National Aeronautics and Space Administration

2013

LANGLEY RESEARCH CENTER

www.nasa.gov

NASA/George Homich

A Hybrid Wing Body model being tested in Langley's 14-by-22-Foot Subsonic Tunnel. The engines are on the top of the airplane to block noise to the ground. The model is mounted upside down, so the microphone array — the large red disk — can easily measure the noise as it heard by people on the ground. The microphone array was moved to different locations in the test section to simulate an airplane flying overhead.

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NASA engineers and technicians tested four payload configurations during the liftoff transition testing of a 67.5-inch model of the SLS in Langley's 14-by-22-Foot Subsonic Tunnel.

NASA/David C. Bowman

DIRECTOR'S MESSAGE

Welcome to the 2013 edition of our annual report on NASA Langley Research Center's accomplishments in the past year, and our plans for the future.

Like most federal agencies, we had some unique challenges due to sequestration and the government shutdown, but are working hard to minimize impacts while continuing our groundbreaking research and technology development.

Our work in space exploration and technology development continues to produce advances that will help NASA build and send robots and humans beyond Earth orbit—to destinations including an asteroid and eventually Mars.

Langley is helping advance designs for expanded launch capabilities, developing next-generation deployable space structures for larger solar arrays, and partnering with commercial companies to provide analysis and testing for the latest class of spacecraft.

We're also working to speed the process of bringing manufacturing technologies to market, including additive manufacturing. We took a big step in that process in November when Langley became the first federal partner in the Commonwealth Center for Advanced Manufacturing, a consortium of manufacturers and universities based near Richmond, Va.

In aeronautics, Langley continues to work on technologies that will make commercial flight safer, cleaner and more efficient. We're working to reduce aircraft noise around airports, boost fuel efficiency, relieve air-travel congestion in flight and on the ground, and are evaluating new aircraft designs in our labs and wind tunnels.

One experiment involves powering airplanes with cleaner alternative fuels—such as camelina plant oil, which we tested on a NASA DC-8 last summer. NASA has been evaluating bio-created kerosene that can be blended with jet fuel for use as a petroleum substitute to reduce harmful exhaust.

And our scientists are learning more about how planetary change affects people, from air travel to public health to the global economy. Langley researchers are conducting experiments from the land, sea, air and space to understand the atmospheric effects from volcanoes, industrial pollution, and changes in Earth's temperature.

One airborne science mission measured air pollution in the San Joaquin Valley of central California and in the Houston region using several NASA aircraft equipped with scientific instruments. The mission, which will continue this year, is aimed at improving the ability of satellites to better observe and understand air quality in the lowest part of the atmosphere—where we work and live.

I invite you to browse these pages and learn more about all that NASA Langley has been doing.

— Lesa B. Roe
Center Director

Leading the Next Phase of Space Exploration

Langley researchers are helping to lead the nation into the next phase of space exploration. From helping to advance designs for expanded launch capabilities, to developing next-generation solar arrays, to partnering with commercial companies to provide analysis and testing for the latest class of spacecraft, the center is on the forefront of expanding the nation's space exploration capabilities.

Developing and Maturing Future Space Technologies

In 2013, Langley joined the Commonwealth Center for Advanced Manufacturing (CCAM) as its first government member. Langley's expertise, combined with the manufacturing capabilities of CCAM's members, will speed the process of bringing advanced manufacturing technologies to market.

Langley engineers in collaboration with NASA's Glenn Research Center are developing lighter, stronger and more compact solar arrays that can operate in a much harsher radiation environment than those currently used on commercial satellites. These new arrays could be used for electric propulsion on future near- and deep-space missions.

Langley also co-leads the aerosciences effort for the Low-Density Supersonic Decelerator Project flight dynamics test, which will launch the first of four planned flight tests in 2014. Center engineers have maintained and delivered the end-to-end aerodynamic database used in flight dynamics simulations to predict vehicle performance from release to splashdown.

Langley is leading the design and development of radiation storm shelters and radiation analysis capabilities for deep space vehicles designed to help protect astronauts from solar radiation or galactic cosmic radiation.

Key SLS Support

To help the agency team led by NASA's Marshall Space Flight Center in Alabama mature the design of the Space Launch System, Langley delivered wind tunnel testing and analysis databases, both critical elements in establishing the atmospheric environment the SLS must safely traverse to carry astronauts and cargo into orbit.

Langley also designed, fabricated and delivered test hardware to Marshall that will enable them to test and characterize the launch acoustic and ignition over-pressure environments. Langley's materials expertise in composites is also being called upon to help increase affordability and reduce overall mass.

NASA/David C. Bowman

An engineer at NASA's Langley Research Center prepares a 10-inch ceramic model of the Sierra Nevada Corporation Dream Chaser spacecraft for high-speed wind tunnel testing.

In addition, Langley has been working on technology to allow spacecraft to safely land on the moon, Mars and even an asteroid, in potentially hazardous terrain areas with Autonomous Landing Hazard Avoidance Technology (ALHAT). Led by Johnson Space Center in Houston and supported by Langley and the Jet Propulsion Laboratory in California, ALHAT provides a planetary lander the ability to land precisely and safely on a surface while detecting any dangerous obstacles such as rocks, holes and slopes.

Assisting Commercial Space Development

Langley has conducted numerous wind tunnel tests, simulations and analyses to help commercial companies validate designs of their next generation of spacecraft to transport crew and cargo to the ISS. The center is providing essential design data to address critical challenge areas such as aerodynamics, aerothermodynamics, environmental loads, and controls. NASA astronauts also conducted landing simulations of Sierra Nevada Corporation's Dream Chaser vehicle in the center's Cockpit Motion Facility.

NASA

The Low-Density Supersonic Decelerator Project tested inflatable decelerators and advanced parachutes in a series of rocket sled, wind tunnel, and rocket-powered flight tests to slow spacecraft prior to landing.

NASA/David C. Bowman

Divers attach tow lines and lead the test capsule to a flooded well deck during the Orion stationary recovery test at Norfolk Naval Base.

Water Recovery a Step Toward Launch

With the U.S. Navy's well deck ship U.S.S. Arlington stationed against its pier at Naval Station Norfolk in Virginia, divers in small boats approached a test version of NASA's Orion crew module. As part of a deliberative process, the divers attached towlines and led the capsule to a flooded well deck.

The stationary recovery test is helping to ensure that when Orion returns from deep-space missions and splashes down in the Pacific Ocean, the methods used to recover the spacecraft and obtain critical heat shield data are sound.

"Today marks a significant milestone in the Navy's partnership with NASA and the Orion Human Space Flight Program," said Navy Commander Brett Moyes, Future Plans Branch chief, U.S. Fleet. "The Navy is excited to support NASA's continuing mission of space exploration. Our unique capabilities make us an ideal partner for NASA in the recovery of astronauts in the 21st Century — just as we did nearly a half century ago in support of America's quest to put a man on the moon."

The stationary recovery test was two years in the making. NASA met in working groups with the Navy to leverage their well deck recovery expertise to develop recovery procedures for the Orion crew module. Together, NASA and the Department of Defense (DOD) carefully choreographed each step of the test.

"It was nice to see how the ballet of it all performed," said Lou Garcia, NASA Recovery Director.

In the sheltered waters next to a pier, the controlled environment test revealed how precise the positioning of the capsule can be over the cradle used to move the crew module, how long the recovery operation takes and how the taglines, winch lines and tow lines work.

