaged in understanding the complex interactions of Earth's physical systems, as well as variables introduced by human civilization. It is truly a challenging and inspiring mission.

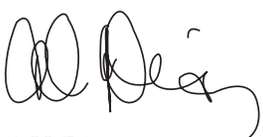
But, in addition to being a science center, Goddard is a technology center. The distinctive contribution Goddard makes to these explorations is that we develop the sensors, instruments, and spacecraft that allow scientists to perform experimental science from the vantage point that only space flight offers. We are engaged in developing the advanced technologies that allow the Agency to continuously expand the capabilities of its scientific spacecraft, instruments, and information systems. We manage these spacecraft in orbit and provide access to scientists around the world to datasets they have created. The result is the expansion of knowledge and human understanding of the Earth and universe and the application of this knowledge to improving life on Earth ". . . as only NASA can."

NASA's third mission area for which we have a significant responsibility is to "Inspire the next generation of explorers." By engaging universities and their faculty and students in the performance of flight missions and scientific research, by providing education opportunities and materials to teachers and students from kindergarten through high school, and through our public education outreach, Goddard is working to ensure that NASA's most essential legacy is the communication of knowledge and the creation of the next generation of scientists, engineers, technicians, and others who will continue this exploration of the Earth and the universe.

The opportunities such a diversified mission provides, our experience, the creativity and dedication of our workforce, and our unparalleled history of success are a true national resource. Together with our fellow NASA Centers, the contractors who work with us, and our university and international partners, we are working together to achieve NASA's mission and vision.

The Goddard Space Flight Center: FY2004 Implementation Plan further identifies our role within NASA, our responsibilities, and the strategies we will follow. We will also continue to build on the three concepts that have guided the Center over the last five years. We will pursue *exciting* work that meets both our mission objectives and our innate curiosity that drives us to explore the unknown. We will achieve a *sustainable workload* that balances our commitments with the resources and capability to successfully meet the cost, schedule, and performance commitments that we have made to our customers. And we will practice *valued-centered* management that places safety first and foremost and that embraces the values that guide our culture: agility, balance, creativity, dedication, integrity, respect, and teamwork.

The challenges of the next decade are no less than when the Agency first began. We enthusiastically look forward to meeting the challenges that are before us and continuing NASA's legacy of exploring the unknown and inspiring the next generation of explorers.



A.V. Diaz
Director, Goddard Space Flight Center

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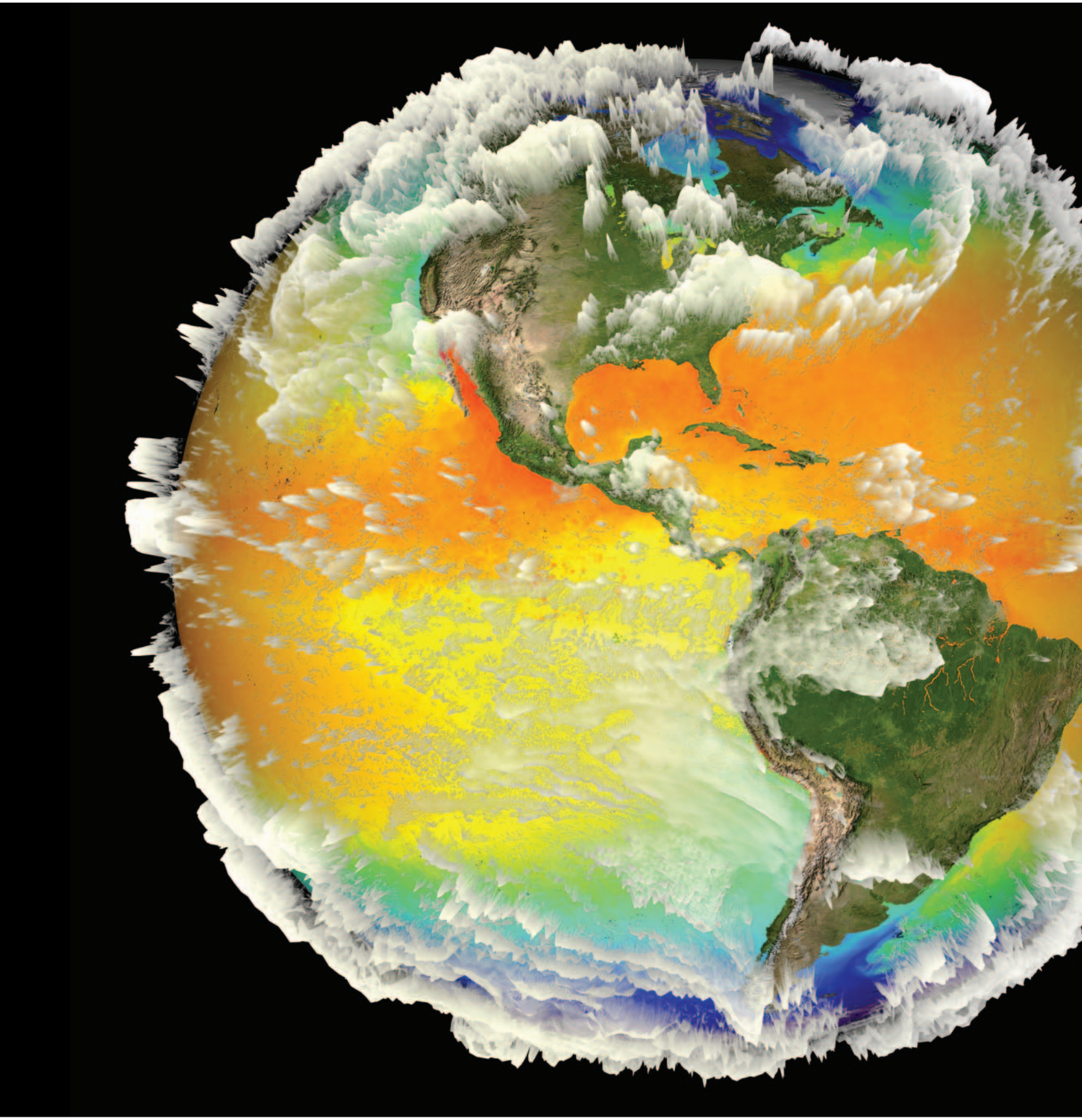
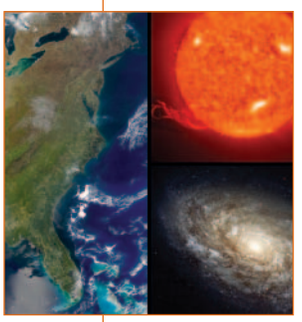




1 The Goddard Space Flight Center in NASA's Vision and Mission

3-D Earth image based on Terra MODIS-derived land surface reflectance, sea surface temperature, snow cover, sea ice extent and cloud reflectance

1 The Goddard Space Flight Center in NASA's Vision and Mission

NASA Vision

To improve life here,
To extend life to there,
To find life beyond.

Goddard's role in fulfilling the NASA vision begins with scientific exploration to revolutionize knowledge of the Earth and the universe by using the unique vantage point of space to look back at the Earth and to look from beyond the Earth's fogging atmosphere to the beginning of the birth of the universe. Our goal is to extend human understanding and to enhance life here on Earth through new knowledge and its application to commerce, education, and everyday life.

NASA Mission

To understand and protect our home planet,
To explore the universe and search for life,
To inspire the next generation of explorers
...as only NASA can.

Within the NASA mission framework, the Goddard Space Flight Center has a principal role in the implementation of the programmatic strategies of the Space Science and Earth Science Enterprises and performs various supporting roles for the other Enterprises. We involve the scientific community, educational institutions, business partners, and international partners who join us in these explorations to understand the Earth and to explore the universe.

To help protect the Earth, we seek to understand the Earth as a complex, evolving system. We seek to use new knowledge to stimulate economic growth, foster education, and inspire the Nation and in particular those who will be the next generation of builders and explorers.

We are committed to doing those things that NASA/Goddard is uniquely positioned to do based on our core competencies. And we are committed to innovation and the creation of new technologies to advance the Agency's capabilities to achieve its mission.

NASA's Core Values

How we deploy these values at the Goddard Space Flight Center

Commitment to safety is first and foremost in all we do. *Agility, balance, creativity, dedication, integrity, respect,* and *teamwork* guide our culture, our decisions, and our work.

Safety

NASA's Mission success starts with safety. A commitment to safety permeates everything we do. We are committed to protecting the safety and health of the general public, pilots and astronauts, the NASA workforce, and our high-value assets on and off the ground.

Safety - We will not compromise the safety of the public or our employees in the conduct of our work. The personal safety and security of all those associated with or potentially affected by Goddard's programs and activities are the cornerstone upon which we build success. We will be active stewards in the use and protection of all resources and assets that NASA and this Nation entrust to us.

People

Our greatest strength is our workforce, a team of highly qualified individuals that is representative, at all levels, of America's diversity. We foster a culture of trust, respect, teamwork, communication, creativity, equal opportunity, and empowerment.

Respect - Diversity among people and their ideas is an inherent strength as we work toward fulfilling NASA's mission.

Teamwork - Accomplishments result from successful teams that capitalize on the strengths and contributions of every team member within the Center, across NASA, or with partners.

Balance - An employee's work life and personal life, including health, family, community involvement, and other interests, contribute to the vitality both of the individual and of the Center.

Excellence

We are committed to excellence. We continuously improve our processes, products, and services to better serve our customers.

Creativity - Freedom to explore new ideas stimulates discovery, fosters innovation, and leads to more effective ways of doing work.

Dedication - Successful results require a commitment to excellence and to individual and team responsibilities.

Agility - Anticipating the future, leading change, and adapting quickly are crucial to thriving in a dynamic environment.

Integrity

We are honest and ethical in all that we do. We deliver on our commitments, and we are accountable for our performance.

Integrity - Trust, fairness, honesty, and accountability for our actions are the cornerstones of personal and organizational integrity.

Goddard Space Flight Center's Role as a National Resource

The Goddard Space Flight Center is a national resource for the pursuit of exploration of the Earth and space. The Center provides customer-centered leadership to implement the goals of NASA and its six Enterprises with principal responsibilities in support of the Earth Science Enterprise and the Space Science Enterprise and secondary roles in support of the other four NASA Enterprises.

The Center works in concert with NASA Headquarters, Enterprise leadership, and the science community to define future scientific questions, to establish the goals necessary to address these questions, and finally to identify the essential measurements that will be used to address the next generation of Earth and space science questions.

Within this broad scientific process, Goddard's capabilities support the Nation's scientific and technology goals by focusing on those roles it is uniquely able to perform as a Federal laboratory. The job of the Federal laboratory is to take the measured risks that cutting-edge research requires and to perform the long-term scientific and technological research that makes breakthrough discoveries possible. Our core competencies in Science (Earth and space), Mission Assurance and Assurance Technologies, End-to-End Mission Systems Engineering, Large Scale Scientific Information Systems, Program and Project Management, Advanced Flight and Ground Systems Development, and Sensor and Instrument Development are matched with complementary capabilities from industry, academia, and international partners. Our goal is to provide increased opportunities for scientists to make new measurements by increasing flight opportunities across a wide range of research platforms and to expand the capabilities of these platforms and the instruments, sensors, and data systems they house.

To implement space flight projects, we work with an extensive set of partnerships including industry, academia, and the international scientific community. Through these partnerships, we concentrate the best capabilities of each to perform the roles that are necessary to translate scientific requirements into space flight projects, to acquire and distribute the data they acquire, and to create new science that helps us to better understand the Earth and the universe.

Goddard manages and uses a broad range of research platforms that hold scientific instruments. These include spacecraft, the Space Shuttle Orbiter, the International Space Station, sounding rockets, aircraft, research balloons, and Earth-based observations. We capture and translate data from various sensors placed on these instruments and transfer the resultant data back to Earth. Most importantly, our job is to ensure that this data is accessible to the scientific community who began the whole process through their scientific inquiry.

The cycle of scientific discovery continues when new scientific findings emerge from this new data and through the rigors of scientific inquiry and peer review. New knowledge is extended not only to the scientific community but also into textbooks and the everyday lexicon of the public. And finally, new knowledge is transferred into applications for government and commercial use that benefit our everyday lives.

The Center is steward of but a small portion of the United States' scientific and engineering expertise. Unique laboratories and test facilities, project management expertise, and over 45 years of experience launching more than 200 spacecraft have developed this expertise. Through partnerships and other activities, we seek to transfer knowledge and experience to others so that they will be able to take on larger responsibilities in the future. This has been the history of NASA, to take the first steps into the unknown and bring others into the process who are then are able to operate on their own.

Such work leads to the transfer of new knowledge and technology and expansion of new capabilities to industry and the American public – who are the customers and benefactors of all that we are asked to do.

Equipping the Center to be a National Resource

While the goal of NASA and the Goddard Space Flight Center is to focus outward, this focus would have little value if our own capabilities were not world class. We cannot assume that the skills and experiences developed across five decades of space exploration are genetically inherited any more than parents can assume that their experiences are automatically transferred to their children. In both cases, a lot of hard work and learning are involved. While each new generation of scientists and engineers builds on the successes of previous generations, there is a period of learning and overlap, much like the transition in a relay race, where one generation runs along beside the other until the handoff is made.

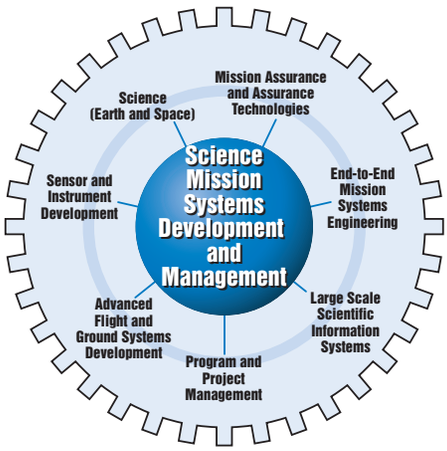
Thus, to be of value to the scientific community and to be a flexible partner to organizations with varying degrees of expertise and capabilities, the Goddard Space Flight Center must maintain its capabilities as a Center of Excellence for research in Earth science, space science, and technology, as well as project and business management. There are a number of essential ingredients to assure that these capabilities in our core areas of responsibility remain at the leading edge of what the Nation requires. Foremost among these is to preserve the Nation's ability to execute, from end-to-end, complex space-based scientific missions.

Goddard's civil service workforce is the Center's most important resource. They are accountable for the execution of those portions of the NASA Vision and Mission that are performed by the Center. They provide the leadership, knowledge, experience, dedication, and creativity to turn goals and objectives into realities. They provide the continuity over time to sustain the Center's core competencies and capabilities. It is the Center's responsibility to assemble and sustain the best possible workforce of leaders and managers, scientists, engineers, technologists, project managers, administrators, and support personnel. The Center will provide them the leadership and management practices, work environment, and work systems and processes to make the most productive use of their capabilities in achieving NASA's Vision and Mission.

In addition, the resources and tools provided by state-of-the-art facilities and equipment must be there to enable these skills to be used to their maximum. To borrow again from a sports analogy, today's athletes may not work any harder than those of a generation or two ago, but the continuing evolution of their tools gives them an undisputed advantage over these earlier generations.

The final component of maintaining world-class capabilities is to be able to do the work that others are asked to do. "Hands on work" allows the Center to develop new means of accomplishing its scientific missions. It is what trains the next generation. It is what sharpens skills. It is what motivates the builders and explorers. Without an element of in-house work to sustain us at the cutting edge, expertise is lost, leaders become watchers, and explorers cease to explore.

