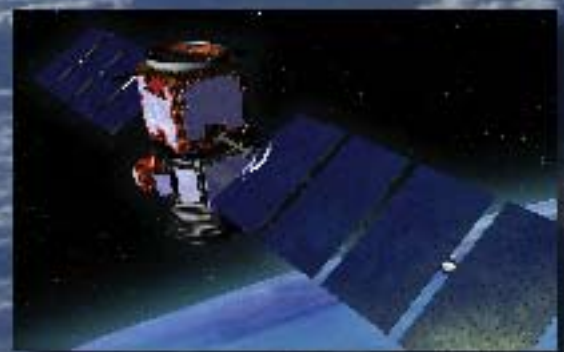
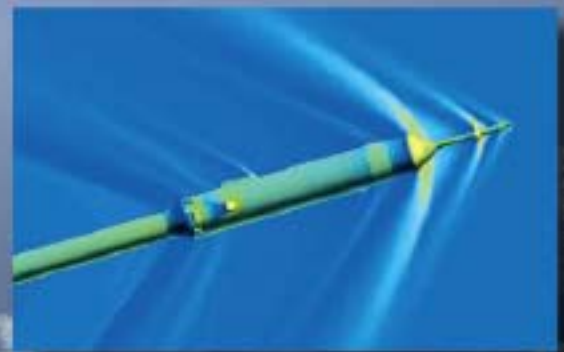


National Aeronautics and Space Administration



Langley Research Center

# MAKING SPACE FOR THE FUTURE





# CENTER DIRECTOR'S MESSAGE

---

**W**elcome to NASA Langley Research Center in Hampton, Virginia.



I hope you'll enjoy getting acquainted in the following pages as we highlight our accomplishments as one of NASA's 10 field centers. We've had an exciting time helping further the exploration of space, making new scientific discoveries about our home planet, and conducting breakthrough research in aeronautics to make air travel safer and better for us all.

What has made the past year so exciting at Langley?

We have become an important part of the nation's quest to explore the solar system – NASA's Vision for Space Exploration to the moon, Mars, and beyond. Langley is helping to develop a space shuttle replacement system, which includes two launch vehicles and the crew capsule known as Orion. As part of this effort, we are evaluating designs for a launch-abort system that will provide crew escape if the vehicle malfunctions during liftoff. We're also helping with designs of Orion's heat shield and landing system – and so much more as you'll find in the Exploration section of this update.

In aeronautics, Langley is hard at work contributing to NASA initiatives to make air travel safer, quieter, and more efficient through a program that includes work in fundamental aeronautics, aviation safety and airspace systems. An example of this is the research being done toward next-generation aircraft – such as the blended wing body, a significantly more fuel efficient and environmentally friendly design than current airplanes. Langley also continues to advance developments in supersonic

and hypersonic flight. Read the Aeronautics section for a more comprehensive review of this effort.

In science, NASA Langley has partnered with researchers around the world to study Earth from space so we may advance understanding of our home planet. Our newest mission was launched in April 2006: the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO). This mission will help us learn more about clouds and airborne particles called aerosols so that scientists may understand how they affect our air quality, weather, and climate. We're also studying the atmospheres on other planets in the solar system – such as Mars – so that we can safely explore those planets.

As a key part of our research and development efforts, Langley has formed strategic relationships with organizations throughout the private and public sectors. These partnerships and collaborations not only help us achieve challenging missions, they also enable the commercialization and availability – to you – of NASA technologies and services. This collaboration also contributes to the economy of the region and the nation, a subject touched on in the Economic Impact section of this document.

Letting you know about our work here at Langley is part of our mission. This update illustrates how your tax dollars are being put to use for the benefit of all.

**Lesla B. Roe**  
Director  
NASA Langley Research Center

# CONTENTS

---

1



## Exploration

Page 4-5

Langley assumes critical roles in the space shuttle return to flight, development of NASA's Constellation Program, and the Orion crew capsule

2

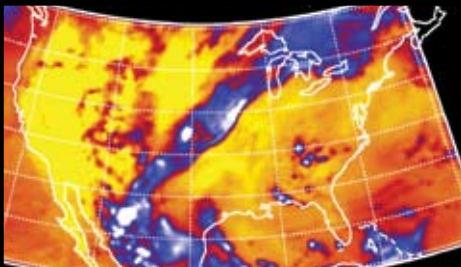


## Aeronautics

Page 6-7

The Center supports NASA research in aviation safety, fundamental aeronautics and future airspace systems, including development of next-generation aircraft

3



## Science

Page 8-9

Planetary-airplane research, atmospheric-sciences studies and development of Earth-sensing satellites mark several of Langley's primary accomplishments

4



## Systems Analysis

Page 10-11

Langley's systems analysis experts support aeronautics, space exploration, science, and space operations by providing critical insight for informed decision-making

# CONTENTS

---

5



## **Partnerships**

**Page 12-13**

Langley's innovative partnerships and collaborations with the nation's public and private sectors promote widespread commercialization and availability of NASA technologies

6



## **People of Langley**

**Page 14-15**

A statistical snapshot of Langley's most important resource: engineers, scientists, researchers, technicians, analysts, and administrative staff

7



## **Economic Report**

**Page 18-20**

With a 2006 budget of \$747 million, Langley is a major contributor to the local, state, and national economies with an output that exceeds \$2 billion annually

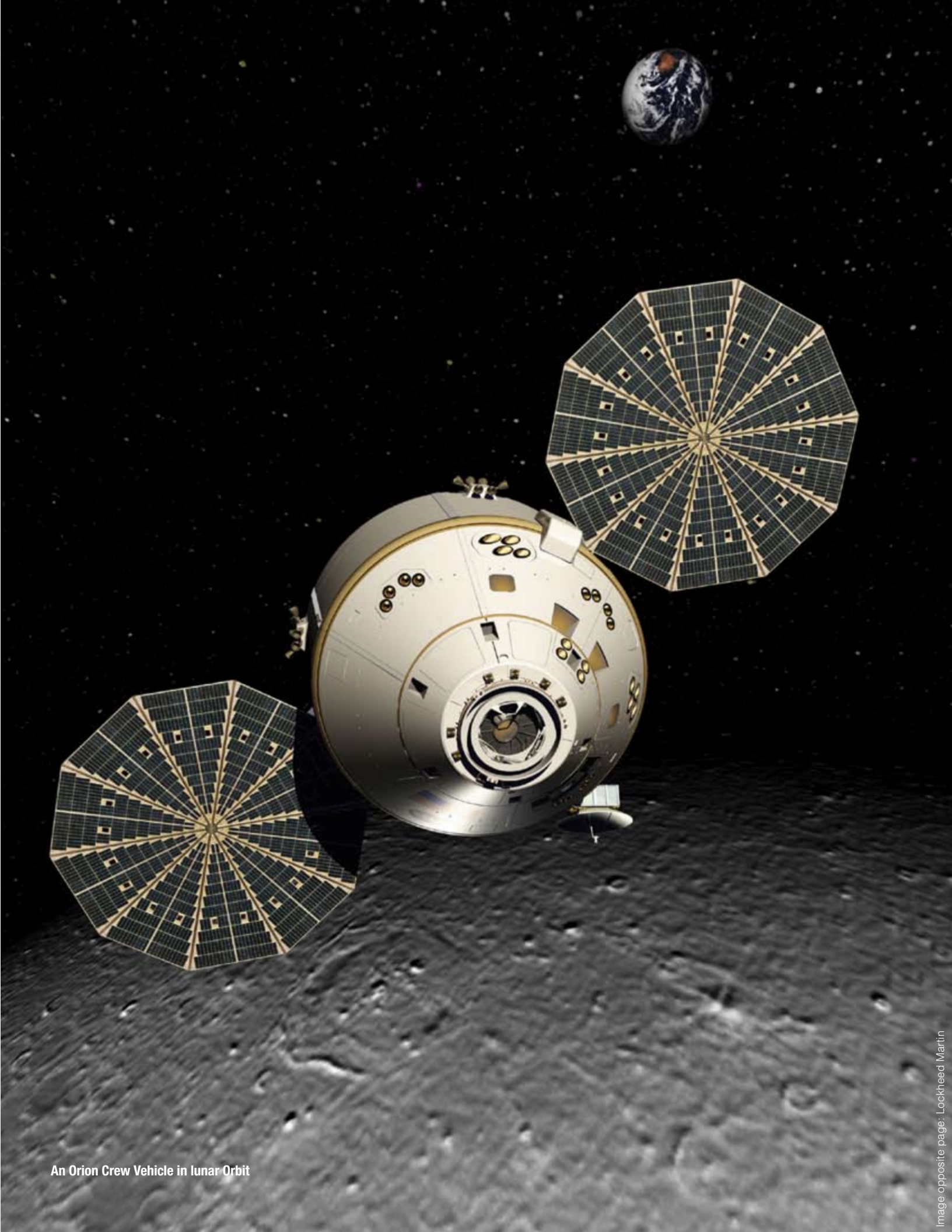
8



## **Education & Outreach**

**Page 22-23**

Langley's comprehensive program to inform, educate, and inspire many audiences, from students and teachers to the general public — while preparing for a 400th birthday party



An Orion Crew Vehicle in lunar Orbit

# EXPLORATION



**H**umankind is reaching beyond the planet of its birth to the moon, Mars, and the outer reaches of the solar system – perhaps even to other star systems. NASA is leading the way in making the Vision for Space Exploration attainable.

After the International Space Station is completed and the space shuttle retired in 2010, the Vision calls for the advancement of American scientific, security, and economic interests through a robust space-exploration program that will have humans return to the moon by 2020 and explore Mars sometime thereafter. Explorers won't have to travel such far distances alone, though: specialized robots will help, as will advanced computer systems and next-generation technologies.

