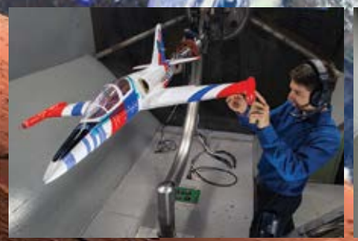
National Aeronautics and Space Administration

LANGLEY RESEARCH CENTER 2015

EARTH MARS and BEYOND



INNOVATION DRIVES THE JOURNEY

National Aeronautics and Space Administration
Langley Research Center
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A splash test of Boeing's CST-100 system, which is being developed for carrying astronauts to and from the International Space Station. The capsule could hold seven people.

NASA/Sandie Gibbs

Director's Message

Our work at NASA Langley Research Center propels the agency toward its many ambitious goals.

We are working to improve the air travel system, which includes making the aircraft you fly on safer and more environmentally friendly. When you fly on an airplane, it's likely that NASA-inspired technology is onboard.

We study the Earth's atmosphere from the ground, the skies, and space in an effort to better understand our changing planet.

We're developing technologies and capabilities that will be needed on the journey to Mars and further into the solar system.

NASA Langley is, for example, advancing designs for expanded launch capabilities, developing next-generation deployable space structures, and partnering with industry to analyze and test spacecraft designs.

In December 2014, NASA took a big step toward flight beyond Earth orbit when our Orion crew capsule took its first test flight. The spacecraft orbited Earth twice to evaluate crew safety systems, including the heat shield, parachute system and launch abort system – all of which Langley helped create. We've paired the heat shield from that flight with a crew capsule mockup, and plan to conduct water-impact landing tests in the coming year.

Langley is also evaluating new aircraft designs and developing technologies to reduce aircraft noise around airports, improve fuel efficiency, and relieve air traffic congestion.

Airplanes of the future may be built from more advanced composites to further reduce weight and improve safety. This year, researchers in one of our specialized labs bent, twisted and broke an entire aircraft section made of composite materials as part of an ongoing effort to mature them for the commercial market.

And our scientists continue to investigate how climate change is impacting the planet. Next year, an instrument built at Langley will be attached to the International Space Station to study Earth's protective ozone layer.

Finally, Langley has decades of experience in building safe, reliable, robust, highly automated systems. NASA Langley is leveraging that experience and unique testing facilities to develop technologies for autonomous vehicle systems.

I invite you to turn the page and join us on our journey.

David Bowles
Director,
NASA Langley Research Center

NASA

The first flight test of the Orion crew capsule sent it into two orbits around Earth as part of the development of a new space launch system for exploring Mars and beyond.

Leading the Way to Future Space Flight

Langley focuses on research, technology, and systems development to support sustainable human and robotic exploration of space. From helping to develop pathways from Earth to Mars, improving designs for launch vehicles, and designing and building hypersonic-entry and autonomous-landing systems, the center identifies how Langley and its partners can help NASA achieve its ambitious space exploration goals.

One of NASA's most daunting challenges is how to protect humans during a Mars mission. Beneath its hazy, pink sky, Mars is rocky, cold, and dry, with a thin atmosphere inhospitable to unprotected terrestrial life. The Martian surface bears witness to a formerly volatile world where volcanoes once erupted, meteors plowed deep craters, and flash floods raged. To enable astronauts to one day safely tread its surface, many new technologies will need to be deployed.

Developing Next-Generation Concepts

In 2015, structural and high-temperature testing validated Langley designs for a next-generation Mars atmospheric entry system. Work continued on formulation of a high-speed orbital reentry experiment to validate these new approaches. Langley is also working on advanced lightweight structural concepts for reducing the mass of future launch vehicles, crew modules and space habitats. Enhanced capabilities for robotic in-space assembly systems for longer missions beyond near-Earth space are likewise being explored.

Ongoing work includes development of an advanced Navigational Doppler Lidar (NDL) system to enable fully autonomous landings on the moon, Mars, and even asteroids. By detecting and evading dangerous obstacles such as rocks, craters and slopes, NDL enables spacecraft to touch down precisely and safely on planetary surfaces.

Langley led a concept development that defined a potential NASA asteroid rendezvous and retrieval mission, demonstrating how asteroid-retrieval concepts might work in space. Additionally, studies were completed on prototype designs for rugged habitats to protect future crews from solar radiation storms during deep space missions.

