

**National Aeronautics and  
Space Administration**

**Ames Research Center  
2004 Implementation Plan**





# Table of Contents

iii		<b>Letter from the Director</b>
1		<b>Ames Research Center in NASA Vision and Mission</b>
5		<b>Supporting NASA Themes and Goals</b>
		10 Space Science Enterprise
		18 Earth Science Enterprise
		21 Biological and Physical Research Enterprise
		25 Education Enterprise
		26 Space Flight Enterprise
		28 Aerospace Technology Enterprise
43		<b>Current Capabilities</b>
		46 Ames Core Capabilities
		51 Ames Workforce
		53 Ames Real Property
		54 Ames Campus Research Facilities
59		<b>Future Plans</b>
		62 Future Research Activities
		67 Building the Future Workforce
		69 Future of Ames Property
73		<b>Implementing Strategies</b>
82		<b>Appendix: For More Information—</b>

(cover) This image shows an "end on" view of a simulated carbon nanotube that is being compressed—the spheres represent carbon atoms, and they are colored according to their potential energy. Carbon nanotubes are of great interest to nanotechnologists at Ames and elsewhere, since they have very useful mechanical and electrical properties.

# Letter From the Director



Ames Research Center boasts a proud history of innovation and discovery that spans more than 60 years. Today, at the beginning of the 21<sup>st</sup> Century, we face new challenges and new opportunities. Our responses will define us as an institution. We will measure ourselves by our creativity, innovation, and dedication to *The NASA Vision*. We will succeed through our unique strengths and capabilities.

The NASA vision that inspires us “*To improve life here*” blossoms at Ames. Our research projects accelerate the development of tools and procedures to improve aviation safety, security, and air traffic management for today and explore advanced concepts for transforming the national airspace system of tomorrow. In addition, our information technologists provide the high-end computational capability to model the complexity of global climate change—a major impact on our everyday lives.

The NASA Vision asks us “*To extend life to there*.” Here, too, Ames advances the horizon. Our life sciences research enables an understanding of the effects of the space environment on living systems, while human-centered computing provides avenues for working in a robotic-assisted universe. Such studies pave the way to prolonged space missions.

Perhaps most audaciously, the NASA Vision challenges us “*To find life beyond*.” Here too, Ames is in the vanguard. Seeking answers to some of life’s

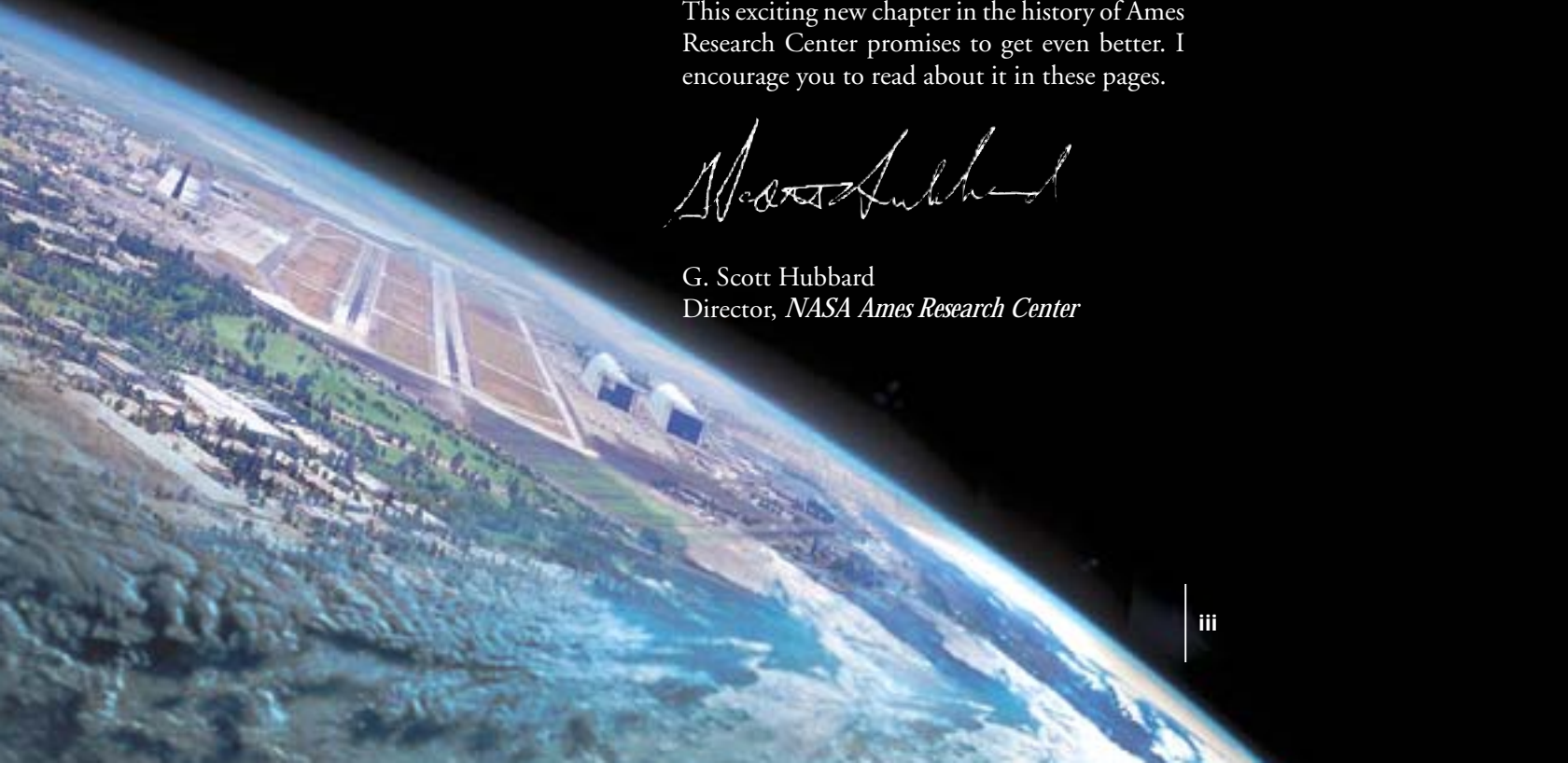
most fundamental questions, the Astrobiology scientists and NASA Astrobiology Institute centered at Ames ask: *How does life begin and evolve? Is there life elsewhere in the Universe? What is the future of life on Earth and beyond?* Ames created the interdisciplinary field of Astrobiology less than a decade ago and today leads more than 700 scientists across the Agency and around the world in pursuing investigations focused on these fundamental questions. Through biotechnology, information technology, and nanotechnology, researchers are developing both the basic knowledge and the applications to create new sensors and capabilities to allow autonomous spacecraft, and ultimately humans, to seek out life wherever it might reside.

Finally, the new education mission challenges us to inspire a new generation of scientists, engineers and explorers in ever more creative and effective ways. Once again, Ames rises to the task with a daring new vision for the 21<sup>st</sup> Century: The NASA Research Park will open the Center’s gates to academia and industry as never before with a college-like campus and a commitment to partnership in the heart of Silicon Valley. Ames and its partners will soon begin developing 213 acres on Moffett Field into a world-class laboratory and educational facility. Here research scientists and students will conduct collaborative research and development in today’s most promising and adventurous fields: Astrobiology, biotechnology, information technology, and nanotechnology.

This exciting new chapter in the history of Ames Research Center promises to get even better. I encourage you to read about it in these pages.



G. Scott Hubbard  
Director, *NASA Ames Research Center*





This image shows a bubbly ocean of glowing hydrogen gas and small amounts of other elements such as oxygen and sulfur. The photograph, taken by NASA's Hubble Space Telescope, captures a small region within M17, a hotbed of star formation. M17, also known as the Omega or Swan Nebula, is located about 5,500 light-years away in the constellation Sagittarius.



**Ames  
Research  
Center in  
NASA Vision  
and Mission**



# Ames Research Center in

Ames Research Center stands at the epicenter of the most prolific and prosperous cluster of high technology businesses, universities, and research laboratories in the world. With an annual budget of more than \$700 million and a workforce of more than 3,000 civil service and contractor employees, Ames is internationally recognized as a pre-eminent research institution with an enduring research culture. Innovative design concepts and breakthrough technologies developed here over the last 60 years are legendary. They include the blunt body concept, the first man-made object to leave the Solar System (Pioneer), the supersonic area rule, hypersonic ranges, arc jets, the chemical origins of life, computational fluid dynamics, massively parallel computing, air traffic management, airborne science, exploration of the outer planets, infrared astronomy, and the discovery of water on the moon.

The past decade brought changes that compelled the Center to reinvent itself. The research center that once maintained the world's largest and most powerful wind tunnels and foremost experts in aerodynamics today seeks innovative breakthroughs in a 21<sup>st</sup> Century arena. Ames' pioneering research in information technology, biotechnology, and nanotechnology will enable development of innovative sensors to probe Earth, other planets, and other solar systems, and dramatically increase the ability to communicate large volumes of information across space. It could also lead to stronger materials, ultrasmall electronic devices, and new space missions with lower-weight components requiring less power and fuel. With leading-edge capabilities in high-end computing, Ames can fully exploit these emerging technologies and interdisciplinary research, which many see as the most likely source of breakthrough technologies in the coming decades.





# NASA Vision and Mission

Ames supports NASA's new vision and mission priorities across the Enterprises. As NASA's lead center for Astrobiology, Ames is opening new pathways of exploration and discovery with investigations into the origin, evolution, distribution, and destiny of life in the universe. The Stratospheric Observatory for Infrared Astronomy (SOFIA) and the Kepler missions will provide scientists with powerful tools to unlock mysteries of the universe. The Center's work in Earth science and Astrobiology helps public policy makers understand global ecosystems and environmental change.

Ames' research and development in air traffic management and aviation safety and security address an urgent national need to improve the capacity, efficiency, safety, and security of the national airspace system.

Using unique capabilities and tools in thermal protection systems, Ames will further the design of next generation reusable launch vehicles to reduce the high cost of space travel and increase safety.

The NASA Research Park will focus the Center's resources on advancing NASA's research leadership, facilitating science and technology education, and creating a unique community of researchers, students, and educators who will "inspire the next generation of explorers."

These and many other Ames Research Center contributions to the Agency's vision and mission represent the bricks along many paths that will lead to future missions—some of which are impossible today. NASA's vision is bold. The Center's capability is strong. Ames will continue to build upon its legacy of accomplishment and service to NASA and the nation.





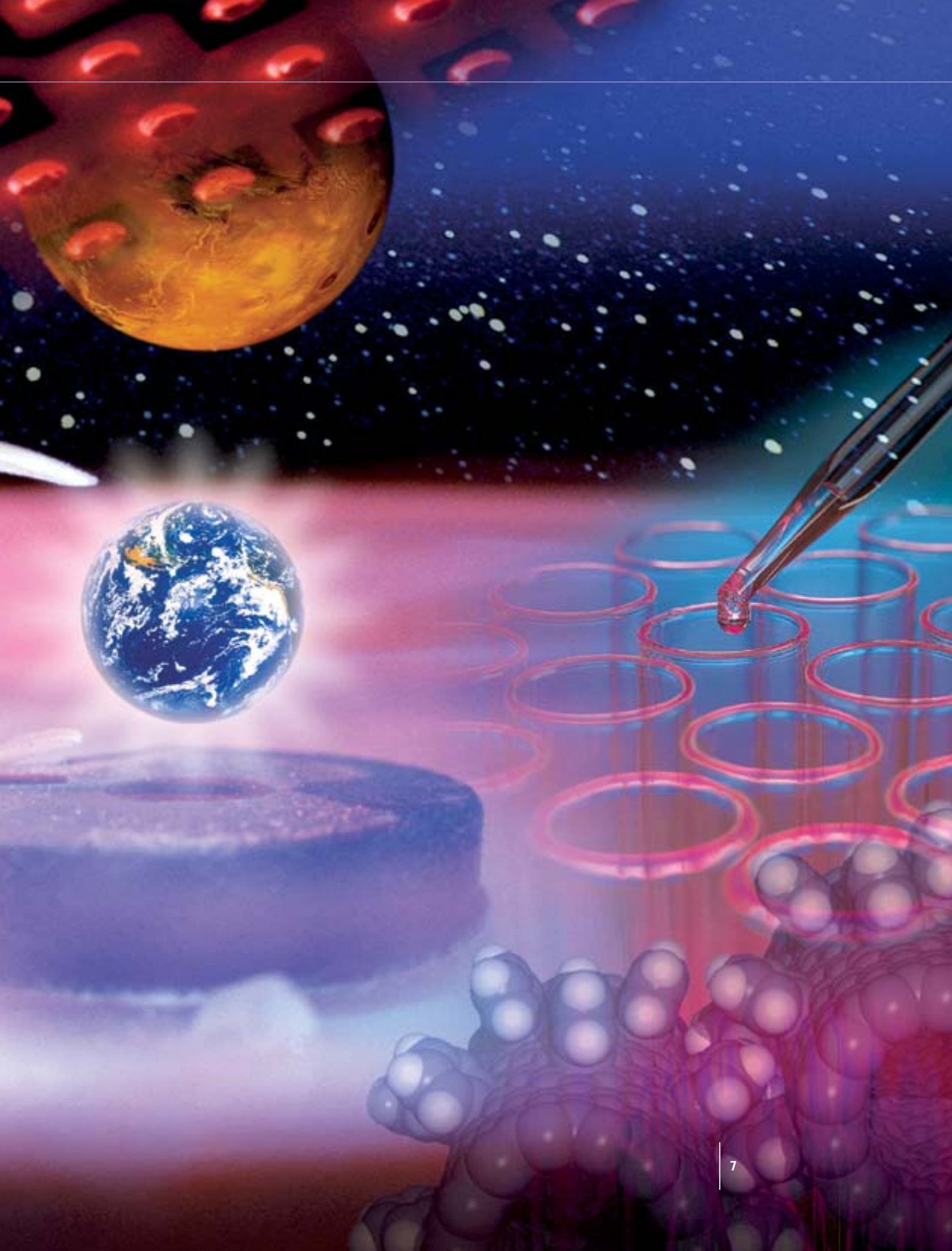
**Supporting  
NASA  
Themes  
and Goals**





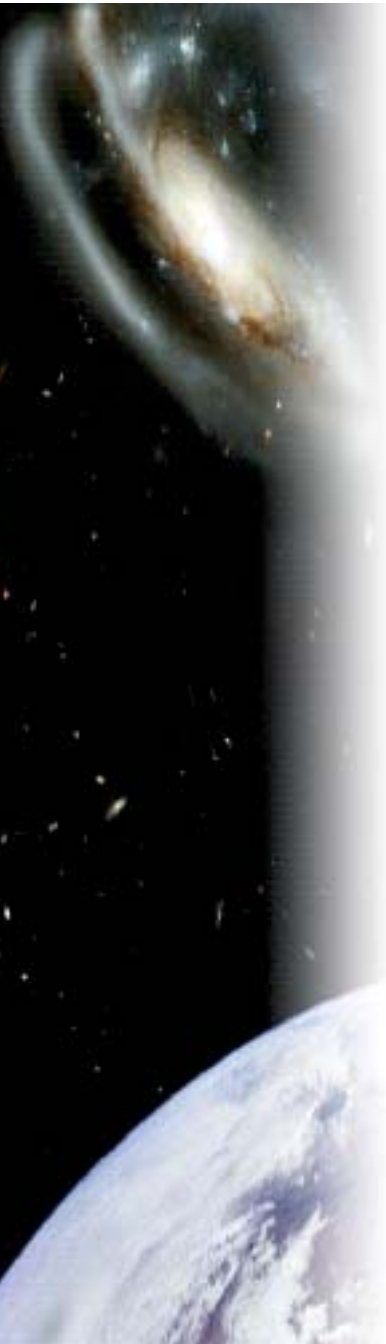
# Supporting NASA Themes and Goals

*The following sections discuss Ames Research Center's role in supporting NASA themes and goals, as defined in the NASA 2003 Strategic Plan. Discussion extends to Ames programs, projects, and research and development activities.*



# NASA Goals and Themes Matrix

All elements of NASA work together to achieve Agency goals, a real demonstration of our One NASA philosophy. The Agency goals are listed below, and all themes are listed by Enterprise. Elements of the matrix indicate each theme's primary and supporting contributions. Themes with primary contributions



Ames Research Center Alignment with the NASA 2003 Strategic Plan Crosswalk		
NASA MISSIONS	NASA GOALS	
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 a safer, more secure, efficient, and environmentally friendly air transportation system.
	3	Create a more secure world and improve the quality of life by investing in technology 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:



have at least one objective for which they are accountable. Themes with supporting contributions are accountable through performance measures in the performance plan that is the Integrated Budget and Performance Document.

		NASA ENTERPRISES																	
		Space Science					Earth Science		Biological & Physical Research			Aero Tech	Ed.	Space Flight		Aerospace Technology			
NASA THEMES		Solar System Exploration (SSE)	Mars Exploration (MEP)	Astronomical Search for Origins (ASO)	Structure & Evolution of the Universe (SEU)	Sun-Earth Connection (SEC)	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 & Flight Support (SFS)	Space Launch Initiative (SLI)	Mission & Science Measurement Technology (MSM)	Innovative Technology Transfer Partnerships (ITTP)
				Dark Blue				Dark Blue	Black Dot	White Dot									
												Black Dot							
							White Dot		Dark Blue	Dark Blue	Black Dot						Dark Blue		Black Dot
		Black Dot	White Dot	Black Dot	Dark Blue	Dark Blue													
		White Dot	White Dot	White Dot	Light Blue	Light Blue	White Dot	White Dot	Light Blue	Light Blue	White Dot	Black Dot					White Dot	White Dot	Light Blue
		White Dot	White Dot	White Dot	Light Blue	Light Blue	White Dot	White Dot	Light Blue	Light Blue	White Dot	White Dot					White Dot	White Dot	Light Blue
														Dark Blue	Black Dot	Dark Blue	Black Dot		
			White Dot					Black Dot	Dark Blue					Dark Blue	White Dot	Dark Blue	Light Blue	White Dot	
											Dark Blue				Dark Blue		Black Dot	White Dot	Dark Blue

Dark Blue = NASA Primary Contribution



Light Blue = NASA Supporting Contribution



Black Dot = Ames Primary Contribution



White Dot = Ames Supporting Contribution





# Solar System Exploration Theme

*NASA's Solar System Exploration Theme challenges its scientists to take on immense technological challenges in an effort to answer fundamental questions about the origin of the solar system. NASA scientists respond with enormous drive, investment, and focus—then quietly achieve the extraordinary: sending robotic vehicles across vast distances in space; furnishing them with power for propulsion, data acquisition, and communication; placing them in orbit around, or onto, distant and unfamiliar planets or other stellar bodies; ensuring that the vehicles survive and function in hostile environments; and acquiring and transmitting data throughout the lifetime of the vehicle.*

*Future NASA missions will demand still greater accomplishments in power and propulsion systems, telecommunications; entry, descent and landing systems; and mobility, autonomy, and science instrumentation.*

NASA's Space Science Enterprise has five themes. Ames supports three of them: Solar System Exploration, Mars Exploration, and Astronomical Search for Origins.



Solar System  
Exploration Theme





## Ames Projects Supporting the Solar System Exploration Theme

Ames supports the Solar System Exploration Theme principally through the Astrobiology and Space Research and Aerospace directorates, responsible for research, product development, and services to support the space community in astrobiology and related areas of Earth, space, and life sciences. Four divisions in these two directorates focus on the Solar System Exploration Theme:

- Space Science Division
- Space Projects Division
- Aerospace Technology Division
- Space Transportation Projects Office

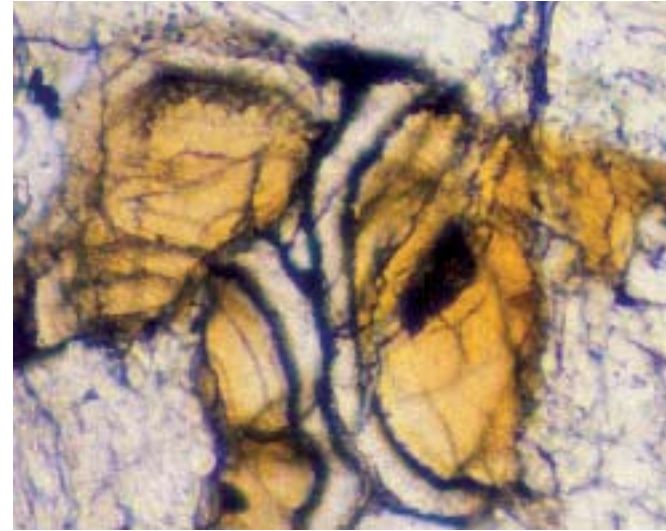
### Space Science Division

The Space Science Division seeks to understand the origins and evolution of stars and planetary systems. With a total science and mission capability unmatched by any other NASA center or national laboratory, the division is a leader in the emerging discipline of astrobiology, the study of life in the universe and the chemical and physical forces and adaptations that influence its origin, evolution, and destiny. A multidisciplinary team of astronomers, astrophysicists, chemists, microbiologists, physicists, and planetary scientists



supports the division, which focuses on the following areas:

- **Astrophysics:** Researchers study the physical and chemical properties of astronomical phenomena by observing their radiation at infrared (and ultraviolet) wavelengths, beyond the range of visible light.
- **Planetary Systems:** Researchers acquire new, fundamental knowledge about the origins of stars and planetary systems and life itself, comprising an integral part of NASA's focus on astrobiology.
- **Exobiology:** Researchers study the history, distribution, and chemistry of biogenic elements in the solar system; prebiotic chemical evolution and the origin of life; and the history of Earth's early biosphere as recorded in microorganisms and ancient rocks. —*Supports NASA Goals 5, 6, and 7*



(above) Ames scientists study carbonate globules from meteorite ALH84001 that may hold clues to the potential for primitive life on early Mars.

