National Aeronautics and Space Administration

EARTH AIR & SPACE

NASA LANGLEY RESEARCH CENTER 2009

Building The Future In Aerospace And Science

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NASA

The Ares I-X is guided to Pad 39-A at Kennedy Space Center prior to its successful test launch in Oct.

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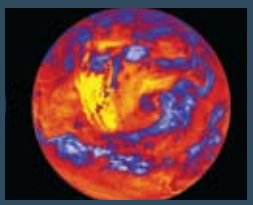

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A message from the Director

Langley had an incredibly successful year. Our work lays the foundation for the nation's future in aerospace and science while making ground-breaking innovative discoveries. I'll highlight just a few of the Center's 2009 research activities here and invite you to turn the pages for more details.

Three new technologies were tested through exciting one-of-a kind flight demonstrations this past year. The Inflatable Re-entry Vehicle Experiment or IRVE was successfully launched from Wallops Flight Facility on the Eastern Shore of Virginia in August. This was the first time anyone has successfully flown an inflatable re-entry capsule which demonstrated that a spacecraft returning to Earth can use an inflatable heat shield to survive near hypersonic speed re-entry into the atmosphere. We plan to further explore the inflatable heat shield technology with future launches at Wallops.

The Max Launch Abort System or MLAS was also successfully tested at Wallops in July. This prototype test evaluated an alternative pad-abort concept.

The Ares 1-X Flight Test Vehicle was successfully launched in October at Kennedy Space Center. This developmental flight test gathered data on many aspects of NASA's new rocket configuration, the first of its kind in over 30 years. NASA and the aerospace community learned much about the development and testing of new space launch vehicles from designing, building, and launching the vehicle. Langley managed systems engineering and vehicle integration; developed the guidance, navigation and control algorithms; and fabricated the simulated Orion crew module, and the launch abort system for this flight test.

Langley was selected as the lead for a new NASA Science mission, Climate Absolute Radiance and Refractivity Observatory or CLARREO. The mission will enable more accurate detection of climate changes and provide new knowledge to improve climate model forecasts. With CLARREO, NASA and partner organizations will monitor the pulse of the atmosphere to better understand climate change.

In July, we also broke ground on a new building, our first in a series of New Town buildings that will support Langley's people for years to come. We partnered with the U.S. General Services Administration (GSA) on the design and construction. The new building will be environmentally friendly and energy efficient earning a prestigious LEED silver rating as recognized by the international green building certification system. This efficient building will replace older facilities and significantly reduce Center operating and maintenance costs.

We are also very proud that Langley, as part of the Commercial Aviation Safety Team (CAST), received the aviation community's highest honor, the 2008 Collier Trophy, for reducing deadly aircraft accidents by over 80 percent in ten years. This is the seventh Collier that Langley has received and is an indication of the high value that is placed on our research by the nation's aerospace community.

As we continue to build America's future in aerospace and science, we appreciate your support and look forward to sharing more of our accomplishments with you.

An artists concept of an Inflatable Re-entry Vehicle Experiment (IRVE) similar to the one successfully tested at Wallops Flight Facility in August.

NASA

Improving Upon a Half-Century of NASA Spaceflight

Striking out from familiar homesteads to unknown territory has long been a human endeavor. There is something innately exciting about the novel and the unexplored. On Earth, that has meant sailing across broad waters to new lands. Now, humankind is pursuing a far more difficult journey: off-planet to the many worlds beyond.

Supporting Ares Development

Carrying a new generation of explorers will be NASA's Constellation family of space vehicles. Two new launch vehicles, Ares I and Ares V, form the basis of NASA's Constellation Program. Ares I will deliver the crew-carrying Orion spacecraft to the International Space Station and other destinations in low-Earth orbit. Ares V, the larger and higher-payload capable vehicle, is slated to carry Earth-departure craft and the proposed Altair lunar lander into orbit and on to the moon.

Langley is responsible for overall vehicle aerodynamics, or how the vehicles will fly, and draws upon unique expertise in computational analysis methods and wind tunnel facilities. Critical contributions include collecting, analyzing and documenting this aerodynamic data to support the Ares I design as it moves through the normal design process.

In addition to the key contributions in aerodynamics, Langley continues to support other key areas such as guidance, navigation and control, and structural and thermal analyses for the Ares I Upper Stage. Langley has provided significant contributions to the larger Ares V launch vehicle development by conducting studies to understand how the use of advanced technologies such as lightweight metallics and advanced composite materials can improve the performance.

Major Contributions to Orion

Langley is also playing a key role in the crew-carrying Orion spacecraft, including managing development of the Orion Launch Abort System, which will fly the crew to safety in the event of rocket malfunction or other emergency, and leading the development and testing of Orion Landing Systems options. Using our expertise in structures, materials, and impact dynamics analyses, as well as our unique drop testing capability, Langley played a key role in driving the discussion of trades between water vs. land landing, resulting in a decision to go with water landing. Given this decision, Langley secured funds to upgrade its drop test facility to perform water-landing tests to help qualify the Orion crew-module structure.

The Orion crew module's energy-absorbing strut concept was successfully tested in June at Langley's Landing and Impact Research Facility.

Langley has also made significant contributions to the Orion heat shield design, analysis, and testing. Langley is manufacturing a series of Orion flight test articles, the first of which includes a command module mass simulator scheduled to fly on the first test of the Launch Abort System. This first test will simulate an abort on the launch pad and is scheduled for early 2010.

Research for the Future

In addition to providing key support to development of the Constellation vehicles, Langley is leading development of technologies for the next set of vehicles to take us back to the moon. These technologies include lightweight structures such as composites, advanced sensors and controls for safe moon landings, inflatable materials for building habitats, tools for predicting harmful radiation, and finally systems for protecting the astronauts from this and other hazards.

Flying Shuttle Safely

Langley continues to play a key role flying the space shuttle by providing real-time

technical support to evaluate heating effects during re-entry into the atmosphere, that may result from debris impact damage to shuttle tiles or wing leading edges. Langley has also developed a new measurement technique to obtain real-time, high-resolution temperature measurements of the bottom of the shuttle as it reenters Earth's atmosphere. This measurement technique has been named HYTHIRM (Hypersonic Thermodynamic Infrared Measurements) and obtains data from a combination of aircraft based and land based sensors, and provides critical data to help validate computer models to design safer, more efficient vehicles that will reenter the Earth's atmosphere at these hypersonic speeds. To date, HYTHIRM has successfully collected data on three shuttle missions.

NASA/JSC

(Above right) Technicians at the Army's White Sands Missile Range in New Mexico practice the stacking process that will one day be involved in mating the Orion Pad Abort-1 flight test launch abort system and crew module hardware.

(Far right) Langley technicians complete stacking of key Ares I-X rocket hardware elements prior to a successful July flight test of an alternative launch-abort system.

(Right) Ares I-X simulated crew module and launch abort system flight hardware at NASA's Kennedy Space Center in Florida.

EXPLORATION

As part of a project managed by ETDP, the Lunar Electric Rover (LER) is shown during a test in the Arizona desert.

ETDP: Developing Technologies for Mission Success

What started 40 years ago with the Apollo Program's achievement of "landing a man on the moon and returning him safely to Earth," has prompted NASA to develop a sustained human presence on the Moon using its new human spaceflight architecture known as the Constellation Program.

The Orion crew exploration vehicle and Ares launch vehicles, complete with Altair lunar lander, will replace the space shuttle, making it possible for return missions to the moon and future missions to Mars and beyond.

NASA's Exploration Technology Development Program (ETDP) is an important part in that effort. ETDP develops and matures technologies needed to travel to the moon, build lunar outposts, collect data from the moon's geography and geology, and provides what is required to survive on the moon for extended periods of time.

ETDP also creates new technologies that lower the risks associated with exploring space for astronauts as they perform a variety of tasks.

Managed from a program office at Langley, ETDP's project teams are comprised from experts from across NASA and industry, spanning space transportation, lunar landing systems, and lunar surface systems. In addition to hosting ETDP, Langley researchers are solving some of the tougher challenges in such areas as radiation protection, materials and structures, and autonomous landing and hazard avoidance.

ETDP's goal is to mature technologies to a demonstration point in the design concept, in a relevant environment to the lunar and Martian surface. Upon reaching the desired technology readiness level, the technologies can be transitioned for use by the Constellation Program.

The NESC: Real-Time Problem Solving

Langley continues to support NASA's Engineering and Safety Center, or NESC, in its mission to analyze issues that confront 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.

The NESC celebrated several notable accomplishments this year, among them the very successful pad abort demonstration test of the Max Launch Abort System from Wallops Flight Facility in July. In addition, NASA's Composite Crew Module was completed and delivered to the Center in September for full-scale structural testing. These achievements provided concrete examples of how agency-wide, diverse, multigeneration teams enable robust, timely and innovative solutions to NASA's tough technical problems.

The NESC remains focused on providing real-time problem solving for the space shuttle and International Space Station programs, with particular attention to the shuttle as it flies out its remaining missions. We also continued to actively support numerous critical robotic spacecraft missions, including the Mars Science Laboratory and the James Webb Space Telescope.

The NESC expanded the NASA Technical Fellows program this year to include passive thermal and electrical power. In addition, we are partnering with the newly established Technical Fellows within the NASA Safety Center and expanded collaboration across the Agency.

Success for NASA Flight Tests

In October, the Ares I-X rocket sailed into the sky during a successful launch at Kennedy Space Center. Ares I-X, the first flight test of the over 300-foot tall Ares I design, produced 2.6 million pounds of thrust to accelerate the rocket to nearly 3 g's and Mach 4.76, just shy of hypersonic speed. It capped its easterly flight at a suborbital altitude of 150,000 feet after the separation of its first stage, a four-segment solid rocket booster. The flight of the Ares I-X provided an early opportunity to test and prove hardware, models, facilities, and ground operations associated with the new Ares I vehicle. Langley was key to the success of Ares I-X. A Langley team led the Systems Engineering and Integration (how all the pieces fit and work together) and was also responsible for the fabrication of the Crew Module/Launch Abort System (CM/LAS) mass simulator.