"This allows us to practice our procedures in a benign environment with no ship movement and minimum wave action," said Jim Hamblin, landing and recovery element operations manager, Ground Systems Development and Operations (GSDO) Program.

Navy divers prepared for the recovery test in Norfolk by training in the 6.2-million gallon pool at NASA's Neutral Buoyancy Lab in Houston.

Scott Wilson, manager, Offline Processing and Infrastructure for Development, GSDO Program, referred to testing strategy as a "crawl, walk, run."

"With this test, we are taking the first steps in learning to walk," Wilson said.

The hardware used in the stationary test will be sent to the West Coast to prepare for a test of Orion recovery operations in open water in January 2014. NASA and the military will use the recovery procedures from Norfolk to evaluate methods for that test.

Test Launch Planned

Lessons learned from the test in Norfolk and January's underway recovery test will be applied to the recovery of the Exploration Flight Test (EFT)-1 in September 2014.

Langley's Launch Abort System project was responsible for delivering an active jettison motor, forward interstage, and abort and attitude control motor inert simulators for EFT-1. Langley also assisted with developing and testing flight instrumentation for the EFT-1 heat shield.

EFT-1 will be Orion's first mission, which will send an uncrewed spacecraft 3,600 miles into Earth's orbit. As part of the test flight, Orion will return to Earth at a speed of approximately 20,000 mph for a splashdown in the Pacific Ocean.

The flight test will provide engineers with critical data about Orion's heat shield, flight systems and capabilities to validate designs of the spacecraft before it begins carrying humans to new destinations in the solar system, including an asteroid and Mars.

EFT-1 will launch from NASA's Kennedy Space Center in Florida and splash down off the Baja Coast on the same day. For EFT-1, the recovery ship and team will be in the splashdown zone at the time of launch.

While the former Marine helicopter doesn't look very damaged from the outside, the crash-test dummies inside took a beating.

NASA/David C. Bowman

Creating Friendlier Skies and Faster Airplanes

Langley has a long history of partnering with the private and public sectors to advance aeronautics research. Such collaboration continues to focus on ways to reduce aircraft noise around airports, and is assessing how to boost aircraft fuel efficiency, evaluating new airplane designs, and creating new ways of relieving congestion in flight and on the ground.

The center's aeronautical research included working with the U.S. Army on helicopter rotor aerodynamics and fuselage drag reduction to increase flight speed and hover performance, and testing with the U.S. Air Force to explore engine health monitoring and human factors. In addition, unmanned aerial vehicle technologies were investigated to extend operational endurance and payload capabilities.

Earlier in the year, NASA also selected eight large-scale integrated technology demonstrations to advance concepts and technologies to ensure that future air travelers fly in quieter, greener and more fuel-efficient aircraft. The demonstrations are part of the agency's Environmentally Responsible Aviation (ERA) Project, which conducts many of its studies at the Center.

Reducing Environmental Impact

Concentrating on aircraft concepts and technologies to reduce the impact of aviation on the environment over the next 30 years, the ERA Project's work will focus on five areas: aircraft drag reduction through innovative flow control concepts; weight reduction from advanced composite materials; fuel and noise reduction from advanced engines; emissions reductions from improved engine combustors; and fuel consumption and community noise reduction through innovative airframe and engine integration designs.

Langley is also providing extensive materials and acoustic modeling in support of development of the futuristic Hybrid Wing Body (HWB) commercial airliner concept, as well as vital wind tunnel testing to aerodynamically validate the HWB concept.

The latest efforts include an acoustic investigation conducted in a wind tunnel aimed at alleviating excessive aircraft noise generated by components upon landing approach, as well as routine operations near airports. Wind-tunnel investigations were also conducted to investigate the validity of new quiet-flap and landing gear concepts designed to decrease excessive aircraft noise.

In addition, Langley is working with industry to develop technologies that would allow environmentally friendly, efficient passenger flight above the speed of sound. That work includes trying to reduce, for both commercial airliners and fighter jets, the sonic booms created by aircraft flying supersonically.

NASA/George Homich

A hybrid wing model is tested in Langley's 14-by-22-Foot Subsonic Tunnel.

Langley's HU-25C Guardian research jet

A NASA DC-8 flies over California in a mission to determine the effect a biofuel blend made with camelina plant oil has on the aircraft's emission and engine performance.

Powering Airplanes with Camelina Plant Oil

In Langley's hangar, Bruce Anderson stood between NASA's HU-25C Guardian airplane and a group of reporters as he explained a series of recently completed flights.

"We're interested in differences caused by different fuels, as well as just trying to understand better the physics and the chemistry of exhaust plumes," said Anderson, project scientist for the ACCESS (Alternative Fuel Effects on Contrails and Cruise Emissions) experiment.

The experiment involved flying a NASA Dryden Flight Research Center DC-8 airplane as high as 39,000 feet while Langley's instrumented HU-25C Guardian trailed behind at distances ranging from 300 feet to more than 10 miles. "This is kind of a unique experiment," Anderson said. "You don't often get that close to another aircraft."

During the flights, the DC-8's four CFM56 engines were powered by conventional JP-8 jet fuel or a 50-50 blend of JP-8 and an alternative fuel of hydroprocessed esters and fatty acids produced from camelina plant oil. More than a dozen instruments mounted on the Guardian jet characterized the soot, gases and ice particles streaming from the DC-8.

As Anderson explained, the FAA and other governing bodies have certified commercial airlines to fly using 50-50 fuel blends. NASA has been evaluating bio-created kerosene that can be blended with jet fuel to be used in the near-term as an alternative to petroleum.

"NASA's focus is renewable fuel, such as camelina or fuel from algae," Anderson said. It's been 17 years since this type of flight experiment took place.

"This is a kind of unique experiment. You don't often get that close to another aircraft."

— NASA Scientist Bruce Anderson

"We had much better instruments this time and some of the questions have changed," Anderson said. "People know more about the atmosphere and about how radiation is transmitted through the atmosphere."

A second phase of ACCESS flights is planned for 2014. They will capitalize on lessons learned from the 2013 flights and include a more extensive set of measurements.

NASA/David C. Bowman

Rich Moore makes his way through an array of instruments on Langley's HU-25C Guardian aircraft, which flew behind the DC-8 gathering data.

Earth: Our Home and Our Mission

Researchers in Langley's Science Directorate are passionate about understanding our home planet, especially Earth's atmosphere and climate. In learning more about how planetary change affects people, from air travel to public health to the global economy, they conduct research from the land, sea, air and space to understand the atmospheric effects caused by volcanic eruptions, industrial pollution, changes in the planet's energy balance and other events.

In developing instruments and measurement techniques, Langley has amassed one of the world's most comprehensive collections of atmospheric data, about 50 times the total holdings of the Library of Congress. This information is housed in Langley's Atmospheric Science Data Center, and serves 130,000 customers in 160 countries.

