National Aeronautics and Space Administration

LANGLEY RESEARCH CENTER

EARTH AIR & SPACE

SOLVING THE HARD PROBLEMS

www.nasa.gov

Some of Langley's 3,700 employees pose for a photo in front of vacuum spheres that capture gases used when running a hypersonic wind tunnel.

DIRECTOR'S MESSAGE

Welcome To Langley

It has been another stellar year for Langley as we focused on some of the biggest technical challenges of our time: understanding global climate change, advancing space exploration, and revolutionizing aircraft and the air transportation system.

Core missions

In space exploration, we continued to help develop a space shuttle replacement system, which includes two launch vehicles, Ares I and Ares V, and the crew module, Orion. We completed an Orion crew module simulator that is a key element of the launch abort system flight test planned in 2009.

Also in 2008, Langley led the development of the Ares I Aerodynamic Databook and initiated the planning and analysis for the Ares V Aerodynamic Databook. These databooks provide vital support to the Ares 1 and Ares V design and development cycles.

In Aeronautics, we are proud to have been a part of the national team that won aviation's most prestigious award, the Collier Trophy. The trophy was awarded for the development of a system that allows pilots to share GPS position information with each other for improved safety and fuel efficiency.

Langley also made significant contributions to two high-speed aeronautics efforts that are helping develop a supersonic passenger jet and testing the X-51A hypersonic scramjet engine.

And in Science, Langley researchers were part of the team that guided the Mars Phoenix Lander to a successful landing. Langley scientists were recognized as part of the research team that shared the Nobel Peace Prize for efforts to assess and predict global climate change. Langley also participated in a mission to improve our understanding of how the Arctic atmosphere is influenced by pollution and wildfires. We continued operations and instrument development for the CERES mission, and operated the CALIPSO spacecraft. Datasets from these missions will help improve climate modeling and climate change predictions. Additionally, Langley was asked to stand up an Agency program office — the Earth System Science Pathfinder Program Office – and was identified to lead CLARREO (Climate Absolute Radiance and Refractivity Observation), a key mission for future climate change studies.

And Much More

There were many spinoffs of NASA technology, some in surprising areas — like the 2008 Summer Olympics. Swimwear manufacturer Speedo wanted to develop a faster swimsuit, so it called on Langley's expertise in drag reduction, gained through years of studying aircraft aerodynamics.

The fabric tests conducted in a Langley wind tunnel identified the fabric that is now worn by champion swimmers worldwide, including gold medalist Michael Phelps!

The Speedo work is one of many relationships we enjoy with public and private sectors locally, nationally and internationally. These relationships help us accomplish our core missions as well as transfer our technologies and knowledge for broader public use and benefit.

By the way, did you know that Langley will be in a movie? It's called "The Box," starring Cameron Diaz and James Marsden, and revolves around a Mars mission and is scheduled to appear in theaters in March 2009. It was filmed in some of Langley's facilities this year.

I hope this welcome peaked your interest and that you will read on to learn more about what Langley has done, is doing, and what lies ahead.

Lesa B. Roe
Director

NASA/Sean Smith

The Langley-built Orion crew module mockup heads to the hangar.

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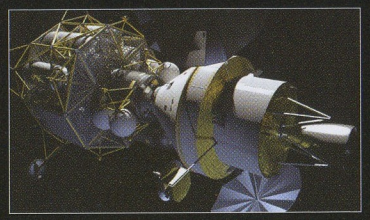

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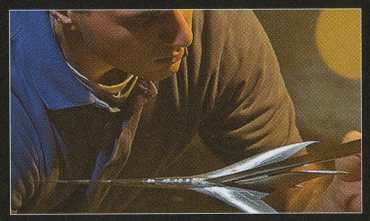

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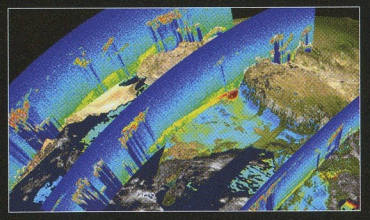

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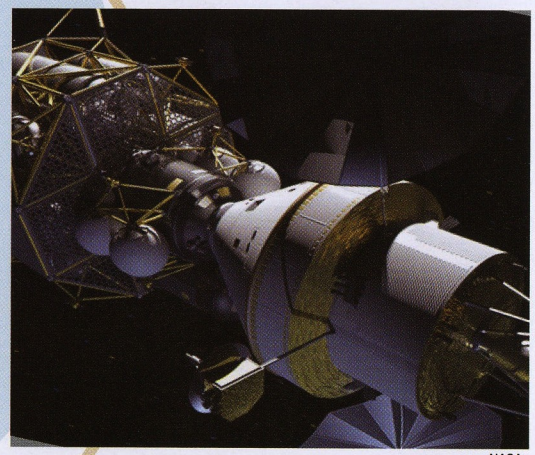
EXPLORATION

Leveraging decades of spaceflight experience and innovation

Early terrestrial explorers traversed vast stretches of ocean. To reach the moon, Mars and other planetary bodies, space sojourners will need to cross a much harsher expanse, that of raw, unforgiving vacuum. To make such a journey safely and affordably requires a new generation of rockets and spacecraft.

NASA teams, including those at Langley, are designing and developing the Constellation family of space vehicles. The work leverages powerful, reliable Saturn-rocket and space-shuttle propulsion elements, as well as a half-century of NASA spaceflight experience and innovation.



NASA

Artist's concept of a Constellation space vehicle.

Taking Aim at Ares

A chief component of NASA's Constellation Program is the Ares I rocket, a keystone of the agency's new space-transportation infrastructure. Langley chairs the Ares I Aerodynamics Panel and leads the characterization of the aerodynamic-design environment for both the Ares I and the Ares V launch vehicles.

In 2008, the Center led the development of the Ares I Aerodynamic Databook, which consists of 14 separate databases covering distinct flight regimes and vehicle configurations. Preliminary planning and analysis for development of the Ares V aerodynamic databases have likewise begun, with an integrated vehicle study. Langley continues to support Ares I guidance, navigation and control-system design, as well as structural analysis, design and manufacturing strategies for the Ares I upper stage.

Langley also leads systems engineering and integration and the crew module/launch-abort system simulator development of the first Ares I prototype flight test, called Ares I-X, which is currently scheduled for mid-2009. The Ares I-X is being constructed at various sites across the nation and will be integrated, assembled and launched from NASA's Kennedy Space Center in Florida.

Developing Orion

Langley is making significant contributions to the development of the Orion crew exploration vehicle by managing the development of the Orion Launch Abort System, a vehicle designed to safely pull the crew module away from the Ares in the event of rocket malfunction or other emergency. The Center also leads the development and testing of landing-system technologies, such as air bags to cushion the Orion from ground impact.

Additional Center contributions include heat-shield design and analysis, thermal/structural testing, and systems engineering. Langley structural design and fabrication expertise is also applied to the manufacturing of flight test articles for future pad and ascent/abort flight tests.

Langley's aerodynamic and aerothermodynamic facilities and expertise are helping characterize Orion's atmospheric-flight profile, including the crew module re-entry. In the future, Langley will lead a space-shuttle-based flight experiment to validate the performance of the Orion relative-navigation system.

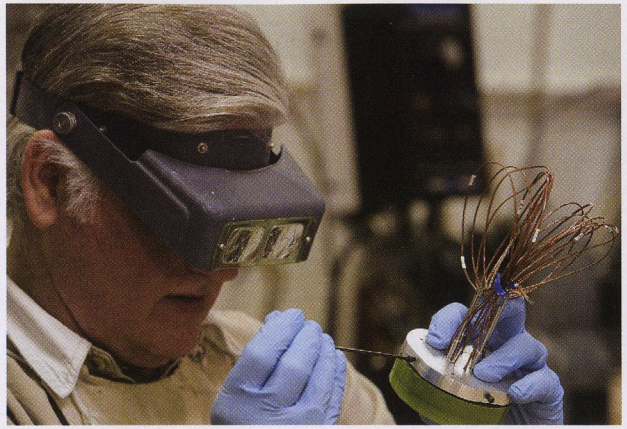
Supporting Space Shuttle Operations

Langley continues to contribute to NASA's space shuttle program, providing mission support and advice throughout shuttle missions.

Center personnel have also assisted aeroheating and damage-assessment teams that evaluate sites of concern on shuttle thermal protection system tiles and wing leading-edge panels. Langley researchers have developed and delivered components that can be used to repair shuttle damage up to eight square inches.

Langley teams are helping to design and develop the Constellation family of space vehicles to take us out of Earth orbit and to worlds beyond.

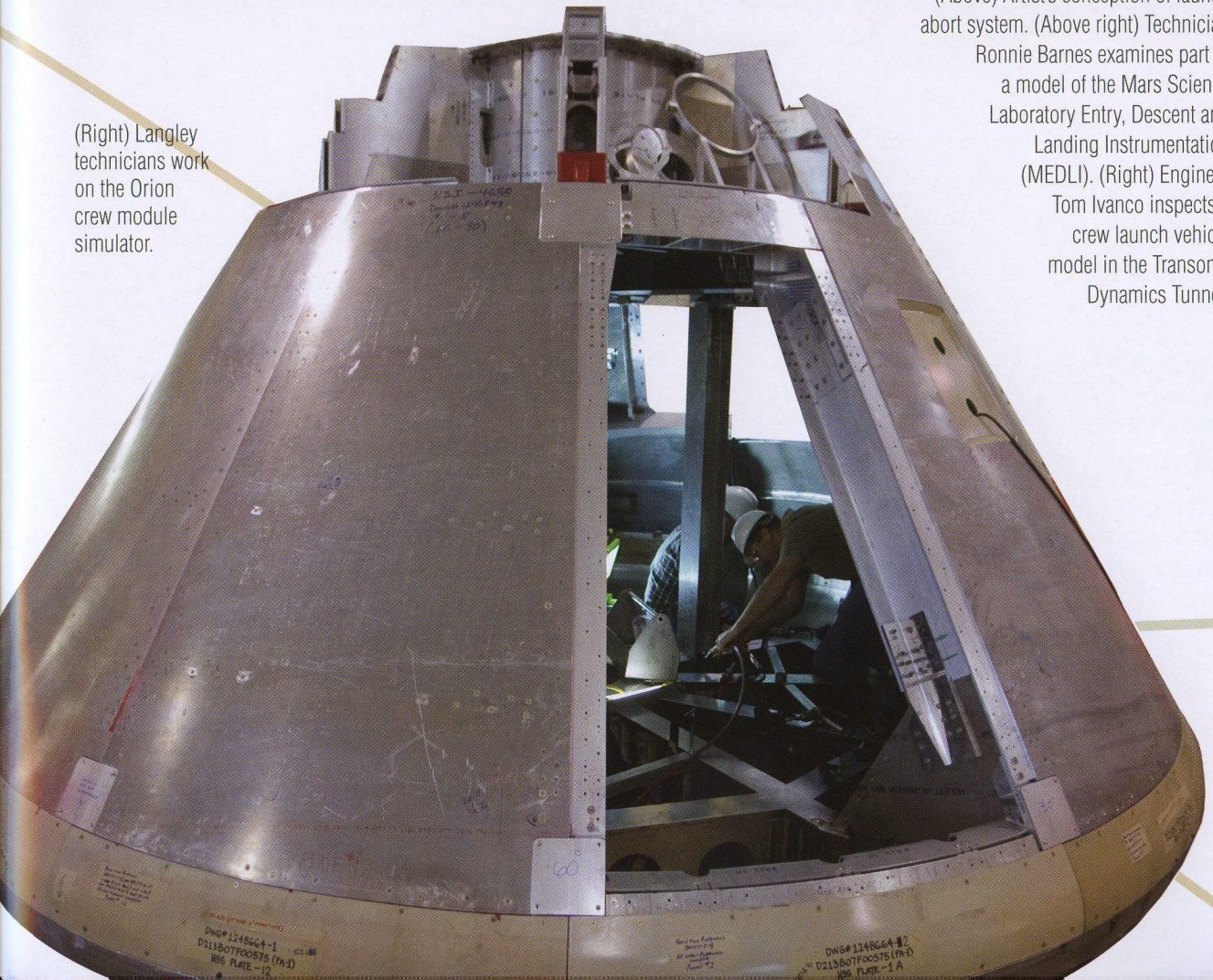
NASA



NASA/Sean Smith

(Above) Artist's conception of launch abort system. (Above right) Technician Ronnie Barnes examines part of a model of the Mars Science Laboratory Entry, Descent and Landing Instrumentation (MEDLI). (Right) Engineer Tom Ivanco inspects a crew launch vehicle model in the Transonic Dynamics Tunnel.