This past July, the Max Launch Abort System, or MLAS, was successfully tested in a simulated pad-abort test at NASA's Wallops Flight Facility on Virginia's Eastern Shore. The unpiloted test was part of an assessment by the Langley-based NASA Engineering and Safety Center (NESC) that, in a mere 20 months, oversaw the design and construction of the 33-foot-tall, 18-foot-wide MLAS launch vehicle.

The unpiloted MLAS vehicle included a full-scale crew module simulator and bullet-shaped composite fairing, integrated launch abort system, a "boost skirt" and a "coast skirt," which mimicked the tip of a crew launch vehicle that could be used for future piloted spacecraft.

Although the bullet-shaped MLAS concept will not replace the Orion abort system, the prototype, used in the test to evaluate means to safely propel a spacecraft and its crew from an errant rocket, represents a departure from the tower-launch abort system used during Apollo launches and retained for the Constellation Program.

Improving the Design of Next-Generation Spacecraft

The Ares I-X launch offered an early opportunity to test and validate hardware, facilities and ground operations: critically important data for the design and development of future space vehicles. During the flight, a wide range of data from 700 sensors was collected and relayed to ground stations that provided unique "flight data" that cannot be collected in computer simulations or ground test facilities, but are invaluable for correlating with and validating computer models and analysis. These sensors gathered information in several areas, including assembly and launch operations, separation of the vehicle's first and second stages, controllability and aerodynamics, the re-entry and recovery of the first stage and new vehicle design techniques.

"Ares I-X provides NASA with an enormous amount of data that will be used to improve the design and safety of the next generation of American spaceflight vehicles — vehicles that could again take humans beyond low Earth orbits," said Doug Cooke, associate administrator for the Exploration Systems Mission Directorate at NASA Headquarters in Washington.

The NESC's launch of MLAS at Wallops Flight Facility in July.

The Ares I-X launch at Kennedy Space Center in October.

NASA/KSC

Pushing the Boundaries of the Known

Safety. Innovation. Breakthroughs. For NASA Langley engineers and scientists, these are but three attributes that sum up Center aeronautics-related studies in 2009.

Accidents at Historic Lows

As a key member of the Commercial Aviation Safety Team (CAST), Langley was corecipient of the 2008 Collier Trophy for helping to achieve an unprecedented level of safety in U.S. commercial airline operations. As the result of years of aviation-safety research, the risk of a deadly airline accident has declined 83 percent, resulting in two consecutive years of no deaths from mishaps on commercially scheduled airlines.

CAST was formed in the late 1990s in response to a government and industry challenge issued by the 1997 White House Commission on Aviation Safety and Security to reduce the commercial aviation accident rate 80 percent over 10 years. Today, fatal accidents have diminished to one in 22.8 million flights, an extraordinary achievement.

Advancing the Science of Flight

Hypersonics, the field of study that examines flight at five times the speed of sound and faster, took an important step forward in 2009 with the Langley-managed Inflatable Re-entry Vehicle Experiment, known as IRVE. Langley personnel delivered the re-entry vehicle and flight-tested IRVE-II, launching it on August 17 to an altitude of 131 miles from NASA's Wallops Flight Facility on the Virginia coast. The liftoff was the first successful flight of an inflatable re-entry vehicle.

Such technologies hold great promise for future space missions because their lightweight but robust heat shields will protect crew and payload during planetary landings.

Greener, Quieter Aircraft - Environmentally Responsible Aviation

NASA is enabling future, advanced, environmentally responsible aircraft and operations. A historic Langley wind tunnel this past year hosted a test of the prototype of a new, more fuel-efficient, quieter aircraft design. The X48C blended wing-body concept, or BWB, was put through its paces in the Langley 30 x 60-Foot Tunnel to determine the aerodynamic effects of design modifications made to reduce community noise.

Blended wing body designs differ from traditional tube-and-wing aircraft. Vehicle wings merge seamlessly into the fuselage for lower drag and reduced fuel

(Right) Workers prepare the Inflatable Re-entry Vehicle Experiment (IRVE) for launch.

(Far right) Researchers test the "deployable energy absorber" at Langley's Landing and Impact Research Facility with the help of a helicopter donated by the Army.

consumption and emissions. These aircraft operate more quietly because engines are placed above the wing surface. Stable flight is achieved with the activation and operation of multiple wing-control surfaces.

As part of the BWB effort, Boeing Research & Technology is partnering with NASA and the U.S. Air Force Research Laboratory to explore and validate structural, aerodynamic and operational advantages. The Air Force is interested in a full-scale X48C version's potential as a multirole, long-range, high-capacity military aircraft.

Helicopter Components Put to the Test

In 2009, NASA's Subsonic Rotary Wing Project conducted three simulator skid-gear — flat-plate swing tests at the Center's Landing and Impact Research Facility, known as LandIR. The research was designed to evaluate the energy-absorption capability of a potential landing-gear subsystem, and in anticipation of crash tests of a full-scale airframe in 2010.

Helicopters are counted among the most complex of any aeronautical vehicle. By nature, such craft experience unsteady air flows from low speeds to speeds nearly at the speed of sound, harsh operating environments, and propulsion systems that are highly stressed.

Rotary-wing studies conducted at LandIR collect vital impact data used to improve crash-dynamic predictions. The results could one day be applied to a new generation of landing-gear components and lead to other structural improvements that would increase survivability in a crash.

(Above) The X-48C 8.5% scale blended wing-body flight test aircraft undergoes evaluation in the final test in Langley's historic 30 x 60- Foot Wind Tunnel. The tunnel has evaluated nearly every type of aircraft since it was constructed in 1930.

(Right) Advanced aircraft configurations offer the promise of environmentally responsible aviation operations; with reduced fuel consumption, reduced emissions and lower noise.

Boeing

Langley Shares in Seventh Collier Trophy

For the second year in a row, NASA is part of a team chosen to receive one of the most prestigious awards in aviation.

The National Aeronautics Association presented the 2008 Robert J. Collier Trophy to the Commercial Aviation Safety Team, or CAST, a unique industry and government partnership established in 1997 with the goal of reducing the U.S. commercial aviation fatal accident rate by 80 percent in 10 years. Langley has been recognized by seven Colliers since its first recognition in 1929.

The 2007 Collier Trophy went to a team that included NASA's Langley and Ames research centers for their work on Automatic Dependent Surveillance-Broadcast, or ADS-B, a system that allows aircraft to be tracked by satellite rather than radar.

CAST represents thousands of people in public agencies and private industry "who have worked diligently since 1997 to produce the safest commercial aviation system in the world," according to the Collier Trophy award nomination submitted by the Air Transport Association (ATA).

CAST analyzed data from some 500 accidents and thousands of safety incidents around the world. The idea was to use that information to come up with the most critical safety technologies, systems and procedures to reduce accident risk and ultimately save lives. NASA funded research and development of analytical tools and data-mining capability, which were incorporated into the Federal Aviation Administration's (FAA) safety monitoring system.

The nomination notes the partnership's original goal was thought difficult, if not impossible, to achieve. However, as the ATA pointed out in its nomination papers, the CAST team reported a fatalities reduction of 83 percent, with "2008 [topping] the previous year as the safest … in commercial aviation history."

NASA's Aviation Safety Program (AvSP) has been a part of CAST since the team was first established. Researchers at four NASA centers have worked with CAST, including Langley; Ames Research Center at Moffett Field, Calif.; Dryden Flight Research Center in Edwards, Calif.; and Glenn Research Center in Cleveland.

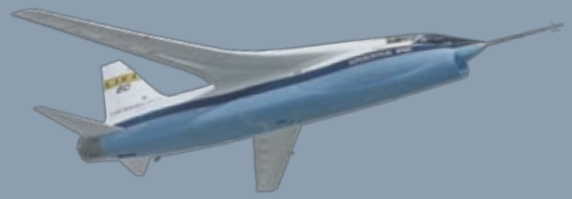
NASA aligns its project activities with CAST's key goals and safety interests, such as runway incursions and aircraft icing, said George Finelli, who managed AvSP from 2002 to 2006 and now heads the Center's Operations Directorate.

"I think it's wonderful that the National Aeronautics Association has recognized CAST's efforts," Finelli said. "One of the things that made the team unique is that member organizations, including airlines, pilots and manufacturers, were volunteering to change what they did, instead of having to follow a mandate."

The Commercial Aviation Safety Team included: NASA, the FAA, the U.S. Department of Defense, the European Aviation Safety Authority, Transport Canada Civil Aviation, the Air Line Pilots Association, the Allied Pilots Association, the International Federation of Air Line Pilots' Associations, the National Air Traffic Controllers Association, the Aerospace Industries Association of America Inc., the Air Transport Association of America Inc., Regional Airline Association, Airbus, The Boeing Company, GE Aviation (representing all engine manufacturers), and the Flight Safety Foundation.

Trophy/The National Aeronautics Association

(Far right) Langley's 14 x 22- Foot Subsonic Tunnel seen with fan blades removed during minor repairs.



Passing of an Aeronautical Legend

Aviation pioneer Dr. Richard "Dick" Whitcomb, known as one of the 20th century's major figures in the field of aerodynamics, died in October 2009. Almost any large airplane today – especially those that fly at supersonic speeds – bear the legacy of the former NASA Langley employee who some believe was a bona fide aeronautics genius.

"Dick Whitcomb's intellectual fingerprints are on virtually every commercial aircraft flying today," says Tom Crouch, noted aviation historian at the Smithsonian Institution. "It's fair to say he was the most important aerodynamic contributor in the second half of the century of flight."