A World-Renowned Climate Record

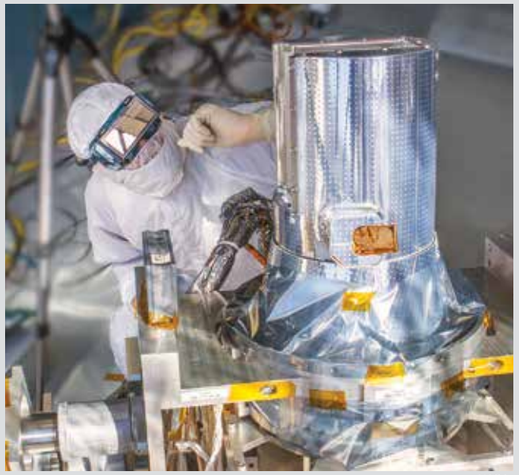
A series of instruments developed by Langley for NASA's Earth Observing System (EOS) — known collectively as the Clouds and the Earth's Radiant Energy System mission, or CERES — are a world-renowned source of information about global climate. To date, the CERES mission has launched six instruments on four satellites. Including the predecessor mission known as ERBE — short for Earth Radiation Budget Experiment — a combined 28 years of data have been archived: the longest and best record of Earth's energy balance.

Understanding climate change requires both long-term and uninterrupted measurements. Because data continuity is crucial, in 2013 Langley built and tested the next CERES instrument for delivery in 2014, and is initiating work on the next-generation radiation budget Instrument scheduled for launch in 2018.

The Climate Absolute Radiance and Refractivity Observatory (CLARREO), now in the early stages of planning and development, will detect climate trends, providing accurate, credible and tested climate data to inform decision-makers as society adapts to and mitigates the effects of climate change.

Eying Climate from Space

Langley's CALIPSO mission — short for Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations — to better understand the role of clouds and aerosols in climate, weather, and air quality, recently marked its seventh year of operation. Thanks to CALIPSO, researchers can now identify what aerosols are made of, and at what atmospheric altitude they occur. By also pinpointing where aerosols originate and how they're transported, this new knowledge helps to refine and improve computerized climate models. So far, more than 900 scientific papers have been published using CALIPSO data.



NASA

Engineer Chip Holloway waits for the sun to align with the SAGE III instrument during a clean room "sun-look" test.

Langley's Stratospheric Aerosol and Gas Experiment (SAGE) III mission on the International Space Station is on track for launch in 2015, continuing a long legacy of measuring ozone, a gas in the upper atmosphere that acts as Earth's sunscreen. This past year, the SAGE III team completed SAGE III hardware refurbishment, receiving permission to proceed to the next phase.

In August, Langley researchers participated in a mission to study how air pollution and natural emissions pushed high into the atmosphere by large storms that affect atmospheric composition and climate. Another mission to improve the use of satellites to monitor air quality for public health and environmental benefit conducted two 2013 campaigns: one in California's San Joaquin Valley in January and February, and another in Houston, Texas in September.

Space Satellite is Goal of Pollution Flights

If you want to understand air pollution, sometimes you've just got to get right in the middle of it.

A multi-year airborne science mission did just that twice this year. Two NASA aircraft equipped with scientific instruments flew repeatedly over the San Joaquin Valley of Central California, and then over the Houston area.

The aircraft were part of a five-year NASA study called DISCOVER-AQ, which stands for Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality.

Researchers are working to improve the ability of satellites to consistently observe air quality in the lowest part of the atmosphere. If scientists can better observe pollution from space, they would be able to make better air quality forecasts and more accurately determine where pollution is coming from and why emissions vary.

A fundamental challenge for space-based instruments monitoring air quality is to distinguish between pollution high in the atmosphere and pollution near the surface where people live. DISCOVER-AQ took measurements from aircraft in combination with ground-based monitoring sites to help scientists better understand how to observe ground-level pollution from space.

"DISCOVER-AQ is collecting data that will prepare us to make better observations from space, as well as determine the best mix of observations to have at the surface when we have new satellite instruments in geostationary orbit," said James Crawford, the mission's principal investigator at NASA's Langley Research Center in Hampton, Va. "NASA is planning to launch such an instrument, called TEMPO, in 2019."

Because many countries, including the United States, have large gaps in ground-based networks of air pollution monitors, experts hope satellites can provide a more complete geographic perspective on the distribution of pollutants.

A fleet of Earth-observing satellites, called the Afternoon Constellation or "A-train," passed over the DISCOVER-AQ study areas daily. The data is giving scientists the opportunity to compare the view from space with that from the ground and aircraft.

Photos this page: NASA/Michael Finneran

Principal investigator Jim Crawford of Langley, left, and pilot Mike Singer in the P-3B.

"The A-Train satellites have been useful in giving us a broader view of air pollution than we've ever had before," said Kenneth Pickering, DISCOVER-AQ's project scientist at NASA's Goddard Space Flight Center in Greenbelt, Md. "DISCOVER-AQ will help scientists interpret that data to improve air quality analysis and regional air quality models."

The airplanes used included a four-engine P-3B turboprop plane from NASA's Wallops Flight Facility in Wallops Island, Va., carrying eight instruments and a two-engine B200 King Air aircraft from NASA Langley with two instruments.

The 117-foot-long P-3B sampled the air as it spiraled between altitudes from 15,000 feet to as low as 1,000 feet over the ground sites. The smaller B200 King Air looked downward from an altitude of 26,000 feet. The plane's instruments look down at the surface, much like a satellite, and measure particulate and gaseous air pollution.

The P-3B at Ellington Field in Houston being prepped for a DISCOVER-AQ flight.

Helping to Reshape Technology's Future

To increase competitiveness, create jobs and improve the balance of trade, Langley helps to transfer NASA-developed technology and expertise to U.S. industry. That's why Langley's Office of Strategic Analysis, Communications and Business Development routinely reaches out to collaborate and partner.

Langley's online Technology Gateway is an indispensable resource for companies looking for answers to technology challenges and problems. Four main technology categories — advanced materials, aerospace applications, sensors and detectors, and software — are listed, with a detailed description of the licensing opportunities available from Langley in these and other areas.

By drawing on existing technology resources, collaboration reduces private-sector research and development costs. Collaboration with Langley can help to leverage a company's technical capabilities, expertise and facilities, harnessing different perspectives to accelerate solutions to technical challenges. The end result: the creation of new products and new technologies.

NASA/David C. Bowman

Henry Haskin, one of the inventors of the quick-change ceramic flame holder, shows a flame nozzle made and tested at Langley.

A 2013 Success Story

When the U.S. Navy was designing a jet engine simulator for jet engine plume studies, stainless steel flame holders used in testing would quickly burn up or melt. This year, two Langley researchers created the quick-change ceramic flame holder, which can withstand temperatures around 4,000° Fahrenheit, a two-fold improvement in heat tolerance.

Adding a twist-lock mounting mechanism to the steel burner translates to easy replacement: no tools are required. The device also saves on maintenance costs and improves safety with better flame control.

The Navy adapted a larger version of the ceramic flame holder for its engine simulations. Another variant is being used simulate a solid rocket launch abort motor in testing of NASA's Launch Abort System. In addition, the technology

NASA/David C. Bowman

Yi Lin (left) and John Connell (right) demonstrate boron nitride nanosheet dispersion.

could find use for metals forging, in casting furnaces, and in pottery kilns.

Wireless Sensors and Liquid Crystals

Wireless sensors developed at Langley that can work without batteries or receivers and can be placed virtually anywhere recently won a 100 Top Innovation Award presented by R&D Magazine. Now, the sensors are being developed commercially.

In one licensing agreement, Alabama-based GLSEQ, LLC will use Langley wireless sensors for instrumentation and control systems for nuclear power plants. Another venture, a partially exclusive license agreement with Kelvin International Corporation in nearby Newport News, Virginia may result in built-in, liquid-level, non-contact sensors for bio-storage containers.