Sending humans to distant worlds requires a new generation of rockets and passenger spacecraft. NASA's Constellation Program is already developing the next generation of such craft. The Ares I and Ares V launch vehicles will provide the thrust, while the Orion crew capsule will be a home in space for astronauts.

## Returning the Shuttle to Flight

In 2006, the return-to-flight team at Langley continued to support the space shuttle program, providing critical tools, analysis, and expertise to minimize foam loss from the external tank and provide real-time assessments of the spacecraft's thermal protection systems. Langley contributions to return to flight include an impact-detection system for the leading edge of the shuttle's wings, methods to repair them in the event of life-threatening damage, and a new infrared camera for astronauts to use during space walks.

## Making Exploration a Reality

A Langley team is playing a significant role in the Orion crew module, evaluating conceptual designs in the Center's wind tunnels at speeds in excess of 5,000 mph. Langley is also overseeing the development of

Orion's launch-abort system to provide crew escape should a malfunction occur.

In collaboration with NASA Ames Research Center in California, Langley is developing the Orion heat shield. The shield will be attached to the cone-shaped Orion to protect astronauts from temperatures that could exceed 4,800 degrees. Langley is also leading the development of options for Orion's landing system, and applying design and fabrication expertise to Orion pad-abort and ascent-and-abort flight tests.

In addition, Langley is providing critical expertise to the Constellation system integration groups, including teams of engineering experts who are defining program requirements and integrating the systems necessary to make this next generation of space-exploration vehicles a reality.

- Shuttle return to flight
- Ares I test flight upper-stage studies
- Orion launch-abort system
- Constellation system integration

## Getting Ares off the Ground

Langley leads development of the Ares launch system prototype for its first flight test in April 2009, managing the integration of all flight hardware elements and delivering the integrated test vehicle to NASA Kennedy Space Center in Florida. The Langley team is conducting wind tunnel assessments and analyses to define the aerodynamics of the Ares I vehicle and to evaluate potential designs.

The Center will conduct structural and thermal analyses in the development of the Ares I upper stage, and will continue studies to determine alternative approaches for several components. Langley is also assisting NASA Marshall Space Flight Center in Alabama with Ares I upper-stage structural and thermal studies, including tests to verify engineering models.



# AERONAUTICS

**F**ly faster. Fly farther. Fly safer – and not just on Earth. At NASA, aeronautics research and space exploration are inextricably linked; one day, “planetary” aircraft could fly the skies of Mars, Venus, Jupiter, and other worlds.

Future aircraft may operate at thousands of miles per hour. They will be made to withstand extreme heating yet boast quiet, energy-efficient engines that don’t pollute and can operate at altitudes much higher than today’s aircraft.

- Aviation Safety
- Fundamental aeronautics
- Airspace systems
- Testing and analysis

## NASA’s New Aeronautics

NASA is focusing its aeronautics research on three primary areas: aviation safety, fundamental aeronautics and future airspace systems.

The Center is playing key roles in NASA’s fundamental research in materials and structures,

aerodynamics, hypersonic and supersonic flight, fixed-wing and rotary-wing subsonic flight, aviation safety, and transformational air-traffic-management technology.

Together, these activities leverage NASA’s aeronautics core competencies and address the fundamental research needs of the Next Generation Air Transportation System (NGATS) for the Joint Planning and Development Office (JPDO).

## Next-Generation Innovations

The Center is working with Boeing and the Air Force to explore low-speed stability and control characteristics of a next-generation aircraft concepts such as the blended wing body, or BWB. A BWB would be significantly more fuel efficient and environmentally friendly than today’s jets. A 21-foot model of the BWB, designated the X-48B, was tested in Langley’s 30x60-Foot Tunnel in April and May 2006. The X-48B will be flight tested at

NASA Dryden Flight Research Center in California in 2007.

In 2006, at Langley’s 8-Foot High Temperature Tunnel, the Center teamed with Pratt & Whitney Rocketdyne and the Air Force to conduct the first testing of a closed-loop, fuel-cooled, variable geometry hypersonic engine at speeds of Mach 5 (roughly 3,200 mph).

In 2006, the Airborne Subscale Transport Aircraft Research Testbed was developed and flown in support of NASA’s Aviation Safety Program. This remotely piloted, dynamically scaled aircraft enables flight validation for high-risk, upset-flight maneuvers in response to damage or environmental hazards, while providing a means of assessing the reliability of flight-control software to withstand and adapt to dangerous flight conditions.

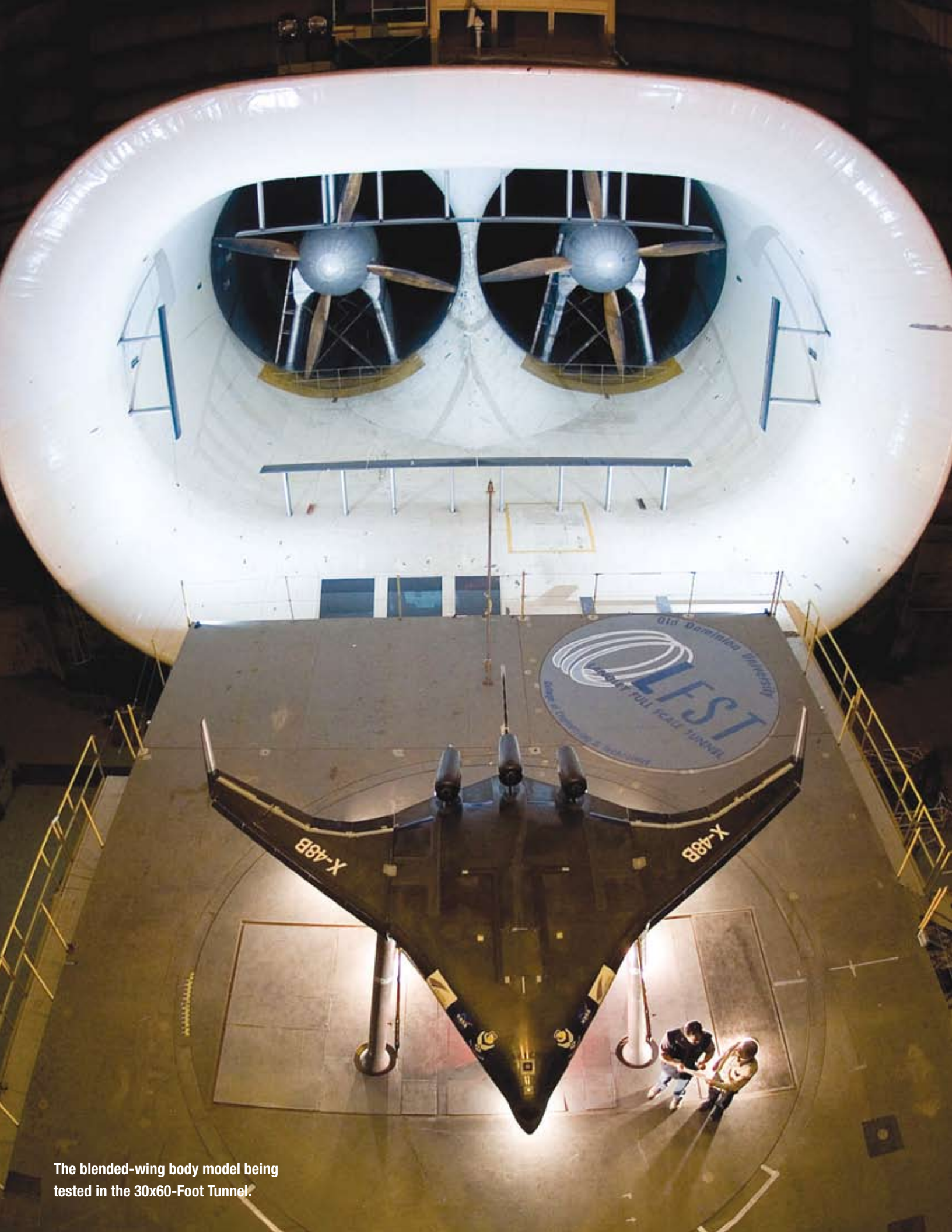
To test advanced concepts and methods for airborne self-separation and spacing to address distributed-architecture research questions posed by the JPDO, Langley conducted air-traffic-management research in its Air Traffic Operations Lab in partnership with NASA Ames Research Center in California, Boeing, MITRE Corp. and United Parcel Service.

## Decoding Turbulence

Researchers are also preparing for a flight test from NASA Wallops Flight Facility in Virginia to study a challenge faced during the Shuttle’s return-to-flight in 2005. Researchers want to better understand boundary-layer transition: the point where air flow over an aerodynamic surface changes from laminar (smooth) to turbulent.

For those studies, a rocket launched from Wallops will fly at Mach 7, or more than 5,300 miles per hour. On board instruments will record data on the boundary-layer transition. Langley will provide programmatic and engineering support to perform the test and analyze the data.

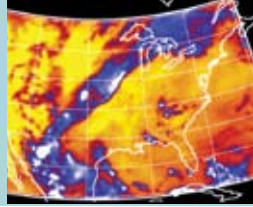




The blended-wing body model being tested in the 30x60-Foot Tunnel.



An artist's depiction of the CALIPSO satellite launched in April 2006.



**T**alk about the weather and you're guaranteed a conversation. Do something about the weather and you'll probably win a Nobel Prize.

At Langley, we seek to understand the measure of weather averaged over time: otherwise known as climate. We're partnering with colleagues around the world to study Earth from space to better understand how the climate system responds to natural and human-induced changes. And we're working to improve our predictions of the interactions of land, air, and water.

The Center has a rich heritage of scientific research that can be traced to the beginnings of Langley's remote-sensing studies in the 1950s and 60s. In the past two decades, we've amassed a huge amount of data gathered from Earth-observing satellites and are applying it to learn more about our home planet. We're also leading several projects that will generate new data from airborne and space-based measurement techniques to support a variety of atmospheric science and applied science research.