Born in Illinois in 1921, Richard Travis Whitcomb was the son and grandson of engineers. He grew up in Worcester, Mass., building model airplanes, in an era when aviation pioneers such as Charles Lindbergh were household names. His interest in aeronautics continued into college at Worcester Polytechnic Institute, where he joined the aeronautics club and spent much of his time in the school's wind tunnel.

Overcoming One of the Biggest Challenges

Whitcomb came to what is now known as NASA Langley Research Center in 1943. In less than a decade he surmounted one of the biggest challenges of the day: how to achieve practical, efficient transonic and supersonic flight.

In interviews over the years Whitcomb recounted his "Eureka!" moment when he envisioned what became known as the Whitcomb area rule. He theorized the shape of an airplane fuselage could be pinched in slightly to reduce the shock-wave drag that occurs near the speed of sound. For that innovation Whitcomb won the 1954 Collier Trophy for the year's greatest achievement in aviation in the U.S.

Whitcomb conceived three important aeronautical breakthroughs while at Langley. The second, his "supercritical wing," revolutionized the design of jet liners after the 1960s. The key was development of an airfoil flatter on the top and rounder on the bottom with a downward curve on the trailing edge. That shape delayed the onset of drag, increasing the fuel efficiency of aircraft flying close to the speed of sound.

An article on birds in the 1970s led Whitcomb to develop his third significant innovation – winglets. Other engineers had suspected that end-plates added to the wing tips could reduce drag. Whitcomb proved a simple vertical plate wasn't enough. "It is a little wing. That's why I called them winglets," said Whitcomb. Many airliners and private jets today sport wingtips that are angled up for better fuel performance.

Richard Whitcomb died Oct. 13, 2009 and was cremated. He is survived by a sister, a brother, a stepbrother and a nephew. Whitcomb's final request was that his ashes be spread from an airplane over the Chesapeake Bay.

Whitcomb & aircraft photos/NASA

Unlocking the Secrets of Earth's Atmosphere

Winds blow. Seas roil. Temperatures plummet — or soar. Rain, snow, hail, sun: all of this, averaged over time, is what we call climate. Understanding how and why climate changes, how and why the atmosphere acts the way it does, is the focus of much research at NASA Langley.

Here at the Center we gather information about our atmosphere by every means available. We develop instruments and measurement techniques for land, air and space. Because we are passionate about understanding what's truly changing on Earth, what we learn is put to use for the greater good: a safer planet and a better tomorrow.

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. So we strive to be as accurate, dedicated, responsible, courageous, curious and persistent about learning the secrets of Earth's atmosphere. A deeper understanding of the planet's complex physical and biochemical systems means all of us can anticipate and respond to environmental threats to ensure a healthy planet for generations to come.

Smoke and Sometimes Fire

In 2009, Center researchers tracked and studied pollution, smoke and fires from both aircraft and space to better understand the large-scale atmospheric impact of small particles known as aerosols, the least understood variable in long-term climate-change scenarios. In April, Langley scientists took vertical-profile images using an instrument known as the High Spectral Resolution Lidar (HSRL) to show how the plumes of smoke from fires near a Myrtle Beach, S.C. wildfire moved up and away from the source. The resultant data will be used to improve U.S. Environmental Protection Agency models of fire emissions. In June, the HSRL team also traveled to the southern Great Plains in search of more detailed aerosols information.

This new information complements data from the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite. CALIPSO's first-ever operational-satellite observations of vertical profiles of clouds and aerosols in the atmosphere, combined with data from other satellite constellations, are enriching our climate-system understanding and providing new insights into air quality. For example, a recently published study used CALIPSO data to show for the first time that the warming effect of aerosols increases with the amount of cloud cover below the aerosols.

This newfound capability could improve long-term projections of global climate models. Incorporating new understanding of the atmosphere, such as the relationship between clouds and aerosols, will improve computer-generated predictions that policymakers use to design the best responses to climate change.

The CALIPSO project completed its nominal three-year mission in June of this year and just received approval to continue operation for another two years.

Upper Atmosphere Insights

In 2009, our scientists took a closer look at the upper atmosphere, studying in depth its relationship to the sun. Through analysis of data from the Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) satellite instrument, our scientists observed for the first time a "breathing," an expansion and contraction of the Earth's upper

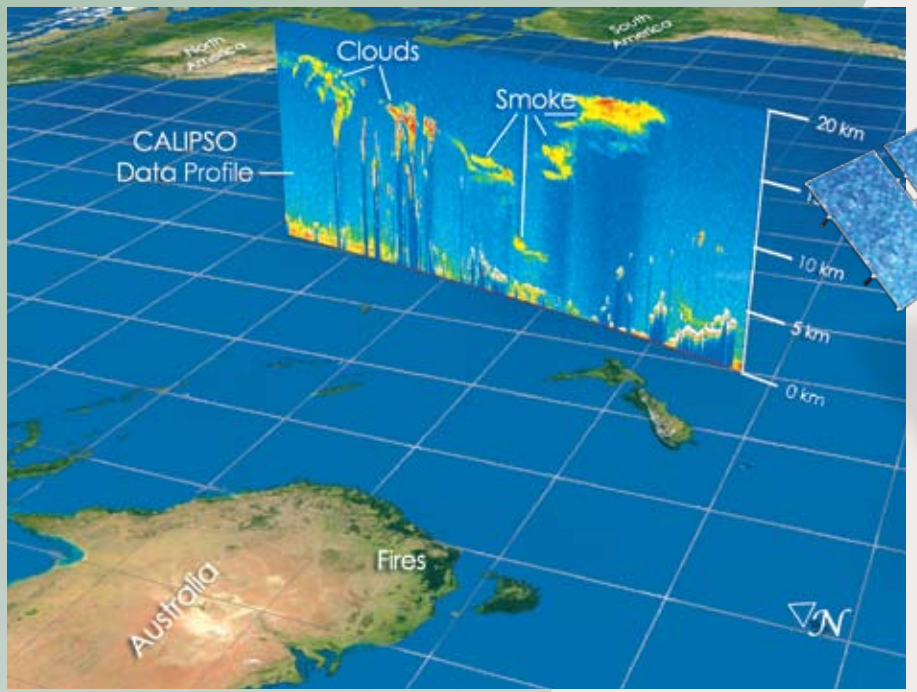
An artist's concept of a solar storm that unleashes bursts of radiation that can reach crew and passengers on commercial flights at certain altitudes and latitudes. Scientists at NASA's Langley Research Center are working on a real-time model of radiation exposure risk for air travel.

NASA

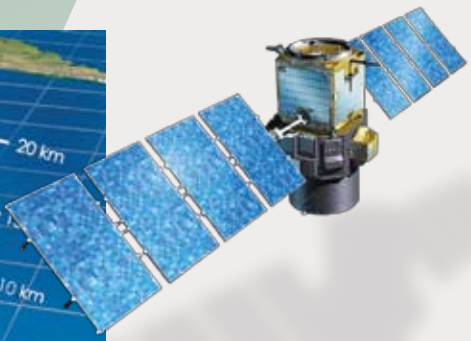
atmosphere in response to periodic, high-speed solar winds. These findings may improve predictions of the ionospheric electron concentration, which affects radio communications and GPS signals. The periodic nature of the solar disturbances may also influence the climate of the upper atmosphere.

Center researchers also studied ionizing radiation that affects aviation safety. Passengers and flight crews are exposed to radiation because the shielding from Earth's atmosphere against high-energy solar particles and cosmic rays is weaker at normal cruising altitudes than at the surface. The issue has been of concern to pilots, crews and scientists for some time, but this is the first real-time, data-driven, global model for predicting not just cosmic background radiation, but also radiation during solar storm events. In 2009, Langley specialists began to develop specialized software that incorporates real-time data and modeling to estimate radiation exposure.

Mike Wusk/NASA HSRL Team



NASA/LaRC



In Feb. 2009, researchers from Langley tracked smoke plumes from wildfires in Australia to altitudes never observed before. CALIPSO's lidar technology took a vertical "slice" of the atmosphere to reveal the distribution of clouds and aerosols.

(Left) Langley scientist Fred Denn adjusts instruments that take a variety of readings for the CERES Ocean Validation Experiment (COVE) program from a Coast Guard tower at the mouth of the Chesapeake Bay.

(Far left) Langley researchers Mike Wusk and Ray Rogers and pilot Les Kagey flew a King Air B200 equipped with a High Spectral Resolution Laser over the wildfires in South Carolina to measure the behavior of the smoke plume produced by a fire that burned 19,600 acres.

Langley Is A Climate Science Powerhouse

Understanding the energetics of the Earth and its atmosphere — the balance of energy absorbed and energy reflected back to space — has long been a focus of the Science Directorate at NASA Langley. Our satellite missions have a legacy of helping scientists around the world understand how the sun affects Earth's climate system and, ultimately, how global climate is changing. Since its inception, the Clouds and the Earth's Radiant Energy System (CERES) mission has gathered that important data, building on the prior observations of NASA's Earth's Radiation Budget Experiment data to create a 30-year record of radiative flux at the top of Earth's atmosphere.

In 2009, NASA Langley continued to use CERES data to give the renewable energy community immensely popular information: Surface Solar Energy, or SSE. Builders, city planners and private citizens use the SSE dataset to determine prime sites for solar panels and even wind turbines. On average, the SSE Web site receives more than 300,000 hits and 150,000 data-file downloads per month.

A new CERES sensor, the Flight Model 5, was delivered late last year and awaits launch on the National Polar-Orbiting Operational Environmental Satellite System Preparatory Project satellite in 2010. Four CERES sensors currently operate on NASA's Terra and Aqua Earth Observing System spacecraft.