This year, North Carolina firm Allotropica Technologies, Inc. received an exclusive license for development of Langley's liquid crystal polymer technologies. The company plans to make liquid crystal polymer materials for use as components in high-temperature, flame-resistant foams, coatings and composites.

Nanotube Commercialization

A 2012 joint venture involving Langley, the Thomas Jefferson National Accelerator Facility and the National Institute for Aerospace that led to the creation of fibril boron nitride nanotubes gained momentum in 2013 with construction of the world's first commercial factory dedicated to the manufacture of fibril boron nitride nanotubes.

A structurally similar ceramic analog to carbon nanotubes, these very strong and versatile submicroscopic cylinders may find wide use in aerospace applications. They may also be incorporated as components of next-generation body armor, thin coatings, batteries, electrical insulation, fire-retardant cabling, and sensors. Biomedical uses may include implants for dentistry, and materials to aid in nerve and bone-tissue regeneration.

NASA in Virginia

Four major launches were made this year from NASA's Wallops Flight Facility on the Eastern Shore of Virginia, and a fifth was planned for mid December. The launches illustrate the impact of the Mid-Atlantic Regional Spaceport at Wallops and the increasing involvement of private companies in the exploration and use of space. Among the launches, one was the first ever from Virginia to the moon. Another was the first launch from Virginia to the International Space Station.

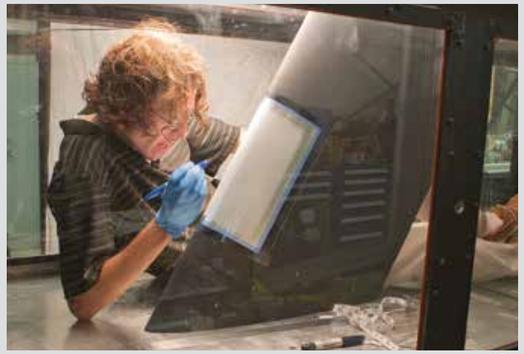
LADEE on its way to the moon in September.

A Minotaur I rocket carrying student-designed cubesat research satellites.

NASA/Bill Ingalls

An Orbital Sciences Corporation's Antares rocket carrying the Cygnus spacecraft to the International Space Station.

Debugging Research



NASA

Researcher John Gardner lies inside the Basic Aerodynamics Research Tunnel, or BART, to prep the leading edge of a scale model wing for a blast of bugs from the tunnel's bug "gun."

Dream Chasing

NASA/David C. Bowman

Bruce Jackson, left, an engineer at Langley's Cockpit Motion Facility, briefs astronauts Rex Walheim and Gregory Johnson as they evaluate a landing simulation for Sierra Nevada Corporation's Dream Chaser.

Langley is developing space exploration concepts like the Hypersonic Inflatable Aerodynamic Decelerator shown here. It would serve as a heat shield and parachute for spacecraft entering a planet's atmosphere. The inflatable is made of materials layered together to withstand temperatures up to 2,300 degrees Fahrenheit.

NASA/David C. Bowman

Inspiring with Outreach and Education

Like all NASA field centers, NASA Langley reaches out through education and outreach programs and events. These showcase Langley's role in space exploration, science and flight, and teach and encourage with hands-on activities and lessons.

High school and college students work with NASA mentors, who help them conduct research and develop technology applications that have far-reaching impact. Teachers participate in workshops that give them the tools to teach. Some teachers spend time working for NASA to develop or run programs for students. Even the youngest benefit from classroom visits by Langley employees and through events designed to engage and inspire the next generation of explorers.

Students in Langley's Virginia Aerospace Science and Technology Scholars (VASTS) program participate in a Mission Design Review Concept Panel. About 180 students worked individually and together to plan a mission to Mars.

NASA/David C. Bowman

Langley employees Pam Stacy and Nancy Hornung have a little fun organizing food donations for the Feds Feeds Families campaign.

NASA/David C. Bowman

Near the end of the final 2013 VASTS session, former program manager Amber Agee-DeHart said the skills students learn during the VASTS program could help to put them "ahead of the game."

NASA/David C. Bowman

NASA Astronaut, Randy Bresnik came to Virginia Air and Space Center in Hampton and spoke to the children attending the museum's summer camp "How to be an Astronaut." He gave a brief talk about being an astronaut and then fielded questions from the youth.

NASA/David C. Bowman

Langley engineer David Way talks with kids at the Virginia Air & Space Center during an event celebrating the landing of the Curiosity rover on Mars. Way and a Langley team played a critical role in the landing.

NASA/Mike Logan

Student interns designed and built an unmanned aerial vehicle that one day may be used to pinpoint wildfire hotspots and lead firefighters to them.

NASA/David C. Bowman

NASA's Associate Administrator for Education, former astronaut Leland Melvin, visited the Virginia 529 Kids Zone at the Richmond International Raceway, where he participated in two NASA engineering design challenges and interacted with the Rockets 2 Racecars' visiting teachers.

NASA/David C. Bowman

Astronaut, Serena Aunon spoke to students of The VALHEN Hispanic College Institute at Virginia State University located in Petersburg. Serena was selected as a NASA astronaut in 2009 and completed astronaut candidacy training in 2011 and serves as a flight surgeon.

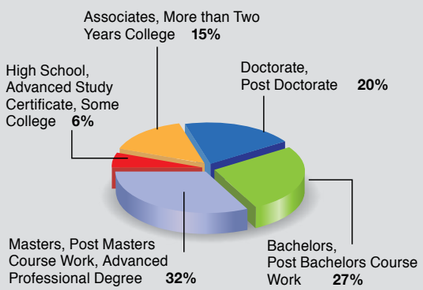
Students in the NASA Aeronautics Academy at Langley assemble under a Langley Air Force Base B-52. College students in engineering and science disciplines work together in the program as research associates to solve real aeronautics problems. They continue to collaborate after they leave Langley to produce technical papers and present their work at professional conferences.

A Diverse Workforce Drives Langley Success

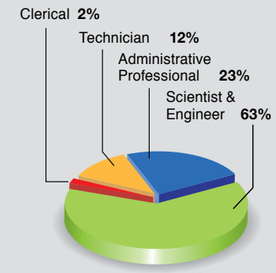
Diversity is key to ensuring a large organization like NASA Langley succeeds. Langley's workforce is made up of scientists, engineers, technicians, administrative professionals, and clerical staff with varying degrees of education, from high school degrees to multiple doctorates.

In 2013, 1,895 civil service and 1,538 contract employees supported NASA Langley.

Education Distribution



Occupation Distribution



Education and occupation distribution numbers apply to 1,895 civil servants only. Data is not collected for contractors.

From top left: Roy Savage, Melissa Yang, Mike Logan, Cynthia Sabonis, Kim Merritt, Mary Beth Wusk, Bethany Schiller, Shawn Gallagher, Qamar Shams, Steve Gaddis, Rebecca Bales, Edith Robinson, Cornelia Altenbuchner, and at right, Glen King.

NASA/David C. Bowman

Langley Engineer Saves Woman from Car Wreck

Before Bill Leath heard the squealing tires, it was just an ordinary Wednesday morning.

He brewed a pot of coffee. He walked out front to grab the newspaper. Then he walked around back to check on his garden.

In his backyard, which overlooks Newmarket Creek in Hampton, Leath noticed that something — probably an opossum — had dug up some cantaloupe rinds from his compost pile. Not wanting the rinds to attract flies, he set about reburying them.