Mission Competencies:
Producing Science and Technology for the 21st Century



Science Mission Systems Development and Management

Experimental and Theoretical Science
Goddard Earth and space scientists perform research that develops theories and concepts unifying existing knowledge and laying the foundation for experimental science. In experimental science, Principal Investigators, Co-Investigators, and project scientists lead the definition of requirements for sensors, instruments, spacecraft, and data systems.

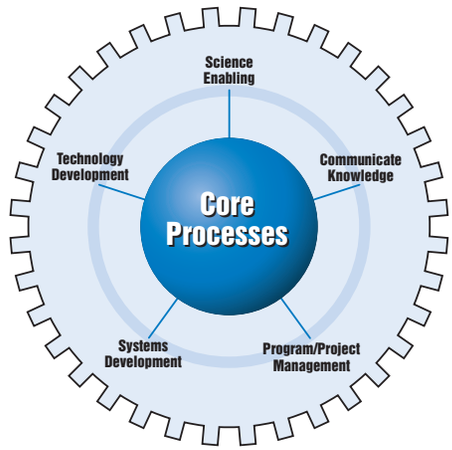
Sensors, Instruments, and Associated Technology
Goddard engineers and technicians develop new technologies in such areas as optics, electro optics such as lasers, mechanisms, and cryogenics that are used to develop sensors and instruments. Goddard nominally has between 40-50 instruments in development.

End-to-End Mission Systems Engineering
Goddard possess the full suite of engineering skills that provide the capability to perform or lead implementation of all mission systems required to design, develop, test, and evaluate, as well as operate scientific spacecraft.

Advanced Flight and Ground Systems Development
Goddard develops spaceflight systems and ground systems for spacecraft communications, operations, and data processing. These systems control the spacecraft, instruments, and data transfer.

Large Scale Scientific Information Systems
Goddard develops and manages large scale scientific information systems that provide the capability to archive data from multiple spacecraft and multiple instruments, to distribute information to users across the world, and to provide the massive computational capability to use extreme large and complex data sets.

Program and Project Management
Goddard employees possess experience in the full suite of management, technical, and administrative skills required to successfully manage multiple, discrete projects simultaneously. At the beginning of FY2004, the Center has 17 projects in implementation, and 22 projects in formulation.



Core Processes

Science Enabling
Processes associated with the acquisition and conduct of scientific research in support of the Earth Science and Space Science Enterprises. These processes span activities from the definition of scientific objectives, to the identification of data requirements, through the acquisition, dissemination and analysis of data, and to the creation and communication of scientific knowledge.

Technology Development
Processes associated with the development of technologies that support the needs to the Earth Science, Space Science, and Space Flight Enterprises. This process includes both the creation of new technology and the innovative use of existing technologies to enable the Center's scientific missions.

Systems Development
Processes associated with the development of flight and ground systems to support the Earth Science, Space Science, and Space Flight Enterprises. These span the ground and space-based hardware and software required for instruments, spacecraft, launch, operation, and information management.

Program/Project Management
Processes associated with the management of programs and projects throughout their life cycle. These include the technical, resource, and schedule requirements from concept through completion of the defined program/project objectives.

Communicate Knowledge
Processes associated with communicating the knowledge acquired by Goddard to educators, academia, industry, and the general public. These include both technical and layman's understanding and the scientific and practical implications of knowledge developed as a result of Goddard's mission.

Mission Competencies: Producing Science and Technology for the 21st Century

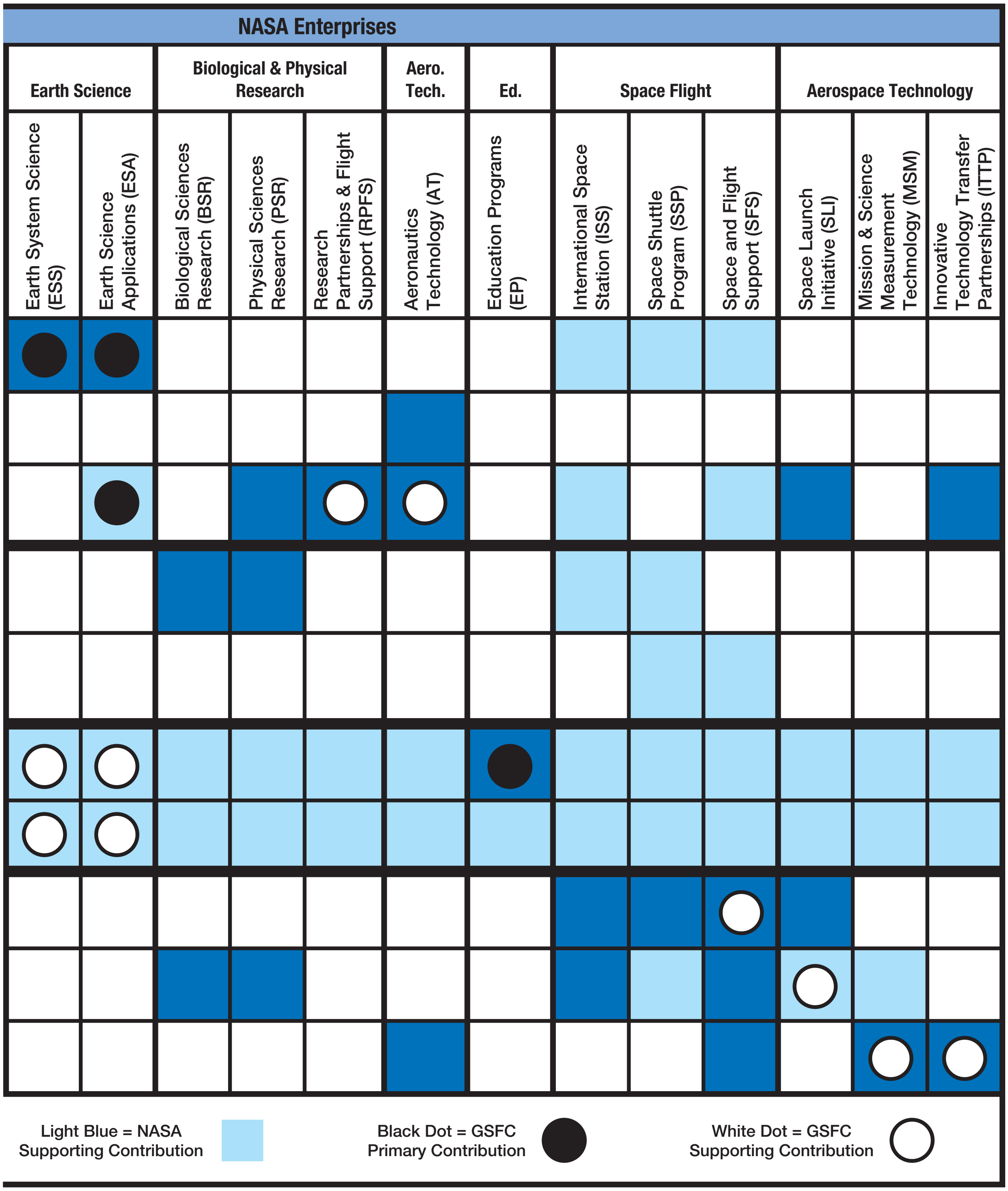
Products and Services:

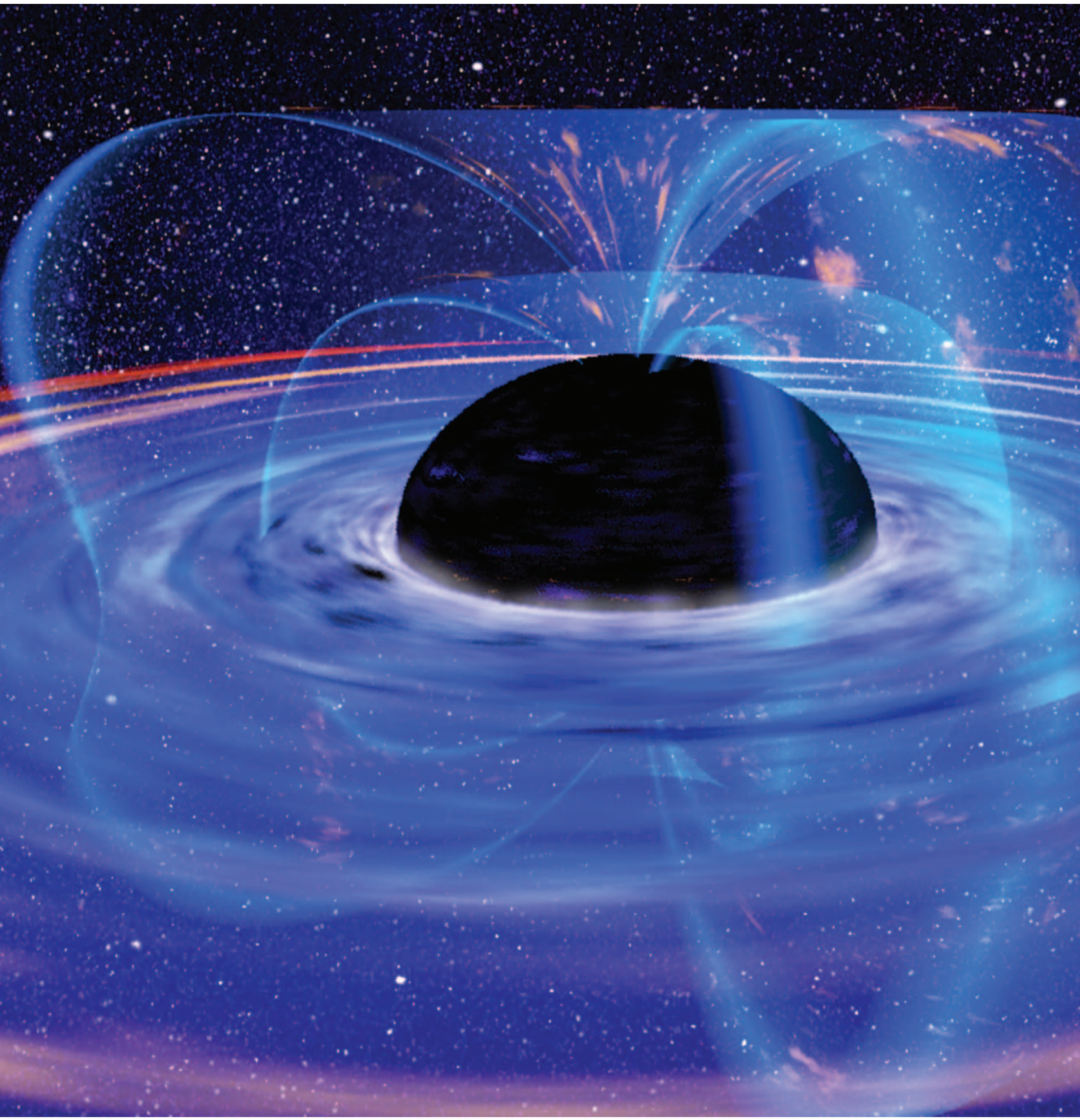
Research and Development (R&D)
Spacecraft and Other Platforms
Sensors and Instruments
Spacecraft Operations
Data Acquisition and Data Management
Research Grants

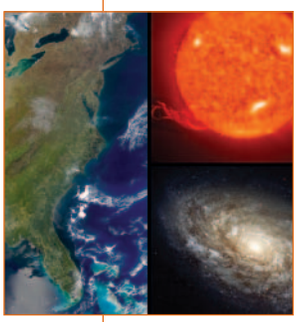
Science - Experimental and Theoretical
Technology and Technology Transfer
Partnerships and Transfer of Expertise
Commercial Opportunities
Education and Education Products
Public Information

Goddard Space Flight Center:
Areas of Responsibility for Achieving NASA's Mission

GSFC Alignment with the NASA 2003 Strategic Plan			Space Science				
MISSION		GOALS / Themes	Solar System Exploration (SSE)	Mars Exploration (MEP)	Astronomical Search for Origins (ASO)	Structure & Evolution of the Universe (SEU)	Sun-Earth Connection (SEC)
Understand and protect our home planet	1	Understand Earth's system and apply Earth system-science to improve the prediction of climate, weather, and natural hazards.	○				●
	2	Enable safer, more secure, efficient, and environmentally friendly air transportation system.					
	3	Create a more secure world and improve quality of life by investing in technologies and collaborating with other agencies, industry, and academia.					
Explore the universe and search for life	4	Explore the fundamental principles of physics, chemistry, and biology through research in the unique natural laboratory of space.					
	5	Explore the solar system and the universe beyond, understand the origin and evolution of life, and search for evidence of life elsewhere.	○	○	●	●	●
Inspire the next generation of explorers	6	Inspire and motivate students to pursue careers in science, technology, engineering, and mathematics.			○	○	○
	7	Engage the public in shaping and sharing the experience of exploration and discovery.			○	○	○
Enabling Goals	8	Ensure the provision of space access and improve it by increasing safety, reliability, and affordability.					
	9	Extend the duration and boundaries of human space flight to create new opportunities for exploration and discovery.					
	10	Enable revolutionary capabilities through new technology.					
Color and Symbol Key:			Dark Blue = NASA Primary Contribution				


NASA Enterprises
Earth Science
Biological & Physical Research
Aero. Tech.
Ed.
Space Flight
Aerospace Technology
Earth System Science (ESS)
Earth Science Applications (ESA)
Biological Sciences Research (BSR)
Physical Sciences Research (PSR)
Research Partnerships & Flight Support (RPFS)
Aeronautics Technology (AT)
Education Programs (EP)
International Space Station (ISS)
Space Shuttle Program (SSP)
Space and Flight Support (SFS)
Space Launch Initiative (SLI)
Mission & Science Measurement Technology (MSM)
Innovative Technology Transfer Partnerships (ITTP)
Light Blue = NASA Supporting Contribution
Black Dot = GSFC Primary Contribution
White Dot = GSFC Supporting Contribution





2 Goddard's Support to NASA's Enterprises and Themes

Visualization of how a black hole may appear as observed by a future Constellation-X mission

2 Goddard's Support to NASA's Enterprises and Themes

Areas of Responsibility

Space Science Enterprise

Space Science

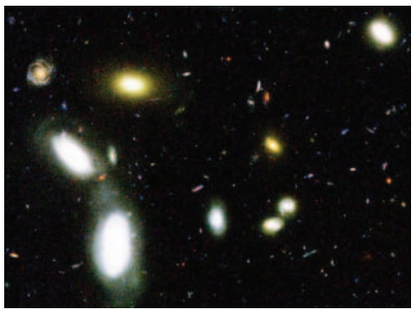
The Goddard Space Flight Center has a primary role in the following Space Science Enterprise themes, Structure and Evolution of the Universe (SEU) and Sun-Earth Connection (SEC), has a major role with the Jet Propulsion Laboratory in Astronomical Search for Origins (ASO), and has a supporting role for Solar System Exploration (SSE) and Mars Exploration (MEP).

The central role of the Center in support of the Space Science Enterprise is to expand scientific knowledge through observational and theoretical research related to each of these themes and to accomplish this work in concert with colleagues at other NASA Centers and in partnerships with national and international scientific communities.

To enable key disciplines in NASA's space science mission, we:

- Strive for ***excellence*** in observational and theoretical research relating to the solar system, the Milky Way, and the universe.
- Foster the expansion of scientific knowledge for the benefit of humanity through ***space flight*** missions.
- Provide expert scientific ***leadership*** to the development and management of NASA programs and projects, as representatives of the world scientific community.
- Perform observations of fundamental importance through the creation and operation of innovative space science ***instrumentation***.
- Promote broadly-based critical ***interpretation*** of space science data through the development and use of tools for data reduction, dissemination, and analysis.
- Seek opportunities in both research and service activities for ***partnership*** with colleagues within NASA and in national and international scientific communities.
- ***Communicate*** the importance of discoveries from the NASA space science program in both scientific and public forums.