(Right) Langley technicians work on the Orion crew module simulator.



NASA/Sean Smith

ORION'S FIRST JOURNEY

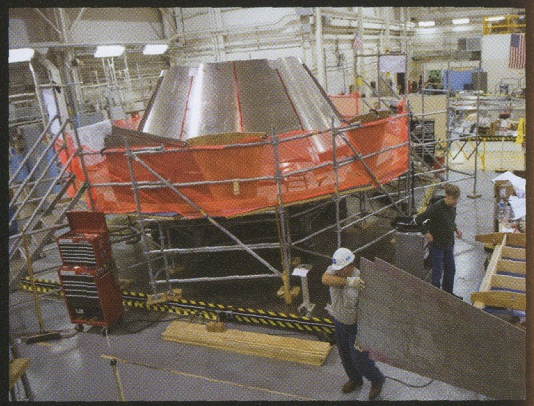
Langley has completed work on a simulated spacecraft structure — a key element of a test of the astronaut escape system designed for NASA's next generation of spacecraft. The Langley crew module simulator accurately simulates the size, outer shape and mass characteristics of the Orion crew module. This makes it an ideal vessel for the short-duration Pad Abort 1 flight test planned at White Sands, New Mexico, in 2009. The test will focus on the ability of Orion's launch abort system to pull the crew module safely away from the launch vehicle in the event of problems on the launch pad or during the climb into orbit. Orion and its Ares-1 rocket are being developed to transport astronauts first to the International Space Station, then on to the moon by 2020.

1. JULY 2007 ▶

Langley technician Kevin Johnson works on the Orion crew module simulator in its early stages of construction. Each precision-machined part was designed and built at Langley.

3. NOVEMBER 2007 ▶

The 16.4-foot-wide crew module is the center of attention in Langley's Flight Test Article Development and Integration Facility.



◀ 2. SEPTEMBER 2007

The Orion mockup starts to take shape once vertical beams were fabricated and attached to the existing hardware.

◀ 4. DECEMBER 2007

Though nearing completion, many finishing touches are required. The side opening will be filled with a simulated hatch cover.

▼ 5. FEBRUARY 2008

The completed structure sits on its transporter at Langley as engineers review what happens next.

6-7. MARCH 2008

(Background photo) The crew module simulator is loaded into an Air Force C-17 at Langley after completion of fabrication and testing. (Below) The module at NASA Dryden Flight Research Center, where it was painted and equipped with the instrumentation needed for the flight test at White Sands Missile Range in New Mexico.

Engineer Mark D'Aprile inspects a supersonic jet concept model in the Unitary Wind Tunnel.

NASA/Sean Smith

Langley is working with industry to develop technologies that will allow environmentally friendly, efficient passenger flight above the speed of sound

Reducing air travel delays and improving safety are just two of the goals of NASA's aeronautics program.

AERONAUTICS

Working to create the future of flight

Whether designing dramatic improvements to the nation's air system or exploring concepts for vehicles that ride their own shock waves at hypersonic speeds, Langley's aeronautics research is helping create the future of flight.

Center engineers continue to investigate critical next generation air traffic management concepts, test aviation-safety technologies, and use Langley wind tunnels to evaluate new aircraft designs. The Center is working to develop quieter, safer and greener aeronautics technologies, all geared for one purpose: improving the nation's air transportation system and the way Americans fly.

Safer, Faster Skies

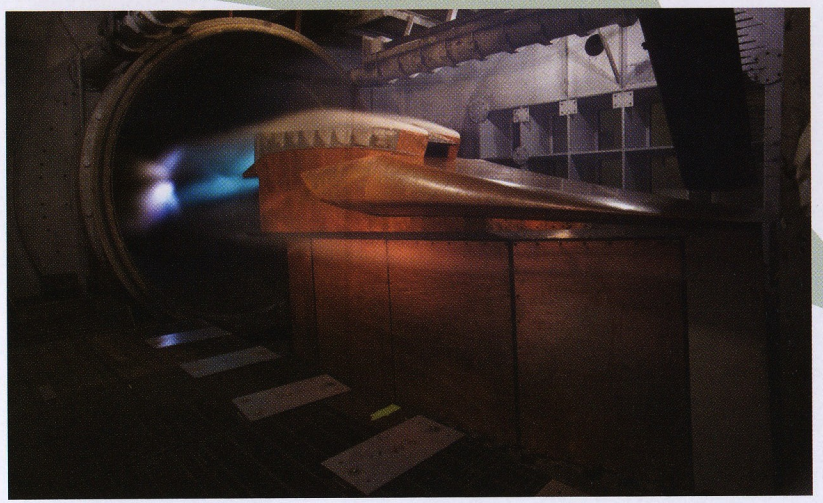
Langley was recognized as a key member of the Federal Aviation Administration-led team awarded the 2007 Collier Trophy for extensive research into the automatic dependent surveillance-broadcast system known as Automatic Dependent Surveillance-Broadcast (ADS-B). ADS-B allows aircraft to share GPS-based position information with other aircraft and controllers, promising a dramatic increase in the efficiency of national air-traffic management.

This year Langley achieved another first ADS-B success, leading the international development of Oceanic ADS-B In-Trail Procedures. The new standard establishes the aerial equivalent of a highway passing lane that should save fuel for airlines flying oceanic routes.

Langley researchers are also supporting the development of ADS-B-based systems to prevent catastrophic runway incursions, noted as one of the National Transportation Safety Board's most wanted aviation safety improvements. And pilots working with the Center's Air Traffic Operations Laboratory in 2008 tested related cockpit technologies to allow for accurate and efficient self-spacing to better coordinate landings.

In addition, Langley is working with industry to develop technologies that would allow environmentally friendly, efficient passenger flight above the speed of sound. In 2008 engineers from the Center and the Gulfstream Aerospace Corporation mounted a small, needle-nosed model of a supersonic jet concept in Langley's Unitary Wind Tunnel to study sonic boom characteristics at speeds from Mach 1.5 to Mach 1.8, about 1,150 to 1,380 miles per hour.

The Center's research portfolio includes assessments of hypersonics technologies that one day may enable aircraft to fly at or above Mach 5, or more than 3,800 miles per hour. NASA Langley, Pratt & Whitney Rocketdyne, the U.S. Air Force Research Laboratory, the Defense Advanced Research Projects Agency and the Boeing Company have teamed to demonstrate extended-duration hypersonic flight capability with the X-51A Scramjet Engine Demonstrator-WaveRider program. Tests in Langley's 8-Foot High-Temperature Tunnel on the engine simulated Mach 5 hypersonic speeds. During flight tests slated to begin in 2009, the scramjet engine will be pushed to speeds exceeding Mach 6, or above 4,600 miles per hour.



The Air Force Research Lab X-51A SJX61-1 scramjet engine in the 8-Foot High-Temperature Tunnel undergoing testing.

Out of This World

To further our understanding of hypersonic and supersonic flight, Langley aeronautics research is heading out of this world and on to other planets. One project is the Mars Entry, Descent and Landing Instrument, or MEDLI. The MEDLI experiment, built at Langley, will fly on the Mars Science Laboratory scheduled for launch in 2011. It will gather data on aeroheating by using sensor plugs and pressure ports embedded in the spacecraft's aeroshell.

A winning team

Langley shares top honor for air travel advances

Think Heisman Trophy, Golden Globe, World Cup, Olympic Gold Medal.

The Robert J. Collier Trophy may not be quite as well known, but it's a household name in the aerospace industry. The Collier has been one of the most prestigious awards in the field since it was established in 1911.

Langley was part of a team that received a Collier – our sixth – this past year.

The National Aeronautic Association chose the Automatic Dependent Surveillance-Broadcast, or ADS-B technology, developed by a team of public and private groups to receive the 2007 honor. It was announced in June 2008.

NASA/Jeff Caplan

GPS-based technology lets pilots see air traffic around them.

Instead of relying on radar, ADS-B uses Global Positioning System satellite information to give pilots and controllers highly accurate traffic data, as well as displays that update in real time. The system also will give pilots access to weather services, terrain maps and flight information services.

Government and industry leaders have worked for more than a decade to develop and implement this technology for the next generation of air traffic management.

"ADS-B is a ground-breaking effort for next-generation airborne surveillance and cockpit avionics," the Collier selection committee said. "Its implementation will have a broad impact on the safety, capacity and efficiency of the national airspace system."

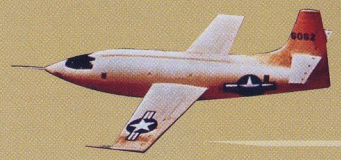
Researchers at NASA's Ames Research Center, Moffett Field, California, were also part of the extensive team that developed and tested ADS-B.

The ADS-B program benefited from wide industry participation, including: Aircraft Owners and Pilots Association; Air Line Pilots Association; Alaskan Aviation Coordination Council; ACSS; Cargo Airline Association; Embry-Riddle Aeronautical University; FAA's Capstone Program Office, Office of Aviation Safety, Safe Flight 21 Program Office, Surveillance and Broadcast Services Office, and William J. Hughes Technical Center; GARMIN AT, Inc.; Independent Pilots Association; Lockheed Martin Transportation and Security Solutions; MITRE Corporation; RTCA's Special Committee and ADS-B Working Group; Sensis, Inc.; University of Alaska, Aviation Technology; and UPS.

The Collier Trophy is awarded for "the greatest achievements in aeronautics or astronautics in America, with respect to improving the performance, efficiency and safety of air or space vehicles, the value of which has been thoroughly demonstrated by actual use during the preceding year."

The trophy has been given to many of America's greatest aerospace pioneers, including Orville Wright and Neil Armstrong.

This was the 21st time research and development projects that included NASA or its predecessor agency, the National Advisory Committee for Aeronautics, have received a Collier Trophy.



The story behind the trophy

Remember the magazine Collier's? It was published from 1888 to 1957. The Collier trophy is named after the man, Robert J. Collier, who was the magazine's publisher.