Helping to support development of the commercial space industry, Langley continued to work with the Sierra Nevada Corporation, the Boeing Company, and SpaceX on analysis and wind tunnel testing to help advance their respective concepts for future spacecraft.

Langley Key to Orion Success

Langley continues to conduct extensive wind tunnel tests and perform analyses to fully understand the aerodynamics and performance capabilities of NASA's Space Launch System. Langley researchers and engineers – who played a key role in development of the Orion Multi-Purpose Crew Vehicle – were instrumental in the success of the Orion's first launch in December 2014, known as the Exploration Flight Test–1 (EFT-1) mission. Langley researchers have been busy analyzing data gathered during EFT-1's two-orbit flight, as Orion flew 3,600 miles above Earth at speeds exceeding 20,000 miles per hour.

Langley also provided critical support in development of the Orion crew module heat shield that will be used in future crewed missions. In June, the heat shield from the EFT-1 Orion test article was delivered to Langley, and a Langley team has worked to install instrumentation in preparation for a planned 2016 series of Orion water-impact landing tests.

NASA

Artist concept of the Orion crew capsule on its first flight test last year.

NASA/David C. Bowman

The heat shield from the Orion crew capsule's first test flight into space in 2014. It was delivered to Langley for testing and analysis.

Orion Heat Shield Completes Journey to Langley

After enduring searing temperatures near 4,000 degrees Fahrenheit during Orion's first flight test in December 2014, the spacecraft's heat shield is just about ready to cool off at Langley's Hydro Impact Basin.

Serving as Orion's protector, the heat shield is designed to keep astronauts and the spacecraft safe from the heat it experiences when reentering the Earth's atmosphere.

The 16.5-foot diameter heat shield arrived at Langley in June 2015 in preparation for water-impact tests next year. During testing, engineers will drop-test an Orion crew module mockup integrated with the heat shield into the 20-foot-deep Hydro Impact Basin. Testing will simulate various water landing scenarios in order to account for different velocities, parachute deployments, wave heights and wind the spacecraft could experience when landing in the Pacific Ocean on future missions.

"It's exciting to have the Orion heat shield here," said the project's chief engineer Jim Corliss. "It's the largest of its kind and has reentered the atmosphere from a high energy orbit. It's gratifying to know it'll be used on our country's next crewed spacecraft."

Upon arrival, Langley engineers dove right into inspecting and performing pre-integration activities on the heat shield, including solving the challenge of how to integrate the crew module mockup with the heat shield.

The heat shield, which fit perfectly with the Orion spacecraft flown during the first flight test, was not designed to mate with other versions of the crew module so they built and fabricated additional equipment to ensure perfect unity.

> "It's exciting to have the Orion heat shield here ... It's the largest of its kind and has reentered the atmosphere from a high energy orbit."
>
> — *Project Chief Engineer, Jim Corliss*

But the Journey to Oneness Wasn't Easy

"It was challenging in the fact that we had to make sure the pieces were aligned horizontally, vertically, rotationally and then angularly," explained project manager Ellen Carpenter. "I had no doubt, however, that the talent, knowledge and dedication from all of the team members would allow us to complete the first initial fit check with the heat shield and crew module with flying colors."

Many More Rewarding Challenges Followed

"After the initial integration, we moved onto instrumenting the heat shield for about 160 channels worth of data and conducted some static testing on the heat shield, to evaluate the accuracy of the heat shield computer model when subjected to well-defined static loading conditions," Carpenter said.

Towards the end of this year and at the beginning of next year, the team will perform the final integration activities, insert test dummies, enclose the capsule and take it to the Hydro Impact Basin for a series of nine drop tests.

Even with all the work ahead, Carpenter feels humbled by her and her team's involvement.

"The whole purpose of the project is knowing how water landings will influence Orion," Carpenter said. "The data we receive will be used by Orion and prime contractor Lockheed Martin to prepare for future Orion missions to places yet explored. It's an exciting project to be a part of."

NASA

Boeing flew its ecoDemonstrator 757 research aircraft to Langley in June. In this image, researchers are counting the bugs that had smashed into the aircraft's wings, as part of an effort to develop a coating that will repel insects and reduce drag.

Aviation Research is Leading to Greener Flight

Applied aeronautics research in the second decade of the 21st century might be remembered by two words: green aviation. Lighter, more robust materials; next-generation technologies for more efficient, fewer emissions flight; and advanced software to reduce air travel delays: all are among the innovations to reduce aviation's environmental impact.