And that's when his morning went from ordinary to extraordinary.

"I just looked up because I heard the tires squealing," he said.

Leath, a Northrop Grumman aerospace engineer working for the Air Traffic Operations Lab at NASA's Langley Research Center, then watched as a car traveling south on LaSalle Avenue launched off the road and plunged upside-down and nose first into the creek.

He was stunned. It took his brain a few startled seconds to process what he'd just seen. Then it clicked: a person was trapped in that car.

"And the next thing I knew I was running," he said.

The 59-year-old Leath crossed more than a football field's worth of land, some of it marshy, at a near sprint. As he ran he could hear a woman calling for help. By the time he got to the water's edge, the car was in so deep he couldn't see anything more than the trunk. There was no sign of the woman, who he feared might still be in the car.

As he ran he could hear a woman calling for help. By the time he got to the water's edge, the car was so deep he couldn't see anything more than the trunk.

Leath, a former lifeguard and competitive swimmer, dove in. Back on shore, Leath's neighbor, Jake Ehret, called out to him. Ehret had seen Leath run through his backyard and thought he might be chasing a burglar. Out of breath, Leath flipped over onto his back and shouted to Ehret for help.

"I think he thought I was the one in trouble," Leath said. "He looked at me like I was crazy, like, 'Why are you swimming that way?'"

Then Ehret saw the car and jumped in to help.

Leath had been swimming for about a minute when he looked up. Just a few feet in front of him, the driver of the car, who police would later identify as Hampton resident Dorothea Allen-Riley, was floating face down in the water.

He grabbed Allen-Riley and pulled her close. Water spilled out of her mouth. She took a huge breath.

"I thought, thank God she's still alive," he said.

Now in about 8 to 10 feet of murky creek water, Leath and Ehret each took one of Allen-Riley's arms and swam back to shore with her, being careful to keep her head raised. With the current behind them, the swim was relatively easy.

Ehret looked up at his seven-year-old son, who was waiting in the backyard with a phone, and told him to call 911. Help arrived quickly — police first, then medics. Thinking the morning's excitement was finally over, Leath went home to shower and get ready for work — but work would have to wait.

"Before I could get out the door the press descended on me like the 17-year cicadas," he said. "I got hit by all three TV channels and the Daily Press."

Though he says he's "not overly religious," Leath can't shake the feeling that "someone" was watching over Allen-Riley that May morning. To him, it's strange that he happened to be outside when the accident occurred, and stranger still that he "swam right into that woman."

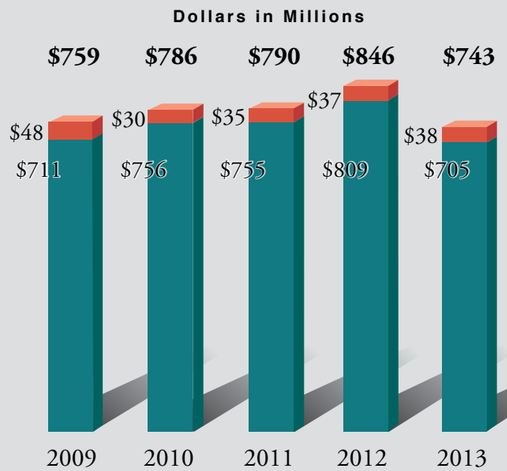
He laughs, though, when someone reminds him that it may very well have been a cantaloupe-craving critter that made the rescue possible.

"Yeah, that opossum," he said. "It was all because of him."

Economic Impact of NASA in 2013

NASA's Virginia operations generated an economic impact of $2.9 billion in 2013. That compares to $3 billion last year. The impact includes the combined effects of activity at NASA's Langley Research Center in Hampton, Va., and Wallops Flight Facility on the Eastern Shore.

Direct spending in 2013 also declined, as illustrated by the chart at right. Planned delays in projects and programs, and sequestration cuts directed by Congress, were factors in the decline.



In Fiscal 2013, NASA Langley Generated the Following Economic Impacts:

- In the U.S., the economic impact was $2.1 billion that supported 16,500 jobs.
- In Virginia, the economic impact was $870 million that supported 7,481 jobs.
- In Hampton Roads, the economic impact was $798 million that supported 6,798 jobs.

NASA Wallops Generated the Following Economic Impact:

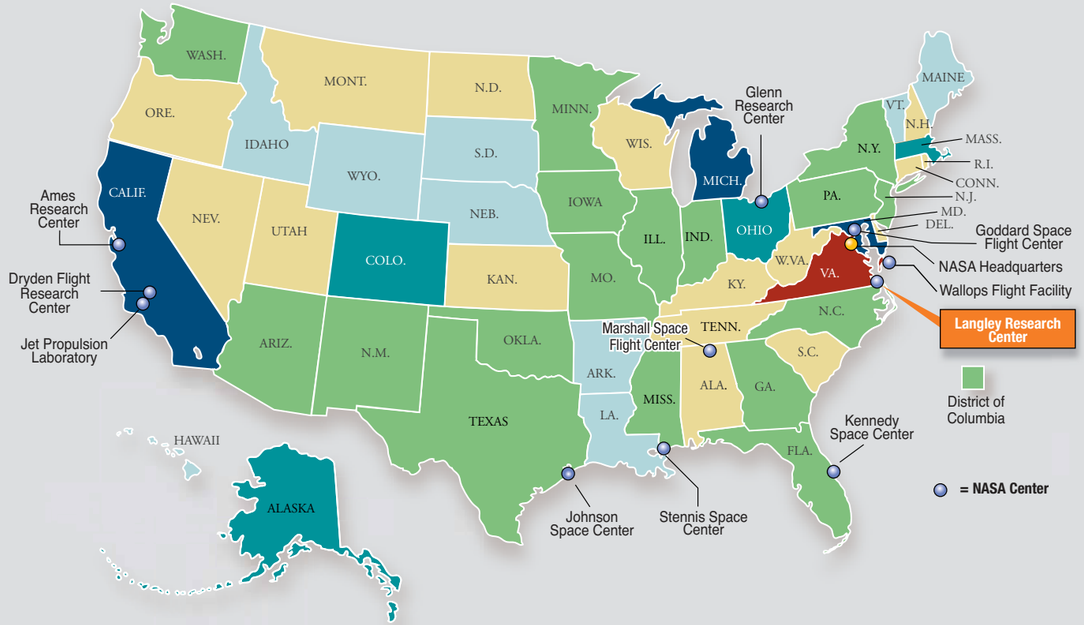
- In the U.S., the economic impact was $829.3 million that supported 5,875 jobs.
- In Virginia, the impact was $267.5 million that supported 2,278 jobs.

Source: NASA and Chmura Economics & Analytics report "The Economic Impact of NASA Virginia Operations for Fiscal Year 2013."