### Space Projects Division

Ames Space Projects Division provides project-management support to midsize space and airborne astronomy missions costing \$500 million or less to develop. Areas of expertise include:

- Bioresearch engineering
- Systems development
- Advanced projects
- Sensors and instrumentation

The division designs, fabricates, and validates selected sensors, instruments, and test beds. During development, the division oversees contract specifications and contract management, typically utilizing a prime or systems integration aerospace

(left column) Tholin, *in situ*, showing optical properties similar to those of Saturn's satellite Rhea, is used for the study of icy bodies in the outer solar system.



contractor to design, build, and test spacecraft and other hardware.

The division supports development of mission science requirements, using in-house analysis capabilities (e.g., mechanical, thermal, and optics) to function as a “smart customer.” In the operations phase of nonhuman missions, the division performs science operations and data collection.

Currently providing support to the Space Station Biological Research Project, the SOFIA Project, and the Kepler missions, the division also leads projects outside the Space Projects Division. The division is currently seeking new missions to test the boundaries and expand the limits of space exploration.—*Supports NASA Goal 5*

Mars Exploration Rover  
Aeroshell: Backshell  
computational fluid  
dynamics simulation  
performed at Ames.

### Space Technology Division and Space Transportation Projects Office

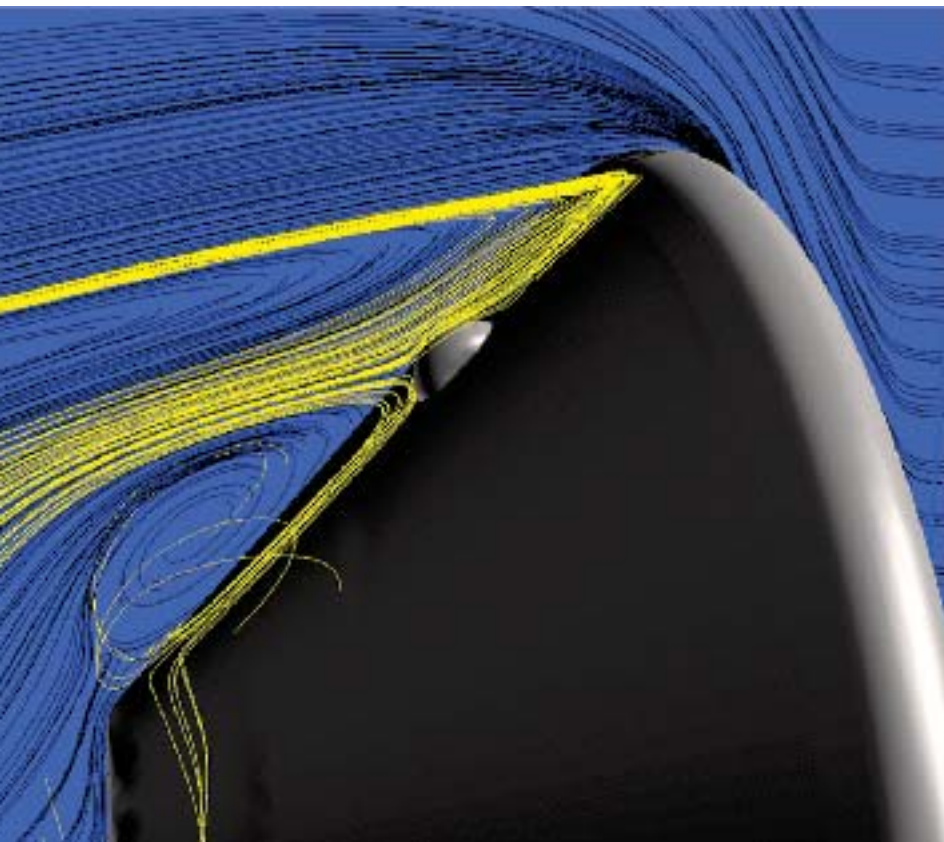
Past explorations of planetary systems via probes such as the Galileo Probe to Jupiter and Venus have resulted in unparalleled successes, due principally

to the successful design and implementation of thermal protection systems that protect the probes from immense heat generated during the entry phase. For example, the Galileo Probe encountered entry heating conditions equivalent to those on the tip of an intercontinental ballistic missile traveling through the center of a thermonuclear explosion.

Ames provides a combination of expertise and facilities in thermal protection systems. With advanced material development and characterization, thermal protection systems environment modeling, development of advanced simulation and measurement techniques, and arc-jet testing, Ames continues to make valuable contributions in this critical area.

Ames also provides unique engineering expertise and critical facilities for future missions. The Space Transportation Projects Office and the Space Projects Division work together to apply thermal protection system technologies to specific missions developed in the Space Technology Division, providing project management and system engineering support during the mission design phase.

The Space Technology Division is currently studying thermal protection needs for probe missions to Titan and Neptune under NASA's In-Space Propulsion Program. Thermal protection system design studies are in progress at Ames in support of planetary missions recommended by the National Research Council's Planetary Decadal Survey and adopted by NASA's Office of Space Science under the New Frontier Missions. Ames will also support future missions to Venus and Jupiter as well as Lunar and Comet sample return missions.—*Supports NASA Goal 5*



# Mars Exploration Theme

*The Mars Exploration Theme seeks to discover evidence of possible life on Mars—past or present. Mars missions focus on investigating the current environment to uncover the geologic and climate history of the planet with an aim toward learning which locales on Mars are most likely to preserve evidence of past or present life. Scientists hope to discover if the Martian climate was once “warm and wet” and learn more about conditions in the crust beneath the surface where Mars may store large quantities of water ice.*

## Ames Activities Supporting the Mars Exploration Theme

Ames supports the Mars Exploration Theme through the Ames Center for Mars Exploration and projects in NASA’s Computing, Information, and Communications Technology Program. Ames also contributes support through collaborative research with other NASA centers responsible for planning and executing Mars exploration missions.

### Center for Mars Exploration

The Ames Center for Mars Exploration seeks to establish collaborations with the Jet Propulsion Laboratory and Johnson Space Center to develop exploration technologies for future Mars missions. The center currently supports the Haughton-Mars Project, an international interdisciplinary field research project centered on the scientific study of the Haughton impact structure and surrounding terrain on Devon Island in the Canadian High Arctic. The Center for Mars Exploration also provides unique, Web-based, Mars mission information and concept maps, links to other Mars Websites, as well as videos, images, and a wealth of other information. The center is a joint activity supported by the Ames Astrobiology and Space Research Directorate and the Ames Information Systems Directorate.—*Supports NASA Goal 5*



### Marsoweb

Marsoweb is an interactive Website to assist the Mars science community in the selection of landing sites that are both safe and directly relevant to the search for evidence of past or present life on Mars. The Center for Mars Exploration created the Website in collaboration with the Exploratory Computing Environments Group of Ames’ Advanced Supercomputing Division. The effort makes vast quantities of data from past and ongoing Mars missions readily available along with software tools that aid in the extraction and the correlation of different types of information—e.g., surface morphology and mineral composition with topography and surface roughness.



The Mars science community used Marsweb extensively in preparing for NASA's 2003 Mars Explorer Rover missions. The Website allows visual navigation of candidate landing sites and maps of data, including high-resolution images, topographic data, and various kinds of spectral data. Data are mainly from orbital missions, including Viking Orbiters 1 and 2, the Mars Global Surveyor, and, most recently, Odyssey. Virtual Reality Modeling Language (a language used to create interactive, three-dimensional worlds on the Web) allows the user to roam the data in three dimensions. —*Supports NASA Goals 6, 7, and 9*

### Haughton-Mars Project

The NASA Haughton-Mars Project is an international interdisciplinary field research project centered on the scientific study of the Haughton impact structure and surrounding terrain on Devon Island in the Canadian High Arctic. Viewed as a terrestrial analog for Mars, the rocky polar desert setting, geologic features, and biological attributes of the site offer unique insights into the possible evolution of Mars. Scientists hope to understand in particular the history of water and past climates on Mars as well as the possibilities for life in extreme environments. The project also supports

A SETI researcher working with the Planetary Systems Branch, in the Hamilton Sunstrand suit mockup at work in the Haughton Crater.



a parallel exploration program aimed at developing new technologies, strategies, human factors experience, and field-based operational knowledge for planning robotic and human exploration of the Moon, Mars, and other planets. —*Supports NASA Goals 5, 6, and 7*

### 2003 Mars Exploration Rovers Mission Support

A number of technologies developed in the Computational Sciences Division at Ames Research Center are providing major support for ground operations at Jet Propulsion Laboratory Mission Control during the Mars Exploration Rovers mission. These technologies represent an innovative combination of information technology and human-centered computing expertise. The result of this effort is a suite of tools specifically designed to meet the complex operational challenges faced by the multiple teams of science and engineering personnel involved in maintaining and directing the twin Mars Exploration Rovers.

- The MERBoard represents a new class of computing platform: the collaborative computer. Scientists and engineers can use the large interactive work surface to view their data, annotate it, then share it with team members. It provides simultaneous access to information within the mission operations area, and real-time collaboration via remote access and control.
- The Mars Exploration Rover Collaborative Information Portal is a Web-based information management and retrieval system that will help 240 engineers and scientists collaborate and oversee the actions of two rovers in two different time zones on Mars during cruise and surface operations. The portal will provide mission operations and science teams with rapid and intuitive access to a broad range of science data and mission status and planning information via a user-customizable web portal.
- The Mixed Initiative Activity Planning Generator is a ground-based decision support system for Mars Exploration Rovers operations and science personnel. It is used to build and refine an activity plan as part of the critical tactical up-



link process. The system takes into account various factors, including mission and flight rules and the intent of the science user in rapidly generating a feasible plan.

- **Viz** is a three-dimensional terrain modeling and mapping tool that will give mission scientists and engineers eyes on Mars. The software-based tool uses images from stereo cameras on board the rover to construct a photo-realistic, three-dimensional model of the Martian environment. A 20-minute communication time delay between Earth and Mars rules out real-time viewing of the rover's surroundings. Viz provides a virtual reality simulation of Mars that allows scientists and rover operators to interactively explore the remote environment and plan experiments. Viz was developed for the 1999 Mars Polar Lander mission and is a descendant of the Ames-developed MarsMap visualization tool, which was used during the 1997 Mars Pathfinder mission. —*Supports NASA Goals 6, 7, and 9*



### Enabling Technologies for Future Solar System Missions

Researchers in the Intelligent Systems Project under NASA's Computing, Information and Communications Technology Program are advancing the state of the art in autonomous robotics and intelligent vehicle systems in order to meet technological challenges posed by future NASA missions. Key research areas include the following:

- **Autonomous instrument placement** on board the Mars Science Laboratory, a NASA mission that will send two robotic landers to Mars in 2009 to prowl the Martian surface for evidence of past

life. Each rover will be equipped with an expansive instrument suite and must be able to search the Martian surface independently of NASA mission control. Ames researchers have successfully demonstrated single-cycle autonomous target selection, location, approach and instrument placement with the K9 rover, a six-wheeled, solar-powered rover developed and tested at Ames that is modeled after the Field Integrated Design and Operations (FIDO) rover developed at the Jet Propulsion Laboratory four years ago.

- **Fault detection, identification and recovery** for a robotic craft in the proposed Surface Atmosphere Geochemistry Experiment mission to Venus. Survival of a robotic craft in the harsh Venusian environment requires extremely robust onboard fault detection, identification and recovery capabilities. Ames researchers have been developing such capabilities and demonstrated an early version aboard the Deep Space 1 spacecraft in 1999.
- **Jupiter Icy Moons Orbiter.** Ames representatives are participating in initial planning for NASA's Jupiter Icy Moons Orbiter mission that proposes to orbit three planet-sized moons of Jupiter (Callisto, Ganymede, and Europa) that may harbor vast oceans beneath their icy surfaces. The mission will launch in 2012 or later. Ames is providing expertise in information technologies that could support mission requirements.
- **Evolutionary design of an X-Band antenna for NASA's Space Technology 5 Mission.** Ames researchers in revolutionary and adaptive algorithms recently demonstrated the evolutionary design of an X-band antenna for NASA's Space Technology 5 spacecraft currently scheduled for deployment in 2004. The mission consists of three small satellites that will take science measurements in Earth's magnetosphere. The antenna evolved to meet mission requirements, most notably the combination of wide bandwidth for a circularly polarized wave. —*Supports NASA Goal 5*

(left column) A three-dimensional Virtual Reality Modeling Language scene of terrain in the Melas Chasma region on Mars. This tool is a component of the Mars Web interface developed at Ames.



# Astronomical Search for Origins Theme

*NASA's Astronomical Search for Origins Theme fosters research that seeks to answer two broad questions related to life on Earth as we know it: How did we get here and are we alone? The answers lie in an understanding of how galaxies, stars, and planetary systems formed in the early universe. Research scientists must determine whether planetary systems and Earth-like planets are typical companions of average stars and if life beyond Earth is a rare (possibly nonexistent) occurrence, or if it is robust and has spread throughout the galaxy. Research in support of this theme aims to study the early universe, find planets around other stars, and search for life beyond Earth.*

## Ames Projects Supporting the Astronomical Origins Theme

Ames provides primary support to the Astronomical Search for Origins Theme via the following:

- SOFIA Project
- Kepler Missions

### SOFIA

Sometime in 2005, in a clear, dry region on the very edge of space, a modified Boeing 747 SP will turn a massive 2.5-meter telescope to glimpse the infrared radiation emanating from planets, stars, and the center of our galaxy—perhaps even from distant galaxies. Flying at more than 41,000 feet, well above 99 percent of the Earth's interfering water vapor, scientists aboard the world's largest airborne observatory will enjoy a view of the universe unmatched by any telescope on the ground. Her name is SOFIA—the Stratospheric Observatory for Infrared Astronomy—and scientists will use her German-made, 2.5-meter, optical, infrared, submillimeter telescope to make advanced astronomical observations at stratospheric altitudes for the next 20 years or more.

The Ames SOFIA Project Office manages the program for NASA and provides technical oversight in systems engineering, optics, electronics, aero-



Astronomical Search for  
Origins Theme



dynamics, and operations. The office also coordinates activities with a consortium of three companies in the Federal Republic of Germany. SOFIA will reside at Ames.—*Supports NASA Goals 5, 6, and 7*

### Kepler Missions

Kepler missions are funded by NASA Headquarters' Discovery Program, which seeks to discover habitable planets orbiting other solar-like stars. Scheduled for launch in 2007, the mission will use a specially designed, wide-field-of-view telescope called a photometer to monitor the brightness of more than 100,000 stars in the Cygnus constellation. Investigations over a period of four or more years will look for a telltale signature of planetary "transits": When a planet orbiting another star passes in front of it, a small change in the brightness of the star will occur. Three or more such changes, or transits—with consistent period, brightness change, and duration—will provide rigorous evidence of a planet, which could be as small as Earth. Ames is developing the mission with the Jet Propulsion Laboratory and will complete system requirements review and preliminary design review by the end of 2004.—*Supports NASA Goals 5, 6, and 7*



### NASA Astrobiology Institute

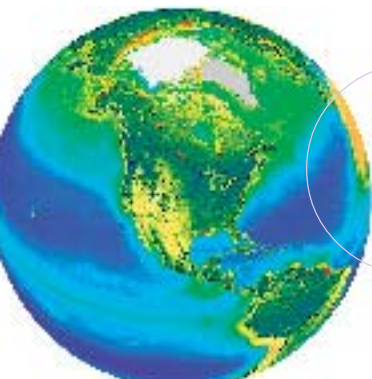
NASA founded the NASA Astrobiology Institute in 1998 as a virtual organization to forge partnerships between NASA and university teams, laboratories, and other NASA centers as a new approach to interdisciplinary, collaborative science. The organization represents a partnership between NASA and competitively selected teams to promote, conduct, and lead integrated, multidisciplinary astrobiology research. These and other partnerships help train researchers in astrobiology and perform education and public outreach.

Lead teams involve researchers from multiple disciplines and usually include members from a variety of geographically distributed institutions. Members collaborate with one another, both in person and virtually, using communication and collaboration tools supplied by the institute. NASA supports lead teams through 5-year cooperative agreements with Ames Research Center. The virtual institute's director and administrative staff reside at NASA Ames Research Center.—*Supports NASA Goals 5, 6, and 7*

(above) SOFIA during an initial configuration test flight.

(left column) Artist's concept of the Kepler telescope in space.





## Earth System Science Theme

*NASA's Earth System Science Theme deploys and operates the first constellation of Earth-observing satellites, airborne platforms, and in-situ stations that will reveal interactions among Earth's continents, atmosphere, oceans, ice, and life. Resulting data and information enable researchers to understand the causes and consequences of global change, and to predict future states. Such information is useful to government policymakers, businesses, and citizens interested in factors affecting quality and sustainability of life on Earth.*

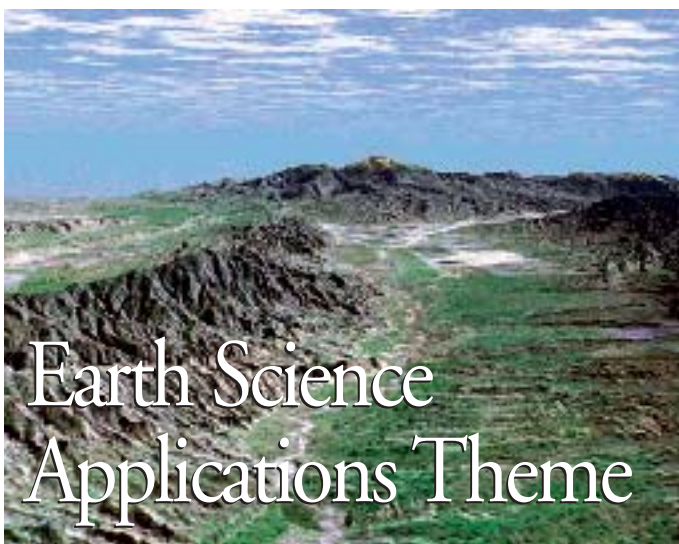
E A R T H  
S C I E N C E  
E N T E R P R I S E

NASA's Earth Science Enterprise has two themes: Earth System Science and Earth Science Applications. Ames contributes to both.



## Earth Science Applications Theme

*NASA's Earth Science Applications Theme takes the science, data, and models of the Agency's Earth System Science programs to the next logical step—for use in making policy decisions and implementing management decisions associated with policy. The theme aims to provide solutions to issues in 12 areas of national applications (e.g., weather-prediction models, terrain databases for aviation, etc.) by inserting NASA science, models, and data into the decision support systems of our partner federal agencies.*





## Ames Research Supporting the Earth System Science and Earth Science Applications Themes

Ames supports the Agency's Earth System Science and Earth Science Applications themes through the Earth Science Division of the Astrobiology and Space Research Directorate and the NAS Systems Division of the Information Sciences and Technology Directorate. Additional support comes from research in the Ames Intelligent Systems Project under NASA's Computing, Information, and Communications Technology Program.

### Earth Science Research Division

The Ames Earth Science Research Division conducts research in Earth science and astrobiology, focusing on scientific issues associated with global change, particularly atmospheric and ecosystem science and biosphere/atmosphere interaction. The



division performs basic and applied research in atmospheric chemistry and dynamics, atmospheric physics, and ecosystem science and technology. It also develops instrumentation and leads or contributes to major airborne science missions in collaboration with scientists and ministries around the world. The division aims to:

- Design, formulate, and perform experimental measurements, remote sensing, in-situ data analyses, and computer simulations of atmo-



spheric and ecosystem processes, and study the exchanges between the biosphere and the atmosphere, using both airborne and satellite sensor data

- Conceive and develop advanced instrumentation to satisfy the measurement requirements of the Earth science enterprise and related enterprises, emphasizing both airborne and selected spacecraft sensors
  - Provide the scientific understanding and the methods needed to apply remote-sensing and geographic data analyses to the study of infectious diseases, and the associated models for risk analysis of disease transmission in the various human populations
  - Transfer scientific knowledge and technology to U.S. commercial and private interests, national and international governmental agencies and ministries, other disciplines, and educational institutions
  - Provide science mission management and science leadership in NASA science programs and other agencies
  - Provide science leadership in the development of uninhabited aerial vehicles as a regular alternative for airborne science
- Supports NASA Goals 1, 3, 6, and 7

(above) The Scaled Composites' Proteus aircraft was one of six employed during the CRYSTAL-FACE experiment to study cirrus clouds.

(left column) Ames conducts earth-observing investigations that collect data required to validate the algorithms that mimic geophysical parameters from orbital data. This information improves the Earth weather predictive capabilities.



## NASA Advanced Supercomputing Systems Division

(below) This wide-view aerial image of a wildfire overlaid on a map was generated as part of the First Response Experiment designed by Ames, the U.S. Forest Service, the State of California, and General Atomics. The First Response Experiment used remotely piloted aircraft, remote sensors, and advanced information technology to send over-the-horizon pictures and data to firefighters over the Internet in near real time, enabling firefighters to react more quickly and effectively.

The NASA Advanced Supercomputing Systems Division conducts computer science research in computational technologies, programming methodologies, and algorithm development. Research focuses on discovering and addressing scientific requirements for performance and developing and applying optimization methodologies to applications in order to make use of emerging high performance technology. Key research areas include:

- Thorough evaluation of high-end computing options that satisfy NASA mission requirements for capacity and capability
- Determination of high-end computing architecture characteristics to optimally support mission production requirements
- Identification of obstacles blocking scientists from achieving high-end-computing-enabled grand challenge objectives with milestones occurring through 2010

- Selection, use, and access to high-end computing systems for maximum benefit to mission applications

- Performance of focused computer science and engineering research with high-end computing vendors in order to influence future architectures and adaptation of mission requirements to product design—*Supports NASA Goal 1*

## Biospheric Forecasting Research: Terrestrial Observation and Prediction System

Ames researchers in the Intelligent Systems Project of NASA'S Computing, Information, and Communications Technology Program are conducting research in support of the Terrestrial Observation and Prediction System, a data assimilation system

that integrates satellite data, surface weather observations, and weather/climate forecasts with a terrestrial ecosystem model. The research focuses on biospheric forecasting and automated data understanding and seeks to:

- Improve prediction capabilities for 1) understanding the impacts of climate and weather variation on the biosphere, and 2) quantifying biospheric feedback to the climate and weather models.