Reducing Fuel Use and Emissions

Langley aeronautics researchers also concluded a series of flight experiments with Boeing's ecoDemonstrator 757 airplane, part of a program to develop and test innovative aviation technologies.

One project, the Active Flow Control Enhanced Vertical Tail Flight Experiment, assessed the effect of tiny devices called sweeping jet actuators. Thirty-one of the actuators were installed on the 757's vertical tail, and studied to determine what effect they had on tail and rudder aerodynamics.

Results suggested future aircraft designers may be able to scale down vertical tail size by about 17 percent and lessen fuel usage by as much as 0.5 percent.

"Solutions to reduce fuel use by one or two percent may not sound like much," said ERA Project Manager Fay Collier. "But shaving aircraft fuel consumption even a few percentage points can save millions of dollars and help protect the environment from harmful emissions."

A second effort focused on tests of five different coatings applied to the leading edge slats of the ecoDemonstrator's right wing to see whether bug residue could be minimized during flight and help to smooth airflow over aircraft wings: another means of reducing fuel consumption.

A third project evaluated Airborne Spacing for Terminal Arrival Routes software, which creates more efficient flight paths around airports, reducing noise during takeoffs and landings.

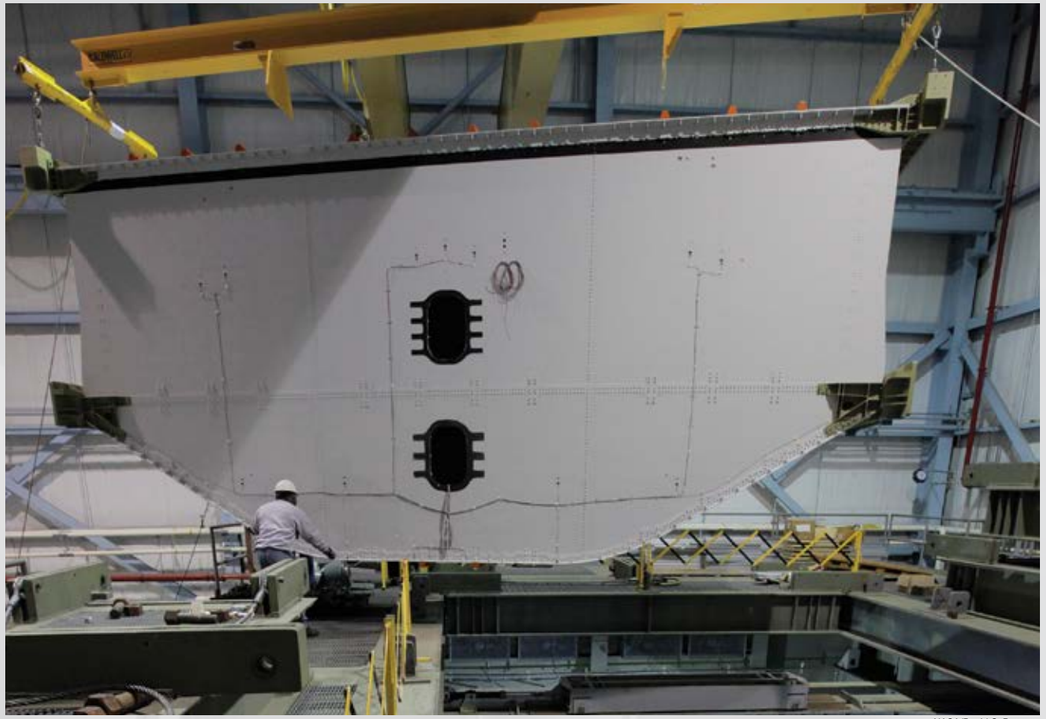
Electronics to the Rescue

Langley's aeronautics researchers also concluded the third and final crash test of five emergency locator transmitters (ELTs), crash test dummies, cameras and data-collecting sensors installed on three different Cessna 172 aircraft. ELTs transmit a distress signal to determine identity and location in the event of an airplane crash.

Because the transmitters face extreme conditions, they must withstand vibration, impact, fire, and structural compromise. The Langley studies were designed to improve ELT performance by demonstrating practical ways to improve the robustness of the system.