The Collier Trophy

Robert J. Collier was an air sports pioneer and president of the Aero Club of America. He commissioned the 525-pound award in 1911 and named it the Aero Club of America Trophy. Winners of the trophy receive much smaller copies to keep.

Collier died in 1918 and the trophy was renamed in his honor in 1922. When the Aero Club dissolved the award was taken over by the National Aeronautic Association (NAA). The award is presented once a year by the NAA president.

The original Collier Trophy is on permanent display at the Smithsonian National Air and Space Museum in Washington, D.C. NASA and its predecessor agency, the National Advisory Committee for Aeronautics (NACA), have received the Collier 21 times since 1929.

Langley has six of the trophies.

1929 For the development of low-drag cowling for radial air-cooled aircraft engines. This was one of the first advances making airplanes more streamlined and efficient in flight.

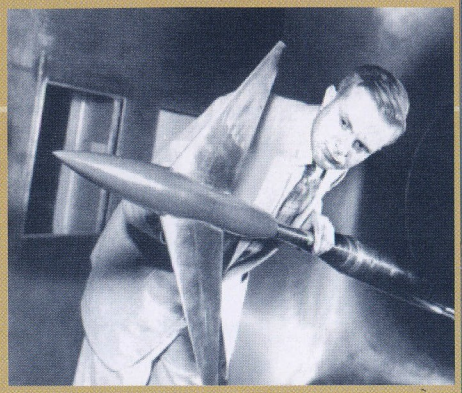
1946 For the development of an efficient wing de-icing system. Today these systems enable aircraft to fly at high altitudes, where temperatures are sub zero, without the wings icing up.

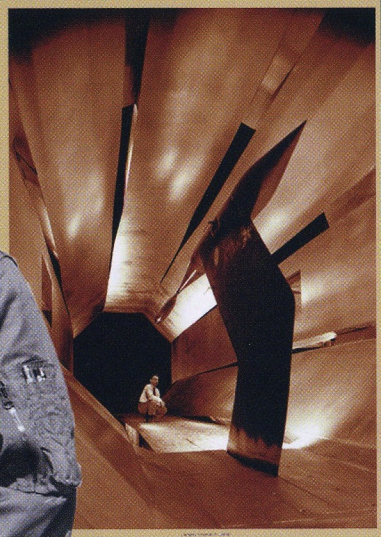
1947 John Stack of Langley Memorial Aeronautical Laboratory for research to determine the physical laws affecting supersonic flight. Lawrence D. Bell and Chuck Yeager also shared in this trophy for their work in demonstrating supersonic flight with the Bell X-1.

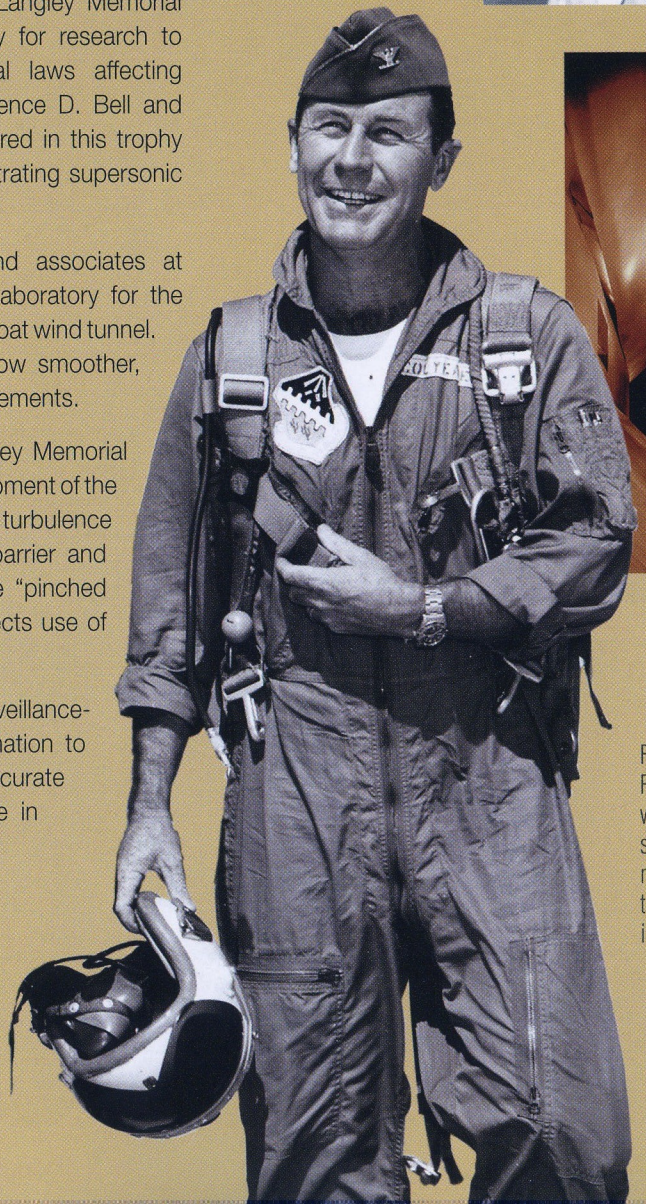
1951 John Stack and associates at the Langley Memorial Aeronautical Laboratory for the development and use of the slotted-throat wind tunnel. The breakthrough made tunnel air flow smoother, enabling much more accurate measurements.

1954 Richard T. Whitcomb of Langley Memorial Aeronautical Laboratory for the development of the "area rule." This rule greatly reduces turbulence around aircraft crossing the sound barrier and made supersonic flight practical. The "pinched waist" look of today's fighter jets reflects use of the rule.

2008 Automatic Dependent Surveillance-Broadcast (ADS-B) uses GPS information to give pilots and controllers highly accurate traffic data and displays that update in real time .







From top left: the Bell X-1, Richard Whitcomb with a wind tunnel model, the slotted-throat wind tunnel, Chuck Yeager, and the NACA engine cowling on a Curtiss Hawk.

SCIENCE

Learning more about a complex, dynamic Earth

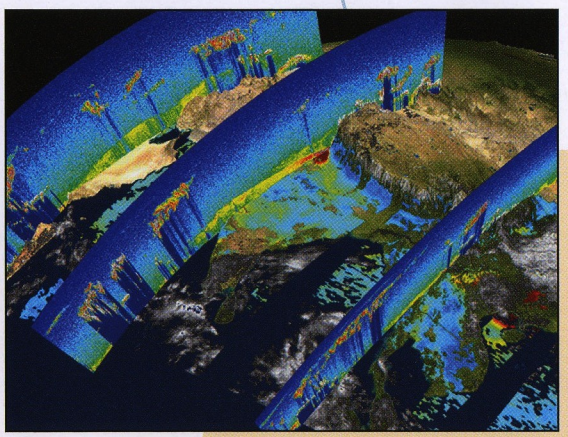
Between the planet we call home and the ones we reach for, there lies a territory full of mystery and wonder, beauty and possibilities, the known and yet to be understood. To us, the scientists at NASA Langley, the atmosphere is the most fascinating place above, around and on Earth. You could say it's our whole world. And we believe it is one well worth understanding. For it holds not only the air we breathe and the clouds we see, but information that will affect the future of life as we know it.

Since scientists first discovered a hole in the ozone layer, we have been on a quest to learn more about every aspect of Earth's vast, complex and ever-changing atmosphere, and share what we learn to help mankind protect our planet, improve lives, conserve resources, improve air quality, and predict and prevent catastrophes.

Uncovering Climate Change Clues

In 2008, our researchers continued their work to understand how the sun's energy drives the Earth's climate system — and, ultimately, how our climate is changing. The Clouds and the Earth's Radiant Energy System (CERES) instruments on four satellites continue, in their 10th year, to measure the flow of energy from the sun to Earth and the planet's heat loss, which shows us how the planet is either warming or cooling. Our Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite successfully completed its second year of studying two of the most visible and important variables in the atmosphere—clouds and aerosols— to help us understand how they may be affecting climate change. Our Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) instrument observations are opening up a new area in the field of radiation balance.

Looking to the future, our researchers are working to continue their climate research with new missions, including CERES FM5, which will launch on the NPOESS Preparatory Project (NPP) satellite. In 2008, our team received funding to lay the groundwork for the Climate Absolute Radiance and Refractivity Observatory (CLARREO), a mission recommended in the National Research Council's Decadal Survey as a key component of the future climate observing system.



NASA/CALIPSO Team

Data from the CALIPSO satellite reveal exciting information about clouds and aerosols, helping scientists to better understand our climate, air quality and weather. Here, CALIPSO data provide a 3-D view of thin clouds and aerosols over India and Tibet.

Celebrating our Home Planet

Taking an exciting new step, we partnered with the Office of Strategic Communication and Education, the Advanced Planning and Partnerships Office and Christopher Newport University to deliver the first EarthFest celebration to our community. With activities for kids, interactive discussions with scientists and exhibitors from NASA and the community, the day-long event highlighted research conducted by Langley to better understand out home planet. EarthFest also inspired and informed our community about how everyone can help protect the planet. EarthFest 2009 is currently being planned for October.

From climate change to water and air pollution, we gather information about our atmosphere by every means available. And when the means don't exist, we invent them. We understand that future policies depend not only on the volume of our data, but its integrity and consistent availability year after year, decade after decade. And so we strive to be as accurate, dedicated, responsible, courageous, curious and persistent as humans can in this, our life's work and our great legacy—to unlock the secrets of Earth's atmosphere for the greater good, a safer planet and a better tomorrow.

EARTH

SUN

NASA/Sean Smith

Mike Dobbs fills a canister with liquid nitrogen to cool the carbon dioxide laser system instrument.

MERCURY

NASA/Sean Smith

Devin Smith follows the "carbon footprints" that guided guests through EarthFest exhibits.

VENUS

Since scientists first discovered a hole in the ozone layer, we have been on a quest to know every aspect of Earth's changing atmosphere and share what we learn to help protect our planet.

NASA/ARCTAS Team

The Airborne Sciences research group played a major role in the ARCTAS campaign and studied fires in the Arctic.

MARS

ARCTIC ADVENTURE

International team tracks climate at the top of the world

Earth's climate is under scrutiny as never before. Global temperatures are on the increase. Arctic Sea ice is diminishing. Greenland's glaciers are retreating. In some places, it is too dry; in others, too wet.

What scientists know for sure is that climate change is occurring fastest in the Arctic, a fragile region that holds many clues for our understanding of our climate.

For decades, researchers have observed the components of urban pollution — a so-called Arctic Haze of soot, sulfate, nitrate, ammonia and organic acids — in the region.

In 2008, our scientists played a major role in one of the largest international field campaigns ever to study the atmosphere in this area, an effort called the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites mission, or ARCTAS.

During ARCTAS, some 50 researchers from NASA Langley traveled to Alaska, northern Canada and Greenland to make coordinated aircraft, ground and satellite measurements of many aspects of that region.

Studying airborne particles, or aerosols, in the Arctic may help researchers better understand what's going on within this first-alert system of global climate change.

Far-flung pollution

How can such desolate and remote areas be so plagued by pollutants attributed to the far more populated, industrialized portions of the world?