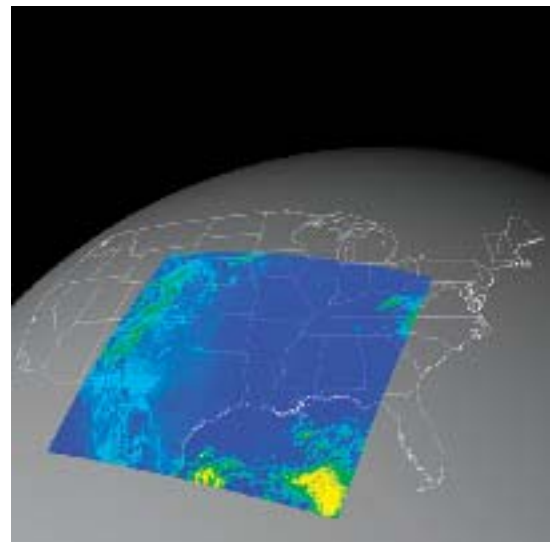
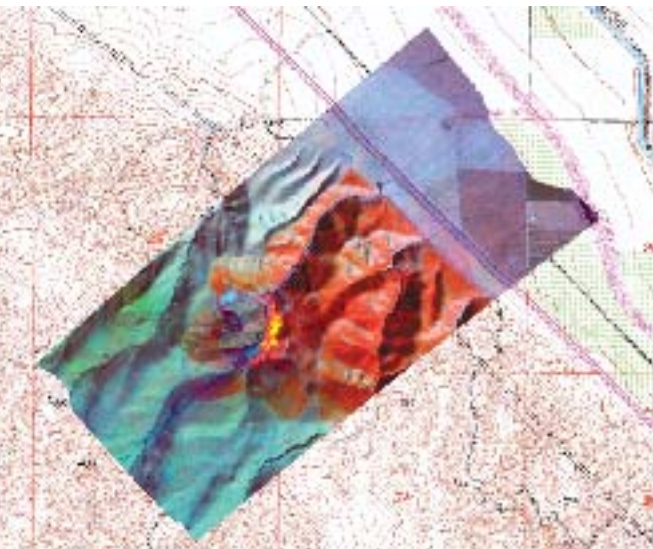


Image obtained from the Earth Observing System (EOS), a series of satellites for monitoring maritime meteorological conditions, atmospheric ozone, gases that promote global warming, and other global environmental changes.

- Prototype ecological decision support systems to improve the quality of the biosphere by rapidly integrating NASA satellite data with data and capabilities from collaborating stakeholder agencies (the USDA Forest Service and National Oceanic and Atmospheric Administration), industry, and academia to predict natural hazards (e.g., fire and floods).
- Enable revolutionary capabilities in the generation of real-time Earth science data products (e.g., evapo-transpiration) and forecast future conditions through novel technologies in planning, scheduling, and automated data understanding.—*Supports NASA Goals 1 and 3*



# Biological Sciences Research Theme

*NASA's Biological Sciences Research Theme fosters strategic research required to support the development of procedures and technologies that will keep flight crews safe, healthy, and efficient during prolonged space missions. The Ames Life Sciences Division in the Astrobiology and Space Research Directorate conducts fundamental research in support of this theme. Studies focus on understanding how microbes, cells, plants, and animals respond to the gravity spectrum—from hypergravity to microgravity. Projects supporting this theme also develop new technologies to improve space flight life-support systems.*



BIOLOGICAL  
& PHYSICAL  
RESEARCH  
ENTERPRISE

NASA's Biological and Physical Research Enterprise has three themes. Ames supports one of them: Biological Sciences Research.

## Ames Programs Supporting the Biological Sciences Research Theme

Humans in space lose bone mass at different rates, according to the location of the bone in the body—e.g., weight-bearing bones lose mass faster. Researchers in NASA's Fundamental Space Biology Program, which is implemented at Ames Research Center, are studying all aspects of bone loss—from the cellular level to integrated animal response. Such knowledge could help identify risks that astronauts face and lead to new medical treatments for bone loss among the elderly. This research is just one of many investigations at Ames focused on acquiring knowledge to enable flight crews to leave Earth, perform their tasks, and return to Earth without adverse health effects.

Ames programs, projects, and research organizations supporting the Biological Sciences Research Theme include the following:

- Space Station Biological Research Project
- Biomolecular Physics and Chemistry Program
- Biomolecular Systems Research Program
- Life Sciences Research Division
- Human Factors Research and Technology Division

Biological Sciences  
Research Theme



(top right column)  
Training is conducted at Ames in the mock-up of the Space Station Centrifuge Facility.

### Fundamental Space Biology Program

The Fundamental Space Biology Program is NASA's Agencywide program for the study of fundamental biological processes through spaceflight and ground-based research. Implemented at Ames Research Center by the Ames Fundamental Space Biology Research Integration Organization, this program provides scientists with the opportunity to examine how gravity and other space environmental factors affect the fundamental mechanisms of life. Ames is responsible for the Space Station Biological Research Project.



of flight hardware and software, including multiple habitats to support a variety of biological specimens; a centrifuge with a selectable rotation rate to house specimens at a variety of gravity levels; a holding rack to house specimen habitats at microgravity; and a fully equipped workstation/glove box. The gravitational laboratory will also include microscopes, freezers, and other research equipment supplied by NASA's foreign partners to conduct experimental procedures.—*Supports NASA Goals 4, 6, 7, and 9*



(above) The Ames Life Sciences Division's acceleration facilities human-powered centrifuge.

### Space Station Biological Research Project

The Space Station Biological Research Project will provide an integrated suite of gravitational laboratory equipment for use in conducting world-class biological research on board the International Space Station. Responsibilities include the design, development, test, verification, and on-orbit validation



Use of the Biomass Production System on the International Space Station.



## Biomolecular Physics and Chemistry Program

The Biomolecular Physics and Chemistry Program is collaborating with the National Cancer Institute to advance the development of technologies and tools that will make it possible to detect, diagnose, and treat disease and injury far faster and with minimal invasion than ever before. Ames leads the Agency's efforts to develop and apply such tools and technologies at the molecular scale. The program focuses on applications that support the development of new sensors to diagnose and treat injury, illness, and emerging pathologies in astronauts during long-duration space missions. Additional applications will focus on monitoring spacecraft and habitat environments and on remotely sensing signs of life in space-exploration missions.

Three key technologies form the cornerstones of the program:

- Physical-sciences technologies (including nanotechnology)
- Information technology
- Biotechnology



*C. elegans*: A commonly found nematode which is used in ground research and space flight studies.

The program will conduct basic research, develop breakthrough technologies, and deliver prototype advanced biomolecular micro- and nanosystems and related technologies for the detection, imaging, recognition, and monitoring of biological signatures and processes at the molecular level. —Supports NASA Goals 4, 6, 7, and 9

## Biomolecular Systems Research Program

The Ames Biomolecular Systems Research Program focuses on developing molecular-level technologies to monitor cellular signals and processes with applications to crew health, safety, basic biology research, life detection, planetary protection, and nanotechnology. The Biomolecular Systems Research Program and the National Cancer Institute cosponsor a joint research program entitled Fundamental Technologies for the Development of Biomolecular Sensors. The goal of this program is to develop biomolecular sensors that will revolutionize the practice of medicine on Earth and in space. —Supports NASA Goals 4, 6, 7, and 9

(left column) Cell Culture Unit (CCU) chambers. The unit is being developed to support basic research on board the International Space Station using animal cells, plant cells, microbial cells, small swimming aquatic cells, and tissues.



(right column) Spatial auditory displays (three-dimensional audio) can enhance aerospace safety by presenting localized sound through a pilot's headset to increase speech intelligibility and situational awareness.

(below) Development and testing of plant chambers for the European Modular Cultivation System prototype.

### Life Sciences Research Division

The Life Sciences Division at Ames Research Center seeks to understand how extended space flight affects the fundamental physiology of living systems. The work is vital in developing countermeasures to the effects of long-term space flight and directly supports the Biological Research Theme. Research activities include:

- Development and implementation of flight experiments on board the Space Shuttle, International Space Station, and other unmanned orbiting vehicles
- Development and operation of technology required to perform life sciences research on the ground and in space
- Technology transfer
- Education for the improvement of the quality of life on Earth

—Supports NASA Goals 4, 6, 7, and 9



### Human Factors Research and Technology Division

The Human Factors Research and Technology Division at Ames Research Center supports a number of research projects funded by the Office of Biological and Physical Research. These projects focus on extending human capabilities in space by advancing knowledge of human performance during space missions, and developing tools, technologies, and countermeasures for safe and effective space operations. Research focuses on human performance measurement and modeling, including work on such topics as spatial disorientation, perceptual adaptation in microgravity environments, psycho-physiological modeling, oculometrics, visual perception, fatigue countermeasures, cross-cultural and gender influences on team performance, and design of spatial auditory displays. —Supports NASA Goals 4, 6, and 9



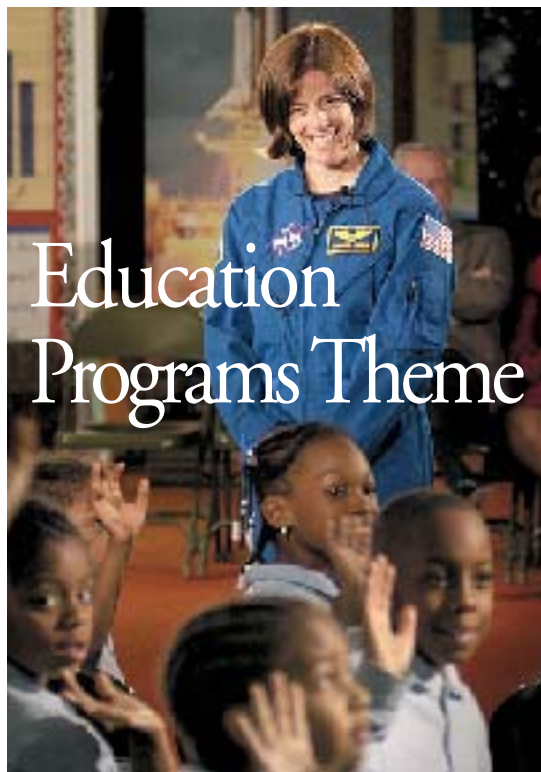
# Education Programs Theme

*NASA's Education Programs Theme develops programs, products, and services to inspire and motivate students from the full spectrum of the U.S. population to pursue careers in science, technology, engineering and mathematics, including minority students and those from low-income families. NASA executes its national education agenda through NASA Headquarters and NASA field centers, including NASA Ames Research Center.*



EDUCATION  
ENTERPRISE

NASA's Education  
Enterprise has one theme.  
Ames contributes to it:  
Education Programs.



## Ames Programs and Activities Supporting the Education Programs Theme

Ames ardently supports NASA's Education Programs Theme through an assortment of programs, projects, products, on- and off-site educational experiences, and other activities that have vastly increased the magnitude, diversity, and technical excellence of its outreach over the last four years (1999–2003). Each Ames research directorate supports ongoing educational outreach with inspiring content, technology and programs. Ames continues to enhance NASA's education and outreach agenda through programs and services for educators and students. Ames produces award-winning multimedia products, such as AstroVenture and Virtual Skies, provides hands-on experiences for thousands of middle school students through the Ames Aerospace Encounter, provides transformative experiences for hundreds of students who work at Ames each year, and delivers unique teaching tools through hundreds of educator workshops and services.—*Supports NASA Goals 6 and 7*



(left) While attending a Director's Breakfast at Ames, winners of the 2002 Santa Clara Valley Science & Engineering Fair, and the San Francisco Bay Area Science Fair, view an Advanced Life Support plant growth chamber on their guided tour.





# Space Shuttle Program Theme

*The Space Shuttle Program Theme promotes research and development required to provide human access to space and the International Space Station.*

## Ames Projects Supporting the Space Shuttle Program Theme

Ames has provided support to the Space Shuttle Program Theme since the inception of the Space Shuttle in the 1970s, contributing expertise in many key areas, in particular the development of the Space Shuttle thermal protection system. In addition, NASA and others have developed dramatic improvements in user-interface and cockpit-display technologies in the years since NASA designed the first Space Shuttle in 1981.

Ames programs and research activities supporting the Space Shuttle Program Theme include:

- Thermal Protection Systems
- Space Shuttle Cockpit Upgrade Project



S P A C E  
F L I G H T  
E N T E R P R I S E

NASA's Space Flight Enterprise has three themes. Ames contributes to one of them: Space Shuttle Program.



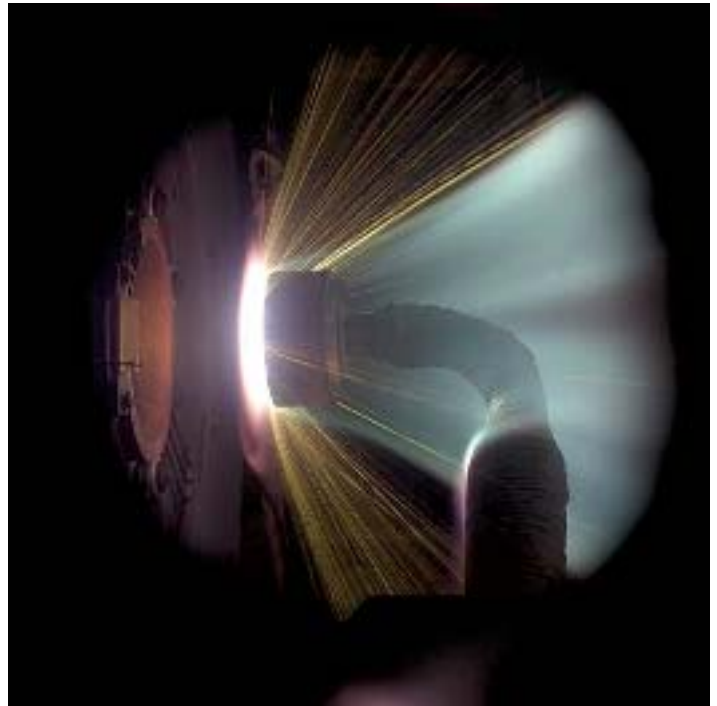


## Thermal Protection Systems

Ames Research Center contributed to development of the original Space Shuttle thermal protection system. Today, Ames is committed to NASA's Implementation Plan for Return to Flight and Beyond and supports thermal protection system improvements. Key contributions include development and characterization of advanced materials, environment modeling of thermal protection systems, development of advanced simulation and measurement techniques, and arc-jet testing.—*Supports NASA Goals 8 and 9*

## Space Shuttle Cockpit Upgrade Project

The Human Factors Research and Technology Division at Ames Research Center is contributing to the redesign of several Space Shuttle cockpit displays and has taken a leading role in evaluating cockpit displays and procedures. The Ames Information Sciences and Technology Directorate will continue to support the Space Shuttle Cockpit Upgrade Project with expertise in cockpit display design and testing, enhanced caution and warning architectures, user interface with intelligent systems, and other human-factors research.—*Supports NASA Goals 8 and 9*



(above) Thermal protection system test.



(left) The Intelligent Spacecraft Interface Systems (ISIS) Laboratory develops techniques to improve the interface between crew members and next-generation spacecraft.





AEROSPACE  
TECHNOLOGY  
ENTERPRISE

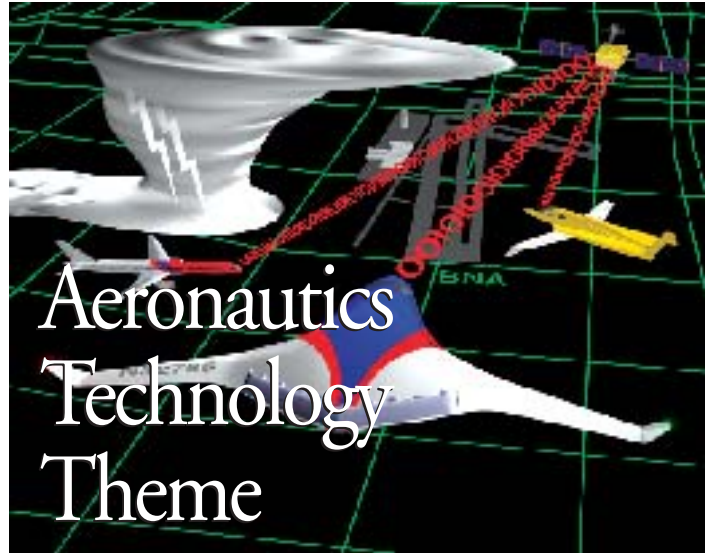
NASA's Aerospace Technology Enterprise has four themes. Ames supports all of them: Aeronautics Technology, Space Launch Initiative, Mission and Science Measurement Technology, and Innovative Technology Transfer Partnerships.

## Aeronautics Technology Theme

*Pioneering technological advances over the past 45 years by NASA and others have revolutionized aviation. Consider the following:*

- Aviation safety has improved tenfold.
- Fuel efficiency has doubled.
- The cost of air transportation has decreased by 50 percent.
- Aircraft noise levels have decreased by an order of magnitude.

*However, the need for fast, safe, and efficient air transportation will continue to increase. To keep pace with demand, the air transportation system and air traffic management system must continue to improve and adapt. In pursuit of that aim, NASA's Aeronautics Theme holds a unique role within NASA as the sole administrator of the*



*Agency's aeronautics investments. The theme fosters research and development focused on increasing the safety, security, efficiency, and environmental friendliness of air transportation. Research areas include adaptive controls, new collaborative design and development tools, air traffic management technologies for new automation tools, and advanced concepts of operations, among others.*

### Ames Research Supporting the Aeronautics Technology Theme

Ames is an expert in the air transportation system and next-generation air traffic management technologies. Ames researchers have conducted research in air traffic control since the mid-1980s. NASA's long association with the Federal Aviation Administration permits special insight into the challenges associated with ever-increasing demands on the nation's air transportation system. At Ames, these challenges take on special significance as the nation enters the 21st century when air transportation operations could change remarkably. Ames' in-depth knowledge of the national airspace and



Ames' FutureFlight Central is a highly sophisticated simulation facility that will emulate Level 5 air traffic control towers and the busiest airports.



air traffic management, together with the Center's unique aviation simulation facilities and core capabilities in human factors and information technology, will keep it at the forefront of NASA's aviation research and development.

Nine Ames research projects support the Aeronautics Theme: six from the Airspace Systems Program and three from the Aviation Safety and Security Program. Both programs are managed at NASA Headquarters. A strategic research and development activity in NASA's Computing, Information, and Communications Technology Program is also based at Ames.

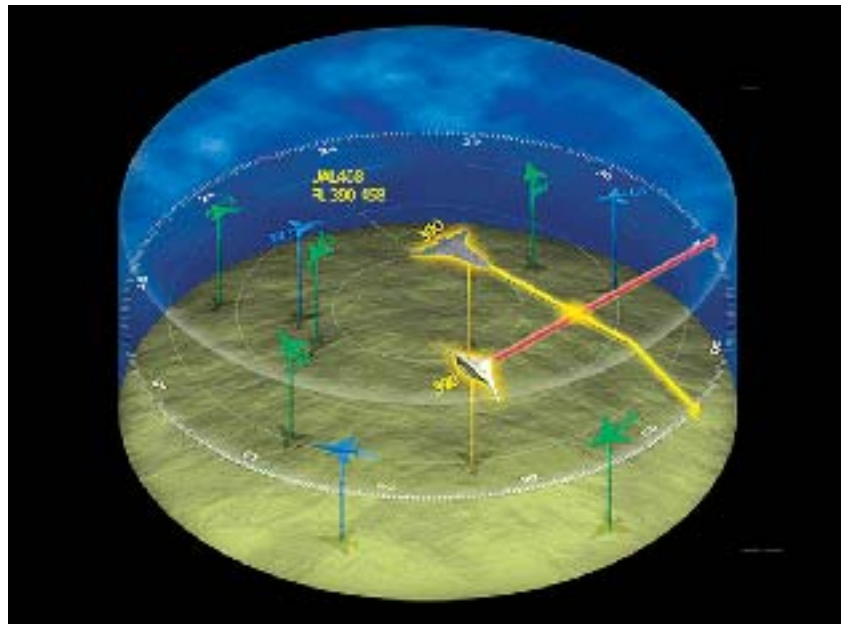
### Ames Projects in NASA's Airspace Systems Program

The following Ames projects support the Aeronautics Technology Theme:

- Advanced Air Transportation Technologies Project
- Efficient Aircraft Spacing Project (new in 2004)
- Efficient Flight Path Management Project (new in 2004)
- Virtual Airspace Modeling and Simulation Project
- Strategic Airspace Usage Project (new in 2004)
- Human Measures and Performance Project

### Advanced Air Transportation Technologies Project

The Advanced Air Transportation Technologies Project aims to improve the capacity of transport aircraft operations at and between major airports and improve the efficiency of traffic flow in the national airspace. The project is developing decision support tools to help air traffic controllers, airline dispatchers, and pilots improve the air traffic management and control processes from gate to gate. The project is also developing flight deck and ground-based tools to support "free-flight operations," a concept in which flight crews, air traffic service providers, and airline flight dispatchers collaborate and utilize distributed decision-making to increase system capacity and enable airline preferences, while meeting air traffic management require-



ments. To support these decisions and avoid potential problems, pilots and ground control personnel need new, automated, decision support systems. In its final phase, the project will assess and validate project objectives. The project runs through 2004. Adapting and integrating the tools into the air transportation system will be the responsibility of the Federal Aviation Administration and industry. —Supports NASA Goals 2, 3, 6, and 7

### Efficient Aircraft Spacing Project (New in 2004)

The Efficient Aircraft Spacing Project will focus on efficient operation of individual aircraft within the National Airspace System. The project will explore medium- and far-term National Airspace System concepts that employ innovations in air/ground information management and responsibilities. The goal is to enable increased safety and capacity in the terminal area through new, internationally agreed-upon standards for wake-vortex operations. Products will include: 1) validated technologies and procedures for managing autonomous air/ground traffic, and 2) wake-alleviation feasibility assessment. —Supports NASA Goals 2, 3, 6, and 7

Cockpit Displays of Traffic Information (CDTI) present 3-D situational traffic awareness information to the flight crew to aid decision making.





(above) Controller using Center/TRACON Automation System (CTAS) tools to plan an efficient arrival flow into a busy terminal area.