Astronomical Search for Origins (ASO)

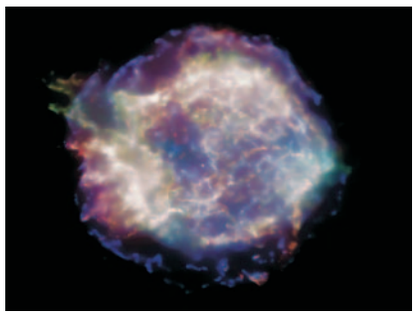


This is a portion of a deep image of the sky obtained with the Hubble Space Telescope/Advanced Camera for Surveys (ACS)

Long-term goals in the Astronomical Search for Origins are: (1) to understand how today's Universe of galaxies, stars, and planets came to be; (2) to learn how stars and planetary systems form and evolve; and (3) to understand the diversity of other worlds and search for those that might harbor life. Goddard will play a major role in achievement of these objectives, and will:

- Develop advanced space telescopes and perform science observations of the early universe.
- Collaborate with other organizations in NASA's Astrobiology Institute to increase understanding of the potential for life throughout the universe and the formation and distribution of organic materials in young stellar systems, including the solar nebula of dust and gas that began to coalesce around the infant Sun.
- Collaborate in the detection and study of terrestrial planets orbiting other stars.
- Develop advanced instrument concepts and technology to explore the formation and evolution of the universe.

Structure and Evolution of the Universe (SEU)



Chandra X-ray Observatory image of the gas remnant of a supernova explosion, Cassiopeia A

Long-term goals are to provide project science leadership in the Beyond Einstein program, part of the Structure and Evolution of the Universe theme. This program is a series of missions to address the questions: What powered the Big Bang, the beginning of the Universe? Visible matter makes up only 4 percent of the Universe; what is the nature of the Dark Matter and Dark Energy that make up the other 96 percent? What happens at the edge of a Black Hole, where the gravitational forces of dense concentrations of matter prevent light from escaping? The long-term objectives are to directly image emitted energy at the event horizons of Black Holes and to directly detect gravitational waves originating from the Big Bang and thus, seeing back to the origin of time. Goddard will play a major role in achievement of these objectives, and will:

- Provide science and project management leadership in the formulation and development of the two Einstein Observatories: Constellation-X (Con-X) and the Laser Interferometer Space Antenna (LISA).
- Manage the formulation and development of the Einstein Probes. These will be scientist-led missions that address focused science issues. Three probes have been identified to: (1) study Dark Energy, (2) search for the signature of inflation in the microwave background; and (3) perform a survey of black holes in the local universe.

Sun-Earth Connection (SEC)

The primary goal of the Sun-Earth Connection theme is to understand the Sun, heliosphere, and planetary environments as a single connected system. Goddard's long-term goals that contribute to this understanding include:

- Understand and predict the response of Earth's magnetic field and radiation belt environment to solar and galactic influences.
- Predict the resulting effects on the Earth's atmosphere and environments of human-made systems in space and on the ground.
- Understand the feedback effects caused by energy deposition into the upper atmosphere and the system trends on all time scales from immediate to the age of the solar system.

Goddard plays a major role in the achievement of missions of the SEC. Goddard manages the Solar Terrestrial Probes (STP) projects and the Living With a Star (LWS) projects for NASA and contributes to the science objectives of these programs through competitively selected instruments, technology, and research.

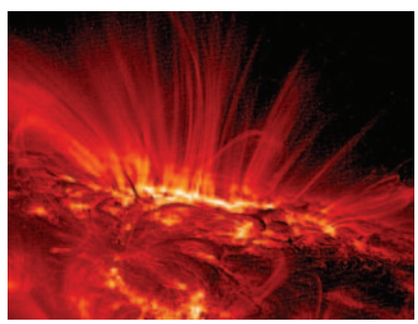


Image of the surface of the Sun at ultraviolet wavelengths obtained with the TRACE mission

Goddard is also a partner in a NASA, NOAA, and U. S. Air Force research activity, the Community Coordinated Modeling Center (CCMC), that develops comprehensive space weather models. Scientists at Goddard, universities, and other organizations develop models of the physics of solar, magnetospheric, and other regions. These models are integrated into the CCMC facility at Goddard to simulate the broader solar corona to Earth upper atmosphere environment and are then transitioned to NOAA and Air Force centers for operational testing.

Solar System Exploration (SSE)

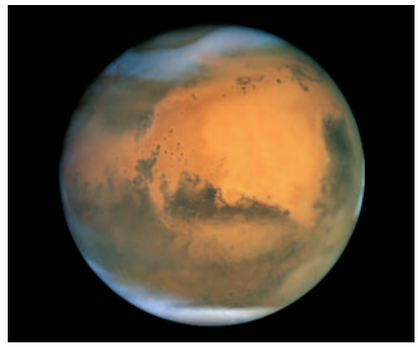
The goals of the Solar System Exploration theme include learning how the solar system originated and evolved, determining the characteristics that led to the origin of life, and understanding how life begins and evolves. Goddard supports these goals by building on its experience and capabilities from closely related investigations in other themes. Examples include interplanetary magnetic field studies, measurement of planetary surface chemistry through X-ray and gamma ray spectrometry and mass spectroscopy. Goddard develops advanced instruments to perform these observations and participates in missions, research, and data analysis.

Long-term goals include:

- Improved understanding of the dynamics and composition of the atmosphere of Saturn, especially relating to implications for the formation and evolution of the solar system.
- Understanding the chemical and thermal structure of Saturn's ring system and how this relates to the dynamics and evolution of the rings and their interaction with Saturn's atmosphere.
- Participation in NASA's planned extensive investigations of Jupiter and its icy moons.

Hubble Space Telescope image of Saturn

Mars Exploration (MEP)



Hubble Space Telescope image of Mars

Goals of the Mars Exploration Program include understanding the current state of the planet and its environment and determining the existence or prior existence of life. Goddard supports these goals by applying expertise and capabilities developed for closely related science investigations under other themes. Long term Goddard goals include:

- Contribute to the understanding of the origins of Mars magnetism, atmospheric electricity, and surface characteristics.

Out of the Box Applications

Most objectives in this plan related to space science address NASA Goal 5: "Explore the solar systems and the universe...." However, the following activity addresses Goal 3, "Create a more secure world and improve quality of life by investing in technology and collaboration with other agencies, industry, and academia."

Near-term objectives:

- Collaborate with other government organizations to apply sensor technology developed for the study of planetary composition to assist in nuclear non-proliferation and in crime scene investigations. Gamma- and X-ray detector technology will enable room temperature sensors that can be used by agents in the field to quickly identify interesting evidence for further analysis.

All Themes

Continue development and flight of instruments for suborbital missions (balloons and sounding rockets) to provide correlative data for space observations, to validate instrument concepts, and to provide training to the next generation of space scientists and engineers.

Earth Science Enterprise

Earth System Science

The Goddard Space Flight Center has a primary role in the Mission goal, "To understand and protect our home planet." We have major responsibilities for both Earth System Science (ESS) and Earth Science Applications (ESA) that support NASA's goal to "Understand Earth's system and apply Earth system science to improve the prediction of climate weather and natural hazards."

There are five fundamental scientific questions that drive NASA's Earth Science program and Goddard's work that supports that program.

- **Variability** - How is the global Earth system changing?
- **Forcing** - What are the primary causes of change in the Earth system?
- **Response** - How does the Earth system respond to natural and human-induced changes?
- **Consequences** - What are the consequences of change in the Earth system for human civilization?
- **Prediction** - How well can we predict future changes in the Earth system?

In addition, a sixth question highlights the inter-relationship between space and Earth sciences that cross in the Space Science Enterprise theme, Solar System Exploration.

- **Comparative** - What can the atmospheres of distant planets teach us about our own planet and its evolution?

To meet its mission requirements in NASA's Earth science mission, Goddard will:

- Provide scientific and technological leadership focused on improving Earth system scientific knowledge.
- Serve as a resource in Earth system science and technology.
- Improve predictions of the Earth system through new observational and modeling capabilities.
- Establish partnerships with agencies with operational responsibility to promote Earth science applications.
- Advance understanding of the evolution of the Earth system through the exploration of planets.
- Enhance the nation's scientific and technological literacy.

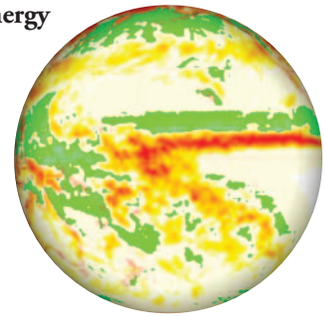
Goddard's research into the Earth system is divided into the following research areas: (1) water and energy cycle, (2) carbon cycle and ecosystems, (3) atmospheric composition, (4) weather, (5) Earth surface and interior, and (6) climate variability and change. These research areas share common characteristics such as interactions and interdependency among the components and the continuous dynamic evolution and reaction to driving forces and perturbations from both within and outside these systems. The time scales that characterize these processes vary from a few minutes in cloud evolution to millions of years in tectonic plate motions. Spatial scales vary from meters to thousands of miles. With these variables as a backdrop, Goddard scientists work with NASA Headquarters, the scientific community, technologists, and project managers to define new scientific questions and to develop new technologies for new observations. They conceive, formulate, design, implement, and participate in the day-to-day operations and management of spacecraft and other missions; plan and deploy experimental campaigns to correlate and validate satellite data; develop algorithms to create data sets; and develop new models to create and interpret scientific data.

Because of the interdisciplinary nature of our activities, projects require the collaborative efforts of many scientists with various backgrounds. These activities are appropriate for a Federal laboratory that focuses on complex interdisciplinary problems in collaboration with and support of the larger national and international scientific communities.

In support of the six science questions, the Center is in the forefront in developing and operating data processing and archival and distribution systems to facilitate the use of Earth science data by the scientific community and others. The bulk of the data system development, processing, and distribution are done within Earth Observing System Data and Information System (EOSDIS), the Global Change Data Center (GCDC) and other distributed data systems housed in Goddard's Earth Science Directorate laboratories.

Research Areas

(1) Water and Energy Cycle

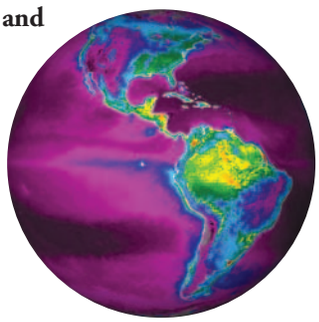


TRMM image of monthly rainfall climatology data

The global water cycle represents the transport and transformation of water within the Earth system, and distributes fresh water over the Earth's surface. While the water cycle delivers the hydrologic consequences of climate changes, the global water cycle is both a consequence of and an influence on the global energy cycle. These two cycles are thoroughly interconnected.

Many of the capabilities and components required for global water-cycle prediction are available at Goddard. The Center is one of the few institutions in the world that has the capability to support the full range of investigation: from large-scale remote sensing to in situ field observations – data acquisition and analysis – development of prediction systems that can assimilate the full range of information. Using these capabilities, the Global Water and Energy Cross-Cutting Theme (GWET) team will facilitate advances in the analysis and scientific integration of NASA's satellite, airborne, and field observations. These activities will foster the advancement of our understanding of the global water cycle; the integration of improved understanding and information into prediction systems; and innovative monitoring and applications for water management and operations. Because of the interdependencies among these research areas, GWET must develop in conjunction with other cross-cutting questions such as the global carbon cycle.

(2) Carbon Cycle and Ecosystems

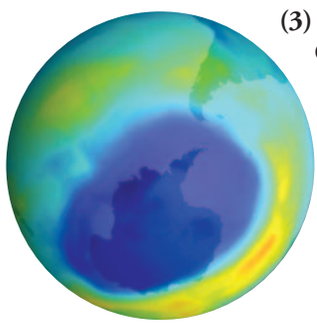


MODIS image that represents Earth's carbon "metabolism"

Goddard Earth scientists contribute to NASA's strategy for reducing future climate uncertainty by improving land, ocean, and atmosphere carbon cycling

models and by developing new observational platforms required to locate global sources and sinks of carbon, quantify their strengths, and understand how they depend on environmental factors. To further address the role of the carbon cycle in future climate uncertainty, new types of global observations must be made: (1) variability in atmospheric CO_2 concentration induced by land and ocean sinks; (2) stocks and rates of change in terrestrial biomass and vegetation productivity; and (3) oceanic and dissolved organic carbon and nutrient-dependent photosynthetic fluxes. Strategic investments in these new capabilities will also accelerate the use of existing satellite capability through integration into the historic and current satellite data record. These satellite-based climate data records will be combined with conventional observation data and will be used in a carbon modeling framework to locate land and ocean carbon sinks and sources and quantify their spatial and temporal variation.

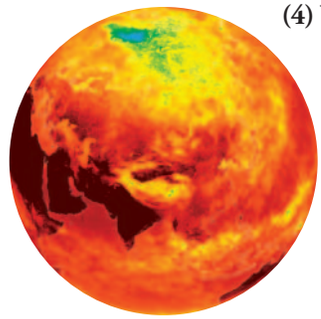
It is the interplay among advances in modeling, new observations of key Earth surface and atmospheric carbon and aerosol properties, and improvements in the computational capacity that will enable major advances in our understanding and ability to predict climate change. Thus, NASA's carbon cycle science program will focus on the development and validation of (1) new observational platforms, (2) coupled physical and biogeochemical cycling models, and (3) acceleration of efforts to develop improved data assimilation techniques. Assimilation of remote sensing data into coupled models is critical to constrain models and improve their accuracy.



September 2002, TOMS image of the Antarctic ozone "hole"

(3) Atmospheric Composition

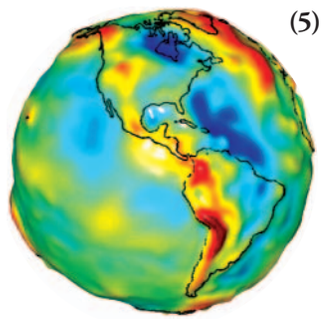
The major goal of our atmospheric chemistry work is to understand both the composition of the Earth's atmosphere and changes of that composition in response to human-produced compounds. To achieve this goal, we conduct both aircraft and satellite observations and use these observations to model the Earth's atmosphere. We support operational satellites, and we assess the impact of anthropogenic (human-centered) and natural perturbations to atmospheric ozone using satellite observations to model these phenomena. We continue to watch ozone recovery through our satellite instruments and provide support for NASA's reports requested by Congress.



Aqua image captures atmospheric brightness temperatures, April 2003

(4) Weather

In the area of weather and climate forecasting, Goddard Earth scientists, in collaboration with scientists from the NOAA Center for Environmental Prediction (NCEP) and the Joint Center for Satellite Data Assimilation (JCSDA) will continue to enhance the impact of satellite data on weather and short-term climate forecasting. We will also conduct Observing System Simulation Experiments (OSSEs) to help optimize the future observing systems for weather and climate prediction and conduct field campaigns to add to our knowledge of weather and climate.