The reason is in the wind. Strong pressure gradients during winter months push air northward. Aerosols are transported into the Arctic from North America and Eurasia.

NASA/Mike Obland

Langley's B-200 aircraft on a runway in Barrow, Alaska.

Over the dark winter months, the Arctic's lack of sunlight and low precipitation allow aerosols longer residence times, and the haze settles in the troposphere.

"During the spring when the sun reappears over the Arctic, the sunlight interacts with the aerosols and photochemical reactions quickly begin to take place" says Jennifer Olson, a NASA Langley research scientist.

Ultimately, these reactions create or remove ozone and other pollutants that have important climatic impacts.

ARCTAS scientists have used multiple approaches – radar-like infrared lasers, on-site measurements and satellite observations – to collect data on the West Coast and in the Arctic. At no other time has this extensive sampling of the Arctic been used on a scale as broad and in such close proximity to the North Pole.

"With Arctic Haze it's important to determine the composition, size and number of particles present, as well as the amount of light being scattered," says Langley scientist Eddie Winstead. "This gives scientists insight into the energy balance and global climate effects."

Back in the lab, researchers like Winstead use

ARCTAS team members in Alaska: (from left) Andreas Beyersdorf, Gao Chen, Bruce Anderson, Terry Latham and Eddie Winstead.

Credit: NASA/ARCTAS

Summit, Greenland as seen from the DC-8 during the ARCTAS campaign.

NASA/Univ. of Hawaii/ Cameron McNaughton

Fires in the Lake Athabasca area of Canada as seen from the P3-B aircraft during ARCTAS.

the combined observation techniques to identify pollution sources and transport pathways, and to study the radiative properties of aerosols in the Arctic.

The results offer opportunities for a better understanding of the strange, rapid atmospheric changes occurring each spring at the top of our world, and how those changes apply to global climate concerns.

Earth's threatened boreal forests

(shown in dark green)

From Alaska to Canada and Greenland, researchers covered many miles studying the role of air pollution in the climate-sensitive Arctic. Some team members also spent time in California examining air quality and tracking pollution plumes. The mission was conducted in the late spring and summer of 2008.

SYSTEMS ANALYSIS

Providing decision makers with critical insights

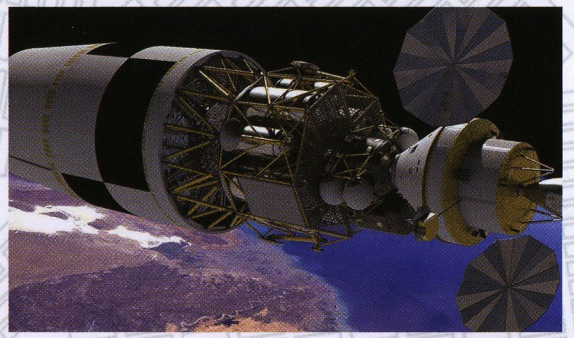
Any complex system contains components that by their nature must interact with other components. Ideally, such interactions are beneficial, ensuring that the end product will be strong and resilient enough to withstand changing scenarios, and optimized to perform its functions efficiently in a robust environment.

At Langley, our systems analysis experts provide predecisional, reliable analytical and critical insights for informed decision making. Their goal is to help researchers achieve mission objectives in aeronautics, space exploration, science and space operations.

Systems analysis addresses broad systems perspectives such as: What are the possible architectures, concepts and approaches? What systems and technologies optimally enable these approaches? What are the associated costs and risks? Answers to these questions go to the heart of the Center's systems analysis process.

Planning for 21st Century Air Travel

In less than 20 years, future air traffic is projected to more than double. Such growth will necessitate dramatic change to air traffic operations, aviation safety requirements and aircraft design. In addition, lawmakers and citizens will expect innovative aircraft concepts that include environmentally friendly green technologies coupled to potentially revolutionary performance gains.



Artists's concept of new NASA space exploration vehicle.

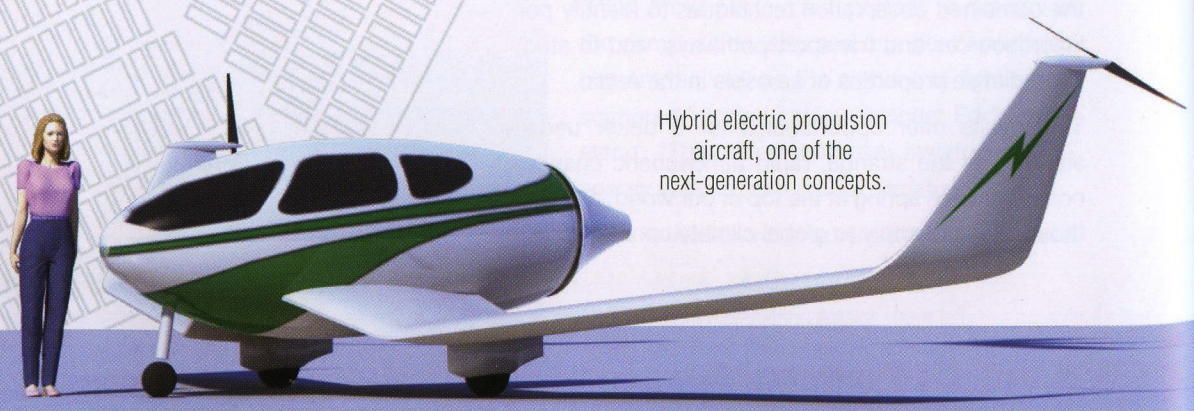
Such improvements require rigorous study and evaluation. Among the 2008 aeronautics research efforts supported by Langley's systems analysis experts were studies of

- Ultra-high bypass-ratio engine systems: proposed improvements in emissions, noise, and fuel economy based on an infusion of a next-generation suite of enabling technologies.
- Aircraft icing: identification of hazards to current and future versions of commercial, general aviation and light sport aircraft.
- Operational airspace risk assessment: the ways airplanes taxi, take off and land at increasingly congested airports and terminals.

Supporting Space Exploration

NASA scientists and engineers are evaluating and testing technologies and systems for America's return to the moon and possibly to other worlds in the solar system, most notably Mars. Safe, reliable exploration architectures are crucial. In 2008, Langley's systems analysts played a significant role in defining and refining such architectures:

- NASA's Constellation Program: assessments of advanced technology suites that would enable the next generation of human space exploration.
- Constellation Program Lunar Architecture Team and the Lunar Surface Systems Project Office: development of initial lunar-surface "buildup" scenari-



Hybrid electric propulsion aircraft, one of the next-generation concepts.

os and associated polar-outpost architectures.

• Small Pressurized Rover (SPR): support of design, development and fabrication of an SPR mockup, which will be used to demonstrate lunar mobility on a simulated lunar surface test site.

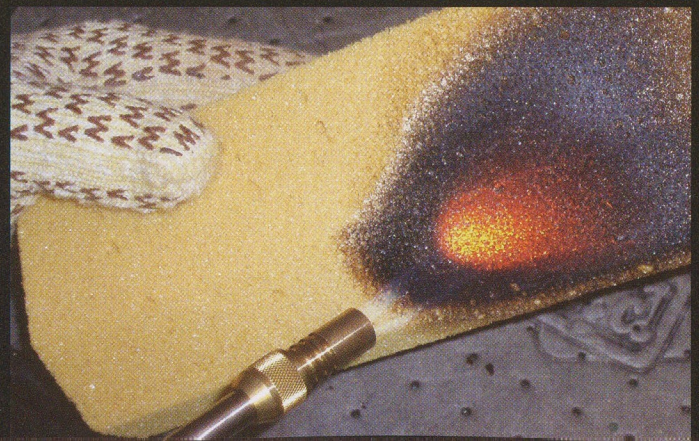
• Ares Launch Vehicle Projects: supported system analysis for the Ares V rocket shroud design, aerodynamic database development for the Ares I rocket, and trajectory analysis for the Ares Flight Test Vehicle.

In addition, in 2008, Langley's systems analysis experts assisted on a variety of NASA's science programs. For the Earth Science Division in NASA's Science Mission Directorate, the Center provided systems analysis support on a number of for Earth Science Decadal missions, which largely focus on climate change and global environmental health.

Langley has also provided systems analysis support to the international Committee on Earth Observation Satellites, evaluating the Earth-observing fleet of satellites currently in orbit.

(Above and right) Interior and exterior views of a lunar habitat concept.

SPEE



FPF-44, the foam that doesn't burn.

"When I hit the water, I feel like a rocket," said Olympic gold medalist Michael Phelps (above) of the Speedo swimsuit, whose material was tested at Langley.

PARTNERSHIPS

Collaborating with others for technology breakthroughs

Langley is known for its technical expertise, innovative technologies and a comprehensive array of unique facilities. The Center continues to play a vital role towards NASA's ongoing legacy of success. But delivering on today's commitments and preparing for future opportunities requires working with partners, big and small, nationally and abroad.

With our partners, Langley develops and builds new and innovative technologies to help explore the universe, expand scientific knowledge and advance aeronautics capabilities. In turn, our exciting discoveries and solutions contribute to improving the quality of life for all people, and to the growth of our regional and national economy.

The accelerating pace of change and rapid advancement of technology make partnerships an essential component of Langley's research and development efforts.

Artist's concept of a low sonic-boom supersonic aircraft design.

A Broad Range of Collaboration

In 2008 Langley initiated over 50 new partnership agreements with a broad range of collaborators, from industry, academia and other government agencies. These partnerships demonstrate the many ways the Center shares its expertise, technologies and facilities, and how we tap into knowledge and expertise outside our gates.

In some cases, partners worked closely with Langley researchers to address important questions such as effects of climate change, air traffic safety, or national security. Other collaborations focused on developing breakthrough technologies like boron-nitride nanotubes, advanced antenna concepts, or low sonic-boom aircraft. Partners also sought access to Langley's unique research facilities, or to license NASA-developed technologies in order to improve the performance and safety of their own products.

In 2008, key partners include aerospace giants Boeing, Lockheed-Martin, Northrop-Grumman, and United Technologies, as well as small innovative firms like Eclipse Aviation, Black Labs and Eagle Aviation.

Vital relationships with governmental organizations range from the Federal Aviation Administration, the Defense Advanced Projects Agency, the National Oceanic and Atmospheric Administration, the Department of Energy, to the Port Authority of New York. We also work closely with all U.S. Military services, top research universities and the National Institute of Aerospace.

Here are just a few examples of how Langley partnerships have made a difference in 2008:

Manufacturer PolyUMAC licensed FPF-44, a foam insulation invented by Langley researchers. The foam does not burn or emit smoke, which makes it ideal as insulation. The company has been producing large quantities for use as insulation on Navy ships.

Speedo's new Lazr swimsuit was a big hit at the Beijing Summer Olympics. World record holder and Olympic gold medal winner Michael Phelps said, "When I hit the water, I feel like a rocket." Warnaco Inc., Speedo's U.S. licensee, worked with Langley researchers, who conducted extensive wind tunnel tests to optimize the design of the suit's low-drag fabric.

Hypersize It

Collier Research Corporation licensed software, called ST-SIZE, from Langley. The software has evolved into a commercial product called "HyperSizer" that is now being used by government and commercial customers for structural stress analysis and sizing optimization. NASA researchers are also using Collier's software to help design NASA's Orion crew launch and crew exploration vehicles, as well as a next-generation lunar lander.