NASA/David C. Bowman

Langley crash-tested three Cessna 172 aircraft in 2015 to test five emergency locator transmitters. The transmitters send distress signals when an airplane crashes. The studies were designed to finds ways of improving their crash-worthiness.



NASA/David C. Bowman

A view of PRSEUS being lowered into Langley's COLTS facility for testing.

Stressed to the Breaking Point in the Name of Safety

An aircraft section built by stitching together layers and rods of composite material spent weeks being bent, twisted and stressed to the breaking point and beyond in NASA Langley's Combined Loads Test System (COLTS). Initial results show it survived the test well.

"We hit the ball out of the park, all the way across," said NASA Langley senior aerospace engineer Dawn Jegley. Jegley led the research into the technology, called Pultruded Rod Stitched Efficient Unitized Structure, or PRSEUS, which was part of NASA's Environmentally Responsible Aviation Project.

The technology could allow unique aircraft shapes to be built, such as an airplane in which the wing seamlessly blends into the main fuselage. Composites are also much lighter than conventional airplane aluminum alloys. Lighter planes use less fuel, resulting in fewer harmful emissions.

A key feature of PRSEUS, according to engineers, is that should any tears or holes appear in the aircraft structure, the stitched composite material design will stop the damage and not let it get worse.

"We're studying the data we gathered during the tests, but just visually you can see instances where we intentionally damaged the structure and the damage stopped where it was supposed to," Jegley said.

"Then having covered all the tests we intended to do, we did some bonus tests to find out what the ultimate limits of the structure were by exposing it to levels you would never see in flight. Even as it finally failed it still worked like a charm," she said.

The section tested at Langley was 11 panels assembled together and stretching 30 feet long, eight feet wide and 14 feet high. It was built by Boeing Research & Technology in California and flown to Virginia in December 2014 on NASA's Super Guppy cargo plane.

At Langley it was installed in COLTS, a large, hydraulically powered test fixture that essentially serves as an aircraft torture chamber used by researchers to put aerospace parts through their paces. Testing of the 30-foot-section took place between January and June.

The tests followed a multi-year, step-by-step PRSEUS evolution during which panels were manufactured and tested and then a 4-foot-cube was assembled and tested. At each step the idea proved itself and provided information about how the materials behave and how best to manufacture increasingly larger structures.

"This brings the technology up to a certain level, but there is still more work to be done," Jegley said.

NASA

Langley scientists take balloon-borne measurements of the atmosphere during a research mission in Asia.

NASA

Langley participated in a multi-agency field campaigning in the mid-western U.S. to study why storms often form after the sun goes down.

Making Atmospheric Discoveries

Earth is a complex, dynamic system we do not yet fully understand. The Earth system, like the human body, comprises diverse components that interact in complex ways. We need to understand the Earth's atmosphere to understand Earth's connected system. Our planet is changing on many scales, and through our research in climate, active remote sensing, atmospheric composition and air quality, NASA Langley makes atmospheric discoveries that lead to a safer planet and a better tomorrow.

A Community of Science

Global challenges, such as climate change, cannot be solved by individuals or single organizations; they require a diverse set of national and international expertise. NASA Langley actively seeks to create strong partnerships capable of addressing issues that impact our home planet.

Langley's Chemistry and Physics Atmospheric Boundary Layer Experiment (CAPABLE) site, a ground-based observation site that studies atmospheric conditions in the Tidewater region of Virginia, extended an air quality monitoring partnership with the state Department of Environmental Quality for another five years. The complementary sets of measurements will support research efforts for NASA's Tropospheric Emissions: Monitoring of Pollution (TEMPO) mission and for continuing research between NASA and the state.

NASA took to the skies of the Great Plains states to find out why so many summer storm systems there form after sunset instead of during the day. The multi-agency field campaign called Plains Elevated Convection At Night (PECAN), was sponsored by the National Science Foundation, the National Oceanic and Atmospheric Administration, NASA, and the Department of Energy.

Scientists traveled to India and Saudi Arabia to collaborate with partners from the University of Wyoming, the National Atmosphere Research Laboratory in Gadanki, India; the Tata Institute of Fundamental Research in Hyderabad, Baranas Hindu University in Varanasi, and the King Abdullah University of Science and Technology, to take balloon-borne measurements of the Asian Tropopause Aerosol Layer, a recurring atmospheric feature in July and August.