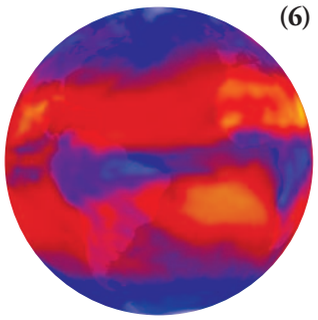


GRACE image of Earth's gravitation field

(5) Earth Surface and Interior

In Solid Earth/Geodynamics the major emphasis will be on gravity field and solid body tidal modeling (especially using data from Gravity Recovery And Climate Experiment [GRACE] and Jason) and on comprehensive magnetic field modeling and applications of this model to studies of the lithosphere. The geomagnetic field work will couple with core dynamo modeling that will also continue. In Solid Earth/Natural Hazards and Solid Earth/Topography and Surface Change, Goddard will continue the study of crustal deformation and hazard assessment using both surface Global Positioning System (GPS) and other surface data, as well as airborne and spaceborne lidar data. These will emphasize areas of high earthquake and

landslide risk, as well as potential volcanic activity, and will use the data to constrain the numerical models of the underlying processes.



Terra image of heat radiated from Earth back into space

(6) Climate Variability and Change

Global observations are the largest part of the NASA program, but climate modeling and analysis provide the rationale and priorities for the observations. The primary focus of our research is the development and application of climate modeling and analysis to address the fundamental climate change issues. Goddard's research strategy is based upon a structured array of climate simulations designed to provide essential input to the analyses of these fundamental issues. It is also intended to examine the role of planned observations in climate analysis, to identify high priority observations, and to help define the research that is needed to convert these observations into an understanding of global climate change.

Comparative Study of Planets

As we begin to explore planets within our solar system, and ultimately planets in remote solar systems, the science and tools developed for Earth science will be applied to these new areas of exploration. One early example of this is Goddard's participation in the NASA Astrobiology Institute (NAI) research. Goddard will support the effort to discover if comets supplied the organic composition for the origin of life on Earth and if they could have done so for alien worlds. Research efforts will explore how organic molecules are created in interstellar clouds and delivered to planets as they form. Ultimately, the research is directed at understanding the question, "Where did we come from?" The interdisciplinary team pursuing these studies includes researchers in Earth science, space science, and instrument development at Goddard, as well as scientists from around the nation and the world.

Other comparative studies involving Mars and Venus, for example, anticipate the study of planetary processes such as loss of atmospheres, surface conditions, water, historic climates and their changes, chemical makeup, and how such conditions and processes might affect the potential for life.

Key Tools for Earth System Science

Global Modeling and Data Assimilation

Global modeling and assimilation is centered on the development and use of satellite observations through the integrating tools of models and assimilation systems. It focuses on developing and maintaining a world-class Earth system model and data assimilation system and using them to advance our understanding of climate variability and change and to improve both weather and climate prediction. Modeling and assimilation are viewed as part of an end-to-end process that extends from defining an instrument, characterizing its in-flight performance, to developing algorithms and models for data assimilation, integrating the data into assimilation products, and finally assessing the impact of the data on products and prediction skill. Assimilation tools are developed to optimize the use of the high-resolution information from satellite observations. Satellite data analyses and assimilation tools are also used to improve the capability of models to simulate our environment. Research-quality assimilated datasets, including trace gas, aerosol and climate products, ocean and land surface products, are generated for use by NASA instrument teams and for research analyses, with the aim of maximizing the return of NASA's investment in Earth observations. Collaboration with scientists throughout NASA, with the NOAA Center for Environmental Prediction through the Joint Center for Satellite Data Assimilation, with the other major modeling centers (National Center for Atmospheric Research [NCAR] and Geophysical Fluid Dynamics Laboratory [GFDL]), and with selected NASA university investigators are essential in providing the integrating role for Earth system science.

Field Campaigns

Many of the Directorate's activities involve developing concepts and designs for instrument systems that provide data leading to a basic understanding of the physical processes of the Earth system and/or serve as calibration references for satellite instrument validation for space-flight missions. Airborne platforms facilitate viewing processes such as precipitation, cloud systems, or surface vegetation, water or ice from a high-altitude vantage point and with high spatial and/or spectral resolution. Such platforms serve as stepping-stones in the

development of the space-borne instruments required for continuous global coverage. Ground-based systems provide surface or near-surface measurements for experimentation or validation of satellite data. Major field campaigns supported by Goddard frequently require observations at multiple levels thus requiring simultaneous ground, air, and space observations.

Scientific Computing and Modeling

The scientific priorities of the Earth Science Enterprise require high performance computing resources for the Earth system models needed to assimilate high-resolution satellite observations and to model and predict global climate changes. Goddard provides the science community with access to state-of-the-art high-performance computing and networking, mass storage for model and data archival, and information system technologies to support the science missions of the Agency. We provide advanced planning for future technology so that the science community can use state-of-the-art computer technology effectively. Advanced networking systems provide high-speed, remote system access to data archives and for scientific computation. We also enable scientific investigations, education, and public outreach through the development of visualization tools to access and display the large data volumes associated with satellite observations and with Earth system models.

Earth Science Applications

In partnership with Headquarters, other NASA Centers, other federal agencies, other governmental and international organizations, and commercial enterprises, we support the transfer of science and research to applications. This facilitates the incorporation of new Earth sciences knowledge and new tools into commercial, educational and governmental uses.

Earth Sciences Applications	
Air Quality	Agricultural Efficiency
Aviation Safety	Carbon Management
Community Growth	Costal Management
Disaster Management	Energy Forecasting
Homeland Security	Invasive Species
Public Health	Water Management

Over the last three decades, tremendous progress has been made in Earth science space-based remote sensing, related technologies, algorithms, and models. Such advancements have improved predictability by increasing lead-time and accuracy of forecasts in weather, climate, natural hazards, and natural resources. It has further reduced or bounded uncertainties by partially improving our understanding of planet Earth as an integrated system. Applications in such areas of energy forecasting, aviation safety, agricultural competitiveness, disaster management, security, air quality, and public health are but a few of the areas that benefit from the application of Earth science and its products.

Despite the growing value of the application of Earth science, there are a number of obstacles that remain, such as: quickly moving data and information from observations and models into relevant decision systems; assuring compatibility and inter-operability of data and models; limitations of spatial, spectral, and temporal resolution; and communications limited by availability of image processing and data compression techniques. Additionally, one of the most critical elements is navigation of the organization and management boundaries that must be addressed at local, state, national, and international levels to permit the timely flow of information amongst various organizations. Finally, science must move from peer-based journals into other venues to communicate with broader audiences so that there is an increased dialogue on the benefits and application of Earth science.

Goddard's strategy in supporting NASA and the Earth Sciences Enterprise in developing applications is to:

- Focus on National priorities requiring global understanding.
- Use commonly recognized architectures to provide a systems approach throughout the Earth science community.
- Leverage our investment in research and investment to maximize their impact and value to the Nation.
- Collaborate with other NASA Centers, other agencies, and organizations in order to apply the best resources to relevant issues.
- Facilitate the transfer of technologies developed for the Earth sciences program to other governmental and commercial uses.
- Improve economic and homeland security by supporting operational decision support tools that use Earth science products.

Biological and Physical Research Enterprise

As the Office of Biological and Physical Research (OBPR) develops various flight opportunities, the Goddard Space Flight Center will work to support those activities for which it has unique capabilities and that are consistent with its core competencies and mission responsibilities.

In the area of "Research Partnerships and Flight Support," Goddard offers expertise in project management, spacecraft systems, mission management, end-to-end mission systems engineering, mission concept development and architecture, technology development, and operations.

In the areas of "Biological Sciences Research" and "Physical Sciences Research," Goddard's participation will depend on the specific areas of investigation and how the Center's scientific expertise in Earth and space sciences are transferable to or offer insights into OBPR's areas of inquiry. Given the intersection of Earth and space science in such areas of study as the Sun-Earth Connection, for which Goddard has a primary role, any low Earth orbiting satellite will be operating in an environment at the boundary of Earth's life-protecting atmosphere and the hostile environment of space. In both these areas, Goddard has scientific expertise to offer to OBPR's scientific research. The Center would examine each area of research for any opportunity to make a contribution.

Education Enterprise

NASA's unique mission in science and technical fields served to motivate students in the late 1960s to move into technical careers, and the result was an aerospace and science bloom that fed much of the Nation's commerce during the last third of the 20th century. Today, NASA's education mission is to re-establish that motivation and sustain the Nation's scientific and technological leadership.

NASA has made a commitment to make education a direct component of all its scientific and technical programs. Goddard has embedded this principle by assuring that from the beginning of a new program there are associated education strategies and goals to ensure some aspect of the Agency's education strategy is supported.

A critical component of NASA' education effort is the concept of " . . . as only NASA can." This concept is crucial to the role of education within the Goddard Space Flight Center because, as one of NASA's science and space flight centers, Goddard is involved in generating new knowledge and communicating the results to the academic and scientific community and to the private sector. We directly involve universities, faculty, students, and researchers in the performance of the Center's programs and projects, and scientists and engineers at universities use the data we produce to do analysis and create new knowledge. They are principal partners in all phases of our work.

Goddard then uses the core missions of the Center to translate science and technology into experiences that motivate students at all grade levels, preschool through post-doctoral fellows. We not only translate content for use in formal and informal education environments, but also investigate mechanisms for using imagery and data sources in learning environments. Part of this challenge is to develop tools that can be used by students and teachers alike in order to actively engage them in NASA missions. Likewise, programs and materials are developed for grade and age specific audiences.

Goddard's education activities focus on four Agency initiatives:

(1) Explorer Schools, which involve 50 middle schools nationwide, is a 3-year program aimed at improving middle school student performance in science, mathematics, and technology in low performing schools. Goddard is responsible for five middle schools located in the northeastern U.S. and will work one on one with these schools to help them meet program objectives.

(2) The Educator Astronaut Program enables teachers to become eligible to join the astronaut corps. In this capacity teachers will be able to use space, and particularly the International Space Station, as a laboratory to explain difficult scientific and mathemat-

ics concepts, as well as to conduct student research. Goddard will use the resources of this program to enhance the other education activities.

(3) A third initiative relates to the development of science and technology scholarships as a mechanism for implementing a human capital "workforce pipeline" that is intended to provide for NASA-related employment needs within the civil servant population, NASA contractors, or academia. This initiative will also create a structure that will enable each of NASA's education programs to identify promising and ethnically diverse students and to cultivate these students so that they will be qualified to join NASA's future workforce.

(4) The last initiative, Explorer Institutes, will begin in 2004. This program provides support services to museums and science centers. Goddard is in a unique position to support implementation of this initiative due to the large number of well-known museums and science centers located throughout the northeastern U.S.

Goddard is committed to the implementation of Education Enterprise, goals, objectives, and initiatives. Goddard is committed to evaluating the effectiveness of its education efforts by using the six criteria established by the Agency: (1) customer focus; (2) content from the science and technology enterprises; (3) implications for the workforce "pipeline"; (4) diversity; (5) evaluation; and (6) partnership and sustainability. Goddard will address these through the following strategies:

- Embed education objectives in our Earth and space science projects.
- Use our laboratories to directly involve students and teachers in NASA missions through direct and substantive involvement in missions.
- Use its flight facilities at the Wallops Flight Facilities to provide support to student programs at the K-12, college, and university levels for flight opportunities involving airplanes, rockets, balloons, Space Shuttle, and the International Space Station.
- Provide virtual experiences through the internet to increase the number of students and teachers who can significantly be involved in NASA missions.
- Use NASA videoconferencing and Web-casting infrastructures to directly involve our scientists and engineers with teachers and faculty.
- Create a "pipeline" of programs through involvement and integration of the Center's K-12, university, equal opportunity, and human resources programs so that high quality students can be nurtured in their career interests.
- Provide targeted educational initiatives that will enhance the Center's ability to attract students with disabilities to pursue career opportunities in math, science, and engineering.
- Create partnerships to enrich the opportunities, depth, and quantity of experiences available to students both across NASA Centers, as well as through its science and technical research resources.
- Pursue research and education opportunities with minority universities to expand their capabilities in areas that will increase the number of minority students in math, science, and engineering and to increase these universities involvement in the performance of NASA's mission.
- Ensure that its education activities supplement formal education opportunities.
- Bridge its education and outreach activities based upon the common theme of learning.
- Establish collaborations with local, regional and state-level customers in elementary/secondary education; higher education, including minority universities; and informal education venues.
- Integrate the themes of NASA's five science/technical Enterprises into its education programs.
- Participate in the design, development, implementation, and evaluation of Agency-wide program priorities.
- Support NASA Headquarters in the development and implementation of flight opportunities for educational institutions and students.

Space Flight Enterprise

Space and Flight Support

We will also continue to provide critical services to support NASA missions and other users, now and well into the future by continuing to provide and improve high-quality, reliable, cost-effective space communications networks and services for the Space Shuttle, International Space Station, launch vehicles, Earth-orbiting satellites, and other spacecraft throughout the solar system. We will integrate the requirements and resources of the NASA Enterprises, and we will partner with other NASA Centers, government agencies, and research facilities to develop new technologies and to incorporate new capabilities into NASA's space communications networks. We will demonstrate the potential of optical space communications between the Earth and Mars, and we will initiate new development projects to ensure uninterrupted Space Network and Ground Network services.

Also, Goddard is responsible for design, development, test, integration, and flight of a group of small payload carrier systems for the Space Shuttle including Hitchhiker, Get Away Special (GAS), Space Experiment Module (SEM), and Complex Self-Contained Payload (CSCP) Programs. These carriers support payloads supplied by NASA, other U.S. Government agencies, universities, high schools, domestic commercial customers, and foreign nationals and governments. Goddard is responsible for the integration of the payloads with the carrier systems and provision of interfaces with payload providers, the Shuttle payload processing offices, and the various safety organizations.

Aerospace Technology Enterprise

Space Launch Initiative

Goddard provides support to both the Orbital Space Plane (OSP) and Next-Generation Launch Technology (NGLT) Programs by developing technology and providing infrastructure capabilities where we are able to meet the needs of the Space Launch Initiative.

In the area of OSP development, Goddard participates in OSP launch and landing operations and on-orbit operations elements to support program planning and offer low-cost concepts to meet mission operational requirements, as well as coordinate ground network and Independent Verification and Validation (IV&V) during development.

For the NGLT Program, Goddard provides launch range, sub-orbital vehicle, payload recovery planning, development, and implementation support for the Hypersonic Technology Experiment (HyTEx) activity that is being used to demonstrate advanced vehicle technology experiments, such as thermal protection systems during re-entry.

Mission and Science Measurement Technology

Goddard develops Earth and space science mission-enabling technology for the Mission and Science Measurement Technology theme. Goddard's role in the technology development programs of this theme include:

- Enabling Concepts and Technologies (ECT) pioneers the identification, development, verification, transfer, and application of high-payoff aerospace technologies that are applicable across many types and classes of systems needed to accomplish NASA's missions. Areas of research include advanced measurement and detection systems, resilient materials and structures, and distributed and micro spacecraft.
- Engineering for Complex Systems (ECS) advances the scientific and engineering understanding of system complexities and failures. Areas of research include: human and organizational risk characteristics; the development of processes, tools, and organizational methods to quantify, track, visualize, and trade-off system designs and/or mission options with an emphasis on risk management throughout the lifecycle of programs; and development of software based resiliency tools and technologies to help mitigate risk in the operational and maintenance phases of program lifecycles.

- Computing, Information, and Communications Technology (CICT) develops cross-cutting technology for a variety of aviation and space applications, such as communications, micro-devices and instruments, information technology, and nano-technology.

In addition to conducting technology research, Goddard is responsible for providing management support to the NASA Institute for Advanced Concepts (NIAC) that funds Phase I and Phase II studies for concepts that may take more than 30 years before they become viable for application to space flight missions.