### Missions to Earth and Beyond

Langley's newest satellite mission – Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations, or CALIPSO – thundered skyward atop a Boeing Delta II rocket in April 2006. CALIPSO will enable scientists to study how clouds and aerosols form, evolve, interact, and affect Earth's air quality, weather, and climate. In June, CALIPSO collected its first data using lidar, an innovative laser-based, remote-sensing technique. Data segments are streamed together to paint a picture of what a vertical slice of our atmosphere looks like. CALIPSO is a collaboration between NASA and France's Centre National d'Etudes Spatiales.

We have also had the opportunity to contribute to a number of planetary science research projects. Our latest such proposal is known as ARES, or

the Aerial Regional-scale Environmental Survey of Mars. If selected, ARES would fly a science payload on the first aircraft to soar over another planet. Our researchers are actively involved in other Mars-related proposals, including an instrument called Martian Atmosphere and Dust in the Optical and Radio (MATADOR) and several entry, descent, and landing activities.

### Sifting Climate Clues

This year, NASA's Clouds and the Earth's Radiant Energy System, or CERES, continued to break new ground in data accuracy essential to climate research. The CERES team has developed new ways to integrate multiple instruments on multiple satellites to uncover key relationships in the climate system. CERES currently collects measurements from four instruments, playing a leading international role in studying global climate change from space.

In February 2006, our researchers were integrally involved in writing and releasing the Assessment of Stratospheric Aerosol Properties report, the most thorough assessment of how small particles interact in our upper atmosphere and affect Earth's climate system.

In March, Langley scientists participated in the first phase of one of the most complex field campaigns ever undertaken in the study of Earth's atmospheric chemistry. The Intercontinental Chemical Transport Experiment investigated air-pollution flows from Mexico City and Asia, bringing together data from research satellites, aircraft, and ground-based instruments to track the pollution plumes and their potential effects on climate and human health.

- Climate impacts of aerosols and clouds
- A potential aircraft survey of Mars
- Clouds and the Earth's Radiant Energy System
- Tracking air-pollution flows



# SYSTEMS ANALYSIS

**B**old ventures require bold preparation. The more complicated a project or program, the greater the need to explore multiple options in order to achieve the desired mission objective.

At Langley, our systems engineers and analysts are helping NASA prepare to return to the moon, explore Mars and conduct missions throughout the solar system. Our experts in systems analysis support

aeronautics, space exploration, science, and space operations, in providing critical insight for informed decision-making to achieve mission objectives.

What are the possible approaches to meet certain mission goals and objectives? What systems and technologies are required to enable these approaches and what are

the associated costs and risks? How much should we spend on developing new systems and technologies? Questions like these go to the heart of Langley's systems-analysis process.

## Exploring Moon, Mars, and Beyond

Langley's systems analysts helped to define NASA's Vision for Space Exploration. We also made significant contributions to the Administrator's 60-Day Exploration Systems Architecture Study, leading the technology assessment and prioritization that defined such systems as the Crew Exploration Vehicle — Orion — and the crew and cargo launch vehicles, Ares I and V.

We are currently playing a leadership role in NASA's Lunar Architecture Study to define lunar-surface access approaches, associated systems, and the ex-

ploratory science that will be done on the moon. We fully anticipate our involvement in similar activities for exploration of Mars and beyond.

Our engineers have also participated in and provided analytical assessment for a congressionally mandated study to detect, characterize, and document near-Earth objects like asteroids and meteorites that could pose a global threat.

## Planning for 21st Century Air Travel

Langley helped commercial aviation become a reality. In this new millennium, we're helping the nation prepare for a dramatic expansion of jet travel. By 2020, air traffic may grow to three times the level of the year 2000.

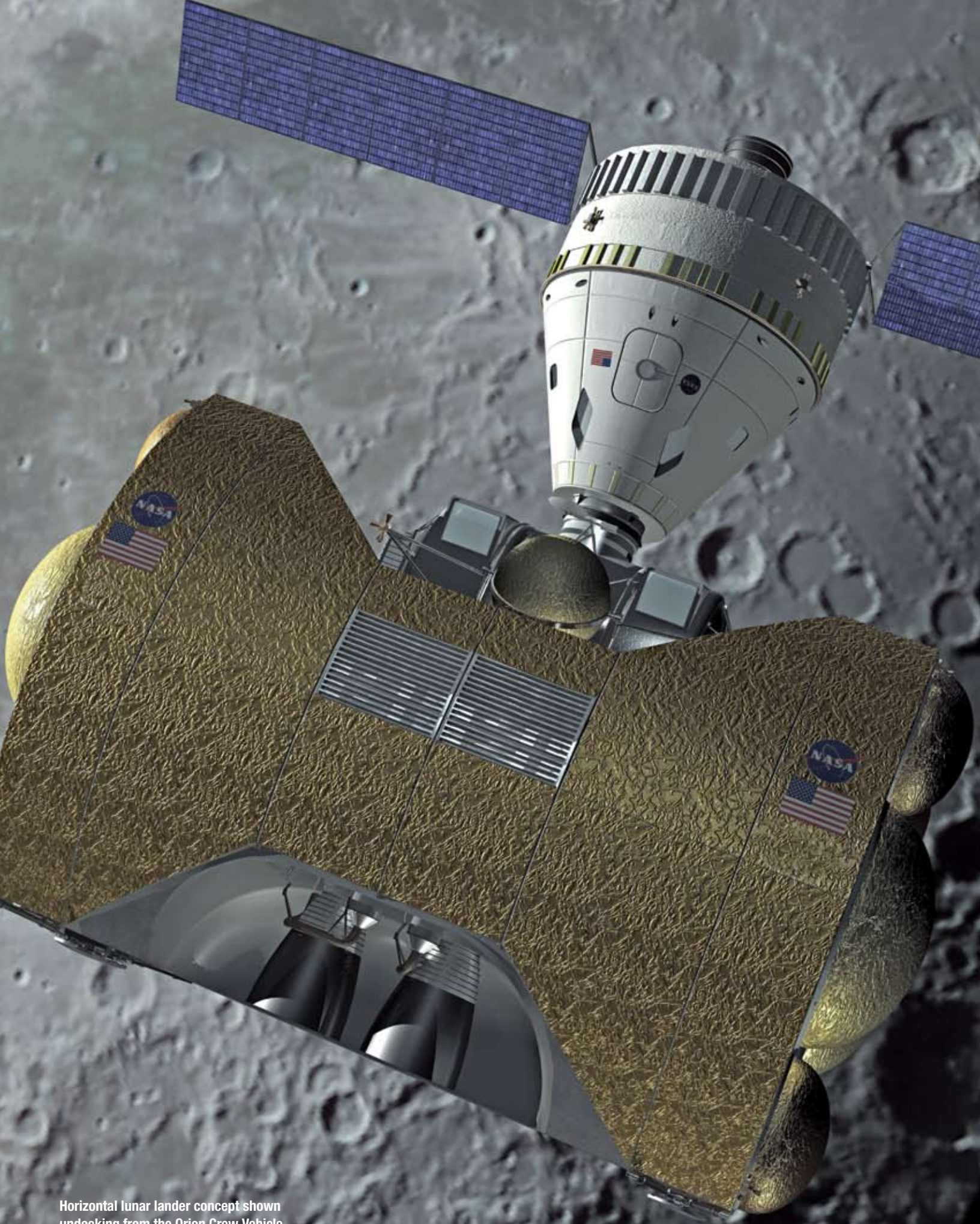
More people, more aircraft, more flights: that's a snapshot description of what we're modeling for other government agencies like the Federal Aviation Administration.

One of our major accomplishments in 2006 was an assessment of the impact of very light jets on the nation's airspace. These aircraft are expected to greatly increase in numbers with flights from medium and small airports not otherwise served by commercial airlines. We also conducted an airspace transportation system vulnerability study under our Aviation Safety Program.

## Our Ultimate Customer

Our ultimate customer is the American citizen. By providing reliable analytical information in advance of complex, multiyear programs and projects, we help decision makers appropriately invest taxpayer money. And we also help our colleagues develop and design robust aircraft, spacecraft, and the advanced technologies necessary for safest possible air travel and the continued exploration of space.

- Space exploration architectures
- Lunar-surface approaches
- Study of the airspace transportation system
- Impact of very light jets on the airspace



Horizontal lunar lander concept shown undocking from the Orion Crew Vehicle.



Our strategic partners participate in studies at Langley's Transonic Dynamics Tunnel.



A National Institute of Aerospace student working in the Morpheus Lab.



Langley licenses a low temperature oxidation catalyst.



NASA technology used in a NASCAR Air Purifying System.

# PARTNERSHIPS



**F**ostering new invention. Transferring innovation from the laboratory to the marketplace. Advancing the nation's competitiveness. Improving the day-to-day lives of American citizens. Educating current and future workforce.

The Vision for Space Exploration reiterates the direction provided in the National Aeronautics and Space Act of 1958 to promote innovative partnerships and commercial collaborations to help accomplish NASA's challenging mission. NASA will continue to utilize and expand the use of partnerships to make available a wider variety of technologies and expertise than is available within the agency.

These partnerships also make NASA-developed technologies and services available for commercialization to stimulate economic development that can further benefit NASA and the public.

## Technology Transfer

Two of the tools used by NASA for promoting private sector participation are the Small Business Innovation Research and Small Business Technology Transfer programs. These initiatives accelerate the involvement of small, high-tech companies by providing funding for research and development.

The creation and transfer of innovation is a key goal of technology transfer at Langley. In the past nine years, the Center has averaged more than 150 inventions per year, resulting in 22 U.S. patents and 12 foreign patents annually. These inventions span a broad spectrum of aerospace technologies, including sensor and instrumentation, materials, aircraft innovations, and software.