SAGE III Ready for Launch to International Space Station

More than 25 years ago, scientists realized that Earth's protective layer of ozone, which acts as a sunscreen, was thinning. Building on a legacy going back to 1975, thus began the family of instruments known as the Stratospheric Aerosol and Gas Experiment (SAGE). The latest one – SAGE III on the International Space Station (SAGE III on ISS), will continue studying ozone and other gases in the upper atmosphere.

Over the past six years, Langley researchers painstakingly prepared the instrument to collect data from an eventual perch on the exterior of the space station. Throughout 2015, the SAGE III on ISS team passed many critical milestones, leading to shipment of the instrument to NASA's Kennedy Space Center in November. It is scheduled for launch to the space station in 2016.

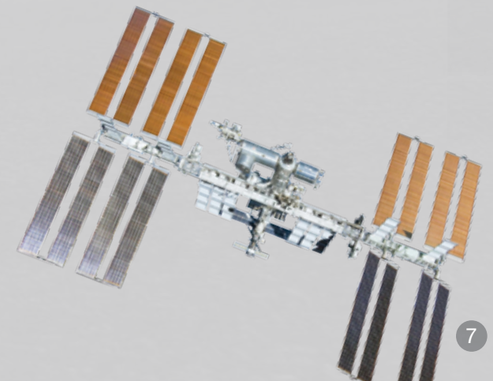
NASA/David C. Bowman

Langley's SAGE III on ISS instrument is scheduled to be attached to the International Space Station in 2016 to study Earth's ozone layer from space. It's shown here just before shipping to Kennedy Space Center.

SAGE III Heads toward International Space Station

Photos: NASA/David C. Bowman

Technicians and engineers prepare Langley's Stratospheric Aerosol and Gas Experiment III on the International Space Station, or SAGE III on ISS, for shipment to Kennedy Space Center. It was shipped to Kennedy in November, where it is scheduled to blast into orbit in 2016 aboard a SpaceX Falcon 9 rocket.



Science

Using NASA's Big Data to Help Small Businesses

NASA didn't have Wicked Joe Coffee Roasting Company in mind as the agency launched hundreds of instruments into Earth orbit over the years. But thanks to a NASA website that tailors satellite-derived data for practical applications, Wicked Joe is reaping the benefits.

And so are the operators of solar-power plants in India, architects designing buildings in Florida, farmers in Africa and everyone around the world who wants to see greenhouse-gas emissions reduced.

Many of the decisions that people make in the fields of green energy, building design and agriculture depend on knowing how much sunlight reaches the ground in given locations, along with information about wind, temperature, precipitation and other factors. But in many places, reliable data has been hard to come by.

Many of the decisions that people make in the fields of green energy, building design and agriculture depend on knowing how much sunlight reaches the ground in given locations, along with information about wind, temperature, precipitation and other factors.

"We've produced these products for years, but those users never knew they existed," said Paul Stackhouse, principal investigator of NASA's Prediction Of Worldwide Energy Resource (POWER) project. "And that's partly because the products were never made available in ways they could use."

That began to change in the late 1990s, when NASA Langley Research Center first offered solar-energy data from satellites in a user-friendly form called Surface Solar Energy (SSE) to help an organization that was promoting solar cooking in East Africa. Soon, people began to employ SSE data to analyze other kinds of solar- and wind-energy projects as well.

Today's POWER project not only incorporates SSE, it also tailors data for people who design buildings and conduct agricultural research.

The Canadian Connection

According to Stackhouse, a Langley civil service employee, a large portion of POWER's traffic comes from RETScreen, an analysis tool from Natural Resources Canada, which is that country's equivalent of the U.S. Department of Energy. RETScreen's name is derived from "Renewable Energy Technologies Screen."

It is used for a wide range of energy-related projects, but its original and still primary purpose is to enable people, quickly and easily, to screen out potential clean-energy projects that are not cost-effective so resources can be focused on projects more likely to succeed. The RETScreen software automatically retrieves the data it needs from NASA's POWER website.

Wicked Joe used RETScreen to evaluate a solar-energy system for its facility in Topsham, Maine. In doing so, it joined more than 430,000 users in many countries and territories of the world, according to Greg Leng, director of RETScreen International Clean Energy Decision Support Center.