Innovative Technology Transfer Partnership (ITTP)

Goddard works with the private sector, academia, and other government organizations by providing leadership and creativity to produce technological synergy that results in benefits to NASA and its partner organizations. Emphasis is placed on building partnerships between Goddard and the private sector that leverage Goddard's assets and increase mission capability while sustaining and enhancing U.S. economic viability. The Tech Inventory, for example, is a database of all Goddard reported technologies. We also identify external sources of technology, "spin-ins," that can contribute to Goddard's programs, and we negotiate alliances with other government, industry, and academic organizations to facilitate transfer of their technology for NASA's use.

Goddard also performs Level II management of the NASA's Small Business Innovative Research (SBIR) and Small Business Technology (STTR) Programs; these programs facilitate the participation of small business in the Agency's research and technology development to ensure all levels of the U.S. business base have the opportunity to contribute to NASA's mission.

Goal 7: Sharing the Experiences of Exploration and Discovery

NASA, because of the very nature of its mission, attracts public interest, and the public has always been curious about what these "rocket scientists are doing." While much of this attention in the Agency's early years was focused on human space flight, the route for NASA's science has been somewhat different. To begin with, the primary audience for most of the data and knowledge gleaned from our scientific exploration is other scientists who are comfortable with the terminology, complexity and acronyms that easily cloak from most citizens what this science is and what it means to human society.

Our mission is to find ways to remove that cloak and engage the public in our mission and to provide to the public a clear, understandable story of science and engineering and their impact.

- The first strategy begins with translating complex scientific and technical findings into information that is relevant and accessible to each potential audience with whom we are trying to communicate. Bringing together the story we are trying to communicate with the needs of the audience are the two essential ingredients to successfully communicate with the public.
- The second strategy is to use the best means available to leverage NASA's resources. We can directly communicate with only a small fraction of the audiences that we are trying to reach. So the best means of leveraging our resources is to provide interesting, relevant, and newsworthy information to those who possess expertise in disseminating this information to media and other outlets such as trade organizations. We use these partners and their expertise to expand our outreach.

  The mass media, including print, television, and radio, provide a cost-effective way of exposing the public to NASA activities, and Goddard works with the mass media to help them tell the story in a compelling and accurate way. The most interesting and relevant discoveries are mined, and the scientists and engineers who can best tell the story are made available to the press at news conferences, *Space and Earth Science Updates*, scientific symposia, tours, and interviews.
- The third strategy is to fully use the tools of science and the tools of communication that have greatly expanded over the last decade. We will continue to examine how to exploit their full potential in our communications with the public. One of the most powerful tools that we have to describe new discoveries in a meaningful and understandable manner to the public is through imagery, which can be in the form of pictures taken from orbit, animations of scientific concepts, or visualizations of actual data.

Stunning pictures taken from space, such as those from the Hubble Space Telescope (HST), have heightened human curiosity about the mysteries of the universe. A growing armada of Earth-orbiting sentinels routinely provides daily images of our planet. Moreover, the ability of these spacecraft to provide a comprehensive global view of the planet is providing new insights into the complex interaction between the land, atmosphere, and oceans, which together regulate the planet's thermostat and are key to understanding the long-term impacts of human-induced and naturally occurring climate changes.

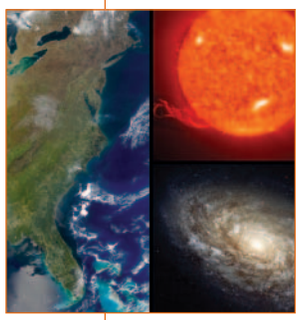
Imagery can also be used to create stories that cannot be captured in a single photograph. Science visualization and visual communications have merged. If a picture is worth a thousand words, effective visualization or animations of complex scientific concepts often can reduce a chapter in a textbook into a 60 second visual that simulates how changing ocean temperatures can forecast a coming El Niño or the fate of matter spinning around and eventually falling into a black hole. These fantastic events cannot be seen by the human eye, but by blending scientific data and sophisticated computer tools, they can be rendered in a way that is understandable by the general public and engages the imagination of the general public.

When the images are combined with text crafted by scientists in collaboration with science writers, these compelling stories have broad use by the mass media, which disseminates these stories that potentially reach tens of millions of people.

- The fourth strategy is to use the World Wide Web to communicate with the public about what we do and how we contribute to NASA's mission. The communications revolution created by the World Wide Web provides Goddard's scientists, engineers, and projects diversified audiences that include the general public, as well as their professional peers. We will provide the general public information that is relevant and understandable and that takes full advantage of all the communication technologies that are available.

The best of Goddard's stories and imagery are routinely provided to the *NASA Portal*, which is accessed by millions of visitors. Other Web sites at Goddard are targeted for a wide variety of audiences and age groups – from the scientifically sophisticated *Earth Observatory* to the award-winning children's site *Imagine the Universe*.

Goddard is committed to these strategies and will employ them in conjunction with each of NASA's goals and Enterprise themes for which we have a role to assure that relevant, meaningful information is readily available to the public.



3 Goddard's Strategic Capabilities

3 Goddard's Strategic Capabilities

National Aeronautics and Space Act of 1958

Title IV - Sec. 102

(a) The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind.

(b) The Congress declares that the general welfare and security of the United States require that adequate provision be made for aeronautical and space activities. . . .

(c) The Congress declares that the general welfare of the United States requires that the National Aeronautics and Space Administration (as established by title II of this Act) seek and encourage, to the maximum extent possible, the fullest commercial use of space.

(d) The aeronautical and space activities of the United States shall be conducted as to contribute materially to one or more of the following activities:

- **(1)** The expansion of human knowledge of the Earth and of phenomena in the atmosphere and space;
- **(2)** The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles;
- **(3)** The development and operation of vehicles capable of carrying instruments, equipment, supplies, and living organisms through space;
- **(4)** The establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;
- **(5)** The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere;
- **(6)** The making available to agencies directly concerned with national

As only NASA can.....Back to the Future

NASA began with a clear mission set forth in the National Aeronautics and Space Act of 1958 and a largely blank slate. Almost everything it engaged in was new, and other than the Soviet Union, there was no competition. There was no choice but to push the edge because there was no option if space exploration was to become a reality. Fast forward 45 years – launch capabilities exist in a number of other countries, private enterprise's role has continued to expand, and even university students now operate satellites. Many aspects of space exploration are well practiced. Yet NASA's mission and that of its first space flight center, Goddard, are unchanged – "the expansion of human knowledge of the Earth and of phenomena in the atmosphere and space."

The challenge is not only to achieve this vision, but to assure that we continue to do the unique, often risky first steps and encourage cooperation and partnerships to achieve this mission.

While what it means to be at the leading edge cannot be reduced to a simple algorithm, a number of questions will be considered in determining Goddard's mission, new business strategy, and technology development.

Mission and New Business Strategy

Ongoing work and new initiatives at Goddard Space Flight Center will be aligned with Agency and Enterprise themes. Discussions and decisions related to new Center initiatives and the scope of existing work will include the following questions regarding relevance, Center capabilities, and resources.

Relevance

- Does this work help achieve the vision and the mission of the Agency?
- Is this work in alignment with the NASA Strategic Plan and the Enterprise Strategies that Goddard supports?
- Has this work been assigned to Goddard by the Agency?
- Is this work encompassed in one of the Center's designated areas of responsibility?

- Does the work maintain the appropriate balance between near-term goals (up to 10 years) and the work necessary to meet the grand scientific challenges that are a decade or more in the future?
- Do the expected results provide sufficient return on investment to the Center's customers and stakeholders?

Center Capabilities

- Does the Center offer a unique capability to support this work and to deliver the required product?
- Are there other better sources from which to obtain it?
- Does the work sustain or enhance the Center's leadership role and core competencies?
- Is it the kind of high-risk, state-of-the-art work the Center should be pursuing?
- Does it demand new technology?
- Does the capability to do the work position the Center to perform future work in alignment with the Agency's mission?

Resources

- Are institutional resources, personnel, facilities, and equipment available within Goddard or with external partners to perform this work in a cost-effective manner?
- Is the new work the most cost-effective option for accomplishing the goal within schedule and with a high probability of success?
- Will the work have a sufficient and timely budget to be self-sufficient and meet schedule requirements?
- Are there partnership opportunities, including international and academic institutions, that will enhance the project?
- Will partnerships or other funding options reduce NASA's funding requirements?

By addressing these questions in the context of Goddard's decision making processes, we will be better able to achieve the mission first set forth in the Space Act of 1958 — and captured in spirit by the phase "as only NASA can . . . ."

defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian agency established to direct and control nonmilitary aeronautical and space activities, of information as to discoveries which have value or significance to that agency;

(7) Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof;

(8) The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment; and

(9) The preservation of the United States preeminent position in aeronautics and space through research and technology development related to associated manufacturing processes.

(e) The Congress declares that the general welfare of the United States requires that the unique competence in scientific and engineering systems of the National Aeronautics and Space Administration also be directed toward ground propulsion systems research and development. Such development shall be conducted so as to contribute to the objectives of developing energy- and petroleum-conserving ground propulsion systems, and of minimizing the environmental degradation caused by such systems.

(f) The Congress declares that the general welfare of the United States requires that the unique competence of the National Aeronautics and Space Administration in science and engineering systems be directed to assisting in bioengineering research, development, and demonstration programs designed to alleviate and minimize the effects of disability.

(g) It is the purpose of this Act to carry out and effectuate the policies declared in subsections (a), (b), (c), (d), (e), and (f).

Figure 1

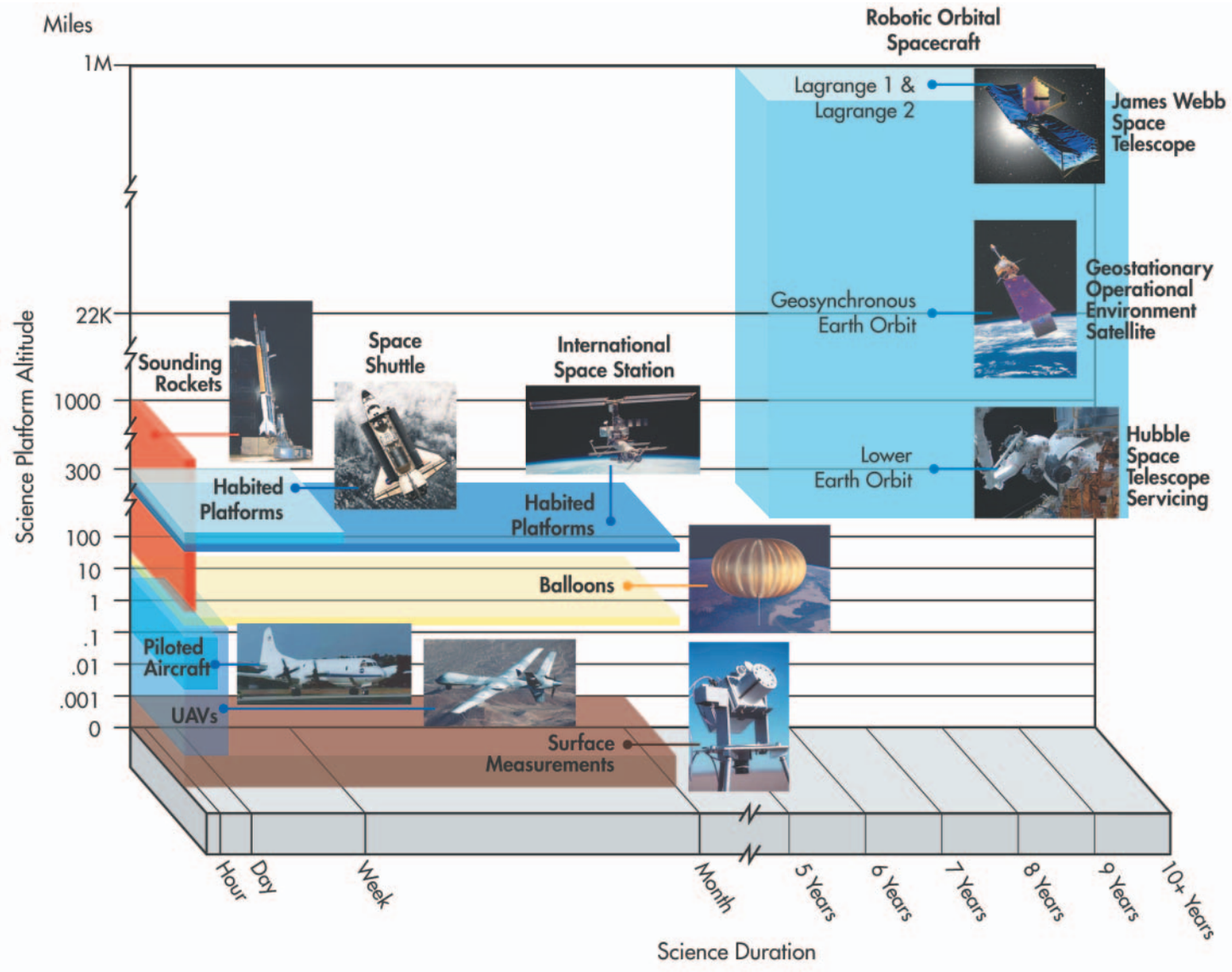
One NASA: Major Inter-Center Partnerships		
CENTER	**GSFC Receives from Other Centers**	**GSFC Provides to Other Centers**
Ames	Information Technologies	Sounding Rockets Free Flyer Spacecraft System Development and Mission Management
Dryden	High Altitude Aircraft Platform Operations	
Glenn	Communications, Power and Propulsion Technology	Sounding Rockets
Johnson	Human Space Flight Mission Services	Mission and Data Services
JPL	Deep Space Systems Spacecraft Instruments	Large Observatories Spacecraft Instruments, Balloons Research Platforms
Kennedy	Space Launch	Carriers, Engineering, and Operations
Langley	Atmospheric Chemistry Laser System Development Spacecraft Instruments	Mid to Low Altitude Aircraft Research Platforms Free Flyer Spacecraft System Development and Mission Management
Marshall	Propulsion Technology Hydrological Sciences X-ray Instruments, X-ray Calibration Facilities/Optics	Free Flyer Spacecraft System Development and Mission Management
Stennis	Applications Support for Earth Science	Science Support to Earth Science Applications

NASA's ten field Centers form the core of the Unites States' civilian space program. Each Center has its own unique capabilities, both in research facilities, workforce competencies, experience, and expertise.

The inter-Center partnerships that are identified in Figure 1, provide an overview of these interdependencies as they relate to Goddard and its fellow field Centers. These reciprocal partnerships draw upon the mission responsibilities, expertise, and facility capabilities of all the NASA field Centers.

While mission responsibilities and capabilities vary from Center to Center, the common thread is NASA's vision and how all Centers work together to accomplish NASA's mission.

Figure 2
Research Platforms



To support Goddard's Earth and space sciences, the Center uses instruments and sensors attached to a wide array of platforms that span from in situ observation on Earth (including some below sea level) to the Lagrange points L1 and L2 (about 1 million miles from Earth). Between these extremes is a continuum of platforms from aircraft and unmanned aerial vehicles, to high-altitude research balloons and sounding rockets managed out of the Wallops Flight Facility (WFF), to low Earth orbiting spacecraft (both robotic and habited), to geosynchronous orbiting satellites some 25,000 miles away, on out to L1. Each option has its advantages tied to the specific science, the length of the observation, and cost. Together these factors determine the platform that is most appropriate for a given science or technology mission.

Human Capital

The human capital that comes together to perform the mission responsibilities of the Goddard Space Flight Center is primarily comprised of the civil service workforce and contractors, both those that provide services and those that provide end item deliverables. However, personnel and partnerships with other NASA Centers, other Federal agencies, state and local governments, academic institutions, and foreign governments and institutions are integral to all aspects of the Center's work.