Langley Research Center

Wallops Flight Facility

Langley Spending by State



Key to Direct State Funding Levels

0 - $100,000 | $100,000 - 1 million | $1-5 million | $5 - 20 million | $20 - 100 million | + $100 million

Top Obligations to Business Contractors

Analytical Mechanics Associates	$ 53,471,782
Science Systems and Applications	48,490,519
Jacobs Technology Inc.	45,965,609
SGT, Inc.	24,291,421
Boeing Company	22,947,999
Cornell Technical Services LLC	13,191,692
Gentech Partners Joint Venture	13,101,082
Dominion Virginia Power	8,838,652
Unisys Corp.	7,558,245
Ball Aerospace & Technologies Corp.	7,361,983
Northrop Grumman Space & Mission Sys.	6,837,980
Chugach Federal Solutions, Inc.	5,841,313
Safety & Quality Assurance Alliance	5,439,774
Inuteq LLC	4,458,556
The Whitestone Group, Inc.	3,177,739
Science and Technology Corp.	2,905,171
Heard Construction, Inc.	2,434,813
Analytical Services & Materials,	2,277,368
Blue Tech Inc.	2,015,014
Lockheed Martin Corp.	1,936,372
Saab Sensis Corp.	1,908,481
Dyncorp International LLC	1,767,006
Alutiiq 3SG LLC	1,709,877
Modern Machine And Tool Company	1,649,493
Straughan Environmental Inc.	1,539,019

Nonprofit & Educational Institutions

National Institute of Aerospace	$ 24,114,288
Regents of The University of Michigan	20,163,899
U.S. Army Corps of Engineers	10,612,957
U.S. General Services Administration	9,615,848
City of Hampton Va	6,726,110
Public Building Service Office	2,700,000
Pennsylvania State University	2,408,723
Georgia Tech Research Corp.	2,319,796
OSU Center for Innovation and Economics	2,114,026
The Aerospace Corp.	1,753,151
U.S. Dept of the Air Force	1,405,924
Research Triangle Institute	1,219,539
Smithsonian Institution	1,180,000
University of Illinois	850,000
University of Southern California	845,616
Old Dominion University Research Foundation	803,041
Christopher Newport University	750,168
City of Newport News Va	550,183
U.S. Department of the Army	463,798
Ohio University	397,177
University Corp. for Atmospheric Research	368,695
University of Maryland Baltimore County	365,323
Regents of the University of Minnesota	350,392
The University of Iowa	334,993
Judiciary Courts of the Commonwealth of Virginia	320,000

Langley Employees Recognized for Professional Contributions

Malcolm Ko, Science Directorate, was selected to serve on the World Meteorological Organization Ozone Assessment Report Steering Committee.

Laurence Leavitt, Research Directorate, has been elected Fellow of the American Institute of Aeronautics and Astronautics (AIAA).

Dan Baize, Aeronautics Research Directorate, was elected Associate Fellow of the AIAA.

Kenny Elliott, Systems Integration & Test Branch, was elected Associate Fellow of the AIAA.

Jeffrey Cerro, Vehicle Analysis Branch, was elected Honorary Fellow of the Society of Allied Weight Engineers and received the president's award in recognition of his leading a committee to plan the Society of Allied Weight Engineers "Journey into the 21st Century."

Eugene Morelli, Dynamic Systems & Control Branch, received the Hampton Roads Section (HRS) AIAA Engineer of the Year award and was selected as the Peninsula Engineering Council Engineer of the Year. He also received the AIAA Mechanics and Control of Flight Award for 2013.

Hyun Jung Kim, of the National Institute of Aerospace (NIA) and the Advanced Materials & Processing Branch, received the 2013 Robert A. Mitcheltree Young Engineer of the Year Award, HRS of the AIAA.

Charles Cockrell, Management Systems Office, was elected a member of the International Astronautical Federation's Space Exploration Technical Committee.

James Crawford, Chemistry and Dynamics Branch, was appointed the Atmospheric Chemistry Editor of the Journal of Geophysical Research-Atmospheres.

Randy Bailey and **Lynda Kramer**, Crew Systems and Aviation Operations Branch, received outstanding support recognition from The Radio Technical Commission for Aeronautics for contributions to DO-341, Minimum Aviation System Performance Standards (MASPS) for an Enhanced Flight Vision System to Enable All-Weather Approach, Landing and Roll-Out to a Safe Taxi Speed.

Ken Jones, Crew Systems and Aviation Operations Branch, was recognized for his contributions to DO-312, Safety, Performance and Interoperability Requirements Document for the In-Trail Procedure in Oceanic Airspace (ATSA-ITP) Application by The Radio Technical Commission for Aeronautics.

Ed Johnson, Crew Systems and Aviation Operations Branch, was recognized for his contributions to DO-339, Aircraft Derived Meteorological Data via Data Link for Wake Vortex, Air Traffic Management and Weather Applications – Operational Services and Environmental Definition (OSED) by The Radio Technical Commission for Aeronautics.

Fuh-GwoYuan, NIA Samuel P. Langley Professor, Department of Mechanical and Aerospace Engineering, North Carolina State University, received a Structural Health Monitoring Person of the Year Award from the 9th International Workshop for Structural Health Monitoring.

Melody Avery, Atmospheric Composition Branch, was elected the Secretary of the Composition and Chemistry Focus Group of the Atmospheric Science Section of the American Geophysical Union.

Soumyo Dutta, Atmospheric Flight & Entry Systems Branch, was elected the Secretary of the Society and Aerospace Technology Technical Committee of the AIAA and received the Robert H. Goddard Memorial Scholarship from the National Space Club.

Greg Slover, Research Services Directorate, received the Antarctica Service Medal from the National Science Foundation for work with Operation Icebridge.

Thomas Pinelli, University Affairs Officer, was named a 2012 Darden Fellow by Old Dominion University.

Jody Davis, Atmospheric Flight & Entry Systems Branch, was elected to the Chancellor's Alumni Hall of Fame at Embry-Riddle Aeronautical University for her work with the Mars Science Lab rover.

Brenton Raisor, Safety and Facility Assurance Branch, received an Industrial Hygiene Technician certification from North Carolina Occupational Safety and Health Education & Research Center.

"Spectral Line Parameters Including Temperature Dependences of Air-Broadening for the 2←0 bands of $^{13}C^{16}O$ and $^{12}C\ ^{18}O$ at 2.3 μm" in the Journal of Molecular Spectroscopy, vol. 276-277, June 2012, p. 33-48, is among the Science Direct Top 25 Hottest Articles downloaded from the journal from July to September 2012. Authors are **V. Malathy Devi** and **Chris Benner** of the College of William and Mary, **Mary Ann Smith**, Chemistry & Dynamics Branch, **Arlan Mantz** of Connecticut College, and **Keeyoon Sung** and **Linda Brown** of the Jet Propulsion Laboratory.

"NO PLIF Visualizations of the Orion Capsule in LENS-I," by **Chris Combs** and **Noel Clemens**, the University of Texas at Austin, **Paul Danehy** and **Brett Bathel**, Advanced Sensing and Optical Measurement Branch, **Ronald Parker**, **Tim Wadhams** and **Michael Holden**, CUBRC, and **Ben Kirk**, NASA Johnson, received the Aerodynamic Measurement Technology Technical Committee best paper award at the 51st AIAA Aerospace Sciences Meeting the University of Texas at Austin.

Chris Lynn and **Ray Rhew**, Aeronautics Systems Engineering Branch, **Greg Jones**, Flow Physics & Control Branch, **William Milholen**, Configuration Aerodynamics Branch, **Scott Goodliff**, Subsonic/Transonic Testing Branch, and **Mike Acheson**, Technologies Application Branch, received the outstanding paper award from the Ground Testing Technical Committee for the paper "High Reynolds Number Active Blowing Semi-Span Force Measurement System Development" presented at the 28th AIAA Aerodynamic Measurement Technology, Ground Testing, and Flight Testing Conference.