How much have users saved with this software tool? "We know it's conservatively $8 billion to $10 billion dollars," Leng said. And he also estimated that the projects supported by RETScreen keep about 20 million metric tons of greenhouse gases out of the atmosphere every year. "Our argument has been, if you can make it a no-brainer for people from an economic standpoint," Leng said, "the environmental benefits, the climate benefits, those are the spinoffs."

NASA/David C. Bowman

NASA

Above: NASA Langley's high-altitude balloon project, known as the Radiation Dosimetry Experiment (RaD-X), launched from New Mexico to learn how cosmic rays deposit energy in Earth's upper atmosphere. **Inset:** Members of the RaD-X team, including project engineer Amanda Cutright, center, follow the balloon's progress from NASA Langley's Flight Mission Support Center.

Science

Making NASA Technology Broadly Available

Langley is focused on increasing the value of NASA developed technologies through collaboration, partnerships and licensing of intellectual property. Langley transfers NASA's technology and expertise to U.S. industry, academia, and other government organizations. Doing so ensures that technologies developed for missions in exploration, aeronautics and science are broadly available, maximizing the benefit to the nation by increasing competitiveness, creating jobs, and improving the balance of trade.

Langley has collaborated with graduate students in the College of William and Mary's Mason School of Business and Entrepreneurship Center in Williamsburg, Virginia, to evaluate Langley's high-tech patent portfolio to determine which technologies have additional commercial potential.

Partnership Successes

In recent years, evaluation licenses have become a popular tool for companies interested in commercializing Langley's inventions, but that first need to take a closer look at the technology involved. Evaluation licenses provide companies the time to learn if a given innovation will fit with their business development goals.

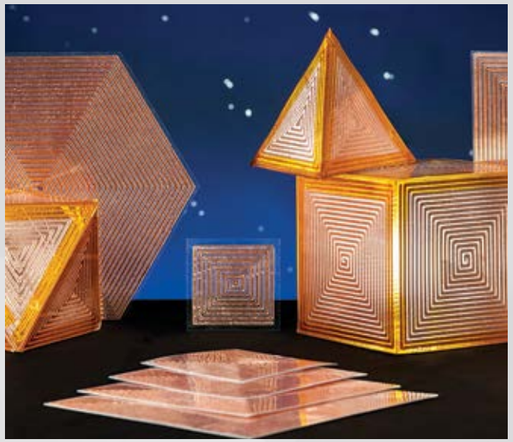
One example of a successful transition was made by GLSEQ, LLC, of Huntsville, Alabama. In 2013, GLSEQ signed an evaluation license agreement for Langley's SansEC wireless sensor technology in nuclear power plants. GLSEQ was given access to the inventors, and was easily able to obtain the needed information to move forward with a commercial product. In June 2015, the company signed a partially exclusive license with Langley to develop advanced instrumentation and control systems for severe accident monitoring within nuclear power plants and nuclear storage facilities.

Another firm, the California-based VSolvit, LLC, was granted an exclusive agreement for NASA's Space Utilization Optimization and Visualization Tool. This software system was originally developed by the Geographic Information System (GIS) Team at Langley to handle facility management across Langley's 800 acres. VSolvit specializes in developing custom GIS tools that enable organizations to manage their space more efficiently. The company intends to deploy the Langley technology as they introduce new products for their clients.

Small Business Innovation

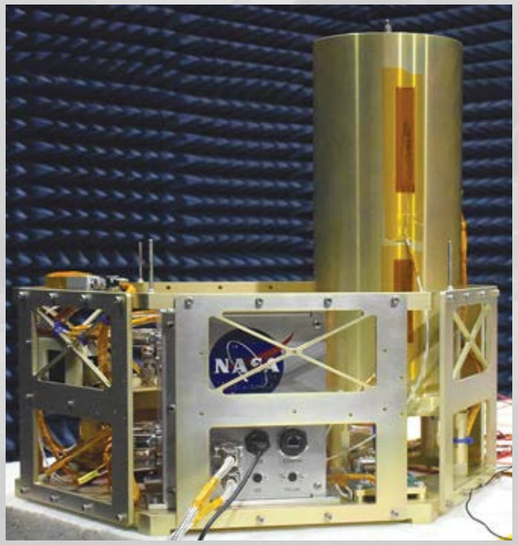
American small businesses and research institutions are critical to technological advance. Through the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs, NASA invests in and promotes successful high-tech small businesses. In 2015, Langley oversaw research efforts involving 140 active SBIR and STTR contracts worth $59 million.