PEOPLE

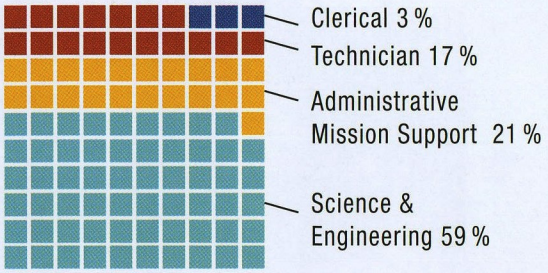
Exceptional talent equals world-class achievement

Any organization's ultimate success depends on its most prized resource: its people. Individual initiative, creativity, inspiration and dedication collectively ensure long-term achievement. At NASA Langley, contributions from engineers, scientists, researchers, technicians, analysts and those in mission support are all essential to mission success.

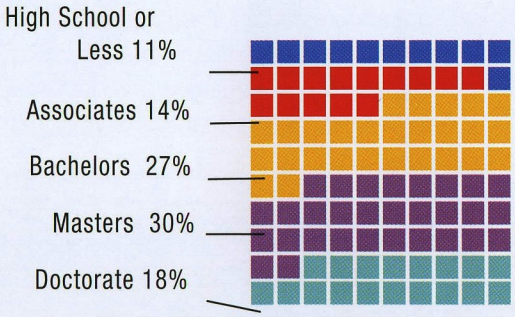
NASA's reputation is that of an exceptional workplace for world-class science and engineering talent. Similarly, NASA Langley is home to a first-rate, technically gifted, highly educated work force. Fifty-nine percent of the Center's civil service employees work in engineering, research and scientific fields. Three-quarters hold at least a bachelor's degree and approximately 20 percent have earned their doctorates.

The majority of Langley staff is made up of full-time, permanent civil servants. However, to increase flexibility, the Center began using term and temporary appointments. Between the beginning of fiscal year 2006 and the end of fiscal year 2008, Langley more than doubled its term population. These time-limited appointments are well-suited to projects of a fixed duration, enabling the Center to meet changing mission requirements and be better postured for a dynamic future.

Occupational Distribution



Education Levels

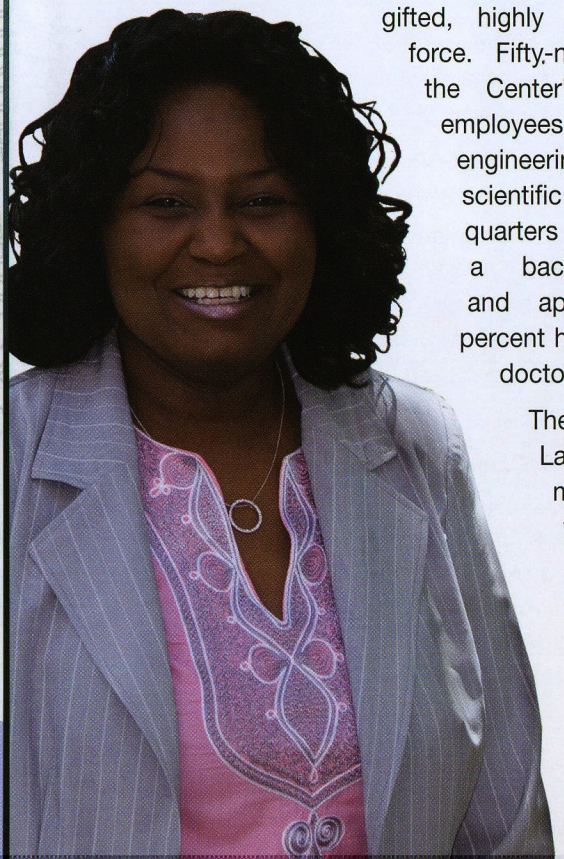


(Excludes student programs)

Although there are four broad occupation categories at Langley, they encompass a variety of positions and areas of expertise. For example, science and engineering positions include aerospace, structural, mechanical, computer and electronics engineers; physical scientists; mathematicians and physicists. Mission support fields include human resources, finance, procurement, information technology and legal. Engineering technicians and electronics technicians account for the majority of technician positions, although the Center also has a number of quality-assurance and equipment specialists. Clerical positions include secretaries and administrative assistants.

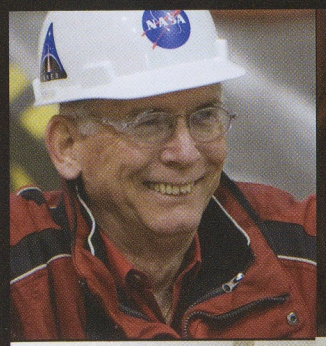
The Langley work force is experienced, with an average of 20.7 years of federal service, surpassing the overall agency average of 18.8 years.

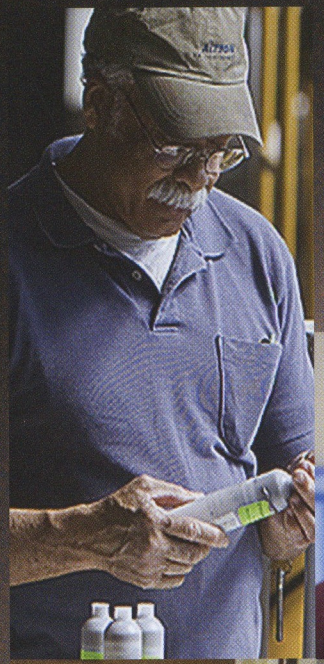
Maintaining a highly skilled, motivated work force is essential for Langley as the Center plays an active role in achieving NASA's mission and vision. Our student pipeline, comprised of a variety of programs, is an important element of our future strategy. Succession planning and effective recruiting are critical, since 40 percent of the Center's civil service employees are age 50 and older. To ensure that information is not lost as employees leave, Langley has developed several knowledge-capture and knowledge-management programs.



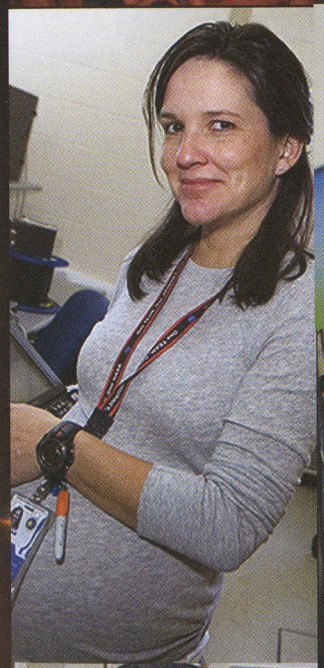
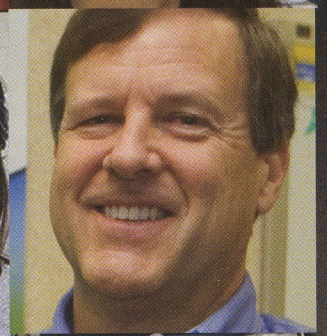
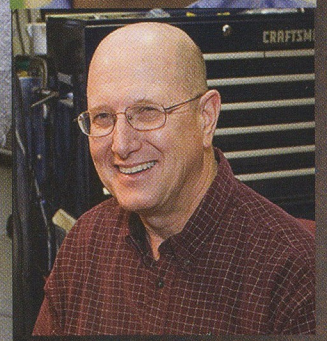
Donna Gilchrist, of the NASA Engineering and Safety Center.

All Photos for NASA by Sean Smith

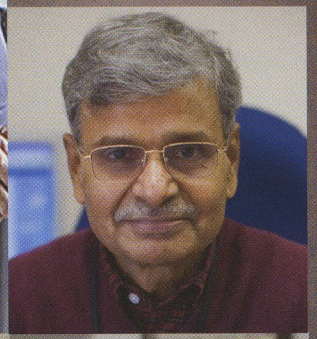


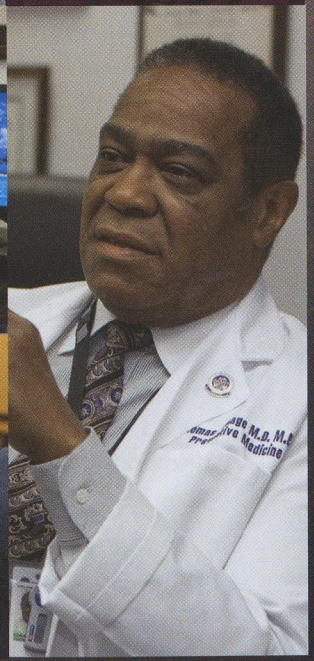


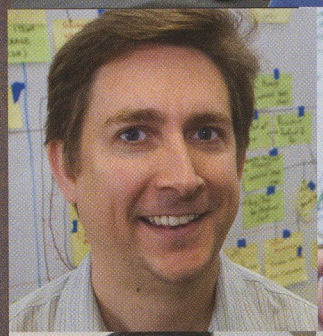
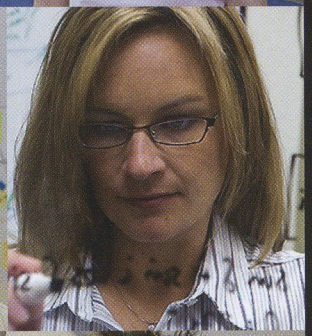
(Clockwise from top left) Cecil Mellanson, Ram Tripathi, Dr. Tom Conage, Penny Allison, and Kim Stone.

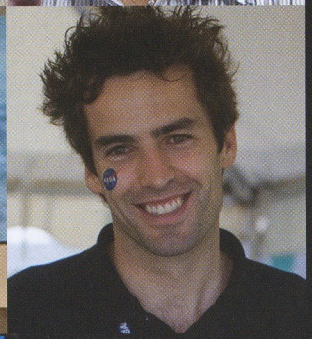
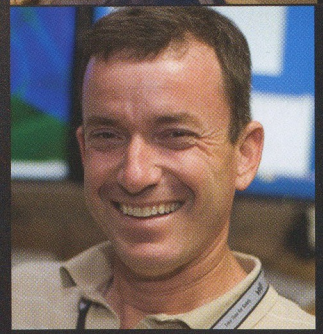




(Clockwise from top left) Eddie Carden, Loreyna Yeung, Bob Charles, Rick Churray, Sudha Natarajan and Kathy Guild.





(Clockwise from top) Luci Crittenden, Jill Prince, Paul Banicevic, Scott Verden, Lynda Kramer and Ronnie Long.

ECONOMIC IMPACT

NASA lifts national and regional economies

Despite a budget decrease in fiscal 2008, NASA Langley's impact on the economy rose in some areas, and remained the same or declined in others, according to an analysis by The Wessex Group, Ltd., of Williamsburg, Virginia.

Overall, the news is good: Langley "generates enormous economic benefits for its neighbors throughout the region, state, and nation," the Wessex report said.

Langley's $740 million budget for 2008 was a decrease of $18 million from the previous year. This includes agreements worth $14 million in work for other government agencies and the private sector.

The Wessex report analyzed the impact of both Langley and its smaller counterpart on the Eastern Shore of Virginia, NASA Wallops Flight Facility. The following is a summary of both the impact of Langley alone, and combined with Wallops.