Langley has led NASA by averaging eight commercialization licenses per year that return approximately \$550,000 in royalties. These licenses have led to products that NASA has utilized on critical space, exploration and aeronautical programs.

## Strategic Partnerships

Langley implements the Agency's strategy through strategic relationships. These relationships extend the scope and application of Langley's competen-

cies in ways that enhance agility and adaptability of the contributions to the agency mission. In certain cases, these relationships leverage cost sharing and other resources. Strategic relationships include partners, suppliers, and customers.

Langley has established relationships with the National Institute for Aerospace (NIA), and the Research Operations, Maintenance, and Engineering (ROME) master contract. Langley maintains relationships with other government agencies and departments as well, including Army Research Labs, the Air Force Research Laboratory, the Naval Air Systems Command, and the Department of Energy's Sandia National Laboratories. Langley seeks a balanced amount of work for its customers in support of the nation's technological competitiveness.

- 1243 patents to date
- Novel technologies
- Applied problem-solving
- Workforce educators

## Work with Others

During 2006, Langley scientists and engineers completed more than 100 projects working with, partners in other government agencies and industry. The projects spanned NASA's mission areas of space exploration, the emerging commercial space sector, space operations, science, and aeronautics applications for the civil defense and security sectors.

Langley has partnered with the Defense Advanced Research Projects Agency and the Air Force, for example, to investigate novel high temperature materials and hypersonic configurations for the Force Application and Launch from Continental United States (FALCON) program. And when NASA Kennedy Space Center and Boeing experienced anomalies in nozzle-gimbal controls on the rocket motors of the Delta II Heavy Launch Vehicle, Langley partnered with Boeing to apply Center expertise in computational methods, flight dynamics, controls, and experimental testing in Langley's internationally acclaimed National Transonic Facility.



# THE PEOPLE OF LANGLEY

People are NASA Langley Research Center's most important resource. The collective contributions from Langley engineers, scientists, researchers, technicians, analysts, and administrative support staff are all essential to achieving mission success.

Although the majority of Langley's current workforce is permanent, the Center is beginning to emphasize the use of term and temporary appointments to increase staffing flexibility. These time-limited appointments are well-suited to projects of a fixed duration, enabling Langley to adjust skills to meet changing mission requirements.

With an active role in NASA's Vision for Space Exploration and continuing efforts in aeronautics, systems engineering, Earth science research, and systems analysis, the future of Langley employment is promising.

- Term and temporary appointments
- 72% are college educated
- More than 40% hold master or doctoral degrees
- The average length of service is 20 years

## By the Numbers

NASA is recognized as a world-class science and engineering agency within the federal government. For its part, Langley is proud to employ highly technical, highly educated personnel, with 57 percent of the Center's civil service employees engaged in engineering, research, and scientific fields. Currently, 72 percent of the Langley's workforce has at least a bachelor degree and almost 20 percent hold a doctoral degree.

While there are four broad categories of occupations at the Center, they encompass a variety of positions and areas of expertise. For example, professional science and en-

gineering positions include aerospace engineers, computer engineers, electronics engineers, physical scientists, physicists, and mathematicians.

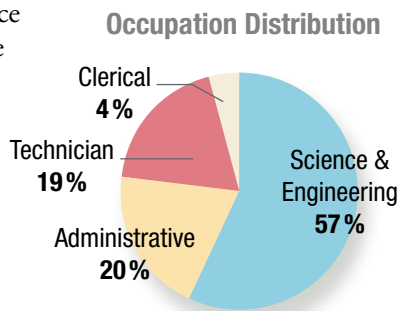
Professional administrative fields include human resources, finance, procurement, information technology, and legal. Engineering technicians and electronics technicians account for the majority of technician positions, although Langley also has a number of quality-assurance specialists and equipment specialists. Clerical positions include secretaries and assistants.

## Dedication and Motivation

Striving to hire "the best of the best" continued at Langley in 2006, when 48 percent of new hires held bachelor degrees and 44 percent held master or doctoral degrees. The Center recruits from an array of public- and private-sector entities, including colleges and universities, the National Institute for Aerospace, industry, business, and Langley's cooperative-education program.

Langley's civil service workforce has an average of 20.4 years of federal service: the second highest within NASA. Personal dedication to NASA's mission and love of the work being performed appear to be key reasons for the continued service.

In the recent Office of Personnel Management Federal Human Capital Survey, 81.5 percent of Langley employees "strongly agreed" or "agreed" that they liked the kind of work they were performing, and 72.6 percent "strongly agreed" or "agreed" that their work gave them a feeling of personal accomplishment. Maintaining this high-caliber, motivated workforce is essential for Langley as it plays an active role in NASA's exploration, aeronautics, and science research and development.



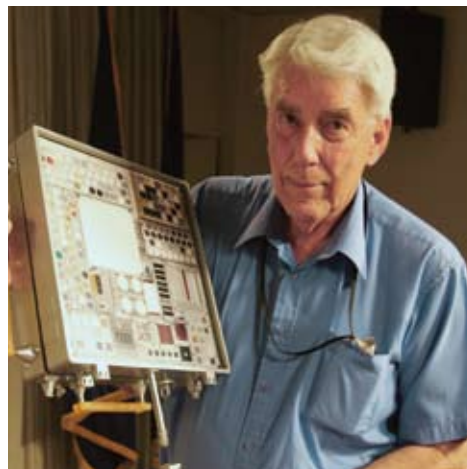




Karen Taminger analyzes an aluminum fractured surface using an electronic scanning microscope.



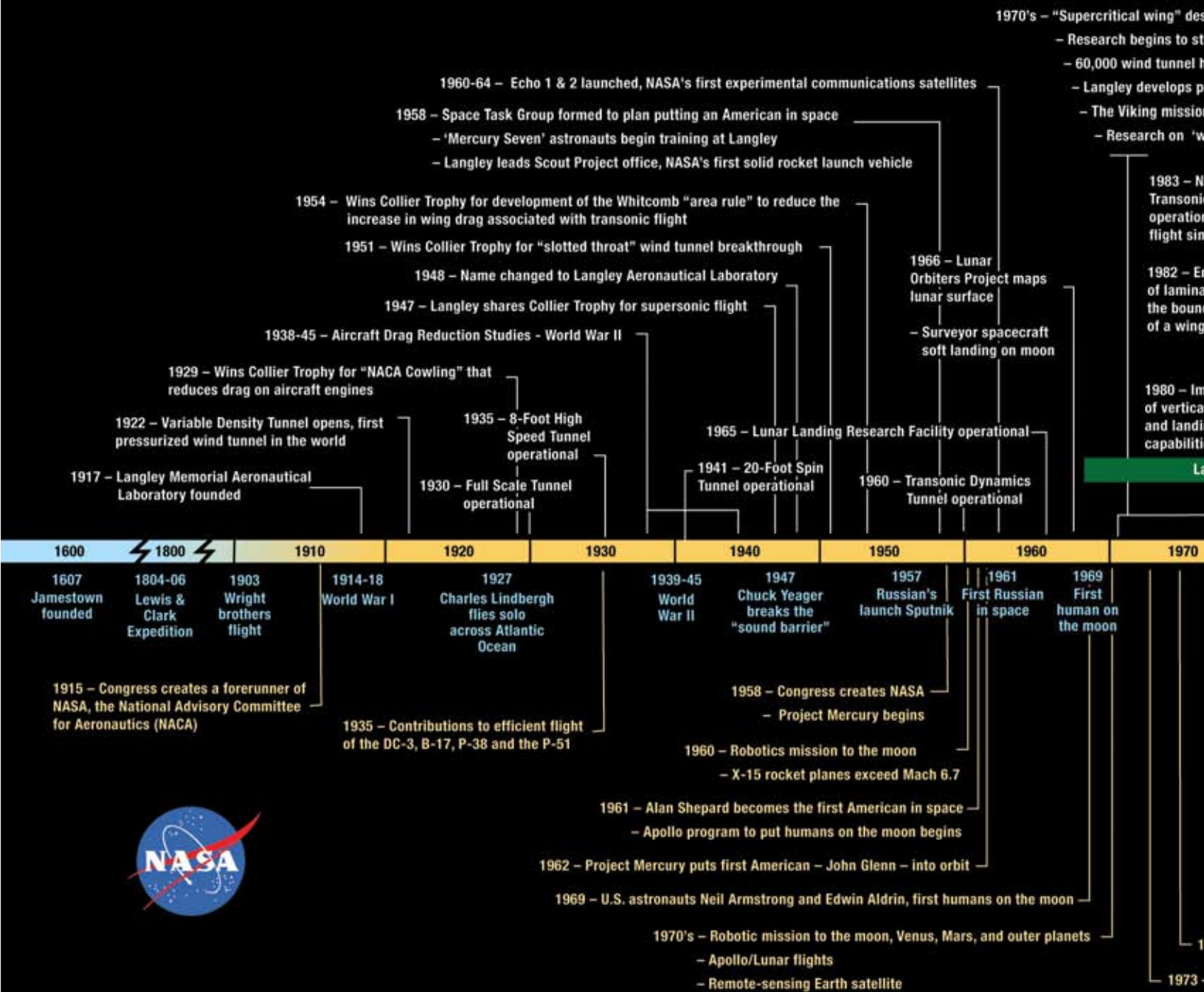
Jeffrey Hinkley, left, and Matthew Boyd work on an experiment involving active materials.



William Kinard with a model of the MISSE experiment that flew on the space shuttle.