Guiding Principles for Strategic Management of Human Capital

To facilitate the Center's success in fulfilling its vision for the future and its mission responsibilities, we have adopted a set of guiding principles to serve as a foundation for our strategic management of human capital. We recognize the critical inter-relationship between the nature of the work and the workforce of the Center. To attract and retain world-class talent and maintain world-class capabilities that permit the Center to be a national resource, three principles guide our Human Capital Management.

- **Exciting work:** Challenging scientific and engineering work with sufficient in-house activity to assure the maintenance of core competencies that are the prerequisites for mission safety and success.
- **Sustainable workload:** A sustainable workload that supports timely revitalization of the workforce, facilities and equipment and that allows the achievement of balance in employees' lives.
- **Value-centered management practices:** A culture that sustains the values of "integrity" and "dedication" that are at the core of the Center's tradition; a culture that embraces the values required for future success including greater flexibility in dealing with rapidly changing customer requirements and expectations, as well as with the needs of a changing workforce; and a culture that supports a "balance" between work and personal life and supports "respect" for diversity of people and ideas.

A Workforce Centered on Core Capabilities

The civil service workforce has responsibilities for inherently governmental responsibilities such as program management and contracting, core technical competencies, and other work basic to the government. However, because the role of Federal research and development is constantly undergoing some level of redefinition, the role the civil service workforce itself periodically experiences shifts in responsibilities or focus. In the first decade of the space program, the civil service workforce was often responsible for nearly all aspects of a given project. With the maturity of the aerospace business, the development of an academic research base, enhanced international capabilities, and other changes, many capabilities have been transferred to the private sector and to other contractor or partnership arrangements, such as the Space Telescope Science Institute for the operation of this telescope. As a result, Goddard is able to focus on establishing core competencies around its unique set of skills and its inherently government responsibilities.

The Center structured its core competencies around three criteria – Goddard will have a core competency in a particular area when: (1) the capability is necessary for fulfilling Goddard's mission and does not readily exist elsewhere; (2) it is necessary for Goddard's support to NASA's mission and Goddard is the best source; or (3) the breadth and/or depth of a capability is essential to Goddard's ability to meet customer requirements. Seven areas meet these tests:

- Science – space science and Earth science – Theoretical and Experimental
- Sensors, Instruments, and Associated Technologies
- End-to-End Mission Systems Engineering
- Advanced Flight and Ground Systems Development
- Large Scale Scientific Information Systems
- Program/Project Management
- System Assurance

In addition, we maintain core technology competencies in four areas:

- High Sensitivity Detector Systems
- Large Aperture Observation Systems
- Distributed Observing Systems/Constellations
- Flight and Science Information Systems

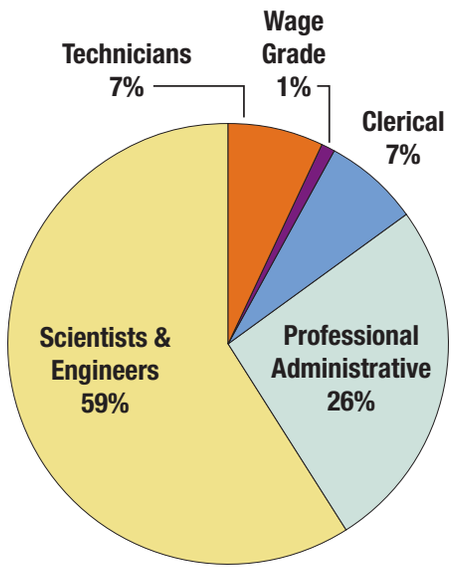
While emphasis within each of these areas may change over time, these are the Center's building blocks. As opportunities present themselves, such as the advancement of new science and new technologies, as new customer requirements emerge, and as external capabilities mature, the Center will continue to examine its competencies to meet customer requirements and adjust its workforce accordingly.

Current State of the Goddard Space Flight Center Workforce

The Center's workforce is comprised of scientists, engineers, technicians, administrative personnel, clerical personnel, and crafts and trade positions. Figure 3 identifies the distribution of this workforce across these skill areas. Figure 4 highlights the educational level of the Center's scientific and engineering (S&E) workforce.

Figure 3

GSFC Full-Time Perm. Employees By Skill

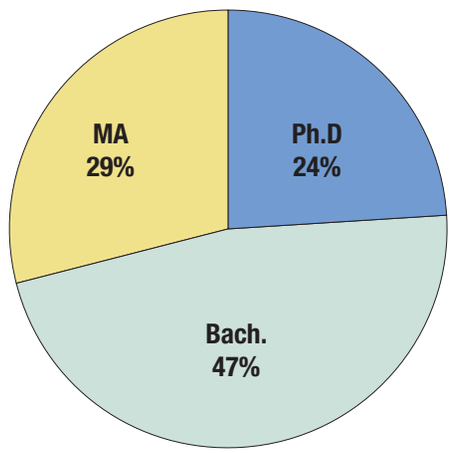


October 2003

Eighty-five percent of Goddard's workforce is professional.

Figure 4

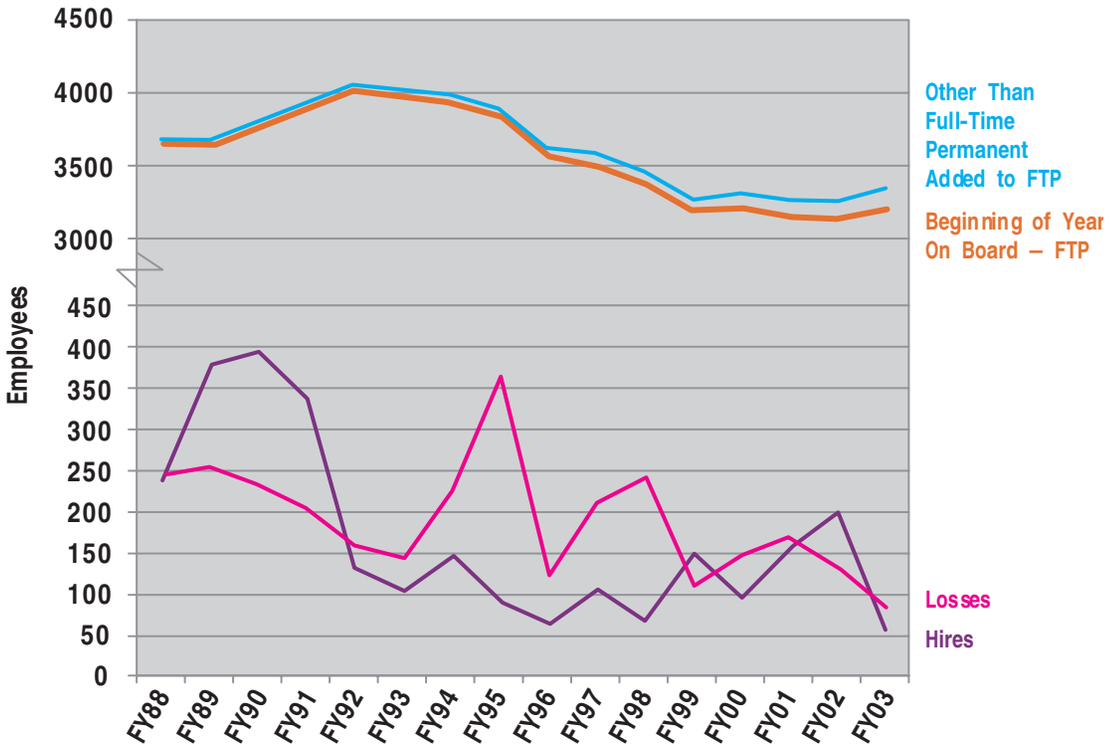
GSFC Full-Time Perm. S&E Employees By High Degree Level



October 2003

Over fifty-three percent of Goddard engineers and scientists have advanced degrees.

Figure 5
Overview of Workforce Changes



The workforce has undergone tremendous changes over the last 15 years. During this time the Center reached workforce peak of 4,108 in 1992, only to see a period of downsizing and limited hiring change the nature of the workforce (Figure 5). Also during this time, the Center has undergone a major change by turning over most of the spacecraft operations work to contractors and picking up responsibilities for a number of NASA Headquarters administrative functions and for the Independent Verification and Validation (IV&V) Facility located in Fairmont, West Virginia. Numerous other adjustments have been made to address changing work and changing workforce conditions. Figures 6 and 7 on the following page highlight the age distributions of the two key components of the Center's workforce, engineers and scientists.

Over the last ten years, the age of both scientists and engineers have shifted significantly to the right. Over 40 percent of scientists are now 55 or older, while less than 15 percent of engineers are younger than 35.

The consequences of these dynamics are significant:

- Loss of critical technical expertise with little opportunity to replace it;
- An able but aging workforce, with 30 percent eligible to retire within the next 5 years;
- A increased workload balanced against constrained resources;
- A generation gap that creates a discontinuity between new, younger generations and those who would normally have preceded them and been their primary mentors;
- A break in the recruitment chain of cooperative education students and other feeder programs; and
- Limited ability to redistribute workforce composition to meet changing competency requirements.

Figure 6

Comparative Age Distribution of Goddard's Scientific Workforce FY93 and FY03

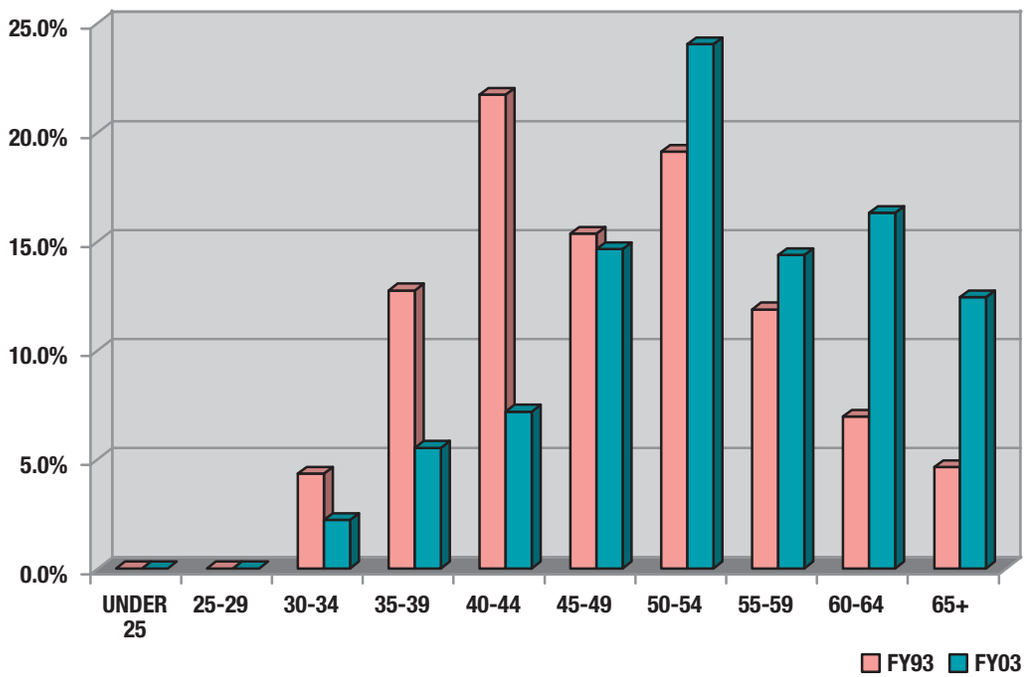
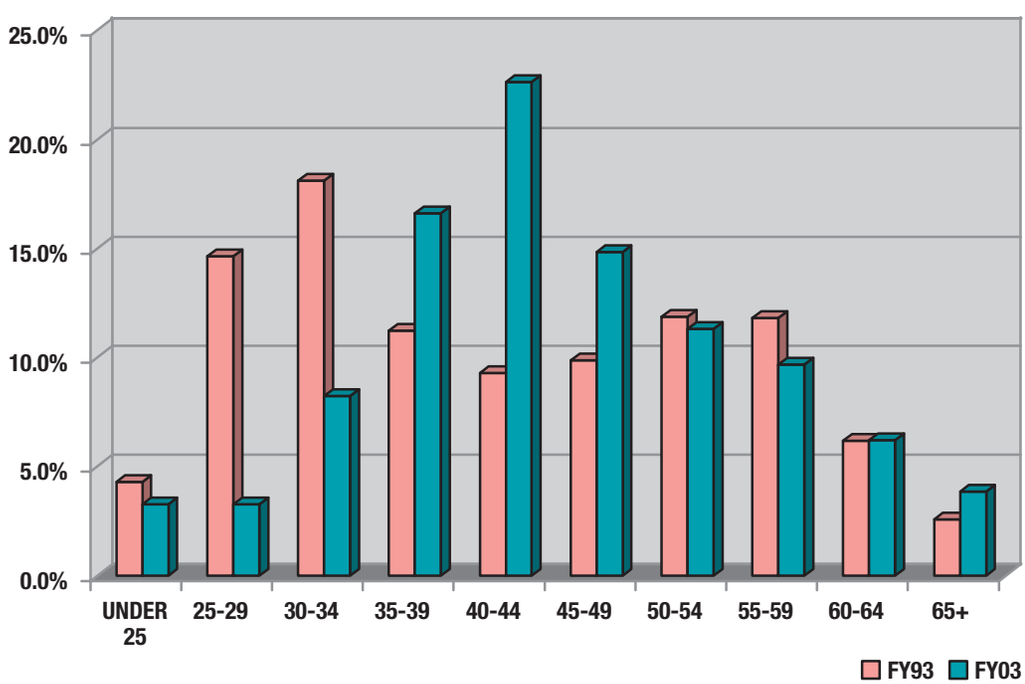


Figure 7

Comparative Age Distribution of Goddard's Engineering Workforce FY93 and FY03



For our civil service workforce, we have already begun to address these legacy questions. We have developed a practical strategy to sustain and grow our core competencies and to fully utilize the capabilities that are available. We will:

- Utilize our full-time permanent civil servants in work necessary to sustain our core competencies and draw upon the expertise that resides within other NASA Centers;
- Increase our use of other than full-time permanent civil servants to address short-term, specialized needs that are governmental in nature, but are not perceived to be needed as a permanent part of the workforce;
- Focus our workforce on the government's inherently governmental role, and consistent with Agency strategies and goals, outsource those areas outside our core competencies that are not inherently governmental;
- Use all available workforce flexibilities to recruit and retain a world class scientific and engineering workforce that is supported by an equally skilled administrative and support workforce;
- Take affirmative steps to increase the numbers of minorities, women, and persons with disabilities in skill areas in which they are underrepresented;
- Transition non-core work requirements to contracts;
- Expand our strategic partnerships with the academic community, businesses, other governmental organizations, and foreign entities to take advantage of their capabilities;
- Use modern management practices and organizational development to strengthen teamwork and performance;
- Create a climate that provides employees the opportunity to maintain a productive balance between personal and professional responsibilities;
- Align reward, recognition, and performance systems with Agency and Center values and goals;
- Foster an organizational climate where diversity and mutual respect are catalysts for creativity and team effectiveness; and
- Enhance our use of knowledge management to facilitate the transfer of knowledge and lessons learned, to provide universal access of information necessary to perform one's job, and to facilitate the training of the next generation of Goddard's workforce.

Overall, these strategies are centered on sustaining Goddard's workforce competencies and viability to serve the Agency as a national resource in our designated areas of responsibility.

Goddard's primary facilities are a unique national resource.