Better Climate-Factors Measurements

In 2009, this legacy was continued when NASA Langley was named the mission lead for the Climate Absolute Radiance and Refractivity Observatory mission, known as CLARREO. CLARREO is one of four "tier one" missions of the National Research Academies Decadal Survey, which has endorsed 17 missions in all.

CLARREO's value will come in providing a more accurate measurement of climate factors and effects than ever before. The mission is being designed to deliver to decision- and policy-makers enhanced climate information: not simply how much ice is melting and temperatures are rising, but also what factors are causing those changes. Results from CLARREO observations will be incorporated to improve computerized climate models and improve their ability to accurately predict the nature and effects of climate change.

> ... this data is going to be used to set national and maybe international policy
>
> CLARREO Mission Formulation Manager Steve Sandford.

"The key issue is that this data is going to be used to set national and maybe international policy," says CLARREO Mission Formulation Manager Steve Sandford.

CLARREO draws from the legacy of the CERES mission. As CERES Coprincipal Investigator and CLARREO Science Lead Dr. Bruce Wielicki notes, CERES aims to "answer a longstanding question in science concerning the role of clouds in amplifying or damping the sensitivity of the Earth's climate system."

The CLARREO group is currently about 50 strong at Langley, with the participation of some 20 others from beyond the Center. That group is likely to grow to 150 in coming years.

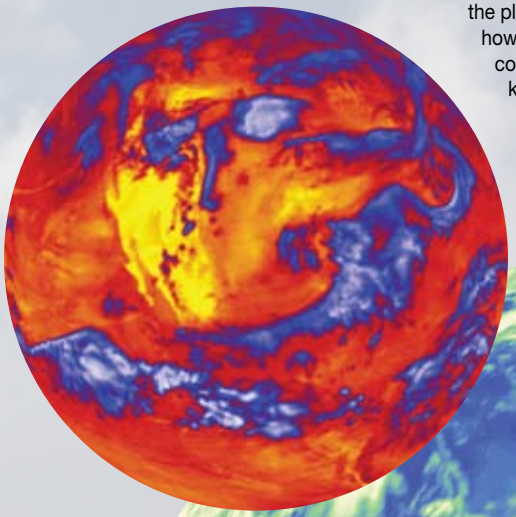
A New Era

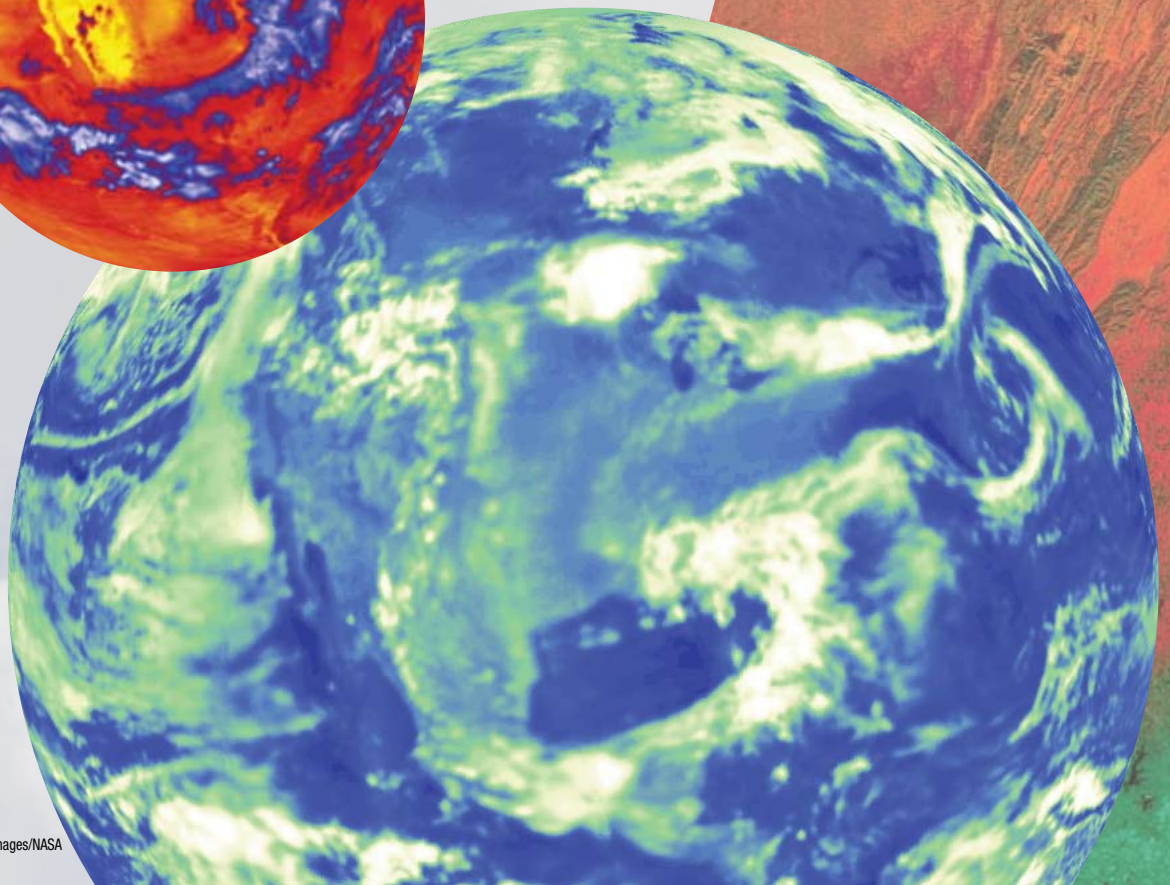
From July through October 2009, several Langley researchers took part in a field campaign high in the Atacama Desert of Chile, at a barren location almost equal to the elevation of the base camp on Mount Everest. The campaign employed Far-Infrared Spectroscopy of the Troposphere (FIRST), a spectrometer to measure the greenhouse effect of far-infrared radiation, which has been largely unexplored but is thought to account for half of the radiation Earth loses to space. FIRST is a prototype instrument: a test-bed for the kind of spectrometer that ultimately could be deployed in the CLARREO mission.

"Langley is on the verge of a new era in scientific contributions," says CLARREO's Steve Sandford, who thinks the mission may be Langley's biggest undertaking since the Center's involvement with Mars Viking in 1976. "The challenge is great, but over the years, Langley has demonstrated that it can meet a difficult challenge."

Image of U.S. mid-Atlantic region from Earth Observatory @ http://earthobservatory.nasa.gov/IOTD/

Langley's CERES instruments 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. These measurements are key to the science community's understanding of climate change.





CERES images/NASA

Critical Insights for Decision-Makers

To fly through the air or to travel into space requires vehicle and system architectures that are reliable and robust. Such systems are by nature complex, comprised of many elements that must work smoothly together. The goal of systems analysis is to ensure that requirements for performance and reliability are met, and solutions are affordable within the required timeframe.

At Langley, system analysis occurs in the disciplines of aeronautics, space exploration, science missions and space operations. The Center's experts provide critical insights for informed decision making.

We address broad systems perspectives such as: What are the possible architectures, concepts and approaches to fulfill a mission? What systems and technologies optimally enable these approaches? What are the associated costs and risks?

In 2009, we undertook a number of notable projects in support of NASA's aeronautics and space exploration initiatives.

Lunar electric rover (LER).

Improving Aeronautics Technologies

Because of the projected growth in future air traffic, the nation's airspace system will undergo a dramatic transformation. Areas affected range from air traffic operations to aviation safety to aircraft design. In addition, a new NASA program will focus on environmentally friendly aviation, whose ultimate aim is to keep the biosphere safe even as researchers create next-generation aircraft concepts featuring potentially revolutionary performance gains.

Among the 2009 aeronautics research efforts supported by Langley's systems analysis experts were studies of

- New wing-fuselage designs and advanced propulsion concepts that would lead to major improvements in aerodynamic efficiencies and significant reductions in carbon dioxide emissions
- Ultra-high bypass-ratio engine systems to substantially reduce polluting emissions and noise while boosting engine fuel economy
- Identification of aircraft icing hazards for current and future versions of commercial, general aviation and light sport aircraft
- Changes to the ways airplanes taxi, take off and land at increasingly congested airports and terminals.

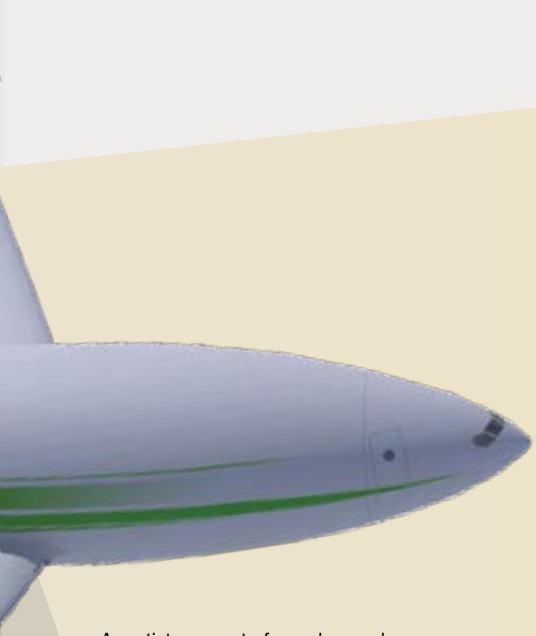
Supporting Space Exploration and Science

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 2009, Langley's systems analysts played a significant role in defining

and refining such architectures.