Frank Leone and **Carlos Dávila**, Structural Mechanics & Concepts Branch, **Shih-Yung Lin**, Structural & Thermal Systems Branch, **Stanley Smeltzer**, ARMD Projects, **Donato Girolamo**, North Carolina State University, **Sayata Ghose**, **Juan Guzman** and **Douglas McCarville**, The Boeing Company, received third place outstanding paper at SAMPE 2013 for "Progressive Damage Modeling of Durable Bonded Joint Technology."

"Heliogyro Blade Twist Control via Reflectivity Modulation" by **Daniel Guerrant**, NASA Space Technology Research Fellow, **Dale Lawrence**, University of Colorado, Boulder, and **Keats Wilkie**, Structural Dynamics Branch, received the Gossamer Systems best paper award at the 53rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference.

"Low-Dissipation Advection Schemes Designed for Large Eddy Simulations of Hypersonic Propulsion Systems" by **Jeffery White**, Computational AeroSciences Branch, **Robert Baurle**, Hypersonic Airbreathing Propulsion Branch, **Travis Fisher**, former co-op in the Computational AeroSciences Branch, **Jesse Quinlan**, National Institute of Aeronautics, and **William Black**, Purdue University was selected as the 2012 AIAA Best Paper by the AIAA High Speed Air Breathing Technical Committee.

Selen Okcu, a National Institute of Aerospace post-doctoral research scholar, was selected by the Institute of Noise Control Engineering to receive the 2013 Michiko So Finegold Award for "Psychoacoustic Analysis of Synthesized Jet Noise," by Okcu, **Jonathan Rathsam**, Structural Acoustics Branch and **Stephen Rizzi**, Aeroacoustics Branch.

The Speed Agile Powered-Lift Demonstration Team (US Air Force Research Lab, NASA, Boeing, Lockheed Martin, Advanced Technologies Inc. and Williams International) received an Aviation Week Laureate Award. NASA Langley's 14 by 22-Ft Tunnel and National Transonic Facility were used in the research, as well as NASA's computational fluid dynamics computer codes USM3D and Overflow and wing design tool CDISC.

Mars Science Lab's Curiosity Entry, Descent and Landing Team received the National Air & Space Museum's 2013 Trophy for Current Achievement.

Michelle Ferebee, Office of Strategic Analysis, Communications & Business Development, was select as a member of the Hampton Economic Development Authority.

LaRC's Methodology for the Effective Stabilization of Tin Oxide-Based Oxidation/Reduction Catalysts received NASA's Commercial Invention of the Year Award for 2012. **Patricia Davis**, Advanced Sensing & Optical Measurement Branch, **Jeffrey Jordan**, Analytical Mechanics Associates, Inc., **Bradley Leighty**, Advanced Sensing & Optical Measurement

Continued from Previous page

Branch, **Donald Oglesby**, retired from Swales Aerospace, **David Schryer** (posthumous), **Jacqueline Schryer**, Advanced Sensing & Optical Measurement Branch, and **A. Neal Watkins**, Advanced Sensing & Optical Measurement Branch. Consultants for this work included **Suresh Gulati**, Corning, Inc. and **Jerry Summers**.

Rania Ghatas, Crew Systems and Aviation Operations Branch, and **Denisse Aranda**, Systems Integration and Test Branch, were judges at the 2013 STEM Robotics Challenge in Virginia Beach, VA.

NASA 360's program "Robots, Rocks, & Rovers" received an Emmy Award® in the Informational/Instructional-Program Special category.

The NASA **Transit of Venus Outreach Team**, which includes the NASA EDGE Team, won the Robert H. Goddard Award for the outstanding education and outreach efforts.

Media Solutions Branch received a Bronze Telly Award for the video "NASA Langley: Solving Problems for More Than 95 Years."

William Bensen, Media Solutions Branch, received a Silver W3 Award, a Silver Communicator Award, and a Platinum AVA Award for "Polynesian Wayfinding."

William Bensen, Media Solutions Branch, received a Bronze Telly Award, a Cine Golden Eagle Award, and the Columbus International Film Festival's Chris Award Honorable Mention for "The Transit of Venus."

Langley-built Orion Boilerplate Test Article Crew Module that underwent a series of water impact tests at Langley was selected by the White House and NASA HQ for the Presidential Inauguration Parade on January 21.

The Virginia Department of Environmental Quality selected **NASA Langley** as a 2013 Sustainability Partner of the Virginia Environmental Excellence Program.

Langley Research Center received the Virginia Governor's Environmental Excellence Bronze Award for the Biomass Steam Optimization Program.

Langley Research Center was awarded the Hampton Roads Sanitation District (HRSD) Diamond Excellence Award for 12 consecutive years of perfect compliance with the HRSD permit.

PATENTS

Yeonjoon Park, Sang Choi, Glen King and **James Elliott** received patent 8,294,989 for Apparatus and Method for Creating a Photonic Densely-Accumulated Ray-Point.

John Chapman, Louis Glaab, Timothy Schott, Charles Howell and **Vincent Fleck** received patent 8,411,214 for Variably Transmittive, Electronically-Controlled Eyewear.

Karen Taminger, William Hofmeister and **Robert Hafley** received patent 8,344,281 for Use of Beam Deflection to Control an Electron Beam Wire Deposition Process.

Stanley Woodard and **Douglas Taylor** received patent 8,430,327 for Wireless Sensing System Using Open-Circuit, Electrically-Conductive Spiral-Trace Sensor.

Qamar Shams and Allan Zuckerwar received patent 8,401,217 for Extreme Low Frequency Acoustic Measurement System.

Henry Haskin and Peter Vasquez received patent 8,529,249 for Flame Holder System.

Sang Choi, Yeonjoon Park, Glen King and James Elliott received patent 8,257,491 for Rhombohedral Cubic Semiconductor Materials On Trigonal Substrate with Single Crystal Properties and Devices Based on Such Materials.

Mahyar Malekpour received patent 8,255,732 for Self-Stabilizing Byzantine-Fault-Tolerant Clock Synchronization System and Method.

Kenneth Dudley, Holly Elliott, Robin Cravey, John Connell, Sayata Ghose, Kent Watson and **Joseph Smith, Jr.** received patent 8,508,413 for Antenna with Dielectric Having Geometric Patterns.

Shahyar Pirzadeh received patent 8,259,104 for Domain Decomposition by the Advancing-Partition Method for Parallel Unstructured Grid Generation.

Stephen Smith, John Newman, Robert Piascik and **Edward Glaessgen** received patent 8,347,479 for Method for Repairing Cracks in Structures.

Lisa Scott-Carnell and **Emilie Siochi** received patent 8,378,659 for Structural Health Monitoring System/Method Using Electroactive Polymer Fibers.

William Yost, Daniel Perey and Elliott Cramer received patent 8,490,463 for Assessment and Calibration of a Crimp Tool Equipped with Ultrasonic Analysis Features.

Yi Lin and John Connell received patent 8,303,922 for Method for Exfoliation of Hexagonal Boron Nitride.

Kevin Somervill, Tak-kwong Ng, Wilfredo Torres-Pomales and Mahyar Malekpour received patent 8,473,663 for Stackable Form-Factor Peripheral Component Interconnect Device and Assembly.

Karen Taminger, Robert Hafley, Richard Martin and **William Hofmeister** received patent 8,452,073 for Closed-Loop Process Control for Electron Beam Freeform Fabrication and Deposition Processes.