The Greenbelt site occupies about 2 square miles at the southern edge of a large, lightly-developed, federally-owned land area which also includes the Beltsville Agricultural Research Center, Patuxent Environmental Research Center, the Baltimore-Washington Parkway, and Fort Meade. Site improvements include buildings, test facilities, utilities, roads and parking, and fences and gates with a collective value estimated at $900 million. With over 3 million square feet of gross area, the buildings constitute about 90% of the value of the improvements, including 30 major structures. Key capabilities include specialized laboratories for scientific research, premiere computing and data management facilities, and spacecraft integration, test, and evaluation facilities including large-scale cleanrooms, centrifuges, and thermal vacuum chambers. Some individual facilities are unique, and the overall combination of research, fabrication, testing, and data capabilities offers a comprehensive set of capabilities to support "end-to-end" mission system engineering.

The Wallops Flight Facility includes a 6.8 square mile island/mainland sub-site and a 2.9 square mile Main Base sub-site. Launch capabilities include vertical launch facilities, vertical dynamic and static balancing facility, payload assembly buildings, radar/telemetry antenna and support facilities, payload integration and testing facilities, and a range control center. Airfield facilities include three runways, two aircraft hangers, and a "fuel farm." One runway is a unique experimental facility outfitted for flood testing and for arresting gear. The airfield is also a backup Space Shuttle landing site. Other unique facilities include a payload fabrication facility, wave tank, high bay material testing facility, magnetic calibration facility, and an oceanfront unmanned aerial vehicle runway. The combination of rocket launch and airfield facilities, restricted air space, and science facilities are a unique set of resources to support scientific, engineering, and flight research.

Facilities and Real Property of the Goddard Space Flight Center

Goddard's facilities serve nearly 9,000 scientists, engineers, project managers, and support personnel at primary facilities in Greenbelt, Maryland and Wallops Island, Virginia and occupy approximately 12 square miles of land. In addition, Goddard includes the Independent Verification and Validation Facility in Fairmont, West Virginia, the Goddard Institute for Space Studies (GISS) in New York City (in GSA-owned facilities), and a series of smaller research and tracking facilities around the globe.

In concert with Center leadership, facilities managers have embarked on a program of strategic change. Many of Goddard's primary facilities (including buildings, roads, utilities, fences, and land use) can no longer reliably meet current or projected needs. Mission success depends on a comprehensive plan for renewal. An intensive master planning process was completed for Greenbelt in 2000, and a comparable plan for the Wallops Flight Facilities is in progress.

Facilities Master Planning

The Center invests approximately $25 million annually in sustaining and renewing facilities through a combination of Cost of Facilities (CoF) funding and Center-funded projects. In addition, the Center has made plans at each site for replacing outdated facilities with new construction, including the Space Science Center at Greenbelt and the Consolidated Engineering Building at Wallops, and demolishing or transferring to partners those facilities that are no longer suitable.

These strategic investments are intended to decrease the backlog of maintenance and repair, though at current funding levels, aging facilities will continue to decline. Current investment levels cannot improve the Center's overall facilities condition on their own: more creative approaches are required to either increase utilization by spreading fixed costs across more activities or to shed facilities so available sustainment funding can be concentrated on those we continue to need. These options have driven the current wave of facilities master planning.

The Center's Greenbelt Facilities Master Plan began in 1998. Five strategies have guided the development and implementation of the Goddard Facilities Master Plan:

Master Plan Goals

A 20-year look into GSFC's Future

Management Strategies	Facilities Goals
Mission Success Starts with Safety	➤ Safety
Focus on performance	➤ Quality
Unify the organization	➤ Unified Campus
Optimize Center resources	➤ Efficiency
Work more closely with our partners	➤ Partners

For Greenbelt, these strategies led to several conclusions: though there is sufficient space to meet requirements, its quality and configuration pose problems that can severely limit mission success. As a consequence, the Center has committed to an aggressive program of facilities change over the next 20 years to provide an integrated, efficient facilities infrastructure.

Greenbelt Facilities Master Plan - Renewal Strategy is Driven by Core Capabilities Assessment

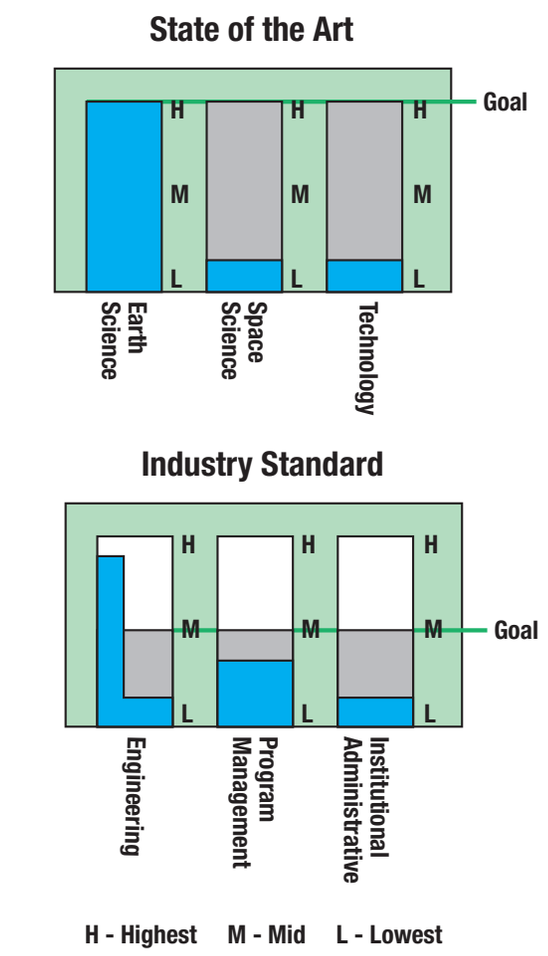
State-of-the-art facilities are the goal for Goddard's principal competencies in Earth science, space science, and technology.

Current Assessment:

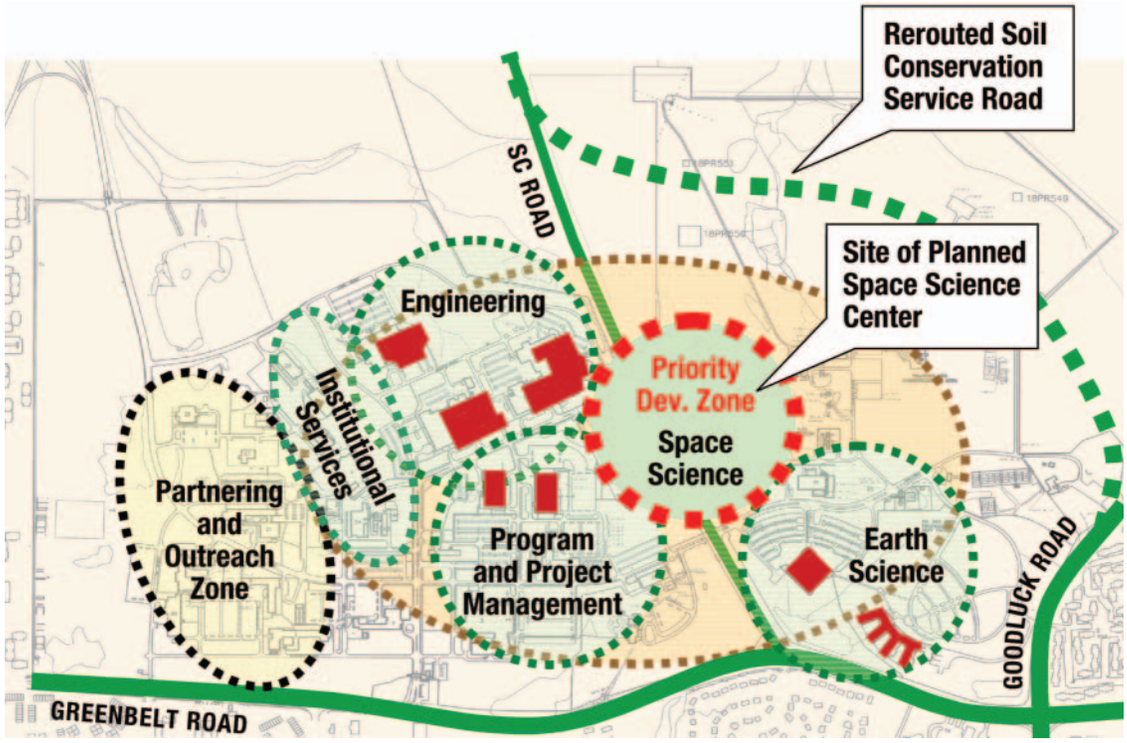
- **Earth Science** facilities are of high quality and generally at or near state-of-the-art. They are of recent design and construction, well suited to current and planned operations, and in good condition.
- **Space Science** facilities are generally poor. They include some of the oldest facilities at Greenbelt and are not well suited to current or future operations. This is the highest priority building initiative in the Facilities Master Plan.
- **Technology** facilities vary considerably in quality. Some areas are new and well suited for their role, but older facilities are generally inadequate for the Center's technology development role.
- The goal for the remaining facilities that house other engineering, program/project management, and institutional service activities is to reach "industry standard," a term that represents facility quality that matches current industry norms.

The overall status of Goddard's Greenbelt facilities are represented in the diagrams below:

Issue: Facilities Quality
Renewal Strategy Driven by Core Capabilities Assessment



Proposed Land Use diagram: Functional Neighbors



The strategy of the Greenbelt Facilities Master Plan is captured in this representation of the future Greenbelt campus. Functional neighborhoods unify those performing common work, a corridor provides improved access among the neighborhoods, and partners have an opportunity to be located adjacent to civil service facilities. The lead times associated with facilities construction and changes are longer than any other activity. This necessitates an understanding of the Center's future mission responsibilities and an aggressive strategy to ensure that facilities are of a quality to match mission requirements.

Continuous Assessment of Facility and Real Property Requirements

For the Wallops Flight Facility, associated institutional investment guiding principles were developed to summarize the facility development strategy. They include: consolidate mission critical activities in a core infrastructure; develop neighborhood/sector planning to localize common functions; optimize facilities to support mission critical activities; focus infrastructure quality/renewal strategy on the core/operations/commercial land use concept; ensure increased security for mission critical activities and critical assets; search for public/private financing opportunities to reduce NASA's infrastructure costs; and optimize facilities infrastructure by aligning NASA planning with partner's mission growth.

Real Property Initiatives

The Center participates actively in Agency initiatives to better understand and manage real property, including the Deferred Maintenance and Facilities Sustainment models and the recently completed report on real property opportunities. In early FY2004, Wallops will pilot a new Mission Dependency model for the Agency that is intended to map facilities against mission priorities.

The Center is actively working to establish facilities partnerships that can enhance our work by attracting advantageous partners to our property and by reducing institutional costs associated with facilities that no longer meet the Center's needs.

Continuing Facility Master Planning Process

There are several key elements to the master planning process currently underway at the Center's

Wallops Flight Facility. The current process is considering the total facility, including partner's missions, visions, and real property. NASA has many partners at the facility including the United States Navy, the National Oceanic and Atmospheric Administration, the United States Coast Guard, the Marine Science Consortium, and the Virginia Space Flight Authority. The master plan seeks to eliminate unnecessary redundancies and share institutional investments. Alternative funding strategies being considered as part of the master planning process are Enhanced Use Leasing and commercialization.

Non-NASA Capital Assets

The Center accomplishes the lion's share of its work beyond its property boundaries through contracts, grants, and partnerships across the country and in many instances with other countries. The Center goal is to maintain the capabilities needed to support its core competencies and perform its inherently governmental responsibilities. The Center also has several agreements with partners to utilize capital assets to achieve the NASA mission, primarily at Wallops. For instance, United States Coast Guard boats are used for payload recovery and clearing of launch hazard zones. With the Navy, joint missions are conducted using Navy radars to provide data and backup.

Leveraging the Center's Real Property

The Center is currently evaluating all its opportunities to share or excess unutilized or underutilized capabilities. Among the authorities that can be used are the Space Act, the Historic Preservation Act, Enhanced-Use Leasing, and the GSA Relocation Program. Among these, Enhanced-Use Leasing is the most attractive and feasible, and the Center is developing a proposal to be selected as a demonstration site for this authority. At Greenbelt, creating a Partnering and Outreach Zone would invite partners to renew and occupy about 28 percent of current facilities space that no longer fits well with our future needs, including the current Visitors Center and many technical, office, and support facilities. At Wallops, several projects are being considered, including the lease of the spin balance facility, the utility plants, and the calibration lab. The lease of airfield facilities to a commercial aviation company is also being considered. Airfield facilities would include a hangar, ramp space, and possibly aircraft. Consideration for the facilities would include the payment of cash and "like services" including aircraft and maintenance support for the Suborbital Science Program heavy lift aircraft platforms.

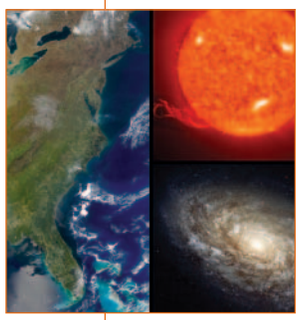
Reducing Excess Property

At Greenbelt, the Facilities Master Plan calls for an overall reduction of 10 percent of facilities space resulting from the demolition or excess of approximately 45 percent of current facilities space over the next 20 years, while constructing about 35 percent replacement space. The result will be to raise facilities quality and eliminate most facilities that no longer meet requirements or whose maintenance and refurbishment costs outweigh their value.

At Wallops, the Center is actively pursuing disposal of excess property. Three projects have been submitted to Headquarters for demolition funding, two in FY 2004 and one in FY 2005. As part of its master planning efforts, Wallops also hopes to replace several core area facilities with new, more efficient and maintainable space, in turn demolishing a substantial portion of current space.

Summary

As they are executed, Goddard's facilities and real property goal plans will re-establish the quality of the Center's capability to continue to serve as a national resource for the exploration of Earth and space.



4 Implementing Strategies (IS)

4 Implementing Strategies (IS)

IS-1. Achieve management and institutional excellence comparable to NASA's technical excellence.

The Goddard Space Flight Center's leadership role as a national resource for Earth and space sciences, technology, and program/project management are supported by the following essential services.

Safety and Mission Assurance: services associated with maintaining personal safety of the employees and others who could be potentially affected by Goddard's program and activities and in maintaining systems safety and mission assurance associated with Goddard programs and projects.

Human Resources: services associated with the employment, career development and training, awards, benefits, organizational development, labor relations, and other activities associated with the civil service portion of Goddard's human capital.

Institutional Management: services associated with managing Goddard's institutional infrastructure.

Financial and Resource Management: services associated with managing Goddard's fiscal and physical resources, including budget analysis, preparation and execution.

Procurement: services associated with Goddard's acquisition of goods and services and the award of grants.

Legal: services associated with providing Goddard management and employees legal counsel to help assure they conduct their work in accordance with laws and regulations, with representing Goddard in litigation, and with conducting Goddard's ethics program.

Information Management: services associated with development and management of an information infrastructure that supports the management of data, information, and business processes in a safe, secure manner.

Goddard employs two key processes for the management of these functional areas as they support the Center's programmatic responsibilities. Goddard will use these core processes to facilitate management of **Human Capital, Competitive Sourcing, Financial Management, and Institutions and Asset Management**.

- The first of these processes is Goddard's Integrated Business Planning (IBP). The IBP is the process by which the Center assesses strategic environmental issues and translates them into budget strategies, workforce management, overhead costs, service pool management, and other funding areas. The IBP also serves as a forum for issue analysis that helps prepare the Center for the annual budget cycle.
- The second of these is the Goddard General Management Council (GMC), which is an institutional parallel to the Goddard Program Management Council. The GMC brings together monthly those elements of the Center that comprise the Center' primary institutional support elements to address performance and accountability.