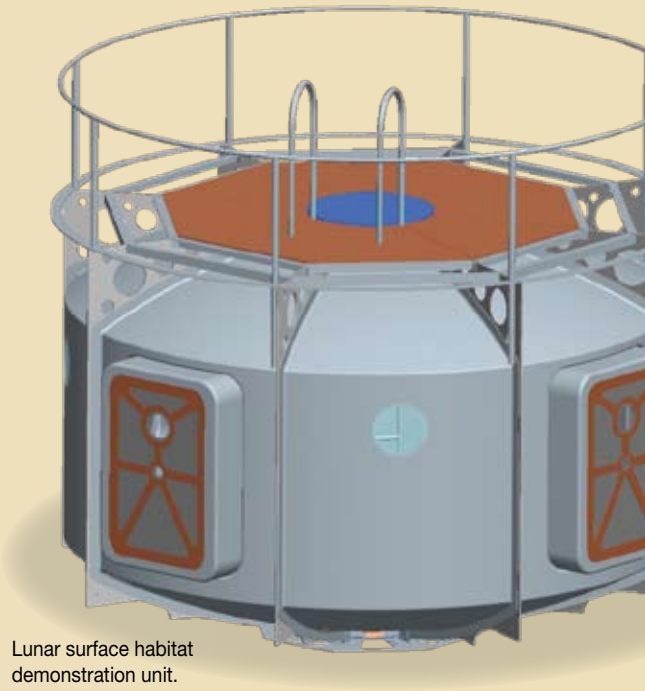
Our analysts conducted assessments of NASA's Constellation Program and its advanced technology suites that would enable the next generation of human space exploration. We supported system analysis for the Ares V rocket-shroud design, aerodynamic database development for the Ares I rocket, and trajectory analysis for the Ares I-X Flight Test Vehicle.

We analyzed development of NASA's initial lunar-surface buildup scenarios and associated polar-outpost architectures. We also examined the



An artist concept of an advanced Truss-Braced Wing (TBW) aircraft.

A concept of the ultra-high bypass-ratio engine system designed to improve emissions, noise, and fuel economy based on next-generation technologies.



Lunar surface habitat demonstration unit.

feasibility of the proposed Lunar Electric Rover. Our analysts evaluated the design, development and fabrication of a rover prototype and Portable Utility Pallet, which will be used to demonstrate lunar mobility on a simulated lunar surface test site.

In addition, 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 Earth science decadal missions, which largely focus on climate change and global environmental health.

Langley continued to provide systems analysis support to the International Committee on Earth Observation Satellites, evaluating the Earth-observing fleet of satellites currently in orbit.

Advanced mobility lunar surface systems architecture.

Images NASA/LaRC

Working Together with Industry

Technology development and transfer has long been a Langley priority. The Center's critical mass of aerospace experts, its unique facilities and tradition of creative problem-solving insures preeminence in applied innovation. Specifically, as a world leader in an ever-expanding universe of technology opportunity, Langley continually explores ways to team with others.

Rather than working in isolation to solve technical challenges, we have created a diverse array of partnerships at home and around the globe. Our traditional and nontraditional partners range from small firms and academia to large corporations and other federal agencies. This year, for example, we hosted an international trade delegation from Wales that had previously visited NASA Headquarters and then headed to Langley to discuss potential collaborations.

Dr. Robert G. Bryant inspects his coating insulation on lead wires of a Medtronic resynchronization device.

In 2009, the U.S. Air Force and Langley teamed on several projects, including testing and evaluating new aircraft developed by the Boeing Company. On the civilian side, the Center continues to work with the Federal Aviation Administration to create safer conditions within the nation's airspace system by improving air-traffic management procedures and processes.

A novel, Langley-developed method for manufacturing known as Electron Beam Free Form Fabrication (EBF^3) is the focus of a Langley-led industry and government alliance focused on reducing material waste and energy requirements associated with titanium structures.

The Business of Innovation

Langley's Small Business Innovation Research and Small Business Technology Transfer Programs (SBIR/STTR) Office actively works with Center researchers to find solutions to engineering challenges. For instance, one SBIR contract, with InterSense Inc. of Billerica, Mass., involves Langley support of InterSense in its development of a computerized head-worn display, or HWD, that future generations of civilian airline pilots may routinely use as the nation transitions to deployment of the Next Generation Air Transportation System.

Honeybee Robotics Spacecraft Mechanisms Corp. of New York City is working with Langley on a device that makes it easier to automatically exchange different tools on NASA's proposed Lunar Surface Manipulation System, or LSMS.

Through partnership seed funding, Langley scientists have also collaborated with engineers at Welch

Medtronic

Mechanical Designs. Maryland-based Welch designed and built a compact, rugged telescope as a constituent of a number of new, advanced air-quality instruments designed specifically for the tight constraints of uncrewed aerial vehicles. The telescope is now slated for future science missions. Langley investment resulted in significant company savings on instrument development.

Down-to-Earth Tech Transfer

While our inventors are creating new technology solutions for NASA's missions, they are also developing technologies that transfer to the commercial marketplace: in effect, bringing innovation back down to Earth.

Medtronic Inc., a leading international manufacturer of medical devices headquartered in Minneapolis, licensed Langley's LaRC-SI, a flexible resin material developed as insulation for an aerospace high-speed research program. The insulation is now used on the left-heart ventricle lead wire of one of Medtronic's cardiac resynchronization devices, which gives it the smallest circumference of any such lead. The device has been FDA-certified in the United States and has been given a similar designation in Europe.

Closer to home, a southeast Virginia small-business startup has licensed a technology known as SansEc from Langley. SansEc is a wireless sensor originally developed as a method for using thermal insulation as a damage-detection system on inflatable space structures. The company has incorporated the technology in a fuel-management system, now being used to measure fluid levels on Hampton, Virginia fire department boats.

NASA/ERIC KERBY

(Above) The fire department boats in Hampton harbor can now check fluid levels using Langley's SansEC wireless technology.

(Above right) An engineer inspects unfinished and polished models that have been manufactured using Langley-developed Electron Beam Free Form Fabrication (EBF^3).

(Right) A June test of a Langley-designed robotic manipulator proved it could lift and precisely position equipment: a useful companion to future astronauts working on the moon or on Mars.

Reaching 2.5 Billion Households

From participating in air shows to being part of a movie starring a famous actress, NASA Langley continues to push the edge of the envelope in its education and outreach activities.

In 2009, Langley connected directly with more than 300,000 students and educators from kindergarten through post-doctorate levels via teacher workshops, digital learning, and a host of other educational activities. Langley reached another 2.5 billion households and individuals through the news media and a variety of public events.

We sponsored a unique event called Yuri's Night, celebrating the flight of the first human in space — the Soviet Union's Yuri Gagarin in 1961 — and the first space shuttle flight in 1981. Yuri's Night celebrations have become an annual tradition around the world and are intended to inspire tomorrow's workforce.

Using eclectic methods to convey the message, a Yuri's Night party may feature anything from art installations, to laser shows, to high-profile bands. Langley's Yuri's Night was held at its official visitor center, the Virginia Air & Space Center in Hampton.

Considering the explosion of social media, Langley created a New Media Team that generated the Center's first presence on Facebook, MySpace, Twitter and similar venues. The team also created an experimental web site called openLangley, which is used by the Center's Emerging Professionals Committee. Thanks to Langley's use of social media, we now have friends and followers around the world, from Barcelona to Bangladesh.

Shows and Exhibitions

Langley also took part in Exploration Day at Busch Gardens in Williamsburg, the Experimental Aircraft Association's annual air show in Oshkosh, Wisc., the First Robotics competition in Richmond, and the Charleston HarborFest Air Show in South Carolina, to name just a few.

In addition, the Center hosted hundreds of students in summer education programs, drew teachers from around the country at the annual preservice teacher workshop, and doubled participation by students in the new Virginia Aerospace Science and Technology Scholars Program. The Scholars Program is an interactive online science, technology, engineering and mathematics learning experience highlighted by a six-day residential summer academy immersing students in research and interaction with scientists, engineers and technologists.

In keeping with NASA's emphasis on studying the

With help from its New Media Team, Langley has many new friends across the globe.

The NASA EDGE show had five million downloads as of December 2009.

Kristen Holden sports the latest in galactic fashion during the Yuri's Night Celebration held in April at the Virginia Air and Space Center.

Virginia Aerospace Science and Technology Scholars hold the robots they built for a competition held during a summer academy at Langley in July.

environment, Langley held an EarthFest daylong celebration at Sandy Bottom Nature Park in Hampton in September. The even was a public celebration, with exhibits, entertainment and activities indoors and outdoors.

Another unique event held in November was TEDxNASA. Dubbed "Space to Create," TEDxNASA was a daylong immersion in topics that ranged from science and technology to entertainment and the arts, with a variety of speakers from around the country gathered at the Ferguson Center for the Arts in Newport News.

Hollywood and More in Hampton

Does the name Cameron Diaz ring a bell? She's the star of the movie "The Box," a mystery thriller that opened in early November. One of "Box's" main characters, played by actor James Marsden, is employed by NASA Langley. The film features the Center's people and facilities, and opened in more than 2,600 theaters across the country.

Langley also has a robust program to engage the public as well as industry and community leaders. We reached audiences through newspapers, magazines, radio, the Internet and television. Our speakers, employees who volunteer their time, engaged dozens of community groups. And one of our Web-based programs, called eClips,™ won a Disney iParenting award for its appeal to young people. The program is available free via www.nasa.gov.

Among the four eClips™ programs, one — NASA 360 — won a coveted Emmy award. NASA 360 is a 25-minute show aired on TV stations around the world and on websites like nasa.gov and YouTube.

NIA/Jennifer Pulley

Mike Bibbo, left, and Kevin Krigsvold show off the Emmy they won for the NASA 360 video program. Both are producers for the National Institute of Aerospace, which creates the popular show in cooperation with NASA and Langley.

Teams from Virginia and as far away as Brazil and Canada competed in the Virginia Regional FIRST Robotics competition held this March in Richmond.