### Efficient Flight Path Management Project (New in 2004)

The Efficient Flight Path Management Project will focus on the coordination of aircraft operations within the National Airspace System. The goal is to develop integrated air traffic management decision support tools and advanced traffic management concepts to facilitate the modernization of the National Airspace System. The project will refine and mature technologies defined in the Advanced Air Transportation System Technologies Project, focusing on interoperability of tools and their integration with more distributed traffic management concepts. Products will include: 1) a collaborative traffic management tool (e.g., regional metering, departure/arrival integration, and airline collaboration), and 2) an advanced routing tool (e.g., tactical, controller-side conflict probe). —Supports NASA Goals 2, 3, 6, and 7

(right column) The use of text-based, Data Link messages may alter the traditional roles of controller-pilot communications.

### Virtual Airspace Modeling and Simulation Project

The Virtual Airspace Modeling and Simulation Project will identify new operational concepts for the National Airspace System in the 2020 timeframe. The project also aims to develop and benchmark a set of analytical models for conducting detailed assessments of the potential operational benefits associated with the new concepts,

identify associated risks and limits, and establish a simulation environment in which specific real-time (human-in-the-loop) assessments support non-real-time system-level assessments. The project will also generate technology roadmaps for selected concepts addressing research paths, technical risks, and potential challenges for introducing concepts into the National Airspace System. The project currently plans to maintain modeling and simulation capability to evaluate modifications to existing air traffic management systems and new operational concepts. —Supports NASA Goals 2 and 3

### Strategic Airspace Usage Project (New in 2004)

The Strategic Airspace Usage Project will focus on the efficient operation of the National Airspace System as an overall nation-wide system with global interaction. The goal is to develop strategic planning tools for air traffic control system command centers and aircraft operation centers. The project will also integrate assessment capability functions into the Federal Aviation Administration traffic-flow-management architecture. Products will include: 1) a system-wide evaluation and planning tool, and 2) technology to manage surface traffic and coordinate departure operations with national traffic-flow-management objectives. —Supports NASA Goals 2, 3, 6, and 7





### Human Measures and Performance Project

Reformulated in 2004 from the former Airspace Operations Systems Project, the Human Measures and Performance Project will focus on human interaction—both with other humans in the system and with the aircraft or other machines—and the performance and reliability in the design of complex airspace systems. The project will take advantage of Ames core capabilities in human factors, air traffic management, information systems, airborne systems, and crew station design and integration to 1) identify, develop, and verify advanced technology concepts, methods, and procedures; 2) transfer the results to industry or other government agencies for application; and 3) contribute facilities and expertise to industry and other government agencies for cooperative technology efforts.—*Supports NASA Goals 2, 3, 6, and 7*

### Ames Projects in NASA's Aviation Safety and Security Program

The following Ames projects in the Aviation Safety and Security Program, which is based at NASA Headquarters, support the Aeronautics Technology Theme:

- Aviation System Monitoring and Modeling Project
- System-Wide Accident-Prevention Project
- Aircraft and Systems Vulnerability Mitigation Project (New in 2004)

### Aviation System Monitoring and Modeling Project

The Aviation System Monitoring and Modeling Project provides aviation decision-makers with tools to help identify and correct conditions that could lead to aviation safety-related accidents or incidents. The project seeks to: 1) develop tools to extract, integrate, and display reliable information from large, dispersed heterogeneous databases with which experts can gain insight into the performance and safety of the airspace system; 2) develop methodologies and tools to enable efficient monitoring of the airspace system by routinely processing large masses of both anecdotal and recorded data; 3) assist and encourage stakeholders to use the tools for operational evaluation, for continuous evolutionary development, and as a basis for sharing information among stakeholders; and 4) develop fast-time simulations incorporating human-performance models that enable reliable predictions of system-wide effects (including operator workloads and propensity for errors) of proposed technological or procedural changes.—*Supports NASA Goals 2 and 3*

### System-Wide Accident-Prevention Project

The System-Wide Accident-Prevention Project conducts research on aviation safety issues associated with human error, procedural noncompliance,

(left column) Human performance of complex cognitive tasks may be studied and evaluated through the collection of oculometric data.

(below) Flight simulation scenarios are studied to investigate the cognitive demands of concurrent task management in the cockpit and to develop methods to reduce flight crew error.





maintenance, and training. Taking advantage of Ames Research Center's expertise in human-factors research, the project focuses on mitigating human error as a contributing factor in aviation accidents and incidents. Research focuses on the following: 1) understanding and predicting the human-error link in a chain of events; 2) understanding and mitigating potential root causes of incidents and accidents intrinsic to aircraft maintenance and inspection operations; 3) understanding and mitigating root causes arising from crew error; and 4) applying crosscutting human-factors expertise and research to mitigate potential human error.—*Supports NASA Goals 2 and 3*

#### **Aircraft and Systems Vulnerability Mitigation Project (New in 2004)**

Ames Research Center's Aircraft and Systems Vulnerability Mitigation Project will develop technologies and human factors research products to help prevent security threats and increase the resiliency of the air transportation system. Researchers will employ a multilayered approach to minimize risk in the system by limiting vulnerabilities, preventing the exploitation of unavoidable vulnerabilities, and mitigating the consequences of hostile acts.

Activities will seek to: 1) enhance the effectiveness of passenger and baggage screening; 2) enable aircraft to fly with degraded control systems; 3) detect aircraft that are deviating significantly from filed flight plans, and assist in responding appropriately; 4) collect, analyze, and disseminate security incident information; and 5) utilize advanced data-mining and knowledge-discovery processes to identify vulnerabilities and assess novel threat scenarios.—*Supports NASA Goals 2 and 3*

#### **Ames Strategic Research in NASA's Computing, Information, and Communications Technology Program**

A new era of adaptive/intelligent control systems and health monitoring and diagnostic technologies are being developed at Ames to maximize the survivability of vehicles, to the extent possible, in the presence of failures or damage that might otherwise result in a catastrophic event. NASA's Computing, Information, and Communications Technology Program funds information technology strategic research in intelligent controls and diagnostics focused on the following areas:

- Adaptive flight control systems that automatically compensate for a broad spectrum of unanticipated damage or failures
- Health monitoring and diagnostics technologies to detect and isolate flight critical component malfunctions and extend component/subsystem life
- Outer-loop methods to intelligently maneuver a vehicle under nominal and off-nominal conditions

—*Supports NASA Goals 2 and 3*



# Space Launch Initiative Theme

*NASA's Space Launch Initiative Theme is currently focused on the Agency's highest space transportation priorities: 1) designing and developing the nation's first Orbital Space Plane, a new capability that will provide crew rescue from the International Space Station by 2008, followed by routine crew and cargo transport to and from the Space Station by 2011; and 2) maintaining technology investments in space transportation launch technologies through the Next-Generation Launch Technology Program, which is aggressively pursuing a new space vehicle and flight technologies that will expand the nation's presence in space and allow people and businesses to routinely travel and work in Earth orbit and beyond. Research and technology development focuses on engines and propulsion systems, hardware, and integrated launch systems.*



## Ames Research Supporting the Space Launch Initiative Theme

Ames is taking advantage of its expertise in thermal protection systems and information technology to support the Next-Generation Launch Technology Program and the Orbital Space Plane.

### Next-Generation Launch Technology Program

Ames supports the Next-Generation Launch Technology Program in the following areas:

- **Integrated vehicle health management:** Ames researchers will focus on the collection and processing of information about the health of a Next-Generation Launch Technology system throughout every phase of operation (preflight, in-flight, postflight). Such information will enable vehicle crews, maintenance personnel, and automated ground systems to make informed decisions concerning the safe operation and use of a space vehicle.



An artist's concept of the X-37 in the space shuttle cargo hold area.



(right column) An artist's concept of the experimental X-37 re-entering Earth's atmosphere after completion of its on-orbit mission.

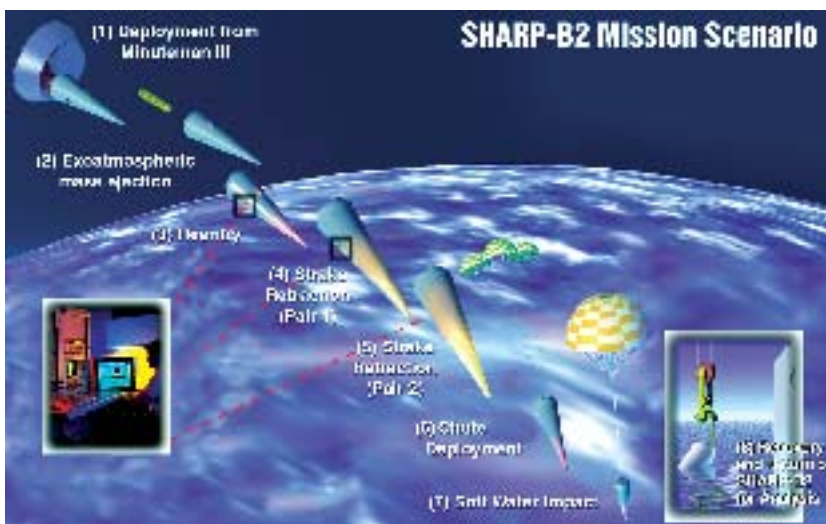
- **Crew cockpit technology and human-factors research:** Ames will contribute to the development of an advanced crew system design for vehicle health monitoring and health maintenance in spacecraft equipped with integrated vehicle health management and other advanced technologies.
- **Systems studies and tool development for systems studies:** Ames will take advantage of its core capability in information technology to support systems studies of advanced space transportation systems. Ames will also lead the way in developing the first “smart systems” for intelligent space vehicles.
- **Thermal protection systems:** Ames also contributes its unique expertise in thermal protection systems to the program, focusing on new materials and systems; rapid design tools for thermal-protection-systems sizing; and general support of industry-led teams developing next-generation vehicles.—*Supports NASA Goals 6, 7, and 8*



### Orbital Space Plane

Ames supports the Orbital Space Plane Program in the following areas:

- **Thermal protection system:** Ames researchers will provide expertise in developing the thermal protection system for the Orbital Space Plane. Development of a more robust system with reduced operational needs is a key requirement.
- **Wing leading edge thermal protection system for X-37 research aircraft:** The Ames team is working with the X-37 project office to develop the thermal protection system for the wing leading edge of the X-37, a NASA testbed for airframe, propulsion, and operation technologies for application in reusable launch vehicles. Tasks include maturation of a new thermal-protection-system material, characterization of the thermal-protection-system environment, and qualification testing of the material for the flight-test program.—*Supports NASA Goals 6, 7, and 8*



On September 28, 2000, the SHARP (Slender Hypervelocity Aerothermodynamic Research Probe) -B2 mission demonstrated the performance of 1-mm radius Ultra-High Temperature Ceramic (UHTC) leading edges at Mach numbers greater than 22 and altitudes greater than 43 km. The thermal materials tested may lead to a radical new concept in aerospace vehicle design and performance.





# Mission and Science Measurement Technology Theme

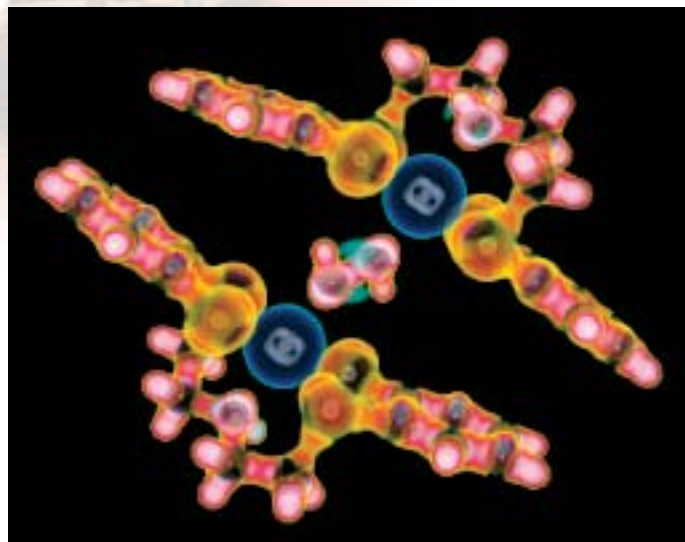
*The Mission and Science Measurement Technology Theme is responsible for developing crosscutting technology for a variety of aviation and space applications, including communications, power and propulsion systems, micro-devices and instruments, information technology, nanotechnology, and biotechnology. Such advances hold the key to a new era in aviation and allow space missions to expand our knowledge of Earth and the universe. Research currently focuses on developing advanced science instruments, sensors, communications, autonomy, and data-analysis technologies for applications in aerospace, space flight, and medicine.*



## Ames Research Supporting the Mission and Science Measurement Technology Theme

NASA missions generate challenges that test the limits in science and engineering. Innovative solutions may lie in new concepts derived from the fusion of expertise in information technology; human-centered and high-end computing; autonomy, risk, and knowledge management; biotechnology; and nanotechnology. Such cross-disciplinary research will become central to the development of future mission operations and science objectives.

Ames supports the Mission and Science Measurement Technology Theme through seven Ames research projects and activities: three projects in NASA's Computing, Information, and Communications Technology Program; two projects and two research activities in NASA's Engineering for Complex Systems Program. Both programs are at NASA Headquarters. Ames also supports the Center for Nanotechnology.



This image depicts the electronic structure of a synthetic analog of nitrogenase, which converts atmospheric dinitrogen ( $N_2$ ) into biologically available form. Designing a fully functional synthetic nitrogenase would revolutionize agriculture and the economy on Earth, as well as provide a fundamental enabling technology for Mars.



(right column) The Intelligent Systems Project focuses on automated reasoning, human-centered computing and intelligent data understanding.

### Ames Projects in NASA's Computing, Information, and Communications Technology Program

The following Ames projects support the Mission and Science Measurement Technology Theme:

- Information Technology Strategic Research Project
- Intelligent Systems Project
- Computing, Networking, and Information Systems Project

### Information Technology Strategic Research Project

Future NASA missions will require new and dramatically different technologies, including new materials; smaller, lighter-weight devices that consume less power; highly reliable software; and reconfigurable computing and information technologies. The Information Technology Strategic Research Project functions as a “technology incubator” for such technologies. The project identifies, explores, develops, and verifies high-risk, high-payoff, long-range technologies, and then transfers them to NASA missions. The project’s research portfolio currently includes development and assembly of nanoscale components; intelligent adaptive, immersive, multimodal control of aerospace vehicles; automated development and verification of high-confidence software; adaptive and fault-tolerant systems; and new models of computing. Focus areas include: 1) intelligent controls and diagnostics, 2) evolvable systems, 3) automated software engineering technologies, 4) bionanotechnology, and 5) revolutionary computing algorithms. —*Supports NASA Goals 9 and 10*

(below) Ames is studying new materials; smaller, lighter-weight devices that consume less power; highly reliable software; and reconfigurable computing and information technologies.



### Intelligent Systems Project

The Intelligent Systems Project seeks to enable smarter, more adaptive systems and tools that will work collaboratively with humans in a goal-directed manner to achieve NASA mission and science goals. Meeting those goals will require advanced computer science and information technology capabilities associated with system intelligence. Such technologies do not exist today and will not grow out of the current government or public information



technology research and development laboratories. The project focuses on research and technologies for automated reasoning, human-centered computing, and intelligent data understanding. —*Supports NASA Goals 9 and 10*

### Computing, Networking, and Information Systems Project

The Computing, Networking, and Information Systems Project seeks to provide NASA scientists and engineers with seamless access to ground-based and mobile distributed computing, information, and knowledge to enable NASA missions in aerospace, Earth science, and space science. Research focuses on technology development that will enable new paradigms of problem-solving and communication using methods that do not require specialized knowledge of underlying hardware, software, or information resources. Such technology will allow NASA scientists and engineers to focus on science, mission control, or new concept development rather than



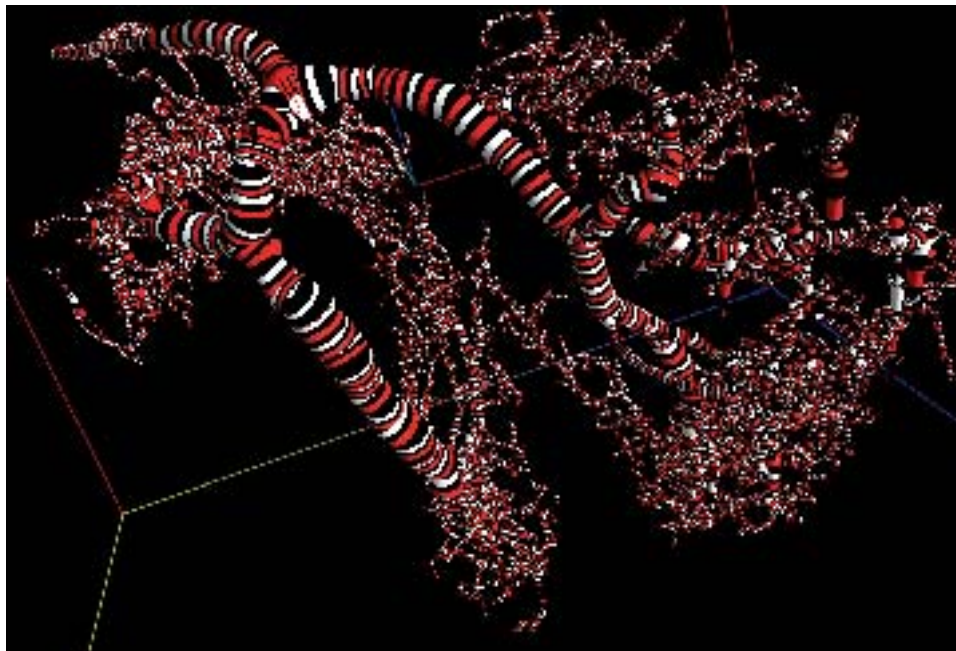
on how to use specialized hardware, software, and information resources. Required technologies include advanced computing and networking test beds, grid middleware to interconnect hardware resources, information management systems, and application environments that support the distribution of multidisciplinary applications operating across NASA's assets. —*Supports NASA Goals 9 and 10*

### Ames Center for Nanotechnology

The Center for Nanotechnology at Ames, heavily supported by the Computing, Information, and Communications Technology Program, focuses on experimental research and development of nano- and bio-technologies and on creating a modeling and simulation environment. Nanotechnology is the creation of materials, devices, and systems through the control of matter on the nanometer scale. (A nanometer is one-billionth of a meter.) Scientists say nanotechnology could lead to changes in almost everything from computers and medicine to automobiles and spacecraft.

Such changes could have profound implications for future NASA programs in aeronautics and space. Nanotechnology could result in stronger materials, ultra-small electronic devices, ultra-sensitive sensors, and ultimately, intelligent spacecraft. Developments in bio-nanotechnologies will dramatically reduce the weight and improve the capabilities of future aerospace systems.

The center also performs research in computational electronics, computational optoelectronics, and computational modeling of processes encountered in nanofabrication and microelectronics manufacturing. More than 50 Ames research scientists and technicians support the Center for Nanotechnology, which aims to develop novel concepts in nanotechnology for application to NASA's future needs. Focus areas include electronics, computing, sensors, and advanced miniaturization. Researchers also focus on developing a highly integrated and intelligent simulation environment. Such an environment will help speed development and validation of future-generation electronic devices and materials. —*Supports NASA Goals 9 and 10*



### Ames Projects and Activities in NASA's Engineering for Complex Systems Program

The following Ames projects and research activities are part of the Engineering for Complex Systems Program based at NASA Headquarters, and support the Mission and Science Measurement Technology Theme:

- Resilient Systems and Operations Project
- Knowledge Engineering for Safety and Success Project
- Investigation Methods and Tools Research
- Core Risk Research

### Resilient Systems and Operations Project

The Resilient Systems and Operations Project seeks to enable revolutionary technologies for the next generation of resilient space flight systems. The project is developing software engineering tools and adaptive control technologies to help mitigate risk in the design, build, test, and operations life-cycle phases. Products will include: 1) intelligent and adaptive flight-control systems, including avionics and propulsion system control; 2) mature, mobile, robotic environmental-monitoring systems capable of interacting with both humans and avionics software as an aid in improving environmental fault

The image above shows an interneuron from the terminal abdominal ganglion of a cricket. This three-dimensional hybrid digital/analog computational device "reads" a sensory neural map and encodes complex details of airflow into a sequence of action potentials—essentially a bitstream.





(above) The Personal Satellite Assistant is a small astronaut support device designed to assist astronauts who are living and working aboard the Space Shuttle, Space Station, and during future space exploration missions.

detection, isolation, and recovery, and enhancing crew productivity; 3) test beds, case studies, and tools to identify and characterize risk precursors in software systems; and 4) an intelligent software engineering tool suite with software algorithms, processes, and development procedures to improve software integrity and reliability. —*Supports NASA Goals 6, 7, 9, and 10*

### Knowledge Engineering for Safety and Success Project

The Knowledge Engineering for Safety and Success Project focuses on 1) human and organizational risk management and 2) risk-advised engineering information management. Research activities include: 1) analysis and modeling of risk precursors related to team and organizational factors; 2) design, deployment, and evaluation of decision support technologies to mitigate organizational risk factors; and 3) design of architectures, tools, and simulation capabilities for “virtual iron bird” technologies—model-based simulations of vehicles that support effective risk management and coordination. Research and development of virtual iron bird technologies focuses on the following:

- *The Digital Shuttle*, a joint collaboration with NASA Johnson Space Center to create a digital representation of the Space Shuttle that is comprehensive, usable, efficient, and risk-aware. The work involves laser scanning of the orbiters to create valid geometric models, digitization of engineering drawings, and development of an ontology to organize vehicle information.
- *Shuttle Wire Integrity Research*, a close collaboration with NASA’s Johnson Space Center and Kennedy Space Center to develop innovative

non-intrusive methods for wire inspection and detection of subtle faults as well as software tools for wire risk assessment and test management. The Digital Shuttle and Shuttle Wiring Integrity Research tasks operate under a Memorandum of Understanding with the Space Shuttle Program Office.