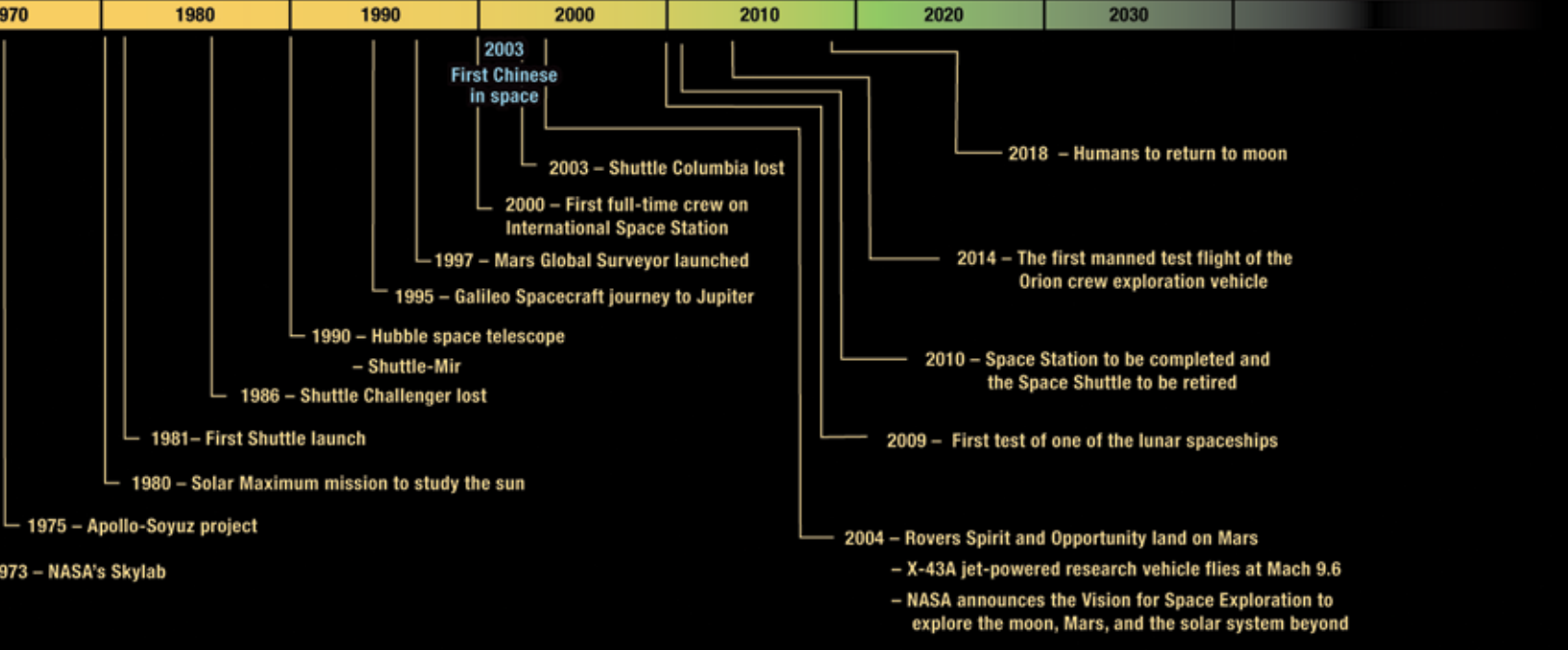
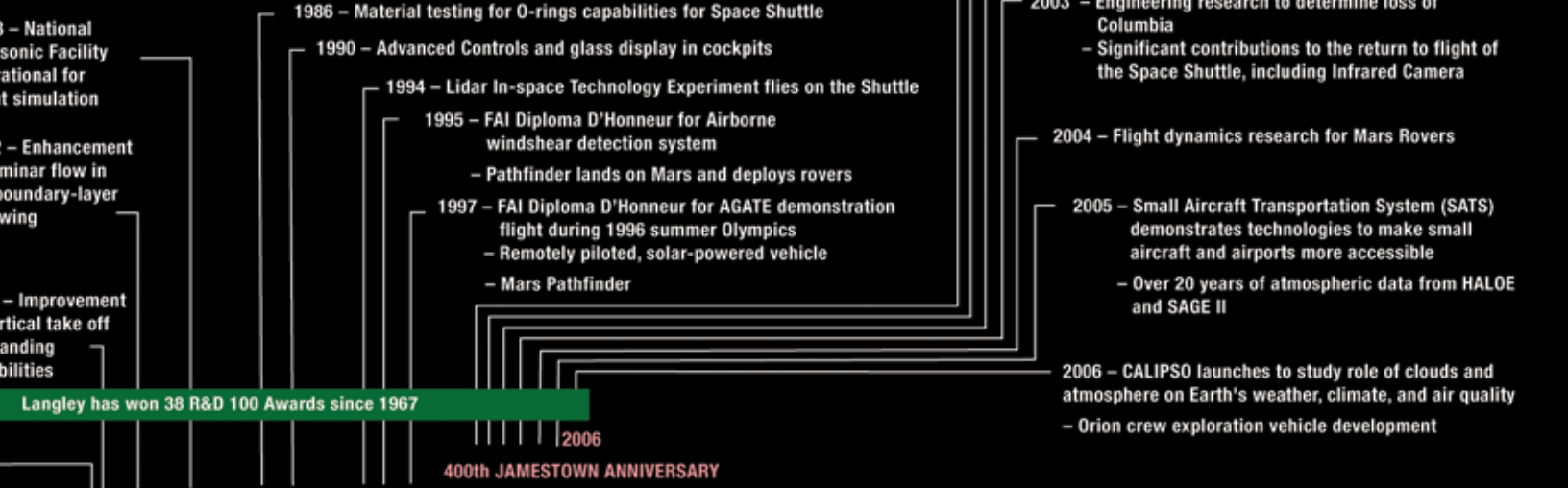
# LANGLEY RESEARCH CENTER: A CENTURY OF INNOVATION





# TURY OF LEADERSHIP IN AEROSPACE

" design developed at Langley to improve speed and fuel economy  
 to study Earth's oceans and continents from space  
 nel hours used to study aerodynamic characteristics of Space Shuttle  
 ps process for Space Shuttle thermal protection system tiles  
 sion to Mars lands twin spacecraft on the Red Planet two months apart  
 n 'winglets' conducted in 8-foot tunnel





# ECONOMIC REPORT

Since our founding in 1917, Langley has continued to pioneer new frontiers in aeronautics and space research. The Center's contributions to aerosciences, atmospheric sciences, and technology commercialization are improving the way the world lives.

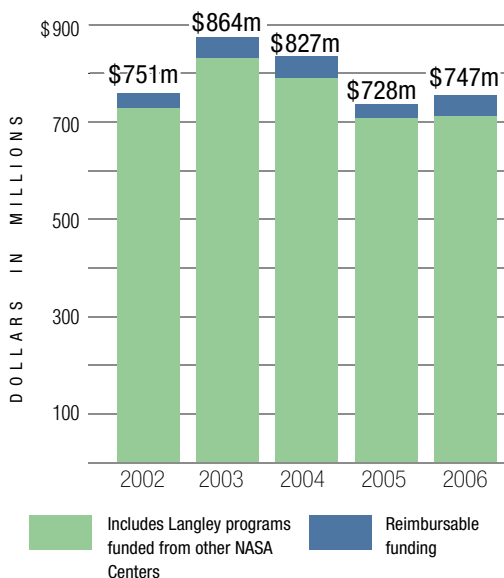
The Center contributes significantly to the local, state, and national economies. Langley's budget in fiscal year 2006 was \$747 million, which reflects an increase from the 2005 fiscal year of \$728 million. In addition, the Center had 198 active reimbursable agreements for work funded by others in fiscal year 2006, accounting for an added \$48 million – an increase of 41 percent over the previous year's level.

- Average budget \$780 million/year
- Diversified portfolio
- Impact on Hampton Roads, Virginia and nation

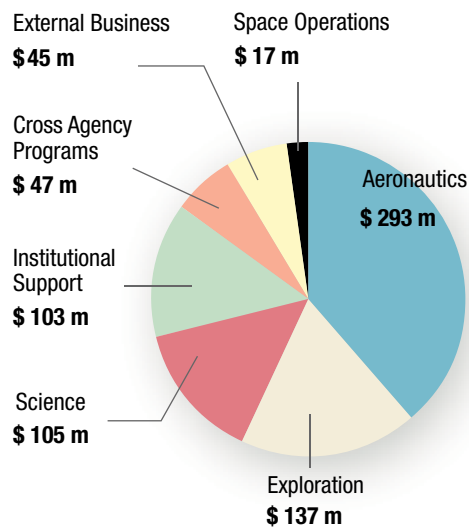
To fulfill our responsibilities and achieve our goals, the Center requires a wide range of commodities and expertise that include engineering services, wind tunnel support and maintenance, laboratory testing, computer equipment, and the like. Langley utilizes innovative and efficient procurement mechanisms to fulfill this ongoing need for services and goods.

As Langley acquires goods and services to perform the NASA mission, the direct, indirect, and induced impacts of expenditures affect the economic health and development of the local, state, and national economies. The dollars spent by Langley enhance business development, create jobs, and increase the tax base.

Langley Funding Level



FY 2006 Research & Development Funding



# ECONOMIC REPORT



## Economic Impact

In fiscal year 2006, NASA Langley and its related organizations generated a total economic output for the nation of approximately \$2,265 million, and created 20,649 full time equivalent (FTE) jobs for research professionals, scientists, engineers, and support services.

The direct economic benefits flow from three primary sources that together create the majority of the direct economic output. Three sources are direct procurements and expenditures, contractor services, and visitors to Langley.

Direct procurement expenditures at Langley's Hampton location for labor, operating equipment, supplies, and construction by the Center and related organizations totaled \$722.0 million in FY 2006. Spending by Langley visitors added another \$5.4 million, yielding total direct expenditures in the Hampton Roads region of \$727.5 million. Indirect expenditures added \$378 million, and induced expenditures totaled \$1,160 million.