NASA/Sandie Gibbs

Going above and beyond to save a life

When Langley employee Paul Roberts went into cardiac arrest at a meeting in November, four other NASA employees immediately leaped to the rescue, administering CPR and summoning emergency personnel. Roberts, 50, was successfully revived and his four colleagues received Exceptional Bravery Medals. The medals were awarded by NASA's deputy administrator, Lori Garver, in December to (from left) Perry Wagner, Chip McCann, Paul Roberts, Mike Kirsch, and Jeff Stewart.

Langley's People Critical to Mission Success

Any organization's ultimate success depends on its most valued 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 performing mission support functions 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. Sixty 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 Langley work force is experienced, with an average of 20.8 years of federal service, surpassing the overall Agency average of 19 years.

To balance this experience with emerging talent, Langley placed special emphasis on its student pipeline programs in 2009. The Center participated in several events across the nation to recruit high-caliber individuals for our Student Career Experience Program (SCEP, formerly Co-Op). Our various student pipeline programs are an important element of our future strategy and increasing awareness of available opportunities and expanded recruitment efforts are critical.

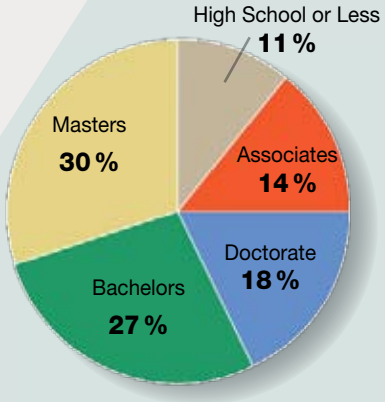
Positioned for a Dynamic Future

Langley also participated in the Agency's Early Career Hiring Initiative (ECHI) designed to recruit entry level hires, particularly in the fields of science, engineering, mathematics and technology. These hires are crucial to the long-term health of the Center's work force, and provide succession planning in critical work force competencies.

Langley's work force possesses a diversity of skills. Although the Center recognizes four broad occupation categories, 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; and mathematicians and physicists.

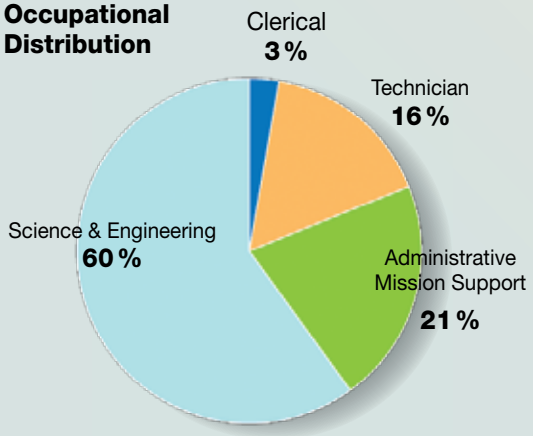
Mission support fields include human resources, finance, procurement, information technology and legal. Engineering technicians and electronics technicians account for the majority of technician positions, although the Center also has a number of quality-assurance and equipment specialists. Clerical positions include secretaries and administrative assistants. Each of these positions contributes to the success of the Langley mission and enables the Center to meet changing mission requirements and be better postured for a dynamic future.

Education Levels



(Excludes student programs)

Occupational Distribution



Whether civil servant or contractor, Langley's dedicated staff come from diverse backgrounds and disciplines — they include: from below left, Surbhi Gupta, John Dorsey, Michelle Munford, Michael Allen, Sarah Hargrove, Richard Boitnott, Tim Marvel and Todd Spangler

Dustin Hitt with a scale model.

Edith Robinson, Charlie Harris, the two Kathy Powell's, and Lelia Vann

Scholars Program Reignites Romance

I knew this summer was going to be important. Working for NASA is a surreal opportunity. New and exciting experiences were practically guaranteed, but I did not expect to fall in love – with jet fuel and combustion, that is.

A little background: I hail from South Dakota. I'm entirely Midwestern, from my accent to my farm-girl childhood. I am currently approaching my senior year at the University of South Dakota, pursuing double majors in chemistry and Spanish and a minor in physics.

I've been in love with chemistry since eighth grade. In high school, my mother let me draw the periodic table on my bedroom wall in permanent marker. I had grand plans to become a research chemist, devoting my life to compounds only a handful of people would ever hear about.

Last summer, however, chemistry and I suffered a nasty break-up as a result of a long and heart-wrenching 10 weeks of monotonous lab research in Tennessee. I hated every minute. The spark was gone. I felt betrayed. Dutifully, loyally, I gutted through junior year with no goals in sight.

In retrospect, as with most break-ups, my split with that old life plan was for the better. Imagine my surprise in April, when I was accepted to the Langley's Aerospace Research Summer Scholars Program (LARSS), to which I'd applied on a whim! Imagine my

hesitance when I found I'd be working in the Aeronautics Research Directorate. I knew nothing about airplanes, except that for me, any in-flight turbulence warrants a barf bag.

Fortunately, my invaluable teammates and mentors patiently brought me up to speed. My team is studying scramjets, hypothesized to fly at Mach 10 through the upper stratosphere.

Two engineering students work with the ideas behind the scramjet itself. I study the combustion of fuel to calculate the resulting amounts and identities of emissions. An atmospheric science student uses the data to determine the atmospheric effects of scramjets.

Immediately after starting my summer research, my flame of passion for chemistry returned. Ironically, the "spark" was ignited by my newfound interest in jet fuel and combustion!

I plan to graduate from USD this spring and pursue further education in the field of aerospace engineering, with goals to eventually do research in combustion and fuels.

The LARSS program has been integral in opening new doors for my future and allowing me to fall back in love with my major. Who knew NASA was such an aphrodisiac?

— Catherine Patrick, Univ. of South Dakota

Photo of Ms. Patrick/NASA/Aly Artusio-Glimpse

Langley Has Large Economic Impact

The economic impact of NASA on Virginia and the nation has been described as equivalent to that of an aircraft carrier.

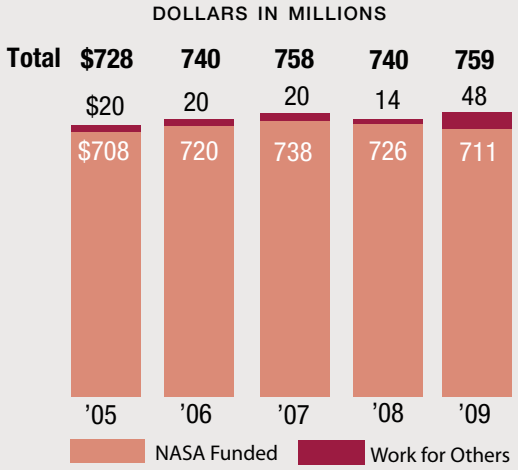
It's big. Some 3,700 employees, a $759 million funded budget authority.

"NASA's operations in Virginia generate enormous economic benefits for its neighbors throughout the region, state, and nation," says the Wessex Group Ltd. of Williamsburg, which was retained by Langley to assess its economic impact.

Despite a slight decline from earlier years, NASA Langley Research Center has maintained a relatively flat budget for the last five years.

There are two NASA field Centers in Virginia, NASA Langley Research Center and Wallops Flight Facility.

NASA Langley Budget Profile



Wessex analyzed the impact of Langley and Wallops, and the following is a summary of both Langley alone as well as combined with Wallops to present an overall picture of impact on the U.S. and Virginia.

Economic Impact of Langley Alone

- U.S.: $2 billion and 16,490 full-time jobs for research professionals, scientists, engineers and support personnel.
- Of those total numbers, $919.7 million and 8,138 jobs are in Virginia.
- $838.9 million and 7,615 jobs are in Hampton Roads.

The Combined Impact of Langley and Wallops

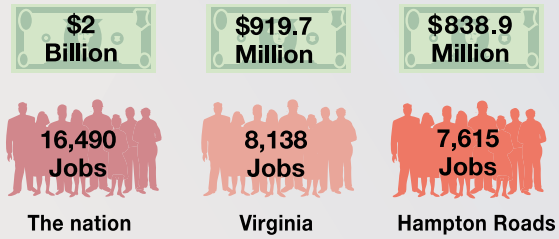
- U.S.: $ 2.7 billion and 21,941 jobs.
- Virginia: $1.15 billion and 10,295 jobs.
- Hampton Roads: $838.9 million and 7,615 jobs.

A Varied Stimulus

Langley's facilities, situated on 788 acres, represent an investment in land, buildings and equipment of around $3.3 billion. And as Langley prepares for new missions and programs, infrastructure investments are generating more economic benefits. For example, Langley's future includes new, state-of-the-art, "green" buildings in its New Town to replace aging structures. Six buildings are planned over 15 years. They will include three laboratories, two office buildings and a joint-use facility. The first building, which will house administrative offices, is a $29 million investment in a three-story, 74,000-square-foot structure.

Langley employed 3,700 people in FY09. About 1,900 were civil service employees and 1,800 were private-sector contractors on- or near-site, providing support to the Center.

Langley's Economic Impact



Langley and Wallops provide stimulus to the economy in a variety of ways, according to Wessex.

"A major source of economic output is obtained from the procurements and expenditures made in support of NASA programs, including payroll, operating expenditures and construction outlays," Wessex says.

"A second source of economic output derives from the contractors hired and paid by NASA to assist it in the fulfillment of its mission."