Budget and Performance Integration: the Center will meet Agency guidelines in the submission of its budget and in the establishment of performance goals. The Center will fully utilize the capabilities of the Integrated Financial Management Program to manage these processes. Goddard is also providing a leadership role to the next phase of this program in the area of Budget Formulation.

Electronic Governance: the Center is supporting the One NASA Portal by matching existing content with the architecture of the Portal and creating new content specifically for the Portal. We will continue to train webmasters to assure that they develop sites consistent with NASA's One NASA Portal strategies, including encouraging visual affinity of its public sites with the One NASA Portal.

As Agency-wide institutional initiatives continue to unfold, the Center will support those activities to ensure that NASA's institutional excellence is on par with it technical excellence.

IS-2. Demonstrate NASA leadership in the use of information technologies (IT).

Goddard will support the Agency initiatives in the use of information technologies that are an essential component of our infrastructure across NASA and are critical to our communication with customers and stakeholders, especially the public.

Security and integrity of data are cornerstones to the foundation of our IT infrastructure. Goddard supports NASA's Network Perimeter Security, Internet Protocol (IP) registration, and User Account management initiatives.

Goddard will identify and define a current state architecture and in conjunction with Agency guidelines work to develop an "ideal" architecture to establish an integrated, low cost information technology infrastructure. In addition, Goddard will participate in Agency initiatives and provide leadership when its expertise is requested. Goddard will complete and implement a computer wireless policy that will be used as an Agency model.

Goddard will use its IT to help manage its business and program/project management responsibilities by providing a variety of management information that is easily accessible and automated tools that facilitate and support decision-making.

IS-3. Enhance NASA's core engineering, management, and science capabilities and processes to ensure safety and mission success, increased performance, and reduce cost.

As a space flight center, mission activities associated with major programs are central to Goddard's work. Our strategies to address these responsibilities are to maintain a world-class workforce focused on our core competencies; facilities and equipment that permit this workforce to maximize its performance; business practices that support the end product; experienced program/project leadership; and management processes that bring together the resources and talent to meet the Center's commitments.

A number of key processes are involved.

Goddard's New Business Process vets proposed work to determine (1) its relevance to its customers and the Center's mission, (2) the Center's capabilities measured against the requirements, and finally (3) the availability of resources to perform the work. Our goal is early involvement of all contributors to a mission so that requirements can be assessed and a cohesive team formed to achieve the overall mission. Contributors include scientists, engineers, project managers, and mission assurance managers, as well as procurement, resources and financial management personnel, and other support functions whose contributions are necessary to successfully bring a project to completion.

Goddard will continue to evolve and develop its Integrated Design Capability (IDC). We will continue to implement new processes, tools, and capabilities to expand services to the IDC customers. We will create and implement new systems engineering capabilities and methodologies to enhance definition of trade space and multiple solution sets and to weight performance, cost and schedule risks. We will strategically evaluate and infuse technologies into new missions and strategically use our resources to develop technology that has the greatest potential return defined as the ability to support future missions.

Since much of the risk associated with state of the art work resides with our ability to safely infuse new technologies, the Center is developing a Technology Strategic Plan that will unify the various elements of technology development, including project specific technology, Research and Technology Development (R&TD), and competitive technology research opportunities.

We will fully implement Goddard's Systems Engineering policies to ensure consistent, effective systems engineering services and products across all Goddard projects and throughout all stages of the development life cycle. We will complete and implement supporting process guidelines for life cycle elements and systems engineering functional areas.

We will maintain a cadre of senior system engineers comprised of civil servants and contractors who will

provide expertise in systems engineering functions including risk, requirements, cost, and performance management. The systems engineers will provide rapid response to customers, and systems engineering support to scientists from pre-formulation through development.

We will continually improve Goddard's Quality Management System (QMS). We will provide value-added management process requirements and guidelines based on best practices and lessons learned. We will conduct a review of the Goddard Directive Management System (GDMS) to ensure that all critical processes are defined, that all documents are relevant and can be tailored to meet the needs of our diverse projects, that missing or undocumented processes will be added to the GDMS, that employees will be trained in these processes, and that periodic, systematic review of their use will be made.

We will continue to implement a risk management process and deploy it to provide for consistent use by all flight projects (in-house and out-of-house) throughout all stages of a project's life cycle.

Goddard's scientific research follows a Darwinian model. Areas of research, science projects, and individual scientists survive based on a process of natural selection that results from various competitive processes that promote the quality of the Center's scientific research:

Mission/Project Level
Scientific missions are the result of priorities that reflect the community of interest of associated disciplines. Goddard competes for mission opportunities by responding to Agency competitions - Announcements of Opportunities (AO's), Research Announcements (RA's), etc. Internal Goddard processes, including the allocation of resources for new proposals (Bid and Proposal - B&P), take place within organization/discipline units before being vetted with the Center's New Business Committee.

Discipline Areas
Individual areas of research exist as a result of a basic demand and supply model. When an area of research no longer attracts resources, it reconstitutes itself or is dissolved. Competitive funding demands that scientific research meet a need, if it fails to meet that need, it ceases to receive funding.

Individual Scientist
As experts in their respective disciplines, scientists have a number of roles to perform. They provide ideas and initiatives that drive new projects. They serve on project teams as Principal Investigators (PIs), Co-Investigators (Co-Is), and project scientists. However, the fundamental role of scientists is to do science. Their research opportunities and associated resources are determined through competitive processes, and their results are tested by a peer review in publications and by presentation at professional conferences.

Center Level
As competition for scientific expertise expands into new areas, Goddard will seek to attract the best scientists by providing them an environment that supports the best research, the resources to pursue new areas of inquiry, and space flight opportunities that are unequaled. The Goddard Senior Fellows, comprised of the best of Goddard's scientists and engineers serve as internal advisors to management to address issues and barriers to maintaining the opportunities, resources, and workforce that will continue the Center's record of scientific achievement.

IS-4. Ensure that all NASA work environments on Earth and in space, are safe, healthy, environmentally sound, and secure.

Goddard maintains a robust safety, occupational health, and environmental program that addresses safety of people and of resources. The essence of the program is captured in the Center's core safety value:

- We will not compromise the safety of the public or our employees in the conduct of our work.
- The personal safety and security of all those associated with or potentially affected by Goddard's programs and activities is the cornerstone upon which we build success.
- We will be active stewards in the use and protection of all resources and assets that NASA and this Nation have entrusted to us.

Goddard's safety and occupational health, and environmental program functions are accomplished by Agency directives that require implementation of Executive Orders and regulatory standards for the many disciplines of the program, such as regulations and rules of the Occupational Safety and Health Administration, Nuclear Regulatory Commission, and Environmental Protection Agency. Nationally recognized management system tools have been adopted by the Agency to facilitate adoption of these laws and regulations Agency-wide.

The two primary functional areas and source of guiding standards include:

- **Safety and Occupational Health:** safety and occupational health encompasses planning, development, and management of policies and procedures for the protection of personnel, property, and the public from hazards generated by processes and operations at Goddard. Program elements include:
  - Chemical Safety Program
  - Occupational Health
  - Emergency Preparedness
  - Occupational Safety
  - Facilities Systems
  - Radiation Protection
  - Fire Protection
  - Workers Compensation Program
  - Industrial Hygiene
  - Mishap Prevention

  Guiding Standards for the Occupational Safety Management System:
  - Occupational Safety and Health Administration (OSHA)
  - Voluntary Protection Program (VPP)

  Guiding Standards for the Occupational Health Management System:
  - Joint Accreditation of Healthcare organizations (JAHCO)

- **Environmental:** The overarching strategy is defined by four areas: *Prevention* (pollution prevention program); *Compliance* (bringing all Goddard operations into compliance with current environmental requirements; *Restoration* (clean up pollution from past operations); and *Conservation* (preserve natural and cultural heritage for future generations). Program elements include:
  - Clean Air
  - Remediation of Chemical Releases
  - Clean Water
  - Pollution Prevention
  - Chemical Uses
  - National Environmental Policy Act
  - Waste Materials
  - Natural and Cultural Resources

  Guiding Standards for the Environmental Management System include:
  - Environmental Protection Agency (EPA)
  - International Standards Organization (ISO) 14000, NASA Environmental System policies derived from Executive Order 13148, Greening the Government through Leadership in Environmental Management

As an implementing strategy, the Center will assess vulnerabilities within functional areas and will take a proactive approach to:

- Identify and remove potential problems before they occur;
- Aggressively address any problems that do occur;
- Establish and implement corrective action;
- Incorporate lessons learned to ensure such actions do not occur in the future;
- Concentrate on the highest, most significant vulnerabilities;
- Develop annual goals and objectives for each area and align them with Goddard's management systems; and
- Align (and realign) programs and personnel to provide the Center with appropriate services to meet requirements.

IS-5. Manage risk and cost to ensure success and provide the greatest value to the American people.

In addition to the processes discussed in Implementing Strategy 3, Goddard will pursue a rigorous risk mitigation strategy and will balance that value of potential outcomes with the associated risk. We will attempt to mitigate risk by careful assessment; we will aggressively pursue technology advances that expand capabilities. Where possible and practical, we will test concepts and technologies prior to making major commitments.

The sounding rocket program and high altitude balloon program are key aspects of the strategy to test before making major resource commitments, as well as a means of involving new organizations and training of the next generation of scientists and engineers.

We will ensure all Goddard program and project teams are trained in current NASA risk management policies and equipped with proven leadership and implementation technologies and tools.

We will continue to expand "lessons learned" methodologies, develop supporting program management tools, and take advantage of information available through the Integrated Financial Management Program and its associated systems. We will implement Risk Based Acquisition Management to improve risk management for major acquisitions.

In the area of cost management, our multi-level approach to cost estimation includes:

- A bottom up estimate on Work Breakdown Schedules (time, materials, and labor) though the use of database tools, developed by the project team
- Integrated Design Capabilities (IDC) perform component level cost analysis
- "Price H" a commercial product for cost validation based on engineering provides a cross check
- Resource Analysis Office (RAO) parametric - power/weight based analysis based on prior missions and experience provides a further cross check
- Validation and recalculation integrates these multiple inputs

Together these provide a set of checks and balances internal to the Center, which is further tested by competitive selection processes that weigh cost as a factor.

In the area of performance, we will track and evaluate specific and systemic causes and make changes to prevent their reoccurrence on the key elements of schedule, cost, and performance on our projects, and we are in process of expanding that analysis to the instrument level.

Despite all theses checks and balances, we also realize that our role as a Federal laboratory is to perform cutting-edge research. Risk is inherent anytime exploration is pushed beyond the boundaries of known and proven processes. We also understand that "opportunity cost," that is the risk of not pushing these boundaries, is one of the most significant losses a research and development organization can experience. The Agency has adopted the phrase, "as only NASA can...," as an embodiment of challenging the unknown. In performing its mission, in working with its fellow NASA centers, and in its partnerships, the Goddard Space Flight Center will always seek to challenge the unknown.

5 Additional Information: Acronyms and Web Sites

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Acronym	Definition
AIRS	Atmospheric Infrared Sounder
AO	Announcement of Opportunity
ASO	Astronomical Search for Origins
AT	Aeronautics Technology
B&P	Bid & Proposal
BSR	Biological Sciences Research
CCMC	Community Coordinated Modeling Center
CERES	Clouds and the Earth's Radiant Energy System
CICT	Computing, Information and Communications Technology
CoF	Cost of Facilities
Co-Is	Co-Investigators
Con-X	Constellation-X
CSCP	Complex Self-Contained Payloads
ECS	Engineering for Complex Systems
ECT	Enabling Concepts & Technologies
EOSDIS	Earth Observing System Data & Information System
EP	Education Programs
EPA	Environmental Protection Agency
ESA	Earth Science Application
ESE	Earth Science Enterprise
ESS	Earth System Science
FTP	Full Time Permanent
FY	Fiscal Year
GAS	Get a Way Specials
GCDC	Global Change Data Center
GDMS	Goddard Directive Management System
GFDL	Geophysical Fluid Dynamics Laboratory
GISS	Goddard Institute for Space Studies
GMC	General Management Council
GPS	Global Positioning System
GRACE	Gravity Recovery And Climate Experiment
GSA	General Services Administration
GSFC	Goddard Space Flight Center
GWET	Global Water & Energy Cross-cutting Theme
HST	Hubble Space Telescope
HyTEx	Hypersonic Technology Experiment
IBP	Integrated Business Planning
IDC	Integrated Design Capability
IFMP	Integrated Financial Management Program
IP	Internet Protocol
IS	Implementing Strategies
ISO	International Standards Organization
ISS	International Space Station
IT	Information Technologies
ITTP	Innovative Technology Transfer Partnership
IV&V	Independent Verification & Validation
JAHCO	Joint Accreditation of Healthcare Organization
JCSDA	Joint Center for Satellite Data Assimilation
JPL	Jet Propulsion laboratory
LISA	Laser Interferometer Space Antenna
LWS	Living With a Star
MEP	Mars Exploration Program
MODIS	Moderate Resolution Imaging Spectroradiometer

MSM Mission & Science Measurement Technology

NAI NASA Astrobiology Institute

NASA National Aeronautics and Space Administration

NCAR National Center for Atmospheric Research

NCEP NOAA Center for Environmental Prediction

NGLT Next-Generation Launch Technology

NIAC NASA Institute for Advanced Concepts

NOAA National Oceanic & Atmospheric Administration

NRC Nuclear Regulatory Commission

OBPR Office of Biological & Physical Research

OSHA Occupational Safety & Health Administration

OSP Orbital Space Plane

OSSEs Observing System Simulation Experiments

PIs Principal Investigators

PSR Physical Sciences Research

QMS Quality Management System

R&D Research & Development

R&TD Research and Technology Development

RA Research Announcements

RAO Resource Analysis Office

RPFS Research Partnerships & Flight Support

S&E Scientific & Engineering

SBIR Small Business Innovative Research

SEC Sun-Earth Connection

SEM Space Experiment Module

SEU Structure & Evolution of the Universe

SFS Space & Flight Support

SLI Space Launch Initiative

SSE Solar System Exploration

SSP Space Shuttle Program

STP Solar Terrestrial Probes

STTR Small Business Technology Programs

TOMS Total Ozone Mapping Spectrometer

TRMM Tropical Rainfall Measuring Mission

USCG United States Coast Guard

VPP Voluntary Protection Program

WFF Wallops Flight Facility

Web Sites

NASA Homepage

http://www.nasa.gov/

provides up-to-date news on NASA's programs and activities, as well as a link to the various Enterprise homepages.

Office of the Chief Financial Officer

http://ifmp.nasa.gov/codeb/library/library.htm

is a compendium of NASA budget information and documentation.

Goddard Space Flight Center Public Homepage

http://www.gsfc.nasa.gov/

is a source of general information about Goddard, its mission, and links to other NASA Web sites.

Goddard Space Flight Center Internal Homepage

http://internal.gsfc.nasa.gov/

is the intranet starting point to Goddard information and documentation.

Click on "Reports and Plans" for documents related to the Center's planning activities.

Destination: Earth

http://www.earth.nasa.gov/

is the Web site for NASA's Earth Science Enterprise and provides a direct link to the Web pages of major projects in development and operation.

Space Science

http://spacescience.nasa.gov/

is the Web site for NASA's Space Science Enterprise and provides a direct link to "Our Missions," which provides a link to Web pages for space science projects.

Prior Year Annual Updates

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