The economic impact of Langley alone:

- U.S. — $2.2 billion and 18,184 full time jobs for research professionals, scientists, engineers, and support personnel.
- Of those total numbers, $1.1 billion and 10,400 jobs are in Virginia.
- $981 million and 9,108 jobs are in Hampton Roads.

The combined economic impact of Langley and Wallops:

- U.S. — $2.7 billion and 22,220 jobs.
- Virginia — $1.2 billion and 11,387 jobs
- Hampton Roads — $981 million and 9,108 jobs.

Langley facilities represent an investment in land, buildings and scientific equipment of approximately $3.3 billion. As Langley prepares for new missions and programs, increasing infrastructure investments likely will generate more economic benefits.

In 2008, Langley employed 3,700 people. Approximately 1,900 were civil service employees and 1,800 were private-sector employees working on- or near-site for companies that were contracted to provide support to NASA.

Support for an organization of this size requires a wide range of commodities and expertise such as engineering services, wind tunnel support and maintenance, laboratory testing, and computer equipment. These goods and services contribute to business development, create jobs and increase the tax base.

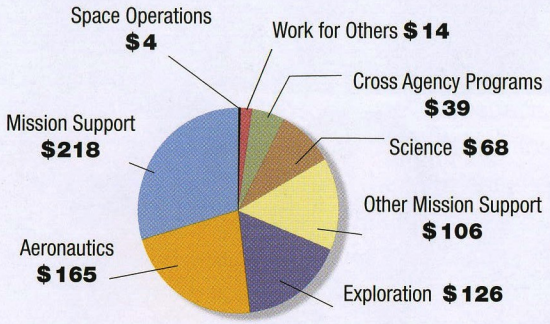
Economic benefits flow directly and indirectly from:

- Procurements and expenditures made in support of NASA programs, including payroll, operating expenditures, and construction outlays.
- Contractors hired and paid by NASA to assist in the fulfillment of its mission.
- Visitors and professionals from around the world who contract with NASA for use of facilities and spend money in the community while they are here.

On the next page is a state-by-state illustration of Langley's top monetary obligations to business contractors, nonprofit institutions, and educational institutions. Nearly every state is a recipient of NASA funding.

Langley FY 2008 Research & Development Funding

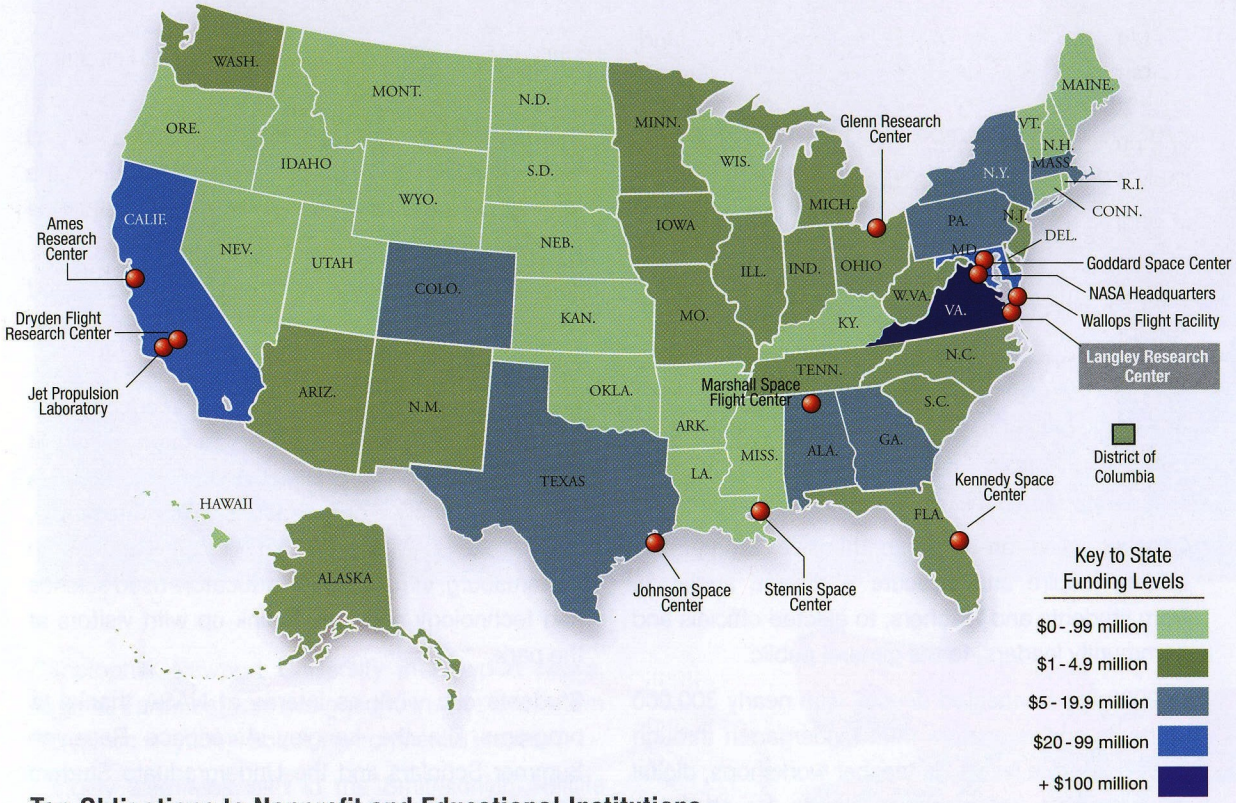
Dollars in millions



Langley Budget Profile

Dollars in millions

Langley Spending by State, Fiscal Year 2008



Top Obligations to Nonprofit and Educational Institutions

Dollars in millions

National Institute of Aerospace	$ 24.7
Pennsylvania State University, State College	7.7
Georgia Tech Research Corp.	4.2
City of Hampton	3.9
Morgan State University	3.3
The Aerospace Corp.	2.3
Virginia Tech	1.6
Stanford University	1.4
University of Arizona	1.2
Old Dominion University Research Foundation	1.2
University of Virginia	1.1
City University of New York	1.1
North Carolina State University	1
Logistics Management Institute	1
George Mason University	1
University of Florida	1
University of Texas, Austin	.9
Northeastern University	.8
Fairmont State University	.8
Virginia Air & Space Center	.8

Top Obligations to Business Contractors

Dollars in millions

Jacobs Technology Inc.	$ 91.4
ATK Swales	47.6
Science Systems & Applications Inc.	37.3
Science Applications Intl. Corp.	24.7
Northrop Grumman Corp.	18.0
Raytheon Technical Service Company	15.5
Lockheed Martin Government Services	14.3
Tessada & Associates Inc.	13.9
Analytical Mechanics Associates Inc.	11.7
The Boeing Company	10.5
Unisys Corporation	8.2
Dominion Virginia Power	7.4
Alliant Techsystems Inc.	6.2
IBM Corp.	6.0
Chugach Industries Inc.	5.6
ILC Dover Inc.	4.8
Science & Technology Corp.	4.8
ASRC Management Services Inc.	4.5
Mainthia Technologies	4.0
CSC Applied Technologies	3.6
Dresser-Rand Product Services	3.1
Modern Machine & Tool Company Inc.	3.0
Four Dimensional Leadership	3.0
Analytical Services & Materials Inc.	2.6
Air Products & Chemicals Inc.	2.1

EDUCATION & OUTREACH

Connecting the next generation

NASA/Sean Smith

Astronaut Andy Thomas talks with students at Langley's annual Aerospace Day at the General Assembly building in Richmond, Va.

Warner Brothers

Actors James Marsden and Cameron Diaz in a scene from the movie "The Box" filmed partially at Langley.

As an agency supported by your tax dollars, NASA has a duty to let you know what kind of return you're getting on investment. That's one of the reasons Langley runs education and outreach programs – we want to tell you about all of the great things being done to positively impact your world.

Another reason: boosting interest among young people in science and math careers. That's especially critical these days because of increasing competition from other countries for global technology leadership.

Langley relies on a comprehensive program to inform, inspire and educate a diverse audience, from students and teachers, to elected officials and community leaders, to the general public.

In 2008, we connected directly with nearly 300,000 students and educators from kindergarten through post-doctorate levels via teacher workshops, digital learning, and activities and events for students. Langley reached another 2.5 billion households and individuals through the news media and public events.

In an effort to reach even more students, Langley launched the Virginia Aerospace Science and Technology Scholars (VASTS) program in 2008. VASTS is an interactive online science, technology, engineering and mathematics learning experience, highlighted by a six-day residential summer academy. Students are immersed in NASA-related research through interaction with scientists, engineers and technologists. The program is a partnership with the Virginia Space Grant Consortium, with assistance from the Virginia Department of Education.

Overall in 2008, some $15 million was obligated to educational programs at 11 colleges and universities.

Another Langley program – informal education – reaches students and educators through events at science centers, museums, planetariums, libraries and community organizations. For example, at Exploration Day 2008 at Busch Gardens in Williamsburg, Virginia, NASA educators used science and technology activities to link up with visitors at the park.

Students can work as interns at NASA thanks to programs like the Langley Aerospace Research Summer Scholars and the Undergraduate Student Researchers Project.

Langley also has a robust program to engage the public as well as officials and industry and community leaders. In the past year we reached audiences through stories about Langley in newspapers, magazines, radio, the Internet and television. Our speakers — employees who volunteer their time — addressed dozens of community groups.

We touched hundreds of thousands of people by sending Center personnel and exhibits to public events, such as EarthFest, held in partnership with

NASA/Sean Smith

NASA/Sean Smith

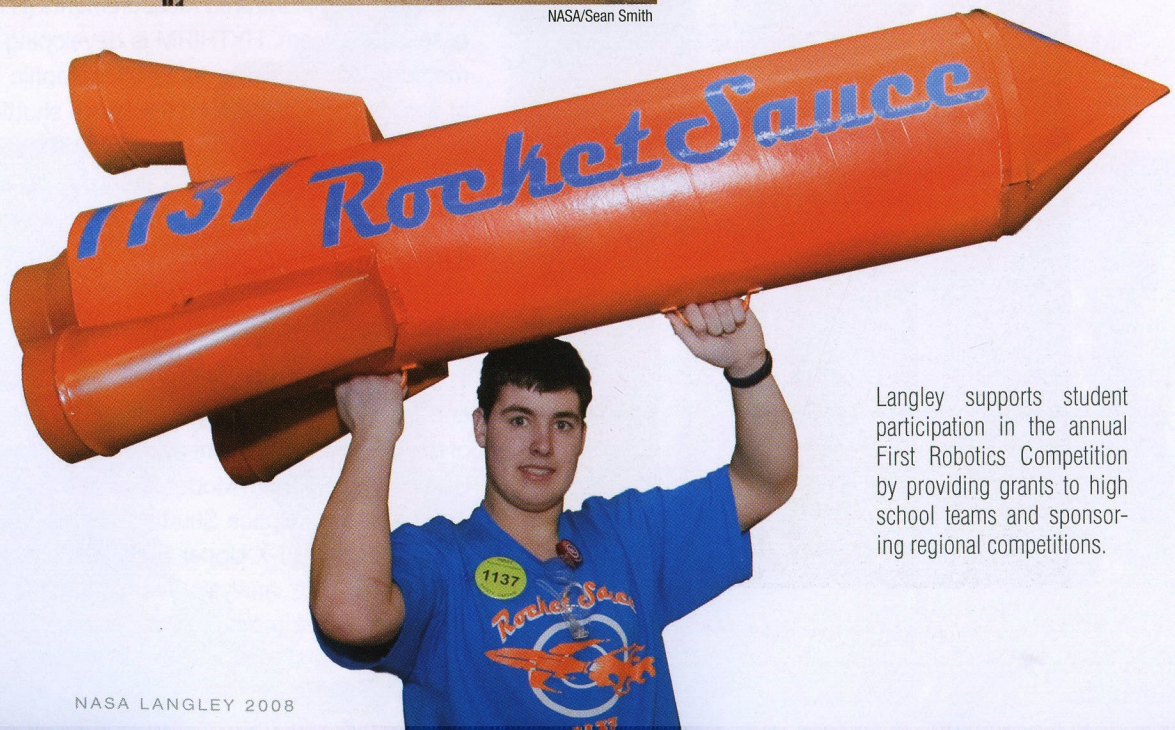
(Above) Teacher Becky Jamarillo works with students during Exploration Day at Busch Gardens in Williamsburg.