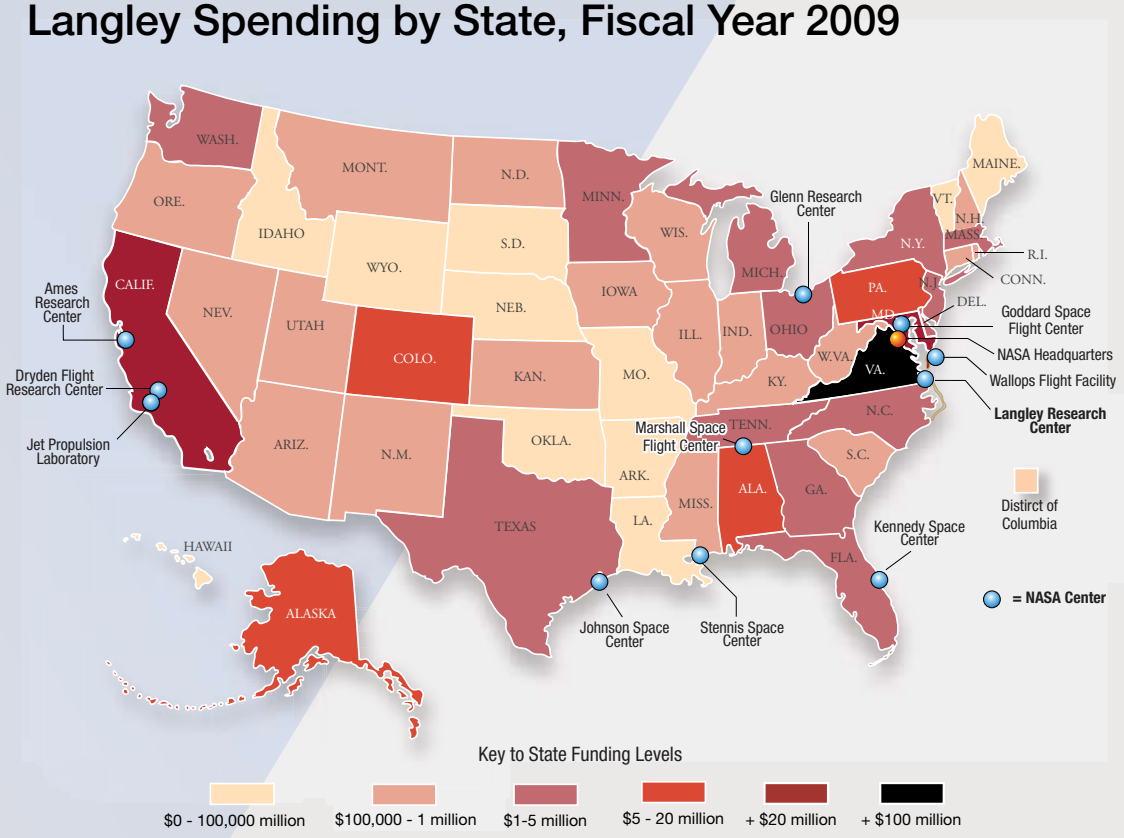
"Third, because of its unique research facilities, NASA also brings many visitors and professionals from around the nation and world ... these professionals contract with NASA, for a fee, to use its facilities for projects unrelated to NASA's primary mission. These fees are respent by NASA further increasing its benefit to the area.

"And, while in Virginia and Hampton Roads, these contractors spend money in the immediate area for accommodations, food and transportation" which translates to additional economic benefit to the local economies.

Top Obligations to Nonprofit and Educational Institutions

National Institute of Aerospace Assoc.	$ 20,764,780
City of Hampton, Va.	4,466,531
The Aerospace Corporation	3,644,457
Morgan State University	2,900,000
Old Dominion University Research Foundation	2,684,888
Pennsylvania State University	2,524,971
Georgia Tech Research Corp.	1,438,691
Cal Poly Corp.	1,419,520
Virginia Tech	1,317,633
Wheeling Jesuit University Inc.	1,200,000
Virginia Air & Space Center	861,000
University of Wisconsin System	745,240
Harvard University	650,000
Institute of Advanced Learning & Research	550,000
Sciencesouth Inc.	500,000
Newport News Waterworks	484,999
University of Illinois	400,000
Middle Tennessee State University	400,000
Leland Stanford Junior University	383,768
National Youth Science Foundation	300,000

Langley Spending by State, Fiscal Year 2009



Top Obligations to Business Contractors

Jacobs Technology	61,752,308
ATK Space Systems Inc.	44,127,854
Science Systems & Applications Inc.	34,653,901
Northrop Grumman	32,989,496
Raytheon Technical Service Company	19,662,479
Science Applications Intl. Corp.	18,962,926
Tessada & Assoc. Inc.	15,568,521
Dominion Power Company	13,355,431
Lockheed Martin Government Services	11,780,807
The Boeing Company	11,716,478
Virginia Natural Gas Inc.	11,271,116
Analytical Mechanics Associates Inc.	10,491,810
Chugach Industries Inc.	6,307,712
ASRC Management Services Inc.	5,892,090
Unisys Corp.	5,208,310
Northrop Grumman System Corp.	4,590,384
Four Dimensional Leadership	4,197,850
CSC Applied Technologies LLC	3,331,777
Analytical Services & Mat Inc.	2,947,922
Science & Technology Corp.	2,276,423
Safety & Quality Assurance Alliance	2,155,492
Center For Systems Management Inc.	2,012,124
Alliant Techsystems Inc.	1,869,476
Northwest Research Associates Inc.	1,804,121
Dresser-Rand Product Services	1,631,411

Celebrating at VASC with Yuri, Buzz and Neil

Serving as the official visitor center for NASA Langley Research Center since 1992, the Virginia Air & Space Center (VASC) is home to more than 30 historic aircraft, interactive exhibits and unique space-flight artifacts that showcase NASA Langley's role in aerospace.

The VASC is a valuable outreach vehicle for Langley, serving as host of numerous public activities. One of the more unique events held at the VASC in 2009 was Yuri's Night, which celebrated the flight of the first human in space — the Soviet Union's Yuri Gagarin in 1961 — and the first space shuttle flight in 1981. Yuri's Night featured interactive art displays, a laser show, local bands and other attractions to draw the younger audience that NASA and the aerospace industry is reaching out to as next-generation employees.

Guided by a mission to educate, entertain and inspire the next generation of explorers, VASC served more than 401,000 visitors in 2009. More than 239,000 of these were students who were exposed to math and science through cutting-edge educational programming, interactive science demonstrations, and docent-led tours that meet standards of learning guidelines. In addition, through VASC's Opportunity Program Inc., over 25,000 at-risk students received discounted or free educational experiences.

Extensive aviation and aerospace exhibits highlight Langley's role in aviation safety and in all aspects of NASA's mission from aeronautics and science to future missions to the moon, Mars and beyond. The Adventures in Flight gallery features a number of hands-on exhibits and flight simulators that span more than 100 years of aviation history.

The Center's space gallery, Space quest: Exploring the Moon, Mars & Beyond, celebrates the spirit of exploration through a number of interactive components highlighting NASA technologies and the past, present and future of space exploration. Visitors can travel to Mars in a simulated theater experience, program Mars rovers for a mission and land on the moon with a lunar landing simulator. The VASC is also home to the Apollo 12 Command Module, a moon rock, and Langley's Lunar Excursion Module Simulator.

A trip to the VASC isn't complete without an IMAX film experience. The five-story, 3D IMAX Theater offers a variety of educational films like "Space Station 3D," and "Walking on the Moon 3D," which chronicle NASA's exploration initiatives.

Volunteers from the Peninsula Astronomy Club offered equipment and expertise to party-goers at Yuri's Night Hampton Roads at VASC in April.

NASA

The 40th anniversary of the Apollo 11 moon landing was marked at the VASC and around the world. In this photo taken by Neil Armstrong, Buzz Aldrin becomes the second man to walk on the moon on July 20, 1969.

In March the launch abort system pathfinder hit the road on a week-long trip to White Sands Missile Range in New Mexico. On the way, it visited museums in Tennessee, Oklahoma, and Texas.

AWARDS & PATENTS

2009 AWARDS

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 recently recognized by professional organizations.

- Mujeeb Malik, Computational Aero-sciences Branch, was selected as a Fellow by the American Physical Society, the American Society of Mechanical Engineers, and the American Institute of Aeronautics and Astronautics (AIAA).
- Patrick Minnis, Climate Science Branch, was elected as a Fellow of the American Geophysical Union.
- Robert Baurle, Hypersonic Air-Breathing Propulsion Branch, was selected as an Associate Fellow by the AIAA.
- Scott Berry, Aerothermodynamics Branch, was selected as an Associate Fellow by the AIAA.
- Victoria Chung, Simulation Development & Analysis Branch, was selected as an Associate Fellow by the AIAA.
- John Davidson, Dynamic Systems & Control Branch, was selected as an Associate Fellow by the AIAA.
- Richard DeLoach, Aeronautics Systems Engineering Branch, was selected as an Associate Fellow by the AIAA.
- Anna Maria McGowan, Aeronautics Research Directorate, was selected as an Associate Fellow by the AIAA.
- David McGowan, Systems Engineering Directorate, was selected as an Associate Fellow by the AIAA.
- Thomas Pinelli, Strategic Relationships Office, was selected as an Associate Fellow by the AIAA.
- Lesa Roe, Center Director, was selected as an Associate Fellow by the AIAA.
- Kurt Severance, Advanced Engineering Environments Branch, was selected as an Associate Fellow by the AIAA.
- Suresh Joshi, Dynamic Systems & Control Branch, received the 2009 Control Engineering Practice Award from the American Automatic Control Council.
- Vincent Zoby, Aerothermodynamics Branch, was selected for the AIAA Thermophysics Award for 2009.
- Richard DeLoach, Aeronautics Systems Engineering Branch, received the AIAA Award for Best Air-Breathing Propulsion Paper for "Bayesian Inference in the Modern Design of Experiments."
- Richard DeLoach, Jill Marlowe, and Thomas Yager, received the AIAA Award for Best Ground Testing Paper for "Uncertainty Analysis for the Evaluation of a Passive Runway Arresting System."
- Jack Fishman, Chemistry & Dynamics Branch, received an Alumni Merit Award from The Saint Louis University College of Arts and Sciences.
- Malcolm Ko, Science Directorate, was selected as a reviewer for the international report "Scientific Assessment of Ozone Depletion 2010."
- Richard Eckman, Chemistry & Dynamics Branch, received a Department of State Group Superior Achievement Award.
- Truong Nguyen, Electromagnetics & Sensors Branch, was awarded a citation for contributions to the DO-294C, Guidance on Allowing Transmitting Portable Electronic Devices, by the Radio Technical Commission for Aeronautics.
- Kenneth Dudley, Electromagnetics & Sensors Branch, received a design logo award for his work with the national Materials Measurement Working Group.
- Christopher Johnston, Aerothermodynamics Branch, received the Robert A. Mitcheltree Young Engineer of the Year Award from the AIAA, Hampton Roads Section.
- John Lin, Flow Physics & Control Branch, received the 2009 Allan H. Taylor Memorial Award from the AIAA, Hampton Roads Section.
- The NASA Langley Geographic Information System (GIS) Team received a Special Achievement in GIS award, accepted by Brad Ball, Maintenance & Utilities Branch, from Environmental Systems Research Institute.
- Fran DeMarco, Information Technology Infrastructure Branch, was recognized by the Red Cross for her years of service as a board member.
- John Connell, Joseph Smith, and Paul Hergenrother received the NASA 2008 Invention of the Year for PETI-330, a composition of and method for making high performance resins for infusion and transfer molding processes.
- R&D 100 Magazine awardees include Langley's Sang Choi for his work on a next-generation silicon chip. Choi is on a team that created the world's first silicon germanium semi-conductive alloy, laying groundwork for development of ultra-fast chipsets.
- Rhombohedral Lattice-Matched SiGe, a semiconductor material for ultra-fast micro electronic applications received an R&D 100 Award for 2009.