Taken as a whole, Langley facilities represent an investment in land, buildings and scientific equipment amounting to \$2.6 billion that include 788 acres. As Langley prepares for new missions and programs, increasing infrastructure investment, even greater regional economic benefits are likely to ensue.

With a 2006 budget of \$747 million, NASA Langley creates a total economic output for the nation worth \$2.3 billion and 20,649 jobs.

## Non-Monetary Benefits

Langley supports the welfare of the region, the Commonwealth of Virginia and the nation in other ways that are not easily monetized, enriching quality of life and the well-being of the community at large.

NASA Langley scientists and engineers have conceived of and helped to put into practice many new scientific breakthroughs. Not only has the direct expenditure on this work benefited the region and nation, it also has spawned numerous commercial activities, many in Virginia. In Fiscal year 2006, Langley personnel developed ideas that led to 109 invention disclosures, 25 patents applications, and 16 patents issued.

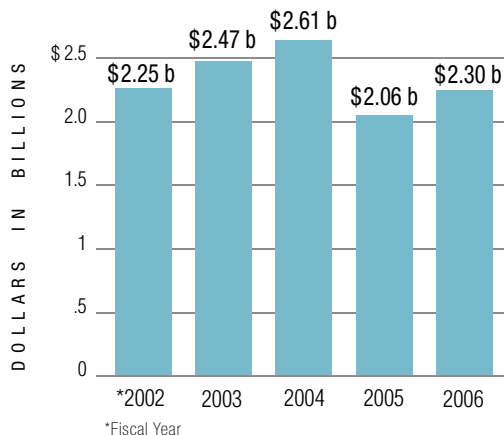
Langley's employees routinely volunteer their time and knowledge. In FY 2006, Langley reached out to the general public through its speakers bureau, presenting 24,341 individual talks, lectures, or speeches to civic organizations, public and private schools, area colleges and universities, chambers of commerce, and numerous other non-profit organizations.

NASA Langley personnel also bring science and engineering topics alive in K-12 and university classrooms, enriching the educational experience for a wide array of students.

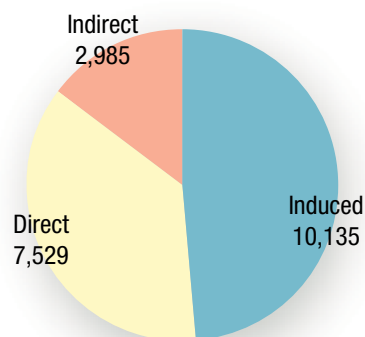
By any standard, NASA Langley is an economic engine that enormously benefits the citizens of the region, the commonwealth, and the nation.

- Economic output exceeds \$2B annually
- 20,649 jobs
- Economic engine

Langley Economic Impact

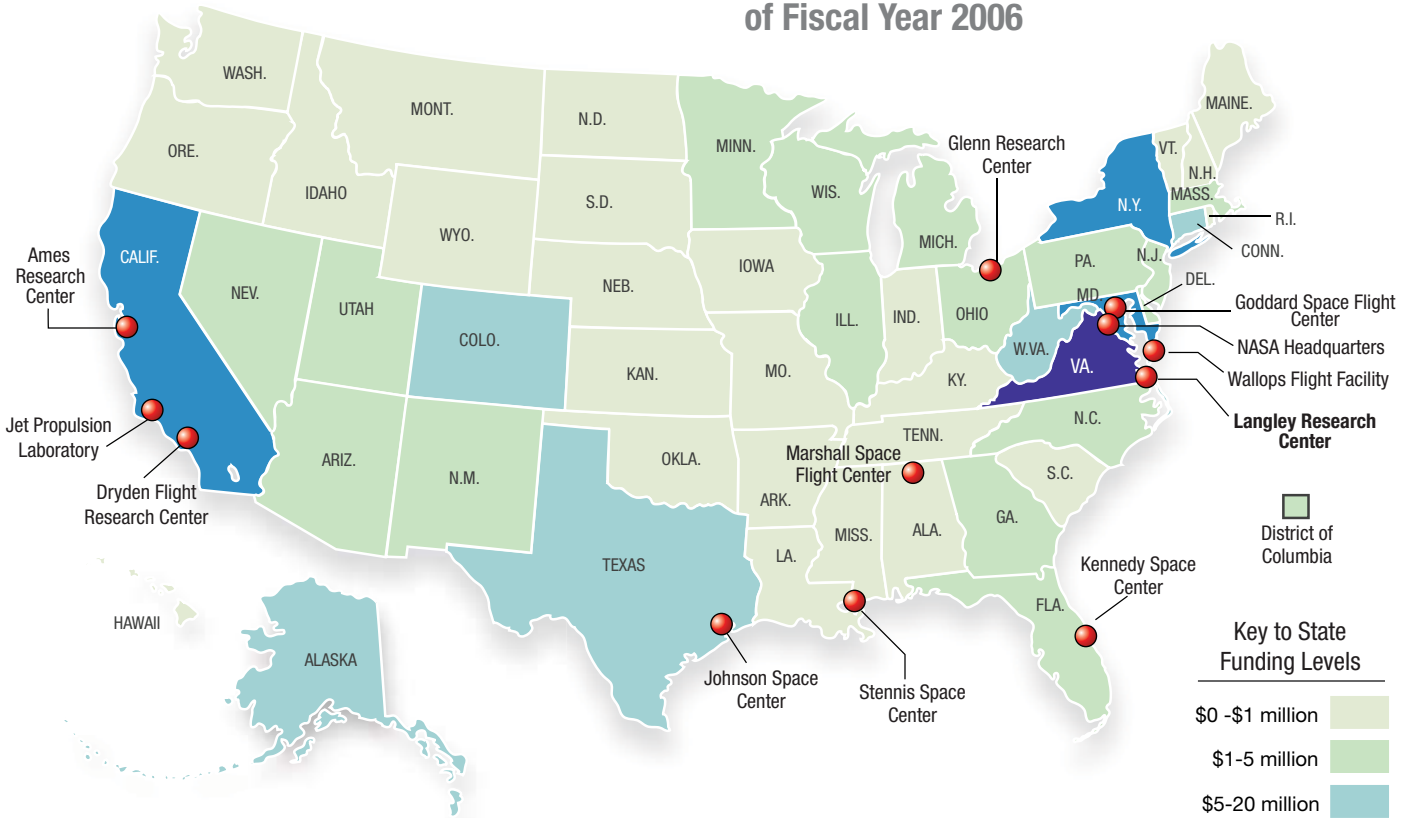


Langley Total Job Creation



# LANGLEY'S IMPACT ON THE NATION

## Geographical Distribution Summary of Fiscal Year 2006



### Top Obligations to Business Contractors:

Sverdrup Technology Inc .....	\$ 69.6 m
Science Applications Intl Corp .....	50.6 m
Raytheon STX Corp .....	29.8 m
Swales Aerospace .....	19.4 m
GASL Inc .....	16.9 m
Air Products & Chem. Inc .....	16.8 m
Dominion Virginia Power .....	15.1 m
Tessada & Assoc Inc .....	14.1 m
Lockheed Martin Gov't Services .....	9.6 m
Chugach Industries Inc .....	6.8 m
Aurora Flight Sciences Corp .....	6.7 m
Unisys Corp .....	6.4 m
ASRC Management Services Inc .....	6.2 m
Analytical Mechanics Associates Inc .....	6.1 m
Praxair Inc .....	4.5 m
Virginia Natural Gas Inc .....	4.4 m
Four Dimensional Leadership .....	3.6 m
Mainthia Technologies .....	3.1 m
ILC Dover Inc .....	2.7 m
Government Technology Serv Inc .....	2.4 m
Center For Systems Management Inc .....	2.2 m
Modern Machine & Tool Co Inc .....	2.1 m
Lockheed Martin Corp Aero .....	2.0 m
Advanced Technologies Inc .....	2.0 m
Nextgen Aeronautics Inc .....	1.9 m

### Top Obligations to Non Profit Institutions:

National Institute of Aerospace .....	\$ 27.8 m
• Georgia Tech .....	2.9 m
• University of Maryland .....	1.3 m
• University of Virginia .....	1.3 m
• Virginia Tech .....	1.2 m
• N.C. State University .....	900 k
• N.C. A&T State University .....	450 k
Aerospace Corp .....	5.4 m
Hampton City .....	4.7 m
Texas Engineering Experiment Station .....	3.5 m
Georgia Tech Research Corp. ....	2.9 m
Institute Advanced Learning & Research .	2.6 m
Virginia Air & Space Center .....	1.7 m
Research Triangle Institute .....	1.5 m
National Consortium for Aviation Mobility .	1.0 m
Clinton-Essex-Warren- Washington BOC .....	920 k
Mid-Atlantic Aerospace Complex .....	915 k
Wise County Va. Develop Program .....	817 k
Old Dominion University Research Foundation .....	736 k
Total Learning Research Institute .....	643 k

### Top Obligations to Educational Institutions:

Glennville State College .....	\$ 3.7 m
Morgan State University .....	3.4 m
Princeton University .....	2.5 m
Utah State University .....	2.4 m
University South Florida .....	1.8 m
University Wisconsin Madison .....	1.1 m
Fairmont State University .....	1.0 m
City Univ. N.Y. City College .....	993 k
Hampton University .....	729 k
University of Colorado Boulder .....	668 k
College of William & Mary .....	578 k



A image of the CloudSat/Calipso launch.



A visitor pictures herself as a NASA astronaut at the NASA booth during the Godspeed Sail tour of the 400th anniversary of Jamestown.



Margaret Pippin and summer interns work on a tropospheric environmental air quality project.



Sharon Bowers, a science teacher detailed to NASA Langley, leads an activity during NASA Explorer Institute training in January 2006.