- *SimStation*, a collaboration with NASA’s Langley Research Center and Johnson Space Center that seeks to develop an integrated framework for modeling, simulation, and visualization of the International Space Station. SimStation will provide a “quick-look” tool for the International Space Station systems engineering team to use for initial analyses and trade space exploration. —*Supports NASA Goal 10*

### Investigation Methods and Tools

Investigation Methods and Tools will develop 1) taxonomies and frameworks to enable comprehensive, comparative analyses and trending in mishap and anomaly reporting data for space transportation and exploration missions; 2) information, organization, analysis, and visualization tools to facilitate and manage the distributed investigation processes; and 3) accident and causal models for emerging complex systems accidents. Part of the System Reasoning and Risk Management Project led by NASA’s Jet Propulsion Laboratory, this Ames activity focuses on researching and developing tools and technology to better understand, characterize, and manage mission and system risk. —*Supports NASA Goals 6, 7, 9, and 10*

### Core Risk Research

The Core Risk Research activity focuses on fundamental research in 1) model-based hazard analysis, 2) complexity measures, 3) risk characterization and visualization, and 4) risk-based design and optimization.

This Ames activity is also part of the System Reasoning and Risk Management Project led by NASA’s Jet Propulsion Laboratory. —*Supports NASA Goals 6, 7, 9, and 10*



# Innovative Technology Transfer Partnerships Theme

*NASA's Innovative Technology Transfer Partnerships Theme fosters the formation of partnerships with industry and academia in order to develop new technology that supports NASA programs. It also promotes the commercialization and transfer of NASA technology to U.S. industry. In 2004, NASA will introduce the Enterprise Engine to create innovative partnerships with individual nonaerospace firms and venture capitalists who will support NASA's new technology mission.*



## Ames Activities Supporting the Innovative Technology Transfer Partnerships Theme

Ames contributes to the theme through the Ames Office of Technology Transfer Partnerships.

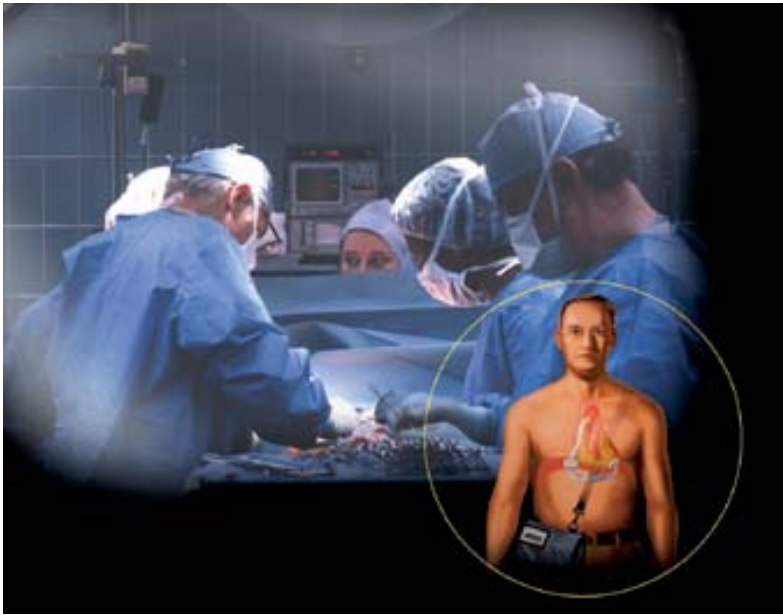
### Ames Office of Technology Transfer Partnerships

Ames Research Center's Office of Technology Transfer Partnerships supports the Innovative Technology Transfer Partnerships Theme through the use of common tools and procedures that include: assessing NASA mission-related technical needs and projects; identifying crosscutting technology developed for one NASA program or project that can meet the needs of other NASA programs or projects; identifying technology developed by other government agencies, academia, and industry that can meet NASA mission-related technical needs; and identifying and pursuing opportunities to match NASA mission-related technology requirements with industry capabilities. If such matches are identified, the office will facilitate the development of NASA mission-related technology through joint-development partnerships with industry and academia in order to reduce NASA's technology life-cycle costs and accelerate development. These types of partnerships also help transfer



Ames Earth Sciences research activity using a Solar-powered Pathfinder Plus Unmanned Aerial Vehicle (UAV) with a Clark University multispectral camera imaging Hawaiian coffee fields in an effort to optimize the harvest of the richest coffee beans.





(above) The DeBakey Heart Pump, a NASA research collaboration, has resulted in a lifesaving heart pump for patients awaiting heart transplants.

NASA mission-related technology into the private sector to maximize the return on NASA's technology investment for the benefit of the U.S. taxpayer. The office also facilitates all Space Act Agreements for Ames. Every year Ames enters into hundreds of partnerships to bring significant value to the Enterprises.

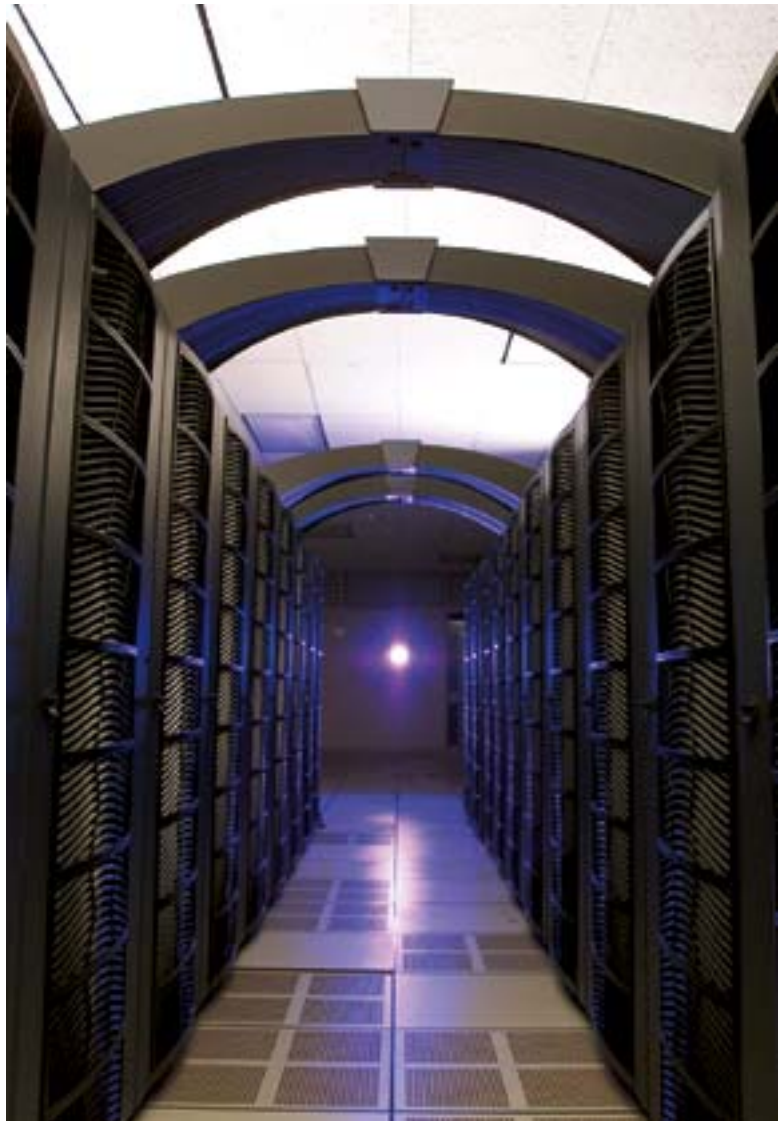
Other responsibilities at Ames include management and coordination of the following: Technology Commercialization Program, Technology Transfer Partnerships Program, Small Business Innovative Research Program, the NASA Small Business Opportunity Initiative, Small Business Technology Transfer Research Program, Far West Regional Technology Transfer Center, Girvan Institute of Technology, Ames Research Center Small Business Technical Advisory, Software Release Authority, New Technology Reporting, Ames Research Center Technology Inventory, and Ames Research Center Agreements Archiving.

(right) The Smart Surgical Probe is a small disposable needle with multiple sensors that can simultaneously measure multiple physiological parameters within a breast tumor. This process is a major advancement in the state of the art of breast cancer detection. The probe, developed at Ames in partnership with Stanford University School of Medicine, was patented and licensed.



## Consolidated Supercomputing Management Office

NASA's Consolidated Supercomputing Management Office (CoSMO) provides management for the production supercomputing services across the Agency. Ames is one of seven NASA CoSMO sites to host a variety of the fastest supercomputers available that satisfy NASA's production, research and development, and secure computing requirements. Resources include parallel vector processors, scalable parallel processors, and clustered test beds. —*Supports NASA Goals 1–10*



Chapman, an SGI Origin 3000 supercomputer housed in the NASA Advanced Supercomputing (NAS) building, is currently the only 1,024-processor single-image, shared-memory system in existence, with one operating system and a single address space. Chapman has 128 gigabytes of main memory, 2 terabytes of disk storage, and will become a major component of NASA's Information Power Grid. The machine is named for Dr. Dean Chapman, who served as the Director of Astronautics at Ames Research Center and earlier developed heat protection systems for the Space Shuttle and other space vehicles.









## **Current Capabilities**



# Current Capabilities



*The following sections discuss the Ames Research Center core capabilities and workforce demographics. The section concludes with a description of the Center's real property and research facilities.*



# Ames Core Capabilities

Ames Research Center's expertise and facilities support NASA missions and goals across the Enterprises. They literally span the universe: from managing the design and construction of the world's largest airborne astronomy observatory (SOFIA) to collaborating with the National Cancer Institute to develop a nanoelectronic-based biopsy sampler that promises to provide results in seconds instead of weeks. The collective value of the Center's core capabilities epitomizes "world-class." The following section describes these core capabilities. Each capability also references one or more NASA competencies as defined in the *NASA Workforce Competency Dictionary*.



(above) Pilot brain wave activity is monitored in the Crew Vehicle System Research Facility's Boeing 747-400 Simulator during a study to determine fatigue, sleep loss, and circadian rhythm disruption during long- and extra-long-haul flights. Fatigue is measured during flight simulations to discover better ways to counter the adverse effects of fatigue on flight crews.

## Ames Core Capability: Airspace Systems

Ames leads the Agency in airspace systems, a cross-disciplinary area that leverages Ames' expertise in air transportation management and human factors to enable revolutionary improvement and modernization of the national airspace system. Ames applied this expertise to pioneer "human-centered automation," a new approach to air traffic control that combines the skill of controllers with new computer-generated advisories. Research and development in the field led to the development of a set of tools to help air traffic controllers manage increasingly busy aircraft traffic at large airports. The FAA selected the new software tools—called the Center-TRACON Automation System (CTAS)—as the future automation system for airport terminals.

## Research Facilities

- Crew Vehicle Systems Research Facility
- Vertical Motion Simulator
- FutureFlight Central
- Human Factors Research Laboratories

## Workforce Competencies

- Air Traffic Systems
- Fundamental Human Factors Research
- Human Factors Engineering
- Advanced Analysis and Design Method Development
- Crew Systems and Aviation Operations
- Advanced Experimentation and Testing Technologies

## Ames Core Capability: Applied Aerospace Information Technology

Aerospace and information technologies converge in this arena where researchers seek to reduce the time it takes to design new aerospace vehicles. Research projects are developing aerospace vehicle design tools that integrate the design system with performance analysis and high-accuracy computational and wind tunnel performance testing. These Ames-developed systems have demonstrated order-of-magnitude improvements in the time required to develop and validate a successful design. Research



also focuses on developing neural-based adaptive flight control technology capable of handling systems failure and other off-nominal conditions.

### Research Facilities

- Fluid Mechanics Laboratory
- Flight Systems Research Laboratory
- Virtual Reality Laboratory
- Crew Vehicle Systems Research Facility
- Vertical Motion Simulator
- FutureFlight Central
- Human Factors Research Laboratories
- NASA Advanced Supercomputing Facility
- Automation Sciences Research Laboratories
- Human Performance Research Laboratories

### Workforce Competencies

- Sensors and Data Acquisition
- Avionics
- Control Systems, Guidance and Navigation
- Communication Networks and Engineering
- Computer Systems and Engineering
- Software Engineering
- Data Acquisition, Management and Storage
- Neural Networks and Systems
- Intelligent/Adaptive Systems
- Mathematical Modeling and Analysis
- Data Visualization
- Aerospace Systems Concept Development and Technology Assessment
- Advanced Analysis and Design Method Development
- Flight Dynamics
- Applied Aerodynamics
- Aeroelasticity
- Aerodynamics
- Thermal Systems
- Thermal Structures
- Advanced Experimentation and Testing Technologies
- Simulation/Flight Research Systems

### Ames Core Capability: Astrobiology

Ames leads the Agency in Astrobiology research, a multidisciplinary field that combines the physical and biological sciences to address fundamental questions of the universe. Researchers conduct basic research, participate in flight missions, develop science and technology requirements for current and future flight missions relevant to astrobiology research, and perform education and public outreach to inform and inspire the public. The Ames-hosted NASA Astrobiology Institute serves as a primary vehicle for these and other activities, bringing science and technology communities together to identify Astrobiology research priorities and translate them into NASA missions, programs, and technology challenges. This “virtual institute” represents a partnership between NASA and competitively selected teams across the U.S. to promote and lead integrated multidisciplinary astrobiology research.

### Research Facilities

- Cryogenics Laboratory
- Image Processing Library
- High Resolution Spectroscopy Facility



(left) An Ames scientist peers into a fermenter growing "extremophiles" (organisms that grow in near-boiling sulfuric acid) as part of a study that seeks to understand the biochemical adaptations that allow these organisms and other life forms to thrive in extreme conditions--a fundamentally important issue in Astrobiology and the search for life beyond Earth. The study is also using proteins from extremophiles to create nanostructures. The proteins self-assemble into robust ordered arrays. The goal is to demonstrate that proteins can be used in nanotechnology to create nanoscale sensors and other devices.



- Center for Bioinformatics
- Two electron microscopy laboratories
- Nanotechnology/Genome Sequencing Laboratory
- Nanotechnology/Advanced Life Support Laboratory

### **Workforce Competencies**

- Cryogenics Engineering
- Cell and Molecular Biology
- Developmental Biology
- Fundamental Physics
- Biology and Biochemistry of Ecosystems
- Space Physics
- Astronomy and Astrophysics
- Planetary Science
- Astrobiology
- Remote Sensing Technologies
- Detector Systems

### **Ames Core Capability: High Performance Computing**

Ames Research Center ranks among the world's pioneering developers of supercomputing systems for scientific and engineering applications. Innovations in parallel computing, mass storage systems, and wide area networking have enabled order-of-magnitude leaps in many areas of scientific research and technology development.

The NASA Advanced Supercomputer Facility is the testbed for the Agency effort to develop, demonstrate, and implement a distributed heterogeneous computing capability that will link NASA's vast computing resources together to create an intelligent, large-scale, and adaptive computational system.

### **Research Equipment and Facilities**

- NASA Advanced Supercomputing Facility
- Parallel and Clustered Test Bed Environment
- Next Generation Internet Test Bed Facility
- Aeronet (aerospace network)
- Information Power Grid Computing Environment
- Nanotechnology Laboratory

### **Workforce Competencies**

- Communication Networks and Engineering
- Computer Systems and Engineering
- Network Systems and Technology
- Software Engineering
- Data Acquisition, Management and Storage
- Neural Networks and Systems
- Intelligent/Adaptive Systems
- Mathematical Modeling and Analysis
- Data Visualization

### **Ames Core Capability: Human Factors**

Ames Research Center leads the Agency in human factors research, which focuses on human performance, technology design, and human-computer interaction. Research findings are enhancing the design of advanced automation in air traffic management and cockpit displays from general aviation aircraft to the Space Shuttle. Airlines rely on Ames human factors studies to increase safety, efficiency, and cost-effectiveness in maintenance, efficiency, and training, both in flight and on the ground.

### **Research Facilities**

- Crew Vehicle Systems Research Facility
- Vertical Motion Simulator
- FutureFlight Central
- Human Factors Research Laboratories

### **Workforce Competencies**

- Fundamental Human Factors Research
- Human Factors Engineering



### Ames Core Capability: Intelligent Systems

Ames Research Center's earlier innovations in artificial intelligence for application in spacecraft and space flight operations evolved over the years into a core capability in intelligent systems, which today enables Mars rovers to scour the Martian surface independently of mission control and helps ground support teams work more efficiently. Ames will continue to leverage its expertise in intelligent systems to achieve advances in automated software development, automated planning and scheduling, collaborative reasoning, data mining, and data management analysis and visualization.

#### Research Facilities

- Automation Sciences Research Laboratories
- Human Performance Research Laboratories
- Marscape Test Facility

#### Workforce Competencies

- Robotics
- Computer Systems and Engineering
- Software Engineering
- Intelligent/Adaptive Systems

### Ames Core Capability: Life and Biological Sciences

Ames has contributed its expertise and facilities to NASA missions since the 1960s with research in fundamental physiology and biology that helps maintain human health on Earth and supports the development of countermeasures to the effects of long-term space flight.

#### Research Facilities

- Centrifuges for gravitational research
- Biological Visualization Imaging and Simulation (BioVIS) Technology Center
- Central Clinical Laboratory
- Electron microscope laboratories
- Microbiological Clean Room
- International Space Station Science Operations Center



#### Workforce Competencies

- Cell and Molecular Biology
- Developmental Biology
- Neural Biology
- Biomedical Research
- Biomedical Engineering
- Space Medicine
- Environmental Control and Life Support Systems
- Habitability and Environmental Factors

### Ames Core Capability: Nanotechnology

Ames initiated investigations in nanotechnology in 1996 and today leads the Agency in fundamental research that seeks to create materials, devices, and systems through the control of matter on the nanometer (one-billionth of a meter) scale. Ames leverages this core capability to support its Center for Nanotechnology and conducts experimental research

Robotic technologies on board the six-wheeled, solar-powered K9 rover undergo testing at the Marscape test facility, which is designed to resemble the terrain on Mars. Scientists hope to utilize new “smart robot” technologies during NASA's Mars Science Laboratory mission anticipated in 2009. Ames developed the K-9 avionics, instrumentation, and autonomy software.



and development in nano- and bio-technologies, modeling and simulation, computational electronics, computational optoelectronics, and computational modeling of processes encountered in nanofabrication and microelectronics manufacturing.

### Research Equipment and Facilities

- Two chemical vapor deposition reactors for nanotube growth
- Plasma chemical vapor deposition reactor for nanotube growth
- Two atomic force microscopes
- Biology support facilities
- Parametric analyzer, 4-point probe systems
- Raman spectroscopy, Fourier transform infrared spectroscopy
- Sputtering and lithography facilities
- Clean room
- Generic microsystems microarrayer and scanner
- Pyrosequencer
- Nanopore gene sequencing set-up

(below) Mockup of the Centrifuge Accommodation Module (CAM), a pressurized laboratory for conducting life science research on board the International Space Station. The actual CAM is scheduled for delivery by the Space Shuttle in 2007 and will be equipped with the Life Sciences Glovebox, Centrifuge Rotor, habitat holding racks, a freezer rack, and stowage racks.



### Workforce Competencies

- Nanoscience
- Nanotechnology
- Bioengineering
- Computer Systems and Engineering
- Software Engineering
- Mathematical Modeling and Analysis
- Data Visualization

### Ames Core Capability: Space Transportation Technology/Thermal Protection Systems

Ames Research Center's history of innovation in thermal protection systems began in the 1950s with the development of the blunt body concept for reentry vehicles and continues to the present day. Ames later pioneered development of the thermal protection system that made the Space Shuttle the world's first reusable launch vehicle. Unlike heat shields on Apollo and other capsules designed to ablate while entering the atmosphere, the Ames-developed black borosilicate coating—called reaction-cured glass—rejects radiated heat without melting. The new class of NASA hypersonic and reusable launch vehicles developed in the 1990s—e.g., X-33, X-34, and X-38—all depended on Ames work in thermal protection. Ames' innovations in thermal protection also protected the Mars Pathfinder and Stardust asteroid return missions. The Center currently contributes its expertise in thermal protection systems in support of NASA's Implementation Plan for Return to Flight and Beyond.

### Research Facilities

- Arc Jet Complex and Testing Facilities
- Ballistic Range Complex

### Workforce Competencies

- Chemistry/Chemical Engineering
- Advanced Materials and Processing Science
- Materials Engineering
- Thermal Systems
- Thermal Structures
- Aerothermodynamics





# Ames Workforce

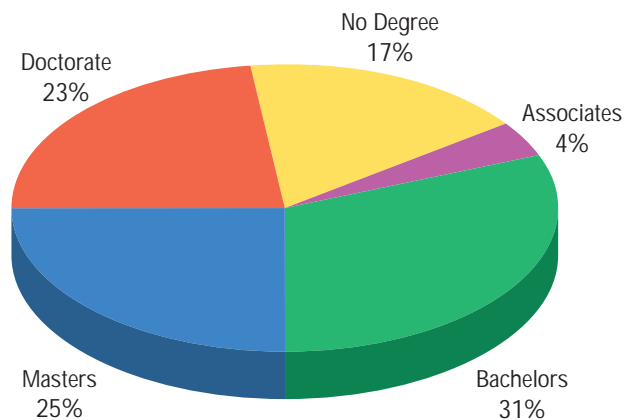
The workforce is the most valuable asset at Ames Research Center. Every effort is made to provide an environment that is fully supportive of professional and personal needs. The Ames reputation for technical excellence has long allowed the Center to recruit and retain a highly educated workforce. The roles and missions of the Center provide scientific challenges that are highly attractive to people with advanced degrees and people who wish to continue their academic pursuits. The state-of-the-art research and development environment, which provides fertile ground for scientific and engineering advancements, is an effective recruitment tool, which resonates with gifted researchers and innovators.

Ames is strongly proactive in creating a high quality of life for its workforce. Ames offers an on-site child care center, health and fitness centers, commuter subsidies, flexible work schedules, work-at-home opportunities, and professional growth and recognition. The work environment at Ames is typically described as collegiate, collaborative, innovative, and creative. The workforce is given great independence in accomplishing the Center's missions.