Alexander Bulyshev, Michael Vanek, and **Farzin Amzajerdian** received patent 8,494,687 for Method for Enhancing a Three Dimensional Image from a Plurality of Frames of Flash LIDAR Data.

Ruth Pater, Peter Vasquez, Richard Chattin, Donald Smith and Thomas Skalski received patent 8,545,986 for Composite Insulated Conductor.

Mool Gupta, Kenneth Dudley, Yonglai Yang, and **Roland Lawrence** received patent 8,424,200 for Conducting Nanotubes or Nanostructures Based Composites, Method of Making Them and Applications.

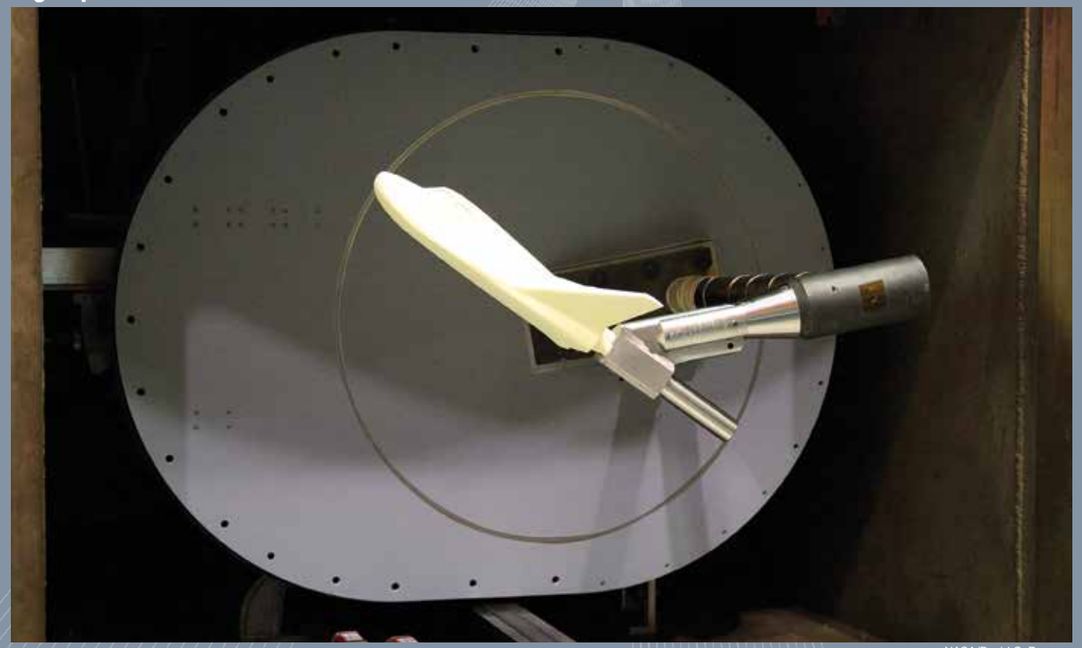
Sang-Hyon Chu, Sang Choi, Jae-Woo Kim, Yeonjoon Park, James Elliott, Glen King and **Diane Stoakley** received patent 8,529,825 for Fabrication of Nanovoid-Imbedded Bismuth Telluride with Low Dimensional System.

2012 Invention of the Year

NASA/David C. Bowman

Inventors from the Advance Sensing and Optical Measurement Branch in Langley's Advance Chemistry Formulation Lab are the happy recipients of the 2012 Commercial Invention of the Year Award, A Langley-developed Low Temperature Oxidation Catalyst. (Left to right) are Donald Oglesby, Jackie Schryer, Jeff Jordan, Brad Leighty, Neil Watkins and Patti Davis. Not pictured: David Schryer

High Speed Heat



NASA/David C. Bowman

A Sierra Nevada Corporation Dream Chaser model undergoes hypersonic testing at Langley. The tests are part of developing materials that will withstand the heat of entry into a planet's atmosphere. Dream Chaser is a result of NASA's work with industry partners to develop commercial spaceflight.

Glow with the Flow

NASA/Oliver Wong

A 37-percent scale powered model of an advanced Kiowa Warrior helicopter is tested in the 14- by 22-Foot Subsonic Tunnel using advanced laser measurement techniques to assess the air flow around the configuration.

LEADERSHIP

NASA/George Homich

From left to right are: Associate Director David Bowles, Center Director Lesa B. Roe, and Deputy Director Stephen G. Jurczyk

How to Contact Us:

Office of Strategic Analysis, Communications and Business Development: 757 864-6300

Government Relations: 757 864-2505

Doing Business with Langley: 757 864-1178

Web Site: http://www.nasa.gov/centers/langley

VASC

The Virginia Air & Space Center

The Virginia Air & Space Center in Hampton is NASA Langley's official visitor center. It features interactive aviation exhibits spanning 100 years of flight, more than 30 historic aircraft, a hands-on space gallery, unique space flight artifacts, and more. While at the air and space center, you can launch a rocket, pilot a space shuttle, program Mars rovers for a mission, become an air-traffic controller, fly an airplane, climb aboard a WWII bomber and experience a 3D IMAX film. Also on display is the Apollo 12 Command Module that went to the moon, a Mars meteorite, a three-billion-year-old moon rock, a DC-9 passenger jet and a replica 1903 Wright Flyer.

For more information, go to http://vasc.org

NASA/David C. Bowman

NASA/David C. Bowman

Construction nears completion on the Integrated Engineering Services Building, the second facility in Langley's "New Town" revitalization program. It is scheduled to open in 2014.

Artist concept of the Material Sciences Lab, the third building in Langley's 20-year revitalization program. The first building was completed in 2011 and serves as Langley's administrative headquarters.

Second man to orbit Earth dies

Scott Carpenter, the second American astronaut in orbit, died Oct. 10, 2013. As one of the original Mercury astronauts, Carpenter "was in the first vanguard of our space program — the pioneers who set the tone for our nation's pioneering efforts beyond Earth and accomplished so much for our nation," NASA Administrator Charles Bolden said shortly after Carpenter's death. Carpenter's Aurora 7 capsule circled the Earth three times on May 24, 1962 during its four-hour, 54-minute flight. Because NASA Langley was the original home of the Mercury Project, Carpenter and the other Mercury astronauts trained here and lived in the area in the late 1950s. The M. Scott Carpenter Bridge on Armistead Avenue in Hampton, Va., is named after him in a tradition of naming local bridges after the "Original Seven" astronauts. Carpenter was 88.

Passing of former Langley Directors observed

We observed the passing of two of Langley's former center directors this year. Their careers spanned almost the entire Space Age, and their achievements are a tribute to their talent, professionalism and dedication.

Donald Hearth — During his tenure as Director from 1975–1984, Hearth oversaw support for shuttle missions and research into the development of composite materials for commercial and military aircraft. He also spent a year serving as the agency's acting deputy administrator before retiring in 1985. He was 85.

Paul Holloway — In 1960 Holloway began his career as an aerospace research engineer at Langley, and in 1991 he was selected as Director and retired in 1996. He represented Langley on space station, shuttle and space transportation committees, and served three high-level tours of duty at NASA Headquarters. An expert in hypersonic aerodynamics, he led a team of more than 300 people from across the agency on the development of the space shuttle during the 1970s. He was 75.

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

NP-2013-11-508-LaRC