(Left) NASA was a big part of the Smithsonian.Folklife Festival in Washington, D.C.

Christopher Newport University in Newport News, Virginia. EarthFest was designed to inspire and inform the public — you — about environmental issues.

Langley also took part in the Smithsonian Folklife Festival in Washington, D.C. More than a million people from around the country heard NASA speakers, toured exhibits, and engaged in hands-on activities at the National Mall. The festival showcased the role that the men and women of NASA have played in broadening the horizons of science and culture.

In addition, Langley's offsite visitor center, the Virginia Air & Space Center in Hampton, offers education and outreach activities highlighting technology achievements. For more on the Virginia Air & Space Center, see page 32.



Langley supports student participation in the annual First Robotics Competition by providing grants to high school teams and sponsoring regional competitions.

AGENCY OFFICES

NASA Engineering & Safety Center

Langley continues to support the NESC mission to address NASA's high-risk programs and projects. Langley is home to the NESC's Directors Office, Systems Engineering Office and the Management and Technical Support Office.

Space Operations Support

In 2008, Langley assisted investigation of damage discovered in the space shuttle's thermal-protection system. The Center's carbon-carbon composite material experts are investigating exactly how such damage occurs, and are assisting in developing solutions. Langley experts in structures, materials and nondestructive evaluation are also assessing the integrity of structural elements related to NASA's new generation of rockets, including the Ares I and Ares V launch vehicles that will be used for missions to the International Space Station, the moon and, eventually, Mars.

The Ares I and Ares V launch vehicles.

Calibration and Validation

Langley provided technical leadership in 2008 for NESC-sponsored development and release of a NASA technical standard for models and simulations, as well as to the NESC-sponsored Hypersonic Thermodynamic Infrared Measurements (HYTHIRM) assessment team. HYTHIRM is developing sensing methods and software for thermographic imaging of aerodynamic heating on the space shuttle during atmospheric reentry. The ultimate goal is to provide data for calibration and validation of empirical and theoretical computer models to evaluate the aerodynamic forces faced by NASA's emerging family of rockets and spacecraft.

NESC Awards

This year Langley personnel received four group and four individual awards from NESC. Recipients of the Group Achievement awards were the 8% Max Launch Abort System Model Team, the Ice Mitigation Approaches for Space Shuttle External Tank Team, the NESC ARES I-X Upper Stage Simulator Critical Initial Flaw Size Analysis Team, and the Langley Mission Support Team.

Earth System Science Pathfinder

The Earth System Science Pathfinder (ESSP) Program is an innovative approach for addressing Earth science research, providing windows of opportunity for new scientific innovations. It includes a series of projects that are built, tested, and launched in a short time interval. This approach gives the program the flexibility to take advantage of opportunities presented by domestic and international cooperative efforts or technical innovation.

Missions are peer-reviewed science investigations selected from proposals submitted in response to Announcements of Opportunity. Missions are led by a principal investigator, who is responsible for science integrity, assembling the mission team, and the overall success of the mission. Mission teams may include university, industry, government, Federally Funded Research and Development Centers and international partners.

ESSP manages previously selected operational and developmental missions and is chartered to implement the Earth science decadal survey Venture initiative. Venture missions provide the Earth science community with frequent opportunities, focus on innovative science and span both suborbital and orbital mission options.

Independent Program Assessment Office

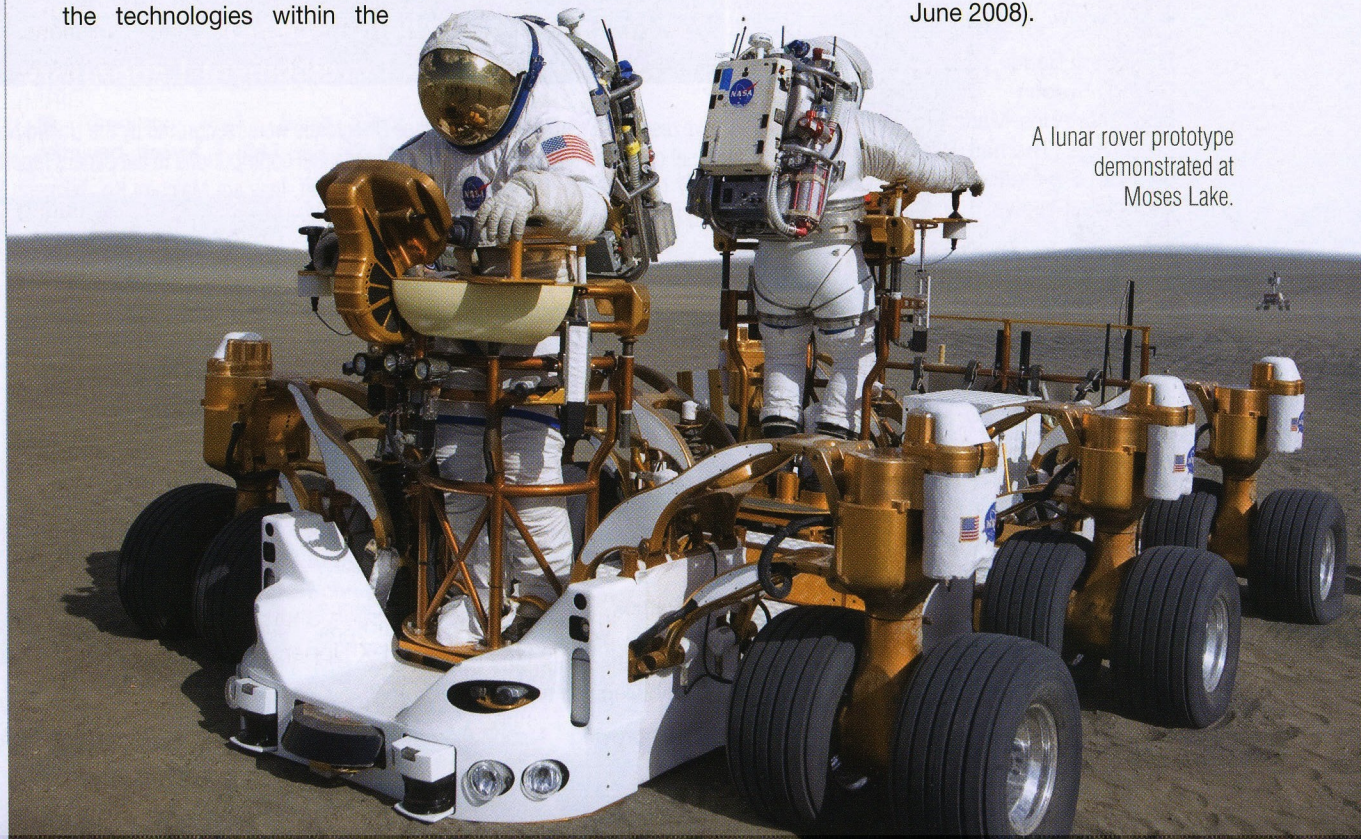
Within NASA's Office of Program Analysis and Evaluation, the Independent Program Assessment Office (IPAO) provides unbiased, nonpartisan findings and recommendations to NASA decision-makers. IPAO has the responsibility for enabling the independent review of the agency's programs and projects at life-cycle milestones to ensure the highest probability of mission success.

In 2008 IPAO continued to develop and finalize the Standing Review Board (SRB) Handbook construct for life-cycle reviews, introducing the concept of integration of key requirements into a single, standalone assessment. One of the major issues addressed in the finalization of the Handbook was working with the Office of Chief Counsel and Procurement to ensure the avoidance of conflict of interest. SRB implementation also ensured that decision authorities, mission directorate associate administrators and technical authorities will benefit from consistent, efficient, and value-added independent lifecycle reviews and products.

In calendar year 2008, IPAO completed more than 16 reviews consisting of biennial program implementation assessments, project milestone reviews and other special reviews including comprehensive evaluations of the Constellation Program and Projects system requirements review. IPAO has made several recommendations to enhance program and project mission success that focus on remediation of major issues while building on existing program and project strengths in management and execution.

Exploration Technology Development Programs

The Exploration Technology Development Program (ETDP) seeks, formulates, and matures advanced technology for NASA's Exploration Mission, initially returning humans to the moon and then further to the solar system. ETDP's diverse technology portfolio consists of over 20 high-priority, requirements-driven projects which span space transportation, lunar landing systems, and lunar surface systems. While ETDP is managed from a program office located at Langley Research Center, the project teams are comprised from experts from across NASA and industry. Nominally, the technologies within the ETDP will mature until a demonstration of the design concept in a relevant environment is completed. At that point, they will be transitioned to the Constellation Flight Program (e.g. Lunar Lander). ETDP projects also work with the Lunar Precursor Robotic Program to provide spacecraft design input and to validate technologies for flight prior to the human application (e.g. validate a fuel cell first on a robotic mission to the moon). Also, ETDP provides support to analog demonstrations of future vehicle and surface systems (e.g. Desert Research and Technology Systems field tests at Moses Lake, Washington in June 2008).



A lunar rover prototype demonstrated at Moses Lake.

RECOGNITIONS

NASA Langley employees are active participants in professional organizations. This participation helps Langley researchers share information with peers and learn more about trends in their fields. The following employees were recognized by professional organizations.

■ Robert Hall was recognized as the 2008 Engineer of the Year by the American Institute of Aeronautics and Astronautics (AIAA) Hampton Roads Section, and in AIAA Region I.

■ Ivatury Raju was selected as the 2009 Engineer of the Year by the American Institute of Aeronautics and Astronautics (AIAA) Hampton Roads Section.

■ Damodar Ambur was selected as an AIAA Fellow.