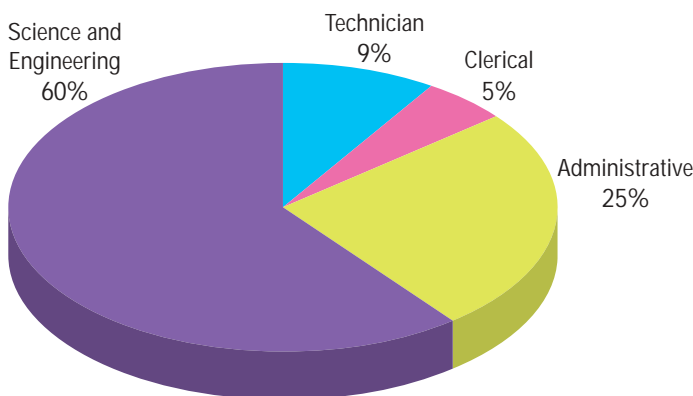
Education is a core value at Ames. As a result, Ames continues to lead the Agency in the percentage of employees with advanced degrees, i.e., 48% of all Ames employees and 70% of all scientific and engineering personnel hold masters or doctorate degrees.

The Center encourages all employees to continue their professional development through an array of fellowships and academic study. The continuing education opportunities include college courses taught on-site and at NASA Research Park, as well as full-time graduate study. Having several world-class universities from which to choose, e.g., the University of California campuses at San Francisco, Berkeley, and Santa Cruz, along with Stanford University and Carnegie Mellon University, is a substantial incentive to join the Ames workforce.

**Education Levels**



**Occupation Categories**



Ames recognizes that collaboration with academia, private industry, and other government agencies, as well as international organizations, fosters professional growth. Ames fully supports these collaborations as well as attendance at technical conferences where our scientists and engineers are often invited speakers.

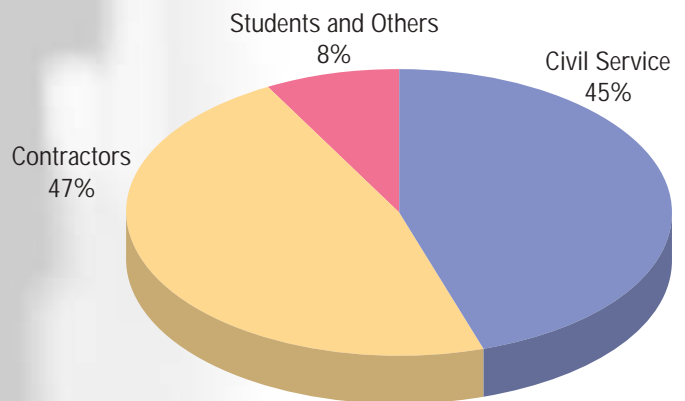
The average age of Ames employees is 48.7 years, which reflects the professional maturity of the staff. The average Ames employee is at the height of his or her professional career, typically recognized as an expert or technical advisor in one or more highly specialized areas. In recent years, hiring plans focused on recruiting mid-career employees who were able to immediately contribute to the Ames programs at a professionally competent level. This was an effective staffing philosophy at a time when Ames was realigning itself to meet changing missions.

It was critical to attract experienced personnel. The average age of employees hired in the last five years is 42.4. In this same period, Ames has experienced an attrition rate of 4%.

In addition to technical excellence, Ames places an aggressive emphasis on having a diverse workforce. Currently women and/or members of a targeted minority group comprise 47% of the workforce. As a fundamental tenet, Ames embraces a harassment-free and prejudice-free work environment that promotes the benefits of diversity and cultural synergy.

On average, Ames supervisors provide direction and support to 10.4 employees. This level of supervisory oversight is appropriate for a large organization with a wide diversity of programmatic functions, ranging from multidisciplinary scientific research, engineering, and development in emerging technology fields, to design and operation of unique research and development facilities.

**Ames Workforce**



# Ames Real Property

Ames Research Center's real property consists of 301 facilities and structures spread over 1,864 acres with 2,718,000 square feet of usable space with an estimated replacement value of more than \$3 billion. Most of the Center's civil service staff and contractors work on the original 448-acre Ames campus, which expanded in 1994 following the U.S. Navy's decommission and transfer of the adjacent Moffett Field Naval Air Station to NASA. However, an ambitious development project is underway to transform the original Ames campus and the former Moffett Field Naval Air Station into an integrated, dynamic research and educational community in the center of Silicon Valley.

Ames offsets some of the operational costs of running the former Navy facilities through partnerships with the California Air National Guard, U.S. Army Reserve, the Federal Emergency Management Agency, and other Department of Defense organizations and federal agencies. Ames Research Center currently maintains four sites:

- Ames Research Center (pre-1994 campus)
- Moffett Complex (formerly Moffett Field Naval Air Station)
- Camp Parks
- Crow's Landing Flight Facility

## Ames Campus

The Ames campus physical plant consists of many unique and specialized research facilities essential to supporting NASA mission requirements: flight simulators, wind tunnels, arc jets, advanced computing facilities, and a range of laboratories. The campus also contains support facilities essential to Center operations: office buildings, warehouses, maintenance facilities, and recreational facilities. The campus contains approximately 1.4 million square feet of research and development space, most constructed between 1940 and 1963.

## Moffett Complex

A part of Ames Research Center since 1994, the former Moffett Field Naval Air Station adjoins the Ames campus and consists of 140 buildings comprising more than 1.5 million square feet. The Moffett Complex includes areas and facilities previously used by the military for airfield support, barracks, maintenance, motor pools, and storage. Twenty-two buildings are historically significant. The 952-acre Moffett Federal Airfield is essential to NASA's continuing aerospace research and development. Plans are under way to integrate Moffett Field and the adjoining Ames campus into a world-class, shared-use research, development, and educational resource in association with government, industry and academia.



## Camp Parks

Located in Pleasanton, California, Camp Parks serves as a long-term storage facility co-located at the U.S. Army Reserve's Camp Parks Facility. Ames is exploring alternatives for relocating the warehouse function from Camp Parks to Moffett Field.

## Crow's Landing Flight Facility

NASA obtained the 1,500-acre Crow's Landing Flight Facility in 1994 with the transfer of Moffett Field Naval Air Station. In 1999, Congress directed NASA to convey the property, which is located in Patterson, California, to Stanislaus County. Ames will transfer the property following completion of environmental remediation by the U.S. Navy.



# Ames Campus Research Facilities

(below) Studies have shown that human error contributes 60% to 80% of all aviation accidents and incidents. The Advanced Concepts Flight Simulator (shown) works with a simulated air traffic control system to allow scientists to study how errors are made. This human factors research also studies the effects of automation, advanced instrumentation, and other factors, such as fatigue, on human performance in aircraft.

The following section describes major research facilities at Ames used to support NASA mission requirements. A listing of other facilities follows.

## Aviation Simulator Facilities

Ames operates three aviation simulator facilities: the Crew Vehicle Systems Research Facility, the Vertical Motion Simulation Complex, and FutureFlight Central.

- The *Crew Vehicle Systems Research Facility* serves as a unique national research tool for studying basic human factors issues critical to developing an understanding of the mechanisms and environmental factors that can lead to human error in the national aviation system. The facility includes two full-mission flight simulators: a Boeing 747-400 and an Advanced Concepts Flight Simulator.



- The *Vertical Motion Simulation Complex* is comprised of several laboratory systems: the Vertical Motion Simulator, interchangeable simulator cockpits, embedded computing systems, graphics systems, real-time software systems, and other specialized subsystems.
- *FutureFlight Central* is a premier technical design studio for 21st century airport operations and planning. The facility provides a 360-degree, high fidelity, visual simulation of a current or future airport, and a functionally accurate physical and software replication of a current or future tower or operations center. The facility allows research and operations staff working with NASA to plan new runway configurations, test new ground traffic and tower communication procedures, and validate air traffic plans using remarkably accurate “human-in-the-loop” simulation.

## Wind Tunnel Facilities

Ames currently operates two premier wind tunnels with a broad range of proven testing capabilities:

- The *11-Foot Transonic Wind Tunnel* is a closed circuit, single return, variable density, continuous flow wind tunnel capable of a Mach number range of 0.40 to 1.40 and a pressure range of 0.5 to 2.25 atmospheres.
- The *9- by 7-Foot Supersonic Wind Tunnel* is a closed circuit, single return, variable density, continuous flow wind tunnel capable of a Mach number range of 1.50 to 2.55 and a pressure range of 0.3 to 2.0 atmospheres.

These tunnels comprise the Ames Unitary Plan Wind Tunnel Complex, which utilizes a single drive set of drive motors and two large axial-flow compressors to power both wind tunnels. Recent facility modernization efforts have enhanced data quality and testing productivity. Customers in NASA, industry, academia, the Department of Defense, and other government agencies use the facilities.





(left column) A model of an FA-18 aircraft undergoes testing in the 11-foot transonic wind tunnel.

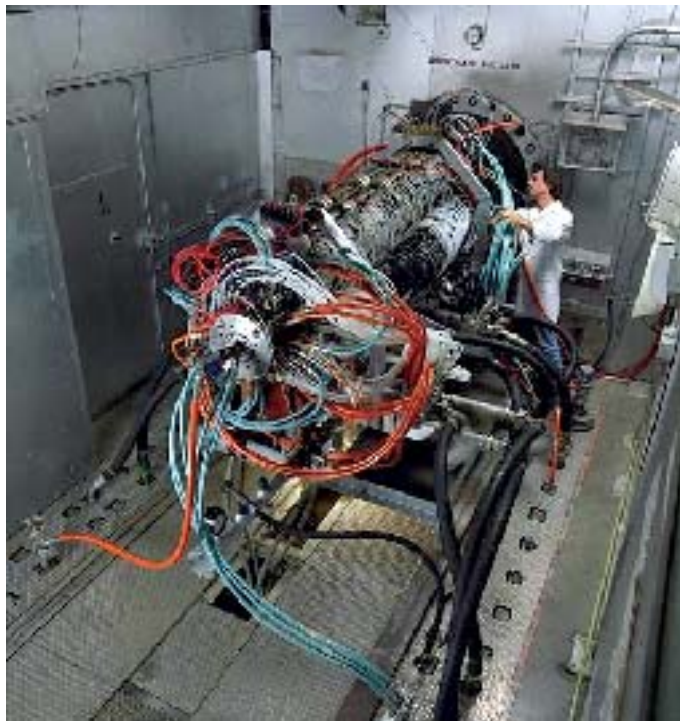
- The *Ballistic Range Complex* is a unique national facility that enables the study of heating and aerodynamic effects on projectiles flying at very high speed conditions and gas composition similar to those encountered during entry.
- The *Electric Arc Shock Tunnel Facility* is used to build and verify physics-based simulation models for use in predicting temperature and radiation behind the shock wave generated by the probes during entry.

The Center initiated closure of the *National Full-Scale Aerodynamic Complex* and *12-Foot Pressure Wind Tunnel* in May 2003, citing budget issues. NFAC is comprised of the 40- by 80-Foot and 80- by 120-Foot Subsonic Wind Tunnels, both the largest in the world. Discussion is under way to develop a fiscally viable solution to keep these wind tunnels operational. If Ames does not bring the facilities back on-line by the end of 2004, they will close permanently.

### Thermal Protection System Facilities

The Thermal Protection Simulation Facilities laboratory conducts research, development, and qualification of materials suitable for heat shield applications and for materials and structures studies of vehicles entering planetary atmospheres at high velocity. The following arc jets and other unique facilities support the design, testing, and verification of thermal protection systems for NASA missions in solar system exploration.

- The *Arc Jet Testing Complex* is used to verify thermal protection system design and has been used to test every NASA probe mission. It is comprised of the *Aerodynamic Heating Facility*, the *Interaction Heating Facility*, and the *Panel Test Facility*.
- The *Vertical Gun Range* allows scientists to study the impact of a comet on a planetary surface and to design, develop, and verify instruments for future missions.



The Aerodynamic Heating Facility is a hypersonic wind tunnel where Ames researchers develop and refine reentry thermal protection systems for the Space Shuttle and other reusable launch vehicle programs. Future work will support the X-37 and Orbital Space Plane.



## **Stratospheric Observatory for Infrared Astronomy (SOFIA)**

SOFIA is a Boeing 747SP aircraft currently undergoing modification by NASA and the German Aerospace Center to accommodate a 2.5-meter reflecting telescope. Scheduled for completion in 2004, SOFIA will be the largest airborne observatory in the world and will make observations that are impossible for even the largest and highest of ground-based telescopes.

## **High-End Computing Resources**

Ames Research Center leads the country in the research, development, and delivery of revolutionary, high-end computing services and technologies.

The *NASA Advanced Supercomputing Facility* (formerly the Numerical Aerodynamic Simulation Facility) houses the high-speed processors, mass storage systems, and network interfaces Ames uses to provide supercomputing resources to NASA scientists throughout the Agency. The facility also contains computing resources used to conduct research and development of new, integrated high performance computing environments—e.g., the NASA Information Power Grid, a network of high performance computers, data storage devices, scientific instruments, and advanced user interfaces intended to foster collaboration and sharing of scientific results among NASA researchers.

## **Other Ames Research Facilities**

Additional Ames research, education, and support facilities include the following:

### ***Life Sciences Facilities***

- Center for Gravitational Research, including:
  - Human Powered Centrifuge
  - 20 g Human Rated Centrifuge
  - 24 ft Centrifuge
  - 8 ft Centrifuge (International Space Station analog)
  - 30 ft Programmable Acceleration Sled
  - Hypergravity Facility for Cell Culture
  - Vestibular Research Facility (multiaxis)
  - Life Sciences Flight Integration and Research High Bay

- Biological Visualization Imaging and Simulation (BioVIS) Technology Center

### ***Space Projects***

- Cryogenics Laboratory

### ***Air Transportation System Automation Facilities***

- Air Traffic Management Automation Laboratory

### ***Human Factors Research Laboratories***

- Advanced Displays and Spatial Perception Laboratory
- Advanced Flight Deck Display Laboratory
- Applied Human-Computer Interaction Laboratory
- Aviation Operations Laboratory
- Cognition Laboratory
- Crew Factors Laboratory
- Distributed Decision-Making Laboratory
- Fatigue Research and Countermeasures Laboratory
- Human Centered Systems Laboratory
- Intelligent Spacecraft Interface Systems Laboratory
- Professional Pilot Training Laboratory
- Psychophysiological Laboratory
- Vision Laboratory

### ***Earth Science***

- Airborne Sensor Calibration Facility

### ***Education***

- Ames Aerospace Encounter
- Educator Resource Center

### ***Other***

- Hypervelocity Free-Flight Facility
- Systems Development Facility
- Automation Sciences Research Facility
- Balance Calibration Laboratory
- Hypersonic Free Flight Aerodynamic Facility
- Fluid Mechanics Laboratory
- High Pressure Air System
- Steam Vacuum System





NASA's Hubble Space Telescope has snapped a panoramic portrait of a vast, sculpted landscape of gas and dust where thousands of stars are being born. This fertile star-forming region, called the 30 Doradus Nebula, has a sparkling stellar centerpiece: the most spectacular cluster of massive stars in our cosmic neighborhood of about 25 galaxies. The mosaic picture shows that ultraviolet radiation and high-speed material unleashed by the stars in the cluster, called R136 [the large blue blob left of center], are weaving a tapestry of creation and destruction, triggering the collapse of looming gas and dust clouds and forming pillar-like structures that are incubators for nascent stars.





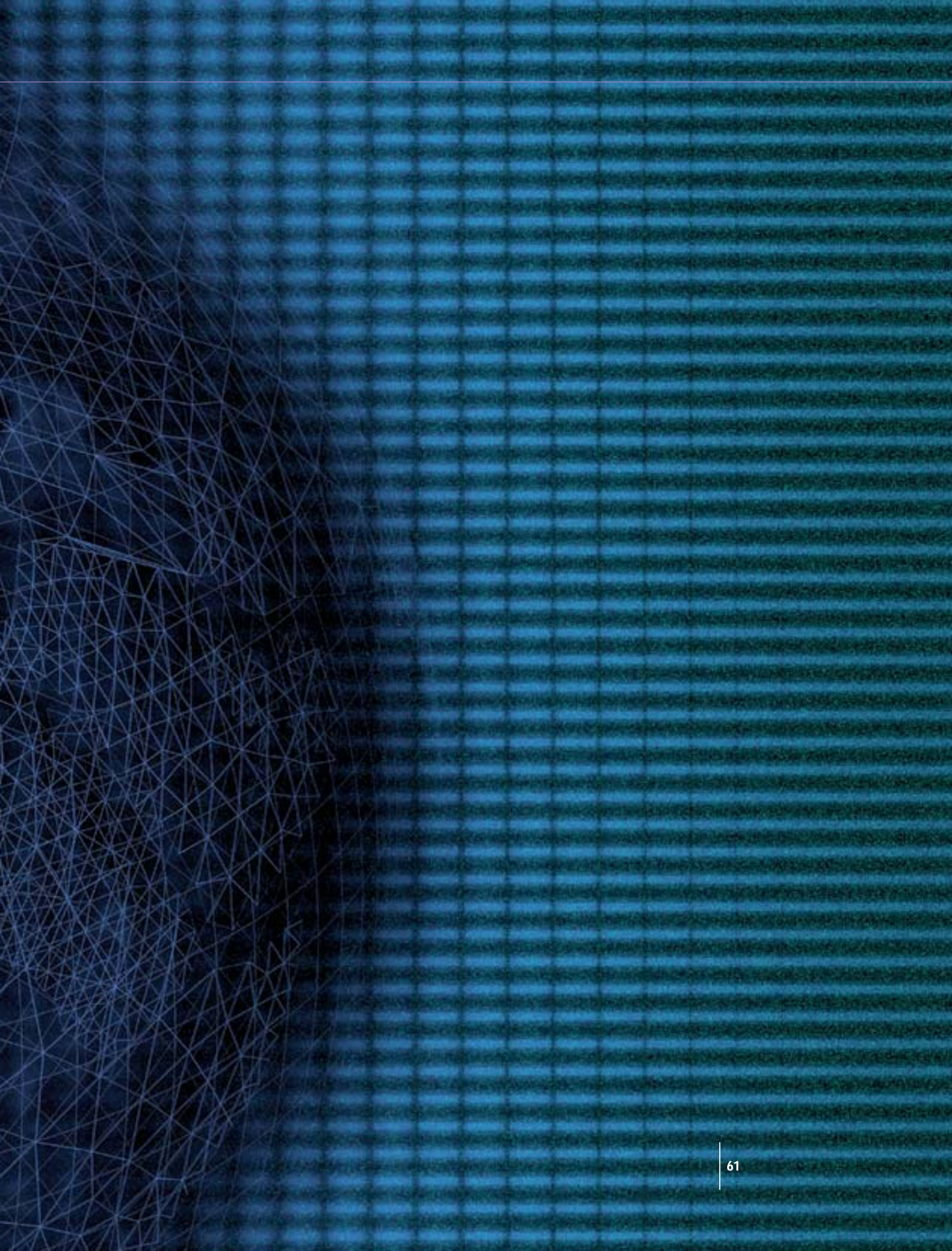


## **Future Plans**



# Future Plans

*The following sections discuss Ames Research Center's plans to prepare its workforce and infrastructure to meet the Agency's future requirements. The first section identifies key areas of research and development Ames will undertake over the next ten years in support of the NASA Strategic Enterprises. The final sections describe the Center's future plans for workforce and property.*



# Future Research Activities



Ames will continue to lead the Agency in accelerating the development of selected tools and technologies for air traffic management for use in improving the capacity and reliability of the current system. The Center will also continue its efforts to facilitate their implementation by the FAA and industry.

Ames will provide foundational research and long-term exploratory investigations for the air transportation system of the future. Ames will lead the effort to develop advanced concepts and an airspace system modeling and simulation environment to assess these promising technologies and concepts. The Center will also develop transformational concepts for increasing airspace system capacity and technology road maps for enabling them.

## Aerospace Technology Enterprise

NASA's Aerospace Technology Enterprise is responsible for providing technology leadership in the pursuit of long- and near-term technology solutions to advance NASA missions and goals. As the Institutional Program Office for Ames Research Center, the Enterprise sets the agenda for much of the Center's research and development. The following section highlights key areas of research and development Ames Research Center will support over the next decade.

### Aeronautics Technology Theme

Mission success begins with safety, and Ames will continue to leverage its expertise in human factors analysis, experimentation, and modeling to make dramatic improvements in the safety, security, and efficiency of the nation's airspace. The Center will also increase research and development on tools and techniques for reducing aviation hazards and proactively managing risk.

### Space Launch Initiative Theme

Major research and development over the next ten years at Ames Research Center will support the development and demonstration of a safe, affordable, and reliable crewed space vehicle for accessing and returning from the International Space Station. Ames will focus on the research and development of thermal protection systems and other critical access-to-space technologies that will benefit NASA, the Department of Defense, and other government agencies.

Ames will also develop technologies to collect and process information about the health of a next-generation launch technology system throughout every phase of operation (preflight, in-flight, post-flight). Such information will enable vehicle crews, maintenance personnel, and automated ground systems to make informed decisions concerning the operation and use of a space vehicle.



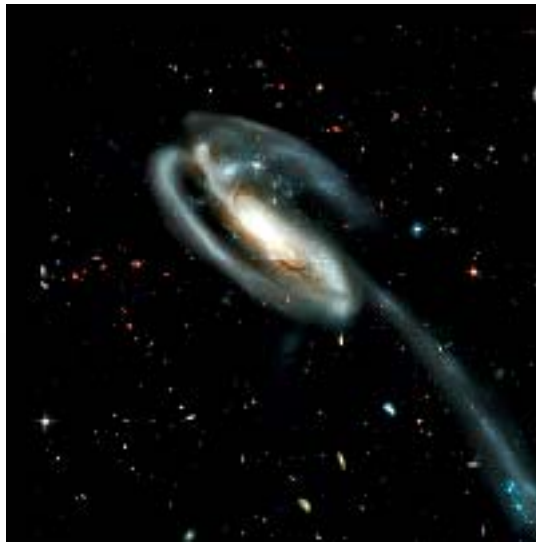
## Mission and Science Measurement Technology Theme

Future NASA missions will need new technologies dramatically different from those in current use today. In response to that need, Ames will research, demonstrate, and infuse advanced computing, information, and communications technologies to allow NASA to accomplish missions with greater mission assurance, for less cost, and with increased science return. Ames will focus on human-machine interfaces, knowledge discovery, terrestrial-space communications interfacing, software verification and validation tools, and embedded information systems, including nanoscale systems. During the next ten years, Ames will build on advances in nanotechnology material sciences to enable more cost-effective fabrication of nanoscale structures, sensors, and electronic components.