Teachers in a NASA Explorer Schools Technology Immersion Workshop pose for a photo in a digital-learning lab at Langley.



# EDUCATION & OUTREACH



**F**our hundred years ago, intrepid explorers set foot on North American soil for what would become the first permanent English settlement in the New World. As NASA prepares to lead the nation in the exploration of space, Langley relies on a comprehensive program to inform, educate, and inspire its audiences – from students and teachers to the general public.

In 2006, Langley's Education programs generated approximately 3 billion "looks" – people or households reached multiple times – at the work Langley does through outreach and education programs and events.

Some 9.5 million people had the opportunity to share in the excitement of NASA's aeronautics breakthroughs, its space exploration vision, and its Earth-observing missions through state fairs, air shows, community events, and museums. Through the news media, some 1.8 billion looks were generated at stories in newspapers, magazines, TV, radio and the Internet. And another 1.4 billion looks were produced through education programs involving students and faculty around the nation.

## **Prepping for a 400th Birthday Party**

Langley is an official partner in the Jamestown 2007 celebration. As part of the 400th anniversary preparations, the Center participated in the Godspeed Sail, using speakers, educational materials, and exhibits to highlight agency activities and draw parallels between exploration of yesteryear and today. Godspeed visited six major East Coast ports, with some 450,000 people attending the festivities.

## **Aero-Space Day**

On February 2, 2006, some 80 Langley representatives, aerospace industry leaders, and members of professional organizations converged in Richmond for Aero-Space Day. They met with General Assembly members and key Commonwealth officials to discuss the importance of aerospace to the Commonwealth.

## **Education at Home and Across the Globe**

Other informal education partnerships with Morehead Planetarium, the North Carolina Museum of Natural Sciences, and the Colonial Williamsburg Foundation helped Langley reach an estimated one million people.

Through Langley's precollege programs, three new NASA Explorer School partnership awards were competitively selected for three years: four public elementary schools in Virginia, and in North and South Carolina. Each school will receive \$17,500 over three years for technology development needs. Over 200,000 students and 1,500 teachers were reached in the Center's Aerospace Education Program. Through NASA's Digital Learning Network, Langley delivered 260 distance-learning events to schools, informal

education sites, and conferences across the world. A total of 5,750 students and 1,358 educators participated in interactive sessions with Langley subject-matter experts and education specialists. The network is managed by Langley and has staff and studios at all NASA centers. Across the network, 1,271 events were presented to nearly 45,000 students and educators.

## **Robust University Participation**

Our higher-education programs supported 165 students from 70 minority colleges and 41 universities. The National Institute of Aerospace, the University of Maryland Eastern Shore, and Bennett College partnered in conjunction with Langley to host the 10th Annual Pre-Service Teacher Conference. Participants came from 30 states, including the District of Columbia, and consisted of 493 students, 83 faculty members and 38 ambassadors from 76 colleges and universities. The Center also welcomed Oak Ridge Association of Universities as the new manager of NASA's Post-doctoral Program.

- 3 billion reached
- Exhibits, events, and informal education
- Distance learning
- K-12, higher education

# AGENCY FUNCTIONS

## NASA Engineering and Safety Center

The NESC mission is to perform independent testing, analysis, and assessments of NASA's high-risk projects to ensure safety and mission success. The NESC engages proactively to help NASA avoid problems and is a strong, Agency-wide technical resource that offers a forum for reporting technical issues and contributing alternative viewpoints for high-risk NASA programs. For each technical assessment that is conducted, NESC accesses a ready group of engineering experts – called Super Problem Resolution Teams (SPRTs) – from 15 technical discipline areas.

The NESC is funded by the Office of the Chief Engineer and is comprised of technical experts from each NASA center, industry and academia. The NESC management office is at Langley. Langley employees have been instrumental in the NESC's success



LaRC/Jeff Caplan

NESC researchers work on a special-purpose combined-loads testing machine at Langley.

by providing expertise to the SPRTs and assessment teams. In addition, the NESC has utilized Langley's facilities to complete a number of critical independent tests and analyses. For example, Langley played an important role in the NESC's assessment of: shuttle external tank

debris transport, Crew Exploration Vehicle water-vs.-land landing risks, CEV smart buyer, Atlas V tank failure investigation and stress analysis, Delta II tank investigation and the Langley 8-Foot High Temperature Tunnel oxygen storage pressure vessel inspection requirements.

---

## Independent Program Assessment Office

The Independent Program Assessment Office, at Langley, provides independent, unbiased information and findings to NASA decision makers. The IPAO mandate is to assess newly proposed and ongoing programs and projects to provide an objective advisory to mission directorates and the NASA Program Management Council.

In 2006, among several other significant changes, IPAO improved the independent review procedures to assure mission success by emphasizing pre-site review preparation by the review teams, strengthened member commit-

ments to thorough vetting of issues, and developed independent cost-estimate validation by the technical team members.

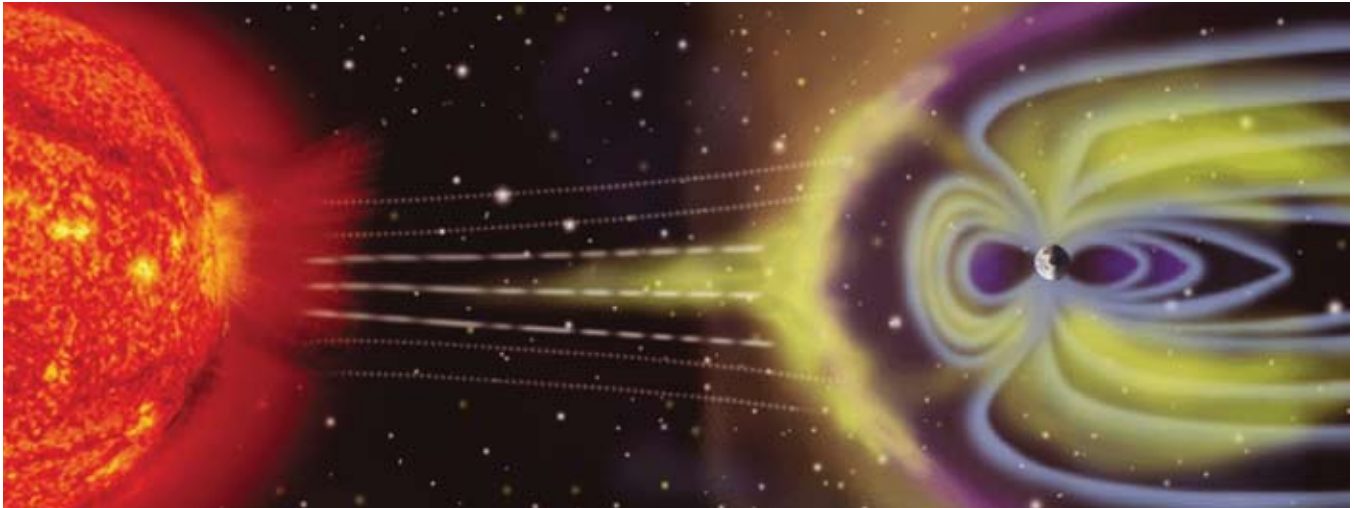
IPAO also completed a number of program implementation reviews, and identified several program management issues which led to improvements in NASA program management and execution.

Also IPAO completed reviews on such programs and projects as Mars Science Laboratory, James Webb Space Telescope, Lunar Robot Orbiter and the Robotic Lunar Exploration Pro-

grams, and the Ocean Surface Topography Mission.

Through these reviews, IPAO made several recommendations to enhance mission success, ranging from improvements to entry, descent, and landing, to the addition of redundancy to the cruise stage and select hardware, to implementation of vigorous risk management process, and finalization of clear requirements and success criteria. IPAO also recommended program rebaselining with an adequate financial reserve and implementation of test-as-you-fly mitigation strategies.

# AGENCY PROGRAMS



NASA/JPL/CTEC

The image above illustrates the complex interaction between the Earth and the sun.

## Science Support Office

The Science Support Office (SSO) at Langley supports the Science Mission Directorate at NASA Headquarters in the acquisition of Earth and space science missions and instruments. The SSO was initially established at Langley in 1996 to support the Explorer, Discovery, and

Solar Terrestrial Probes programs. Today, the SSO also supports the New Frontiers, Living With a Star, Mars Exploration, and Earth System Science Pathfinder programs. The SSO assists these programs during the development of Announcement of Opportunity (AO) solicitations

and the technical, management, and cost evaluations of proposals received in response to the AO solicitations. The SSO additionally has responsibility for special studies, assessments, and reviews for Science Mission Directorate.



## The Exploration Technology Development Program

Execution of the Vision for Space Exploration will require development of both transportation elements, including Orion, Ares I and Ares V, and lunar and planetary surface systems. The Vision's success will require sustained and focused investments in surface systems and advanced crew vehicle systems. The Exploration Technology Development Program (ETDP), within the Exploration Systems Mission Directorate (ESMD) is developing advanced technologies to pursue these systems. Langley has been assigned the role of overall management of

the ETDP and consequently maintains the Exploration Technology Program Office (ETDPO). Rigorous project management, including documented project expectations, earned-value management, and strict costing control, is applied to the technology projects to ensure that the investments are relevant to Constellation needs. With a rich history of developing relevant technologies and experienced program and project managers, Langley has the unique combination of skills to ensure that the program is successful and meets its objectives.

# LANGLEY'S VISITOR CENTER

The Virginia Air & Space Center (VASC) is a nationally recognized, non-profit science center in Hampton, Virginia that serves as the official visitor center for NASA Langley. It is the permanent home for the Apollo 12 Command Module, lunar geologic samples, and an impressive collection of more than a dozen historic aircraft

The facility, partially funded by Langley, also boasts a five-story IMAX, 3D Theater that extends

the visitor's experience with a variety of compelling and educational giant-screen films, like Space Station 3D and Roving Mars, that chronicle NASA's exploration initiatives.