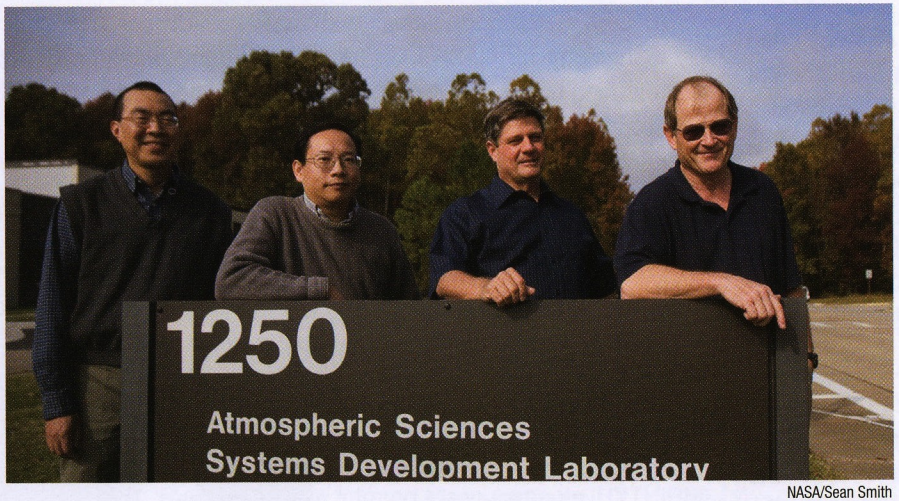
■ Robert Baurle, Scott Berry, Victoria Chung, John Davidson, Richard DeLoach, Anna-Maria McGowan, David McGowan, Thomas Pinelli, Lesa Roe, and Kurt Severance were selected AIAA Associate Fellows.

■ Bruce Wielicki received a 2008 Presidential Rank Award for Distinguished Senior Professional.

■ Cindy Lee received a 2008 Presidential Rank Award for Meritorious Executive.

■ Jill Prince was recognized as the recipient of the first Robert Mitcheltree Young Engineer of the Year Award, presented by the AIAA Hampton Roads Section. She also received the Doug Ensor award, presented by the Peninsula Engineers Council.

■ Sang Choi, Advanced Materials and Processing Branch, was named among the top 50 Nanotech innovators for 2008 by Nanotech Briefs.



NASA/Sean Smith

Five researchers in Langley's Science Directorate were recognized by the United Nations International Panel on Climate Change for making substantial contributions to the panel's report, which shared the 2007 Nobel Peace Prize with Al Gore. From left, they are Malcolm Ko, Takmeng Wong, Pat Minnis, and Bruce Wielicki and Larry Thomason (not pictured.)

■ Bruce Wielicki, Climate Science Branch, was named a Fellow of the American Meteorological Society (AMS).

■ Richard Eckman, Chemistry & Dynamics Branch, was invited to serve as an Associate Editor of the IEEE "Journal of Selected Topics in Applied Earth Observations and Remote Sensing" (J-STARS) for a three-year period.

■ Patrick Minnis, Climate Science Branch, was named the 2008 Distinguished Alumnus of the University of Utah Department of Meteorology.

■ "Improving National Air Quality Forecasts with Satellite Aerosol Observations," was one of five papers selected for the highest level of 2007 Scientific and Technical Achievement Award by the US Environmental Protection Agency (EPA). Langley co-authors include Jassim Al-Saadi, Brad Pierce (now with the National Oceanic and Atmospheric Administration), Chieko Kittaka, Doreen Neil and Jack Fishman.

■ Richard Eckman became the coordinator of the Climate Change Science Program (CCSP) Atmospheric Composition Interagency Working Group, a 23-member interagency team.

■ Bruce Doddridge, Chemistry & Dynamics Branch, was elected to the Board of Directors of the American Association for Aerosol Research (AAAR).

■ Donna Speller Turner, Advanced Planning & Partnership Office, was selected as one of 12 Women of Distinction in Career Government by the YWCA Virginia Peninsula.

■ Jeff Cerro, Vehicle Analysis Branch, was elected Fellow by the Society of Allied Weight Engineers and was recognized for serving as chairman of the government/industry committee.

■ Natalia Alexandrov was appointed to the membership committee of the Society for Industrial and Applied Mathematics (SIAM) and was recognized for outstanding work as a graduate student team mentor at the Workshop on Mathematical Modeling in Industry at the University of Minnesota, Institute for Mathematics and Its Applications (IMA).

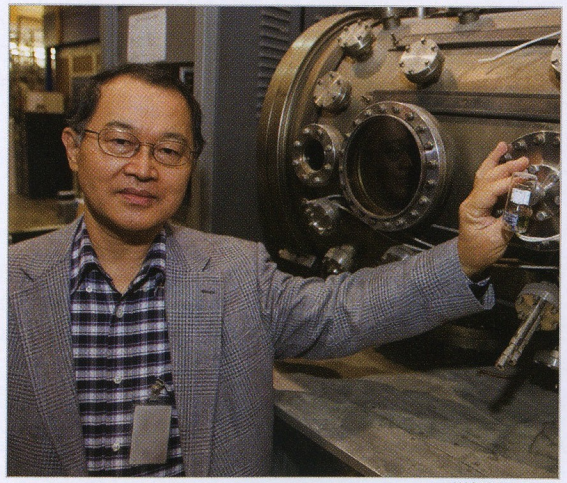
■ Susan Gorton, Research & Technology Directorate, received the US Army Aeroflightdynamics Directorate Andrew W. Kerr Award for Interagency Cooperation.

■ Fabiola Martin, Environmental & Logistics Branch, was recognized by the Virginia Peninsula United Way for serving as the 2007 NASA Combined Federal Campaign Loaned Executive.

PATENTS

In pushing the boundaries of knowledge, Langley researchers frequently develop new techniques, materials, and devices with applications that are beneficial outside of their uses in aerospace and science. These unique achievements are registered with the U.S. Patent Office. In 2008, Langley researchers developed ideas that led to 99 invention disclosures, 24 patent applications, $324,604,00 in royalties, and 11 patents issued.

- Jan Smits, Marlen Kite, Thomas Moore, Russell Wincheski, JoAnne Ingram, Anthony Watkins, Phillip Williams received patent 7,278,324 B2 for Carbon Nanotube-Based Sensor and Method for Detection of Crack Growth in a Structure.
- Toshiaki Ueno, Alan Hargens, and William Yost received patent 7,381,186 B2 for Method and Apparatus to Assess Compartment Syndrome.
- Jeffrey Jordan, Anthony Watkins, Jacqueline Schryer, and Donald Oglesby received patent 7,318,915 B2 for Oxidation-Reduction Catalyst and its Process of Use.
- Billy Upchurch (posthumously) and David Schryer received patent 7, 371,358 B2 for Catalyst for Treatment and Control of Postcombustion Emissions.
- Sang Choi and Yeonjoon Park received patent 7,375,808 B2 for Method and System for Sensing and Identifying Foreign Particles in a Gaseous Environment.



NASA/Sean Smith

Sang Choi, Advanced Materials and Processing Branch was awarded three joint patents in 2008.

- Yeonjoon Park, Sang Choi, Glen King, Jae-Woo Kim, and James Elliott received patent 7,379,231 B2 for Ferroelectric Light Control Device.
- Michael Jones, Tony Parrott, Laurence Heidelberg, and Edmane Envia received patent 7,334,998 B2 for Low-Noise Fan Exit Guide Vanes.
- Yeonjoon Park, Sang Choi, and Glen King received patent 7, 341,883 B2 for Silicon Germanium Semiconductive Alloy and Method of Fabricating Same.
- Marc Shultz received patent 7,321,185 B2 for Active Mutistable Twisting Device.
- Ji Su and Tian-Bing Xu received patent 7,394,181 for Hybrid Electromechanical Actuator and Actuation System.
- Jeffrey Jordan, David Schryer, Patricia Davis, Anthony Watkins, Jacqueline Schryer, Donald Oglesby, Suresh Galati, and Jerry Summers received patent 7,390,768 B2 for Stabilized Tin-Oxide-Based Oxidation/Reduction Catalysts.

VISITORS WELCOME

The Virginia Air & Space Center educates and inspires

The official visitor center for NASA Langley Research Center, the Virginia Air & Space Center (VASC) is home to more than 30 historic aircraft, interactive exhibits and unique space flight artifacts that highlight NASA Langley's role in aerospace.

Guided by a mission to educate, entertain and inspire the next generation of explorers, VASC served more than 412,000 visitors in 2008. More than 220,000 of these were students, grades K-12, who were encouraged to pursue careers in math, science and technology through cutting-edge educational programming, interactive science demonstrations, and docent-led tours that focus on math and science standards of learning.

NASA/Sean Smith

More than 23,000 at-risk students received assistance from VASC's Opportunity Program last year, experiencing an array of innovative educational opportunities not available elsewhere.

Extensive aviation and aerospace exhibits highlight Langley's role in aviation safety and 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 Adventures in Flight gallery includes a number of hands-on exhibits and flight simulators that cover more than 100 years of aviation history.

Recently, VASC opened Space Quest: Exploring the Moon, Mars and Beyond, an interactive gallery that celebrates the spirit of exploration through a number of components highlighting NASA technologies and the past, present and future of space exploration. Interactive exhibits and simulators include the Mars Transporter Theater, a Mars exploration rover model and a lunar-landing simulator. VASC is also home to the Apollo XII Command Module, a moon rock, and Langley's Lunar Excursion Module Simulator.

The visitors' experience is enhanced by the five-story-high 3D IMAX Theater that offers a variety of compelling and educational films like "Space Station 3D" and "Walking on the Moon 3D" which chronicle NASA's exploration initiatives.

For more information about the Virginia Air & Space Center, go to www.vasc.org

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LOOKING BEYOND

As NASA Langley looks to the future, we see many exciting opportunities. Langley will continue to play an integral role in NASA's space exploration, aeronautics research, and Earth and space science missions.

On our plate in the coming year:

Testing the Orion's launch abort system. The Orion crew module simulator, built at Langley in 2008, will be part of the launch abort system test conducted at the White Sands Missile Range in New Mexico in 2009. This will be the first in a series of uncrewed abort tests designed to ensure Orion can execute a safe, reliable method of escape in case of an emergency on the launch pad or during climb to orbit.

Developing technologies for flight above the speed of sound. We will continue to work with Gulfstream Aerospace Corporation developing technologies that will allow environmentally friendly, efficient passenger flight above the speed of sound. In addition, we will extend the hypersonic X-51 scramjet engine operation to the Mach 6.0 range during tests beginning in 2009, as part of a continuing effort to enable flight at extremely high speeds.

Expanding our understanding of Earth's climate. Our scientists will continue their climate research with new missions, including the launch of the Clouds and the Earth's Radiant Energy System FM5 (CERES FM5). This mission will help determine the effect of changes in the Earth's cloud cover on planet temperature and climate.

Celebrating the first steps on the Moon. We look forward to celebrating the 40th anniversary of the first human steps on the Moon on July 16, 1969, during the Apollo 11 mission. You'll see a lot about this historic event in the news and on the Internet in the coming months.

Reaching young people

We will also continue reaching out to our many stakeholders – like you – who help us achieve our mission. I am particularly enthusiastic about our many education programs focused on encouraging students to pursue technical careers. We had terrific success with a pilot program, the Virginia Aerospace Science and Technology Scholars (VASTS) program, this year and will continue the success into 2009. This is a critical time nationally as other nations challenge the U.S. leadership in technology research and development, and are producing many more engineers than we are. NASA is working to address this challenge through our current and new educational initiatives like VASTS.

On behalf of everyone at NASA Langley, thank you for reading this report. We are proud of what we have accomplished and are excited about the future. Through your interest and support, and that of others, the spirit of exploration will continue as we work to build a better tomorrow.

Lesa B. Roe
Director