## Innovative Technology Transfer Partnerships Theme

The Ames Office of Technology Transfer Partnerships will provide significant support in the capture, protection, promotion, and management of intellectual property in support of NASA missions. The office will continue to support NASA's Small Business Innovation Research Program, the Small Business Technology Transfer Program, and the NASA Alliance for Small Business Opportunity Initiative. The office will also coordinate Space Act Awards activities with the NASA Inventions and Contributions Board.

The Ames Office of Technology Transfer Partnerships will continue to leverage partnerships between NASA and U.S. industry, academia, other government agencies, and the venture capital community for innovative technology development.



## Space Science Enterprise

### Solar System Exploration Theme

Ames will continue to support the design of the Interplanetary Communications and Sensor Network, a “network of networks” with connecting nodes between near-Earth systems and deep space systems across the solar system that will provide high-rate, continuous coverage for space missions.

### Mars Exploration Theme

Ames will lead the effort over the next 10 years to design the space Internet. The Center will design and develop technologies and architectures to enable intelligent, autonomous communication anytime, anywhere with end-to-end information delivery from space directly to users.

Ames will continue scientific, technology, and human factors research in the Haughton-Mars Project over the next decade. Science projects will investigate Arctic ground-ice phenomena, impact geology, paleolake studies, and valley formation. Technology studies will take advantage of the isolated, hostile



terrain of the Haughton complex to test the viability of new technologies for both robotic and eventual human exploration. Technologies include communication networks, autonomous aerial vehicles with take-off and landing capability, telepresence control of robots through both line-of-sight and satellite links, and, in time, habitat designs. Human factors studies will begin in earnest when NASA is ready to prepare for long-term human missions beyond Earth orbit.

The Center will expand Marsoweb datasets to include those from NASA's 2005 Mars Reconnaissance Orbiter and, when available, the European Space Agency's Mars Express. The Website is evolving toward one that permits users to "mine" the global Mars dataset for scientific purposes other than landing-site selection. Marsoweb could become a powerful tool for public education and outreach. Ames will soon launch an education and public outreach version of Marsoweb at the Ames Visitor Center.

## Astronomical Search for Origins Theme

Ames will initiate science operations on board SOFIA in 2005 and will open a new era in astronomy. The airborne observatory will provide a unique platform to investigate the following:

- Interstellar cloud physics and star formation in our galaxy
- Protoplanetary disks and planet formation in nearby star systems
- Origin and evolution of biogenic atoms, molecules, and solids
- Composition and structure of comets and planetary atmospheres and rings
- Star formation, dynamics, and chemical content of other galaxies
- The dynamic activity in the center of the Milky Way
- Ultraluminous infrared galaxies as a key component of the early universe

SOFIA will provide important contributions to the development of new observational techniques and instrumentations and in the education of young scientists and teachers in the discipline of infrared astronomy.

The Center will complete system requirements review and preliminary design review for the Kepler Mission by the end of 2004. Scheduled to launch in 2007, the mission will survey the extended solar neighborhood to detect and characterize hundreds of terrestrial and larger planets. Results from this mission will allow scientists to place our Solar System within the continuum of planetary systems in the Galaxy. Ames will conduct flight operations through 2011. An educational program that began in 2002 will also continue through 2011.



## Earth Science Enterprise

### Earth System Science Theme

Ames will optimize code for global climate modeling on the Ames-operated 1,024-processor SGI Origin 3800 supercomputer. Its unique architecture has increased the number of simulated climate days from 900 daily to more than 2,900 a day.



Ames will continue to support Earth observation missions. The missions will carry more than 200 different instruments, providing measurements of many environmental change parameters. Ames and other NASA scientists will improve communication between various mission planners by using automated scheduling technology to coordinate satellite imaging and manage the increasing volume of scientific data produced during the missions. A science team will design algorithms for integrating new observation requests with an Earth observation satellite constellation's existing operations plan, then integrate science observation scheduling technology developed at Ames with an Automated Mission Planning and Scheduling system developed at NASA's Goddard Space Flight Center. Finally, the team will develop a technology plan for coordinated science planning for multiple missions and an enhanced automated tool for coordinated science planning of future missions.

### Earth Science Applications Theme

Ames will continue to utilize uninhabited aerial vehicles in the detection of fires, commercial crop infestations, and environmental health monitoring.



## Biological and Physical Research Enterprise

### Biological Sciences Research Theme

The Space Station Biological Research Project is expected to complete development of the Space Station Biological Research Facility in 2008. Science operations with this hardware will commence in 2005 and continue through 2020 or longer. In the interim, Ames will develop Small Payloads as part of the sortie activities supporting the International Space Station. Future efforts also look toward the use of unmanned free flyers to conduct both physical and biological experiments. In another area, Ames will develop an intelligent virtual model of the International Space Station to help NASA monitor and operate the International Space Station, train astronauts, and support fault detection, isolation, and recovery. Ames will also conduct ground research in biological models to support human exploration of space beyond low Earth orbit and increase our understanding of the effects of microgravity on biological systems.





## Space Flight Enterprise

### Space Shuttle Program Theme

Ames will develop new approaches to human-computer interaction on board the Space Shuttle. Future research is expected to focus on the best ways to configure virtual environments to enhance human performance of complex tasks.



## Education Enterprise

### Education Programs Theme

Ames will strengthen its ties to local community colleges in the next decade by increasing the number of faculty fellowship programs and student internships. Ames will support efforts to integrate the science, technology, engineering, and mathematics curriculum between the University of California, California State University, and California community college systems. Ames will bring education institutions with high minority representation into the NASA Research Park.

Ames will continue to serve as the Agency's lead for education in 10 western states by providing greater access to Ames programs, products, and services. Ames will significantly strengthen its connections to science centers, museums, planetariums, scouting groups, and other organizations that serve educators and students.

Ames will also contribute significant support to NASA Explorer Schools, Educator Astronaut Programs, Explorer Institutes, Scholarship for Service, and other Agency education initiatives.





# Building the Future Workforce

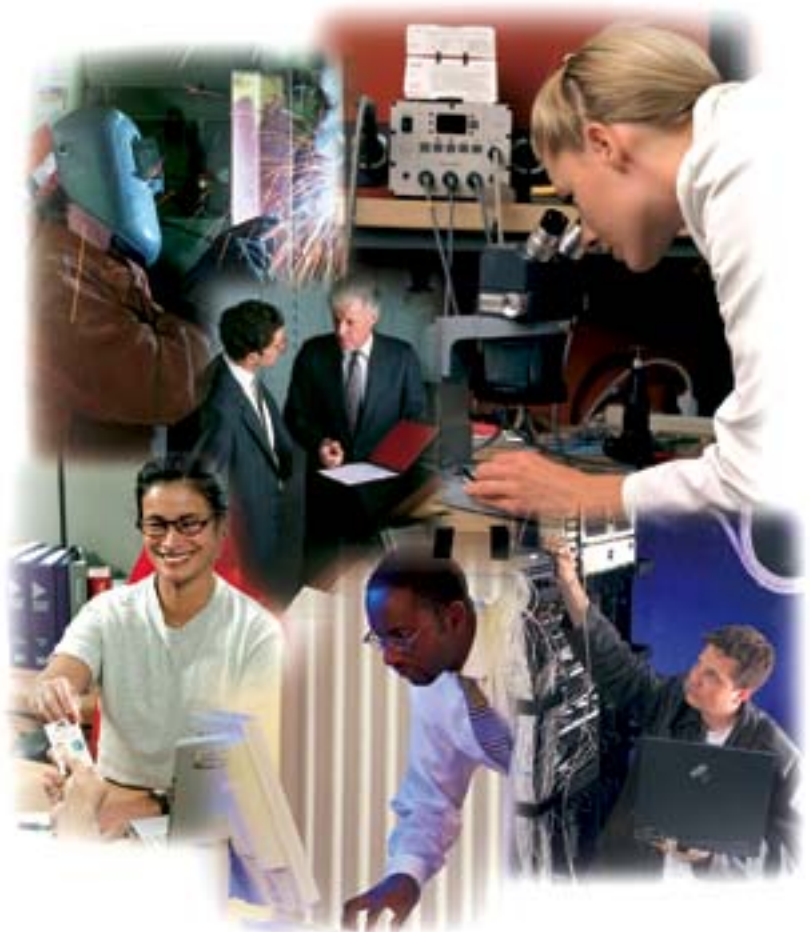
The evolution from traditional aeronautics to new research fields requires an ongoing effort to rebalance scientific and engineering competencies within the Center's portfolio. For example, information technology, physical and cybersecurity, workforce management, and cost analysis will become increasingly critical as the Agency evolves to meet 21<sup>st</sup> Century management and technical challenges. To keep pace, Ames Research Center will focus on two things: maintaining key competencies, and maximizing collaboration with industry, academia, and other government partners.

The Center will take a four-pronged approach to meet the challenge. First, the Center is identifying workforce strengths and weaknesses—assessing competencies, evaluating requirements, analyzing gaps, and developing a plan with hiring targets, competency priorities, and a rationale based on the Agency's new competency management system. Ames will use it to maintain visibility into workforce skills and expertise over time in tandem with developing requirements for future mission and program requirements.

Second, the Center is proactively reshaping its workforce—restructuring jobs and organizations, retraining employees, fostering continuing education and professional development, and recruiting and hiring new employees in key competencies. Ames is also using targeted assignments and reassignments, more term appointments and temporary employees, a full suite of retirement incentives, and detailing employees to special short-term assignments to balance skill sets. To offset retirements over the next decade, the Center will hire entry-level employees. The Center is evaluating competitive sourcing opportunities.

Third, the Center will develop management mechanisms to sustain competencies in a full cost environment. Ames will work to ensure that full cost accounting, budgeting, and management practices support the Center's ability to maintain the right workforce for the future.

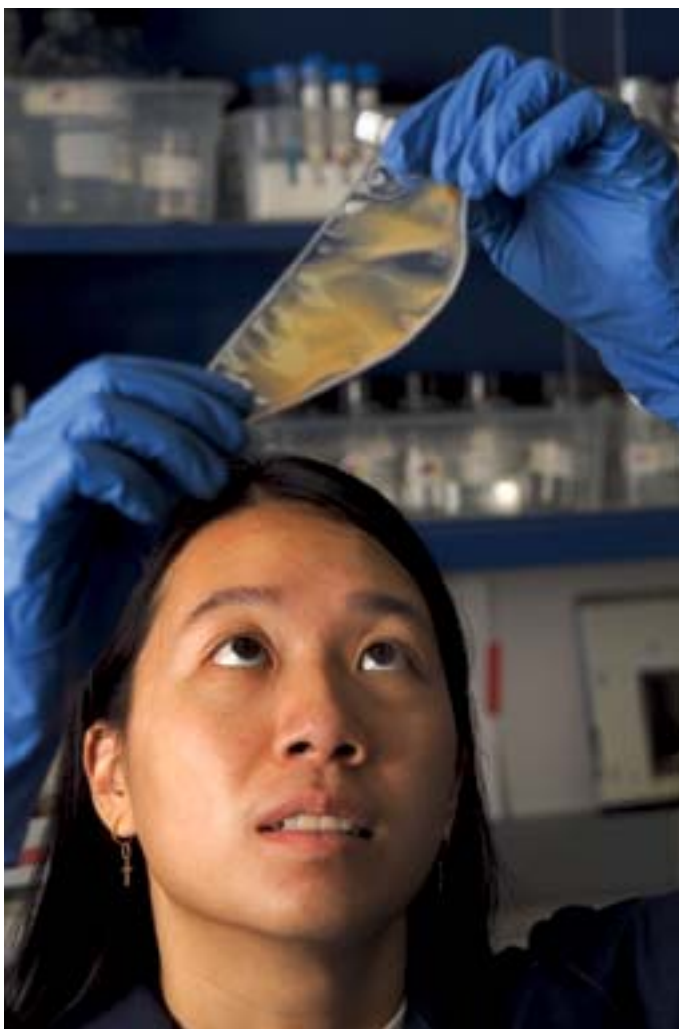
Finally—and most significantly—Ames will continue to develop innovative partnerships and collaborative opportunities with industry, academia, and other government agencies. The new NASA Research Park and the University Affiliated Research Center demonstrate the Center's commitment to such collaborations as powerful mechanisms for fostering innovation in science and engineering.



## University Affiliated Research Center

Ames Research Center is currently establishing a unique, hybrid, research center model consisting of a lean, civil service-based, core research center tightly coupled with a University Affiliated Research Center (UARC). The UARC will improve competitively sourced research by attracting and retaining the best research talent and enabling a more rapid refresh of researchers to meet evolving mission needs. The UARC directly supports the President's Management Agenda and is a key element of the Agency's Human Capital Plan.

The UARC encompasses both a research and an educational mission through a close collaboration between an established university system or non-profit and a NASA research center.



The Ames Research Center UARC will focus on collaborative, multidisciplinary research and science that supports NASA's long-term mission requirements. Program activities will range from fundamental investigations through development and field-testing of prototype systems demonstrating new science and technological advances. UARC core competencies will include information technology, biotechnology, nanotechnology, aerospace operations, astrobiology, fundamental space biology, and computer science.

The UARC will also provide educational interaction between university faculty, students, and Ames researchers to develop future human resources in technology and science. The UARC will manage an on-site "teaching hospital" type of environment in the core technology and science disciplines. This educational environment will apprentice graduate students with experienced NASA and UARC researchers working on complex mission problems and will benefit the entire Agency through the continuing education of the NASA workforce.

The close collaboration enables the Ames UARC to meet demanding, time-critical mission requirements. Under the UARC, an established university or nonprofit can expand its participation from fundamental research traditionally performed under grants and cooperative agreements to include mission-driven research under task order contracts. The UARC also enables Ames to utilize civil servants more effectively in performing their inherently governmental role in research.

The Ames UARC is a cornerstone in the Center's strategy to deliver multidisciplinary research responsive to the Agency's missions in partnership with academia and industry.

A research assistant observing a culture of *C. elegans* grown in an ADvanced SEPARations (ADSEP) cassette bag. *C. elegans* is a nematode that is being developed by the Small Payloads Team at Ames Research Center as a model specimen to be studied in a space environment.





## Future of Ames Property

Ames Research Center began shifting its mission over the past 10 years away from aeronautics research and today maintains considerable expertise in information technology, biotechnology, and nanotechnology. Research and development in these emerging fields will require an enhanced infrastructure. The *2002 NASA Ames Development Plan* provides a strategic framework and set of proposals to guide the use, renovation, management, and development of Ames Research Center land and facilities for the next 15 years. The plan garnered an award for federal leadership—the 2003 General Services Administration Achievement Award for Real Property Innovation. A companion

document to the *2002 Final Programmatic Environmental Impact Statement*, the plan describes NASA's preferred plan for integrating the original Ames campus with the Moffett Complex. The NASA Research Park is the centerpiece of the *NASA Ames Development Plan*.

### **NASA Research Park**

Ames Research Center's boldest plan for the future will integrate the Ames campus and part of the Moffett Complex into the NASA Research Park, a dynamic federal laboratory and shared-use center for research and learning that will fundamentally change the way the Center works and plays.

Artist's concept drawing of the planned NASA Research Park.



Government, academia, industry, and nonprofit groups will partner with NASA to conduct collaborative research and development in astrobiology, biotechnology, high performance computing, and nanotechnology. NASA Research Park will also enable educational programming in science, technology, engineering, and math. The collaborative venture is based on the premise that innovation in science and research requires cross-fertilization of ideas across related disciplines by public and private enterprises and many levels of academia.

Ames has already attracted some of the country's finest universities and colleges to the research park and signed a long-term lease in 2003 with Carnegie Mellon University for the first building in the university's west coast campus. Other planning partners include the University of California at Santa Cruz; San Jose State University; the Foothill De Anza Community College District; the National Center for Women in Science, Technology, Engineering, and Math; the National Association for Equal Opportunity in Higher Education; and the California Air and Space Educational Foundation.

The plan divides the Center's property into four areas: the Ames campus (234 acres); NASA Research Park (213 acres); Bay View (95 acres), and Eastside/Airfield (952 acres).

The NASA Research Park and Bay View development will result in a total of 4.5 million square feet of renovated and new buildings. The NASA Research Park will feature a town center with green open space, outdoor seating, tree-lined streets, and bicycle paths, and a linked system of parks, plazas, and pathways. Some visiting scholars and others engaged in collaborative research, development, and education will even live on campus in new housing specially built for short-term use. Plans call for construction of more than 1000 apartments and townhouses. Partners will finance the renovation and construction of buildings and facilities for their own use.

Moffett Federal Airfield will continue to serve as a limited-use airfield primarily in support of SOFIA and other Agency or partner aerospace research and development activities.

## **Supporting NASA's Master Planning Process**

Plans are under way to develop the next Ames Research Center Master Plan, a 20-year set of proposals and general guidelines to help decision-makers and planners make informed investment decisions about future facilities, land, and road use. Currently scheduled for delivery to NASA Headquarters in 2006, the plan will function as a "living document," with regular updates performed with the aid of a geographic information system currently in use for the Center's facilities engineering and maintenance planning. Extending its use to the master plan, Ames will use the geographic information system to capture, store, analyze, and display information about the Center's buildings, land, and roads according to location.

The master plan will take into account a range of ongoing Agencywide issues and anticipated trends that impact facilities and land use, including reduced maintenance budgets, anticipated research growth areas, and increased security requirements. The plan will propose demolition of underutilized facilities, construction of new, lower maintenance facilities, and enhanced-use leasing opportunities for private sector companies doing business with NASA.

## **Renovation by Replacement**

Ames plans are to fund demolition projects in conjunction with new construction. Plans call for construction of one new office building in 2005, with occupancy planned for late 2006. Ames will relocate occupants from three other Ames buildings slated for demolition, demolish those structures, and construct a new facility on one of the sites. The rolling plan will continue through the next decade. The initiative will reduce the backlog of maintenance, repair, and deferred maintenance; reduce energy consumption; improve space utilization; and improve the NASA revitalization rate.





Resembling the puffs of smoke and sparks from a summer fireworks display in this image from NASA's Hubble Space Telescope, these delicate filaments are actually sheets of debris from a stellar explosion in a neighboring galaxy. Hubble's target was a supernova remnant, denoted LMC N 49, within the Large Magellanic Cloud, a nearby, small companion galaxy to the Milky Way visible from the southern hemisphere. This filamentary material will eventually be recycled into building new generations of stars in the LMC. Our own Sun and planets are constructed from similar debris of supernovae that exploded in the Milky Way billions of years ago.



Amid a backdrop of far-off galaxies, the majestic dusty spiral NGC 3370 looms in the foreground in this NASA Hubble Space Telescope image.

Observations taken with the Advanced Camera for Surveys show intricate spiral arm structure spotted with hot areas of new star formation. But this galaxy is more than just a pretty face. Nearly 10 years earlier, NGC 3370, located in the constellation Leo, hosted a bright exploding star.



## **Implementing Strategies**



# Implementing Strategies

*This section summarizes details of the Center's management and planning activities relative to NASA's "Implementing Strategies," an Agencywide set of goals and performance objectives for improving management and program performance.*





## Implementing Sound Management and Planning Practices

“NASA must ensure that all of its activities are based on a foundation of sound planning and management practices. These practices are critical to NASA’s achievement of its goals and are similar to the management strategies followed by all well-run organizations.

The five Implementing Strategies outlined in this section describe an ongoing framework under which NASA conducts its business. Each strategy

has at least one objective that represents the near-term improvements to which NASA is committed. The responsibility for each objective is assigned to a specific NASA office or offices. Under that guidance, the entire Agency will adopt and practice these strategies to reach the objective. This common management framework will ensure that all of NASA is working together to achieve its Mission as safely and efficiently as possible.”