2009 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 2009, Langley researchers developed ideas that led to 124 invention disclosures, 45 patent applications, $552,822 in royalties and 19 patents issued.

- Daniel Bivolaru, Paul Danehy, and Joseph Lee received patent 7,414,708 B2 for an interferometric Rayleigh scattering measurement system.

Continued next page

- Tian-Bing Xu, Xiaoning Jiang, Ji Su, Paul Rehrig, and Wesley Hackenberger received patent 7,446,459 B2 for a hybrid piezoelectric energy harvesting transducer system.
- Tom Finley and Peter Parker received patent 7,467, 536 B2 for a positioning system for single or multi-axis sensitive instrument calibration and calibration system for use therewith.
- Jan Smits, Russell Wincheski, JoAnne Ingram, Anthony Watkins, and Jeffrey Jordan received patent 7,491,428 B2 for a controlled deposition and alignment of carbon nanotubes.
- Florence Hutcheson and Thomas Brooks received patent 7,484,930 B2 for a noise reduction of aircraft flap.
- William Yost, Toshiaki Ueno, and Alan Hargens received patent 7,491,169 B2 for an ultrasonic apparatus and method to assess compartment syndrome.
- Sang-Hyon Chu, Sang Choi, Jae-Woo Kim, Peter Lillehei, Yeonjoon Park, Glen King, and James Elliott received patent 7,510,802 B2 for a multilayer ferritin array for bionanobattery.
- Theodorus Dingemans, Erik Weiser, and Terry St. Clair received patent 7,507,784 B2 for a liquid crystalline thermosets from ester, ester-imide, and ester-amide oligomers.
- Zoubeida Ounaies, Cheol Park, Joycelyn Harrison, Nancy Holloway, and Gregory Draughon received patent 7,507,472 B2 for a multilayer electroactive polymer composite material comprising carbon nanotubes.
- Stanley Woodard and Bryant Taylor received patent 7,506,541 B2 for a system and method for wirelessly determining fluid volume.
- Sidney Allison, Qamar Shams, and Robert Fox received patent 7,580,323 B2 for a tunable optical assembly with vibration dampening
- Yeonjoon Park, Sang Choi, Glen King, James Elliott, and Diane Stoakley received patent 7,514,726 B2 for a graded index silicon germanium on lattice matched silicon germanium semiconductor alloy.
- Zoubeida Ounaies, Cheol Park, Joycelyn Harrison, Nancy Holloway, and Gregory Draughon received patent 7,527,751 B2 for a method of making an electroactive sensing/actuating material for carbon nanotube polymer composite.
- David Greenblatt received patent 7,537,182 B2 for a simultaneous multiple-location separation control.
- Yeonjoon Park, Sang Choi, Glen King, and James Elliott received patent 7,558,371 B2 for a method of generating x-ray diffraction data for integral detection of twin defects in super-hetero-epitaxial materials.
- Stanley Woodard and Bryant Taylor received patent 7,589,525 B2 for a magnetic field response sensor for conductive media.
- Cheol Park, Kent Watson, Zoubeida Ounaies, John Connell, Joseph Smith, and Joycelyn Harrison received patent 7,588,699 B2 for electrically conductive, optically transparent polymer/carbon nanotube composites and process for preparation there of.
- Tak-Kwong Ng and Jeffrey Herath received patent 7,590,904 B2 for systems and methods for detecting a failure event in a field programmable gate array.
- Roberto Cano, Brian Grimsley, Erik Weiser, and Brian Jensen received patent 7,595,112 B1for a resins infusion of layered metal/composite hybrid and resulting metal/composite hybrid laminate.

POPULAR SCIENCE

TIME

Ares I Rocket, Launch Abort System Earn Accolades

NASA's Ares rocket was recognized by TIME Magazine as one of the top 50 best inventions of 2009 and the Launch Abort System earned a top innovation nod by Popular Science Magazine.

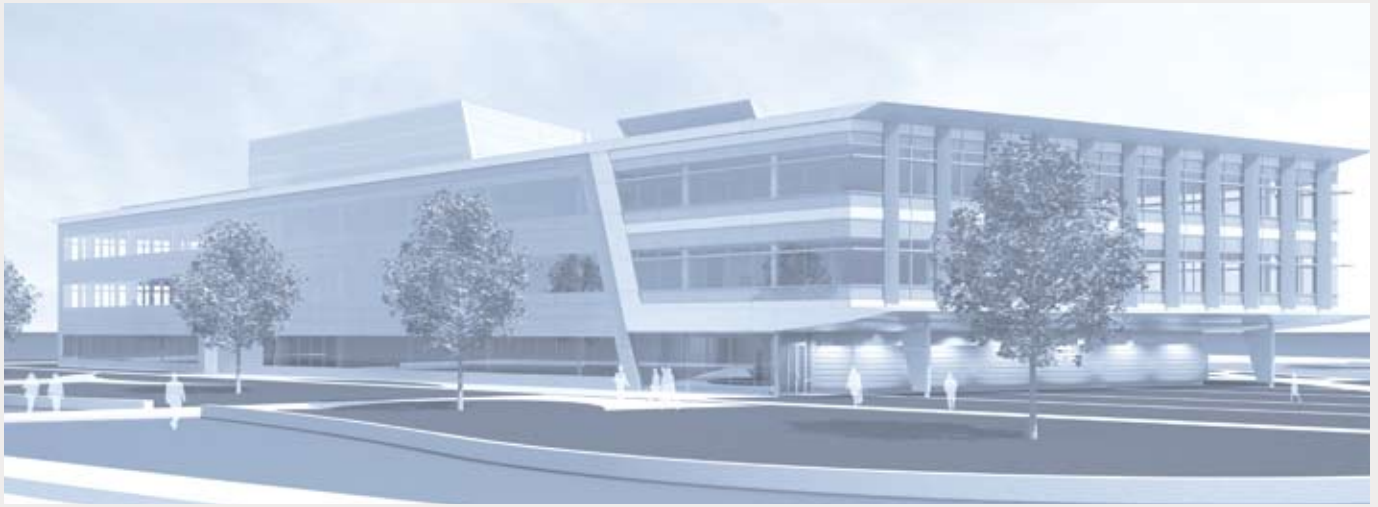
NASA's Launch Abort System was named one of the year's top innovations by Popular Science magazine. In the magazine's December issue, themed "The Best of What's New," editors chose 100 innovations and separated them by category. They were judged on how the innovation has pushed past what was thought possible 12 months ago. NASA's LAS or "escape pod" was listed as the number six top innovation out of 10 in the space and aviation category.

In the same week, TIME recognized the Ares 1 rocket. According to the article, "the Ares I rocket is the best and smartest and coolest thing built in 2009 — a machine that can launch human beings to cosmic destinations we'd never considered before — is the fruit of a very old family tree, one with branches grand, historic and even wicked."

Other top inventions listed in the article included: the AIDS vaccine, NASA's Mercury Probe, and Philips Electronics' 60-watt light bulb.

NASA/KSC

LOOKING FORWARD



Langley's future includes new, state-of-the-art, "green" buildings in its New Town to replace aging structures. Six buildings are planned over 15 years. They will include three laboratories, two office buildings and a joint-use facility. In the photo at right, ground is being broken for the first building, to house administrative offices in a three-story, $23 million, 72,000-square-foot structure (shown above) with an accent on environmental soundness. Construction will be aimed at the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) standards.

From left, Langley Director Lesa Roe hefts a shovel alongside Charles Scales, NASA associate administrator; Molly Ward, Hampton mayor; and Rob Newell, GSA regional commissioner of Public Buildings Service.

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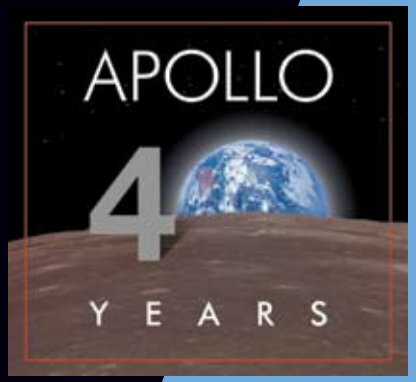

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