### Supporting NASA's mission

The VASC features extensive aviation and aerospace exhibits that explore Langley's role in all aspects of NASA's mission and Vision for Space Exploration,

from aeronautics and science to future missions to the moon, Mars and beyond.

The center also serves as a unique setting for meetings and receptions. It has been host to numerous NASA and community functions, most recently a public lecture by NASA Administrator Michael Griffin.

Since its opening in 1990, the VASC has nearly 1.5 million students with high-quality, interactive educational programming that encourages children to pursue careers in math, science and technology. Many students are considered at-risk, and through assistance from the space center, they are afforded many exciting educational opportunities not available elsewhere.

The VASC has grown from a regional air and space museum to a world-class, science center. A recent expansion resulted in the Adventures of Flight aviation gallery, which spans 100 years of aviation history from the origins of flight to the future of flight. The gallery provides innovative, stimulating educational experiences for visitors, more teaching spaces for student groups and teacher workshops, and enhances the facility's role as visitor center for Langley.

### A New Space Gallery

In a new initiative, the VASC is upgrading its Space Gallery. Over half-a-million cubic feet of existing space is being developed into a state-of-the-art exhibition gallery focusing on NASA technologies and space science through interactive exhibits and stories of human ingenuity. Key concepts that will be presented in the new Space Gallery are: Human Spaceflight – Living and Working in Space, Unmanned Space Exploration, Rockets and Satellites, Visions of Spaceflight, NASA Spin-off Technologies, and Weather.

The Space Gallery exhibit upgrade will also include educational program enhancements like a new Digital Discovery Lab that will promote NASA technology. The new Space Gallery is scheduled to open in the spring of 2007 and will embody the spirit of exploration coinciding with the VASC's 15th anniversary and Jamestown Virginia's 400th anniversary celebrations.

The VASC Strategic Plan 2010 outlines seven key results that will guide growth and direction over the next five years. It also resulted in a new mission statement: to educate, entertain and inspire explorers of all ages, which reflects NASA's vision, mission and core values.

For more information about the Virginia Air & Space Center, go to <http://www.vasc.org>

- Langley's official visitor center
- 1.5 million students served
- IMAX Theater
- New space and aeronautics exhibit galleries



PHOTOSVASC

The Virginia Air & Space Center in Hampton is the official visitor center for Langley Research Center.



Dr. Robert Braun, a professor at the Georgia Institute of Technology, talks to students about the Mars exhibit.



A young visitor explores the center's new Space Gallery Exhibit.

# RECOGNITIONS & AWARDS

■ Dr. Bruce Wielicki has been awarded the Presidential Rank of Meritorious Senior Professional.

■ Dr. Peter A. Gnoffo received the Presidential Rank of Meritorious Senior Professional from the President of the United States.

■ NASA Langley Research Center Director Ms. Lesa B. Roe, Deputy Director Mr. Stephen G. Jurczyk and Director of Systems Analysis and Concepts Dr. Ajay Kumar have been awarded the Presidential Rank of Meritorious Executive.

■ Mr. Howard J. Lewis received the Federal Aviation Professional Award (Managerial Category) from the U.S. General Services Administration.

■ Mr. Frank E. Batts was confirmed by the U.S. Senate for promotion to the rank of Brigadier General in the Virginia Army National Guard.



**Brigadier General  
Frank E. Batts**

■ Mr. Jonathan B. Ransom received Emerald Honors Award for career achievement from Science Spectrum Magazine.

■ Dr. Yongxiang Hu received the prestigious Inaba Prize at the 23rd International Laser Radar Conference

■ Dr. Martin G. Mlynczak received a Distinguished Alumnus Award from the University of Missouri Physics Department.

■ Dr. Robert Tolson, retired, was inducted into Virginia Tech's Academy of Engineering Excellence.

■ Dr. Stephen A. Rizzi received an Outstanding Aerospace Engineer Award from the School of Aeronautics and Astronautics, Purdue University.

■ Mr. Samuel A. Harvey received an Auxiliary Police Officer Service Award for outstanding service to law enforcement from the Newport News (Virginia) Police Department.

■ Mr. Thomas J. Horvath was named the National Engineer of the Year by the American Institute of Aeronautics and Astronautics.

■ Dr. Thomas F. Brooks was named Fellow of the American Institute of Aeronautics and Astronautics.

■ Dr. Edward H. Glaessgen was named Associate Fellow of the American Institute of Aeronautics and Astronautics.

■ Dr. John T. Wang was named Associate Fellow of the American Institute of Aeronautics and Astronautics.

■ Mr. Roger A. Hathaway received the 2006 Educator Technical Achiever of the Year from The National Technical Association.

■ Dr. Joycelyn S. Harrison received the Technology All-Star Award from the National Women of Color Technology Awards Conference.

■ Ms. Anna McGowan received the 2006 Award for Technical Innovation Government from the National Women of Color Technology Awards Conference.

■ The late Mr. Jack Reeder, former National Advisory Committee for Aeronautics (NASA's forerunner) research pilot, was inducted into the Virginia Aviation Hall of Fame.

■ The technical paper "Synthetic Vision Enhanced Surface Operations and Flight Procedures Rehearsal Tool," was named the 2006 Best Paper by the SPIE Defense and

Security Symposium. Mr. Jarvis J. Arthur III, Dr. Lawrence J. Prinzel III, Mr. Steve P. Williams, and Ms. Lynda J. Kramer of NASA Langley authored the paper.

■ The Chemically-Reconstituted Ferritin Bionanobattery Team received the 2005 Nanotech Briefs Nano 50 TM Award. Dr. Sang H. Choi, Mr. James R. Elliott Jr., Mr. Glen C. King of NASA Langley and Dr. Sang-Hyon Chu and Dr. Jae-Woo Kim of the National Institute of Aerospace, and Dr. Yeonjoon Park of the Science and Technology Corporation were the team members.

■ The technical paper "Visualization of a Capsule Entry Vehicle Reaction-Control System Thruster" was named the 2006 Best Paper by the AIAA Aerodynamic Measurement Technology Technical Committee. Dr. Paul M. Danehy, Ms. Jennifer A. Wilkes, Mr. Gregory J. Brauckmann, Mr. David W. Alderfer, Mr. Stephen B. Jones of NASA Langley and D. Patry of Swales Aerospace authored the paper.



LaRC/Jeff Caplan  
Dr. Stanley E. Woodard, Dr. Qamar A. Shams, and Mr. Bryant Taylor received an R&D 100 Award for their Magnetic Field Response Measurement Acquisition System from R&D Magazine.



**ARES** is a proposed Mars Scout mission to study the atmosphere, surface, and interior of Mars.



Testing an aircraft model in the Transonic Dynamics Tunnel at Langley.



# SENIOR LEADERSHIP TEAM



**Lesa B. Roe**  
Director



**Stephen G. Jurczyk**  
Deputy Director



**Douglas L. Dwoyer**  
Associate Director  
for Operations



**Cynthia C. Lee**  
Chief of Staff

## HOW TO CONTACT US

NASA Langley Research Center  
Office of Strategic Communications and Education  
**757 864-6300**

Government Relations  
**757 864-2505**

Doing Business with Langley  
**757 864-3000**

Public Inquiries  
**[public-inquiries@larc.nasa.gov](mailto:public-inquiries@larc.nasa.gov)**

# LOOKING FORWARD



**N**ow that you've had a chance to see what we do at NASA Langley Research Center, I hope you agree it's quite an exciting place. I deeply believe that what we do enriches all Americans, from the joy of learning, to finding ways to improve the lives of people everywhere, to the economic benefit that research and development provides to the nation.

We look forward to the return of humans to the moon and the exploration of Mars and beyond. We are excited by the prospect of providing critical information to our country's leaders so they can make the decisions necessary to preserve and protect Earth. And as for improving the safety and efficiency of air travel – that's something we can all relate to, every time we board an airplane.

We'll continue our tradition of excellence in applied engineering. Our experts in structures, materials and other disciplines in the aerospace sciences, along with the NASA Engineering and Safety Center that is hosted at Langley, helped return the space shuttle to flight after the Columbia accident. A project team in residence at Langley is managing the Orion capsule launch-abort system, which is slated for tests beginning in 2008. Others at Langley are evaluating designs of the Orion's landing system, with vertical drop tests using a half-scale crew module. Still more are conducting wind tunnel

tests of the Ares 1 Crew Launch Vehicle to evaluate the launch vehicle stack.

This is often difficult and tedious work, but our scientists and engineers love what they do. There is an exhilaration that comes with successful accomplishment, as in the record-breaking hypersonic flight of the X-43A, or the development of a new satellite capability, like the CALIPSO lidar instrument.

With the continuing support of Congress and the American people, NASA, Langley, and the agency's other field centers will advance the exploration of space, the study of our planet, and the safety and efficiency of air travel. I thank you for that support and your continuing interest. With your help, I look forward to continuing our critical work in the years ahead – and in the decades to come.

As I mentioned in the Introduction, we at NASA and Langley continually strive to inform you about our activities ... which is a way of saying, I'll keep you regularly informed of our projects, programs and progress.

Share our excitement about the NASA Mission and Langley's role in this historic endeavour.

**Lesla B. Roe**  
Director  
NASA Langley Research Center  
December, 2006



EXPLORATION

AERONAUTICS

SCIENCE

SYSTEMS ANALYSIS

PARTNERSHIPS

PEOPLE of LANGLEY

ECONOMIC REPORT

EDUCATION & OUTREACH



National Aeronautics and Space Administration  
Langley Research Center  
Hampton, VA 23681-2199

[www.nasa.gov](http://www.nasa.gov)

FS-2006-10-124-LaRC