– *2003 NASA Strategic Plan*



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

<p><b>Obj. IS-1.1</b> Attract and maintain a workforce that is representative of the Nation's diversity and includes the competencies that NASA needs to deliver the sustained levels of high performance that the Agency's challenging Mission requires.</p>	<ul style="list-style-type: none"> <li>• Use the NASA Competency Management System to identify current workforce competencies and future gaps.</li> <li>• Implement the strategies set forth in the <i>NASA Human Capital Implementation Plan</i>.</li> <li>• Use <i>Ames Human Capital Plan</i> to identify the competencies required to support the <i>Ames Strategic Plan</i> and methods needed to reshape the workforce.</li> <li>• Increase freshout hiring in critical competencies showing high near-term retirement projections.</li> <li>• Actively participate in the NASA Corporate Recruitment Initiative.</li> <li>• Use a recruitment firm to assist in the identification of diversity candidates for key positions.</li> <li>• Use human resource flexibilities, including new legislative initiatives, to attract and retain top talent, especially in critical competency areas.</li> <li>• Strengthen leadership and management programs to provide training and support to Ames supervisors and develop strong candidates for future management positions.</li> <li>• Recognize high performance with appropriate monetary and honorary awards.</li> <li>• Strengthen relationship and interactions among human resources, equal opportunity, education, and budget organizations to facilitate an integrated and synergistic approach to tactical workforce planning.</li> <li>• Strengthen relationships with Minority Serving Institutions, community advocacy groups, and professional organizations for recruitment.</li> <li>• Recruit at colleges and universities with large concentrations of minority students.</li> <li>• Provide funding for programs and other activities sponsored by Special Emphasis Advisory Committees.</li> </ul>
<p><b>Obj. IS-1.2</b> Define and adopt procedures to improve the competitive acquisition of programs, services, and assets to benefit the NASA Mission and the American taxpayer.</p>	<ul style="list-style-type: none"> <li>• Continue formulating the Ames Acquisition Strategy Planning Initiative, to facilitate development of effective acquisition strategies.</li> <li>• Continue integrating small-disadvantaged businesses, and small and women-owned businesses, together with minority universities into the competitive base from which NASA can purchase goods and services.</li> </ul>
<p><b>Obj. IS-1.3</b> Improve and streamline the NASA financial management system to enhance accuracy, timeliness, and accountability.</p>	<ul style="list-style-type: none"> <li>• Utilize the SAP Core Financial module, the WebTADS Time and Attendance system, and Gelco's Travel Manager to ensure timely, accurate and efficient financial processing and reporting.</li> <li>• Participate in the development of agency follow-on systems, including Asset Management and the Contract modules of IFM.</li> <li>• Participate in the transition to the e-Government payroll and travel systems.</li> </ul>



<b>IS-1 continued</b>	
	<ul style="list-style-type: none"> <li>• Develop sound financial processes and use IFM Core Financial and interfacing modules to contribute to the achievement of an unqualified opinion for the Agency's financial statements.</li> <li>• Develop financial and resources reports to support the implementation of Full Cost management and performance measurement.</li> <li>• Support the development and implementation of the NASA Shared Services Center/Finance to streamline financial processes and improve service.</li> <li>• Provide full cost, financial, resources, and systems training to program, research and business support personnel.</li> </ul>
<p><b>Obj. IS-1.4</b> Unify the processes for strategic and budget planning, budget reporting, and performance planning and reporting.</p>	<ul style="list-style-type: none"> <li>• Support NASA programs through the utilization of cost estimation and analysis tools.</li> <li>• Implement the IFM Budget Formulation module to streamline and enhance the budget formulation process and the analysis of financial performance.</li> <li>• Develop and provide effective and timely decision support reporting to Agency and center stakeholders.</li> <li>• Strategically evaluate the organizational structure of the Office of the CFO to support full cost, performance management, and changing business.</li> </ul>
<p><b>Obj. IS-1.5</b> Beginning in early 2003, provide an integrated and user-friendly NASAwide Internet portal that will provide improved public access to NASA Mission results and other products, improved visibility into NASA plans and programs, and enhanced communication among NASA employees and contractors.</p>	<ul style="list-style-type: none"> <li>• Participate in the Agency Editorial Board and continue to provide Mission-related content to support the NASAwide Internet Portal.</li> <li>• Redesign the internal portal, ARCweb, to increase information distribution, collaboration, and to provide productivity tools and capabilities.</li> </ul>
<p><b>Obj. IS-1.6</b> Improve the institutional management of capital assets to ensure that NASA's real property, personal property, processes, and systems are sustained and optimized to support NASA's missions and the capabilities required for today and tomorrow.</p>	<ul style="list-style-type: none"> <li>• Update and maintain Ames Real Property Master Plan and Space Utilization Plan.</li> <li>• Update Ames Real Property Investment Plans for focus areas and unique facilities.</li> <li>• Implement the Integrated Asset Management system to improve property user validation and tracking.</li> </ul>



<b>IS-2: Demonstrate NASA leadership in the use of information technologies.</b>	
<p><b>Obj. IS-2.1</b> By 2005 provide all NASA operations with secure, highly reliable, interoperable information systems.</p>	<ul style="list-style-type: none"> <li>• Maintain leadership role as the Agency Competency Center for Information Technology Security, which includes: Agency-level ITS policy, ITS initiatives project management, and IT security advanced technology evaluations and demonstrations.</li> <li>• Deploy and operate IFMP IT systems to provide reliable, integrated administrative services.</li> <li>• Implement a managed, secure campuswide wireless network infrastructure.</li> <li>• Deploy general encrypted data storage capabilities for Ames users.</li> </ul>
<p><b>Obj. IS-2.2</b> By 2005 enable NASA people to communicate across an integrated, low-cost information technology infrastructure.</p>	<ul style="list-style-type: none"> <li>• Participate in the One NASA e-mail pilot demonstration, evaluating the application service provider model for service delivery of integrated e-mail, voice mail, calendaring, and file sharing.</li> <li>• Outsource desktop acquisition, support and management, improving our service delivery model and adding the capability of automated software distribution.</li> </ul>
<p><b>Obj. IS-2.3</b> By 2005 design and operate a One NASA network to improve organizational interactions and foster improved collaboration and sharing of accumulated NASA knowledge assets.</p>	<ul style="list-style-type: none"> <li>• Contribute IT security architecture design expertise and steering committee membership to the NASA Communications and Computing Center for the design and implementation of the One NASA wide area network service.</li> </ul>
<p><b>Obj. IS-2.4</b> By 2005 establish systems to deliver superior information services to consumers, educators, students, researchers, and the general public, as well as to Government agencies, NASA contractors and suppliers, and other businesses.</p>	<ul style="list-style-type: none"> <li>• Upgrade the legacy video infrastructure to support digital video to facilitate best possible presentation of Ames science and research video content.</li> <li>• Deliver new Ames external web site, consistent with the NASA portal concept, to provide better representation of Ames projects and research to the public.</li> </ul>

<b>IS-3: Enhance NASA's core engineering, management, and science capabilities and processes to ensure safety and mission success, increase performance and reduce cost.</b>	
<p><b>Obj. IS-3.1</b> Implement collaborative engineering capabilities and integrated design solutions to reduce the lifecycle cost and technical, cost, and schedule risk of major programs.</p>	<ul style="list-style-type: none"> <li>• Establish training programs that promote systems management tools and their effective implementation in cost estimating, earned value management, systems engineering, and program/project management.</li> <li>• Provide the Project Starter Kit, a resource for program/project managers to use as an initial set of tools, aides, information sources, and guides to support the successful execution of their programs and projects.</li> <li>• Deploy and provide training on cost estimating tools and scheduling tools for performing systems engineering, cost analysis, and project planning.</li> <li>• Provide cost estimating and earned value management consulting services.</li> </ul>



IS-3 continued	
	<ul style="list-style-type: none"> <li>• Provide training on Risk Based Acquisition Management practices.</li> <li>• Provide collaborative knowledge sharing forums.</li> </ul>
<p><b>Obj. IS-3.2</b> Apply methods and technologies to ensure that designs are safe and have a high likelihood for success.</p>	<ul style="list-style-type: none"> <li>• Provide systems analysis throughout the design process to identify and effectively control safety and mission risks according to the <i>Ames System Safety, Reliability, and Quality Management Manual</i>.</li> </ul>
<p><b>Obj. IS-3.3</b> Improve our systems engineering capability and ensure that all NASA programs follow systems engineering best practices throughout their life cycles.</p>	<ul style="list-style-type: none"> <li>• Provide independent assessment of program and project systems engineering practices and performance.</li> <li>• Deploy systems engineering tools and best practices across program and project community.</li> <li>• Capture and disseminate systems engineering lessons learned from past and current projects.</li> <li>• Support the NASA Systems Engineering Working Group and the Project Management Working Group.</li> <li>• Integrate systems engineering professional development activity with Ames program/project management development program.</li> <li>• Provide “best practices” systems engineering workshops and forums.</li> </ul>
<p><b>Obj. IS-3.4</b> Establish a process management approach that can be tailored to the needs of all projects and programs based on safety, scope, complexity, cost, and acceptable risk.</p>	<ul style="list-style-type: none"> <li>• Use the NPG 7120.5 compliance matrix and program/project planning document to provide consistent application of project management planning activities.</li> <li>• Provide the Ames Project Starter Kit to new programs and projects.</li> <li>• Provide sample plans for systems engineering, risk management, and program/project management.</li> <li>• Provide cost estimating and earned value management consulting services for programs and projects.</li> <li>• Provide monthly reviews of all major Ames projects by the Ames Project Management Council.</li> <li>• Encourage Project Management Working Group to identify and implement improvements to project management at Ames.</li> <li>• Use the <i>Ames System Safety, Reliability and Quality Management Manual</i> to define a tailorable approach to program/project risk assessment and risk management.</li> <li>• Use the Ames Environmental Management System to set priorities, objectives, and targets based on frequency and severity of impacts to safety and health, natural and cultural resources, cost, mission, reputation and stakeholder relationships, and legal and regulatory compliance.</li> </ul>
<p><b>Obj. IS-3.5</b> Use peer review to ensure that NASA's scientific research is of the highest quality.</p>	<ul style="list-style-type: none"> <li>• Continue research funding based on Research and Technology Objective and Plans (RTOP) submissions and proposals to NASA Research Announcements (NRA) which are approved based on peer review and passing scores.</li> <li>• Continue basing research metrics on grant approvals (RTOPS, NRAs) and on publications in peer reviewed journals.</li> </ul>



<p><b>IS-4: Ensure that all NASA work environments, on Earth and in space, are safe, healthy, environmentally sound, and secure.</b></p>	
<p><b>Obj. IS-4.1</b> Prevent injuries from occurring during the course of NASA activities on NASA facilities or in the use of NASA equipment.</p>	<ul style="list-style-type: none"> <li>• Provide occupational safety guidance and oversight of all Center activities, including equipment, system, and facility operations and maintenance, through the Ames VPP Star Program.</li> </ul>
<p><b>Obj. IS-4.2</b> Work closely with other Government agencies and local authorities to identify and try to remove all security threats to NASA people, facilities, and information.</p>	<ul style="list-style-type: none"> <li>• Participate in the FBI's Joint Terrorism Task Force and coordinate with the Department of Defense and other government intelligence organizations, to receive timely and relevant threat information.</li> <li>• Maintain a high level of training for Ames security/law enforcement officers.</li> <li>• Coordinate closely with the U.S. Marshal and the U.S. Attorney's Office to ensure adequate federal law enforcement first response capabilities as most of Ames is under federal exclusive legislative jurisdiction.</li> <li>• Work closely with the Santa Clara County Sheriff's Office to ensure adequate law enforcement response to incidents where they have jurisdiction.</li> <li>• Utilize training opportunities with local law enforcement in areas such as use of arrest authority and firearms.</li> <li>• Work closely with the NASA IG on investigations within the IG's jurisdiction.</li> <li>• Maintain training levels for the Ames Emergency Operations Center and coordinate with the CA Office of Emergency Services and local fire departments to provide first response to and/or recovery from a threat or other incident.</li> <li>• Coordinate with the Air National Guard 129th Rescue Wing to maintain the Ames Fire Department and mutual aid relationships with local fire departments to ensure first response capabilities.</li> <li>• Provide support to Ames Information Technology Security group.</li> <li>• Provide timely and efficient personnel security screening, background checks, clearances, etc.</li> <li>• Provide training to ensure information, especially classified information, is properly maintained.</li> <li>• Ensure compliance with export laws and regulations through Export Compliance Working Groups and other outreach and training.</li> </ul>
<p><b>Obj. IS-4.3</b> Protect NASA's physical assets from damage or theft.</p>	<ul style="list-style-type: none"> <li>• Coordinate with Ames organizations and HQ to maintain a list of mission essential facilities and equipment.</li> <li>• Maintain trained security force with arrest authority to patrol and guard Ames critical facilities.</li> <li>• Invest in up-to-date physical and technical security systems, such as alarm, camera, and card-key access systems.</li> <li>• Maintain perimeter security officers at exterior gates leading into all Ames property as well as the interior gates leading into the Ames campus.</li> </ul>



<b>IS-4 continued</b>	
<p><b>Obj. IS-4.4</b> Eliminate the incidence of occupational health problems for the NASA workforce.</p>	<ul style="list-style-type: none"> <li>• Maintain accreditation of the Ames healthcare program at the JCAHCO level, which has the highest healthcare standards.</li> <li>• Ergonomically assess employee work environments to improve any conditions that may negatively impact the health of the employees.</li> </ul>
<p><b>Obj. IS-4.5</b> Eliminate environmental incidents, toxic chemical use, hazardous waste, and environmental liability at all NASA sites.</p>	<ul style="list-style-type: none"> <li>• Comply with NPD 8500.1 and meet all California state and local environmental regulations.</li> <li>• Implement programs to reduce toxic chemical use, minimize hazardous waste, respond effectively to hazardous materials spills and releases, and clean up soil and groundwater contamination according to the <i>Ames Environmental Procedures and Guidelines</i>.</li> </ul>

<b>IS-5: Manage risk and cost to ensure success and provide the greatest value to the American public.</b>	
<p>Obj. IS-5.1 Provide tools, techniques, and expertise that will enable all elements of the Agency to make well-informed decisions on matters of critical Mission importance.</p>	<ul style="list-style-type: none"> <li>• Provide independent assessment of programs and projects and provide the results to decision makers.</li> <li>• Provide tools and training to programs and projects.</li> <li>• Consult with programs and projects to establish best practices.</li> <li>• Recommend tools for program and project management and systems engineering.</li> <li>• Continue to collect lessons learned from past and current projects.</li> <li>• Utilize the Academy of Program &amp; Project Leadership's Performance Enhancement Support Services to provide decision-making mentoring and coaching consulting services to Ames program and project managers.</li> <li>• Provide lessons learned forums on decision-making and cultural and organizational issues.</li> </ul>
<p>Obj. IS-5.2 Improve processes for cost estimation and the management of major NASA projects and programs.</p>	<ul style="list-style-type: none"> <li>• Provide cost estimating and earned value management consulting services for the programs and projects.</li> <li>• Participate in the Earned Value Management Focal Point Council to establish cost estimating standards and practices.</li> <li>• Promote the use of cost estimating software tools.</li> <li>• Provide training and expert assistance in cost analysis and estimating.</li> <li>• Provide comprehensive program/project management development and training programs, to include education, work experience learning; mentoring, and knowledge-sharing activities.</li> </ul>



# Appendix: For More Information—

## A

### **Aerospace Technology 2004 Strategic Plan**

<http://ifimp.nasa.gov/codeb/budget2004/17-Aeronautics.pdf>

### **Aerospace Technology Theme**

<http://www.aerospace.nasa.gov/themes/at.htm>

### **Advanced Air Transportation Technologies Project (AATT)**

<http://www.asc.nasa.gov/aatt/>

### **Airspace Systems Program**

<http://www.asc.nasa.gov/>

### **Ames Aerospace Encounter**

<http://encounter.arc.nasa.gov/>

### **Ames Bio-Visualization Imaging and Simulation (BioVIS) Technology Center**

[http://www.nasamedicalimaging.com/pdf/SPIE-02-2002/01SmithJD\\_SPIE02.pdf](http://www.nasamedicalimaging.com/pdf/SPIE-02-2002/01SmithJD_SPIE02.pdf)

### **Ames Commercial Technology Office**

<http://technology.arc.nasa.gov/homepage.html>

### **Ames Educator Resources/Workshops**

<http://education.arc.nasa.gov/pages/edresources.html>

### **Ames Office of Education**

<http://education.arc.nasa.gov/>

### **Ames Simulation Laboratories**

<http://www.simlabs.arc.nasa.gov/>

<http://www.simlabs.arc.nasa.gov/>

<http://www.ctas.arc.nasa.gov/>

### **Astrobiology and Space Research Directorate**

<http://space.arc.nasa.gov/>

### **Astrobiology Institute**

<http://nai.arc.nasa.gov/>

### **Astrobiology Magazine**

<http://astrobiology.arc.nasa.gov/>

### **Aura Atmospheric Chemistry**

<http://eos-aura.gsfc.nasa.gov/>

### **Aviation Safety Web Sites**

<http://www.hq.nasa.gov/office/hqlibrary/pathfinders/avsfty.htm>

## B

### **Biological Sciences Research Theme**

[http://ifimp.nasa.gov/codeb/budget2004/14-Biological\\_Sciences\\_Research.pdf](http://ifimp.nasa.gov/codeb/budget2004/14-Biological_Sciences_Research.pdf)

### **Biomolecular Sensor Development**

<http://nasa-nci.arc.nasa.gov/index.cfm?fuseaction=nasanci.NCIObject>

## C

### **Center for Nanotechnology**

<http://www.ipt.arc.nasa.gov/index.html>

### **Computing, Information, and Communications Technology (CICT) Program**

<http://www.cict.nasa.gov/>

[http://www.cict.nasa.gov/Public/assets/pdf/CICT\\_Brochure.pdf](http://www.cict.nasa.gov/Public/assets/pdf/CICT_Brochure.pdf)

### **Center for Mars Exploration (CMEX)**

<http://cmex/CMEX/index.html>

### **Center TRACON Automation System (CTAS)**

<http://www.ctas.arc.nasa.gov/>

### **Center for Gravitational Biology Research**

<http://lifesci.arc.nasa.gov/cgbr/cgbr.html>

### **Computational Sciences Division**

<http://ic.arc.nasa.gov/>

## E

### **Earth Science Mission Planning**

[http://amesnews.arc.nasa.gov/releases/2003/03\\_20AR.html](http://amesnews.arc.nasa.gov/releases/2003/03_20AR.html)

## G

### **GIS for NASA Facilities Management**

<http://www.esri.com/news/arcnews/spring02/articles/gisforNASA.html>

## H

### **Haughton-Mars Project**

<http://www.arctic-mars.org/team/2002/lee.html>

### **Human Factors Research and Technology Division**

<http://human-factors.arc.nasa.gov/>

### **Human Factors Research in Space Shuttle Cockpit Upgrade**

[http://human-factors.arc.nasa.gov/web/research/factsheets/pdfs/McCann\\_cockpit\\_displays.pdf](http://human-factors.arc.nasa.gov/web/research/factsheets/pdfs/McCann_cockpit_displays.pdf)

## I

### **Innovative Technology Transfer Partnerships Theme**

<http://www.aerospace.nasa.gov/themes/ittp.htm>

### **Information Sciences and Technology Directorate**

[http://infotech.arc.nasa.gov/index\\_flash.html](http://infotech.arc.nasa.gov/index_flash.html)





## K

### Kepler Mission

<http://www.kepler.arc.nasa.gov/>.

## L

### Life Sciences Division

<http://lifesci.arc.nasa.gov/>

## M

### Mars Exploration Program

<http://mars.jpl.nasa.gov/>

### Marsoweb

<http://marsoweb.nas.nasa.gov/landingsites/>

### Minority University Research and Education Program

<http://eo.arc.nasa.gov/murep/murep%20mission.htm>

### Mission and Science Measurement Technology Theme

<http://www.aerospace.nasa.gov/themes/msm.htm>

## N

### NASA Aerospace Education Services Program

<http://www.okstate.edu/aesp/AESP.html>

### NASA Advanced Supercomputing (NAS) Division

<http://www.nas.nasa.gov/>

### NASA Ames Research Center

<http://www.arc.nasa.gov/index.html>

### NASA Ames Research Center Mission Overview

<http://amesnews.arc.nasa.gov/factsheets/FS-020102-ARC.html>

### NASA Ames Wind Tunnels

<http://windtunnels.arc.nasa.gov/>

### NASA Central Operation of Resources for Educators (CORE)

<http://core.nasa.gov/>

### NASA Earth System Science Enterprise 2004 Plan

[http://ifimp.nasa.gov/codeb/budget2004/10-Earth\\_Science.pdf](http://ifimp.nasa.gov/codeb/budget2004/10-Earth_Science.pdf)

### NASA Educator Resource Centers

<http://spacelink.nasa.gov/ercn/>

### NASA Innovative Technology Transfer Partnerships Theme

<http://www.aerospace.nasa.gov>

### NASA Mission and Science Measurement Theme

<http://www.aero-space.nasa.gov/themes/msm.htm>

### NASA Office of Biological and Physical Research

[http://spaceresearch.nasa.gov/research\\_projects/themes.html](http://spaceresearch.nasa.gov/research_projects/themes.html)

### NASA Office of Space Flight

<http://www.hq.nasa.gov/osf/>

### NASA Research Park

<http://researchpark.arc.nasa.gov/>

### NASA Solar System Exploration Theme

<http://solarsystem.nasa.gov/index.cfm>

### NASA Wind Tunnels History

<http://www.hq.nasa.gov/office/pao/History/SP-440/contents.htm>

### NASA Workforce

<http://nasapeople.nasa.gov/workforce/default.htm>

## S

### Slender Hypervelocity Aerothermodynamic Research Probe

<http://www.montana.edu/wwwmsgc/Text/Sharp.html>

### Space Launch Initiative Theme

<http://www.aerospace.nasa.gov/themes/sli.htm>

### Space Launch Initiative News

<http://www.slinews.com/>

### Space Projects Division

[http://spaceprojects.arc.nasa.gov/Space\\_Projects/Index.html](http://spaceprojects.arc.nasa.gov/Space_Projects/Index.html)

### Space Science Themes

<http://spacescience.nasa.gov/admin/themes.htm>

### Space Shuttle Program

<http://spaceflight.nasa.gov/shuttle/index.html>

### Space Station Biological Research Program (SSBRP)

<http://brp.arc.nasa.gov/>

### SOFIA

<http://www.sofia.arc.nasa.gov/>

## T

### The President's Management Agenda

[http://www.fgipc.org/02\\_Federal\\_CIO\\_Council/Resource/48\\_Presidents\\_Management\\_Agenda.htm#sourcing](http://www.fgipc.org/02_Federal_CIO_Council/Resource/48_Presidents_Management_Agenda.htm#sourcing)

### Thermal Protection Materials and Systems Branch

<http://asm.arc.nasa.gov/asmlinks.shtml#references>

## V

### Virtual Airspace Modeling and Simulation Project (VAMS)

<http://www.asc.nasa.gov/vams/>

## X

### X-37 Reusable Launch Vehicle Test Bed

<http://std.msfc.nasa.gov/tech/x37.html>





**This picture from the NASA Hubble Space Telescope's Advanced Camera for Surveys dramatically demonstrates the reverberation of light through space caused by an unusual stellar outburst in January 2002. A burst of light from the bizarre star is spreading into space and reflecting off of surrounding shells of dust to reveal a spectacular, multicolored bull's eye.**

**The red star at the center of the eyeball-like feature is an unusual erupting supergiant called V838 Monocerotis, located about 20,000 light-years away in the winter constellation Monoceros (the Unicorn). During its outburst the star brightened to more than 600,000 times our Sun's luminosity. From May to December 2002, the circular feature expanded to slightly larger than the angular size of Jupiter on the sky. For several more years it will continue to expand as reflected light arrives from more distant portions of the nebula.**





## The NASA Vision

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

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To explore the universe and search for life,  
To inspire the next generation of explorers,  
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