Through Langley SBIR partnerships, and by leveraging matching-fund investments, Space Environment Technologies, LLC flew a radiation dosimeter to collect data in support of NASA's Radiation Dosimetry Experiment, and soon will be providing radiation exposure information for the airline industry. Other companies developed a voice-activated cockpit-management system for the Next Generation Air Transportation System; developed nano materials to enable lighter weight, more durable vehicles for future space missions; and provided sensors and probes to ensure more accurate tests in NASA wind tunnels.



NASA/Sandie Gibbs

SansEC is a wireless sensor technology that GLSEQ in Alabama is looking at for use in nuclear power plants.



NASA

NASA's Radiation Dosimetry Experiment instrument shown above will provide radiation exposure information for the airline industry.

Langley Technology May Help Protect Firefighters

Langley research into flexible, high-temperature space materials may some day improve personal fire shelter systems and help wildland firefighters better survive dangerous wildfires.

NASA Langley is working with the U.S. Department of Agriculture's Forest Service to see if flexible thermal protection system technology being developed for space entry vehicles could also work to protect firefighters caught in a raging forest fire.

Two NASA Langley researchers, Anthony Calomino and Mary Beth Wusk, reached out to the Forest Service following the loss of 19 firefighters in central Arizona in June 2013. Members of the elite Granite Mountain Hotshots were trapped and used emergency fire shelters in an attempt to survive during the Yarnell Hill fire.

"I was watching the news and I thought, just like I am sure other people did, what could have been done to save them," said Wusk. "What if the firefighters had been cloaked in some of the spacecraft heat shield materials we had spent years developing?"

She and Calomino weren't sure exactly where to start, so they sent an email to the Forest Service.

Their interest led them to the Forest Service's National Technology and Development Center (T&D) in Missoula, Montana and Fire Shelter Project leads Anthony Petrilli and Mary Ann Davies. The NASA researchers found the team was already reviewing the fire shelter design and new materials technology with the goal of producing an improved shelter by 2018.

"Our Technology and Development Program had already been doing market research into materials, laminates or components that might improve heat protection while still maintaining strength, especially as compared to the current wildland firefighter personal fire shelter," said Petrilli. "So NASA's call could not have come at a better time."

Wildland firefighters carry personal fire shelters in the rare event that they get trapped and need to protect themselves from heat, smoke and/or ember showers. Forest Service versions are aluminized cloth tents, shaped like a half-cylinder with rounded ends. They reflect radiant heat and provide a certain amount of breathable air. The Forest Service says fire shelters have saved many firefighter lives, but can be damaged by extensive direct flame contact.

NASA and the T&D team formed a partnership called CHIEFS, which stands for Convective Heating for Improvement for Emergency Fire Shelters. CHIEFS team lead Josh Fody and student interns at NASA Langley immediately began screening candidate materials solutions using a number of test and design methods.

Tests were conducted in a remote section of Canada's Northwest Territories.

Photos: U.S. Forest Service/Ian Grob

Upper inset: NASA Langley, U.S. Forest Service and University of Alberta researchers tested a number of personal fire tent concepts in realistic wildland fire conditions near Fort Providence in Canada in June. **Lower inset:** Personal fire tent prototypes faced more rigorous direct, flame-on testing at the University of Alberta in Edmonton in September, 2015. CHIEFs team members Kamran Daryabeigi, Mary Beth Wusk and Josh Fody, seen in this photo, took part.

At the Rockets 2 Racecars™ event in Richmond, Virginia, Langley staffers use hands-on activities to illustrate technology shared by rockets and racecars.

Inspiring and Educating the Next Generation

Participating in events in its five-state region of Virginia, West Virginia, Kentucky, North Carolina, and South Carolina, Langley informs the public of its accomplishments through exhibits at events and museums, a variety of social media and an active speakers bureau.

Collaborating with the National Institute of Aerospace and the Virginia Space Grant Consortium, Langley promotes science, technology, engineering and math (STEM) education to the next generation of scientists and researchers. Langley's education reach is further enhanced via the agency's Digital Learning Network (DLN) which allows Langley subject matter experts to virtually interact with students and teachers.

Langley worked with 25 museums in the past year to loan NASA exhibit items to museums in the five-state region and in New Mexico, New York, New Hampshire and London, England.

SciGirls Soar

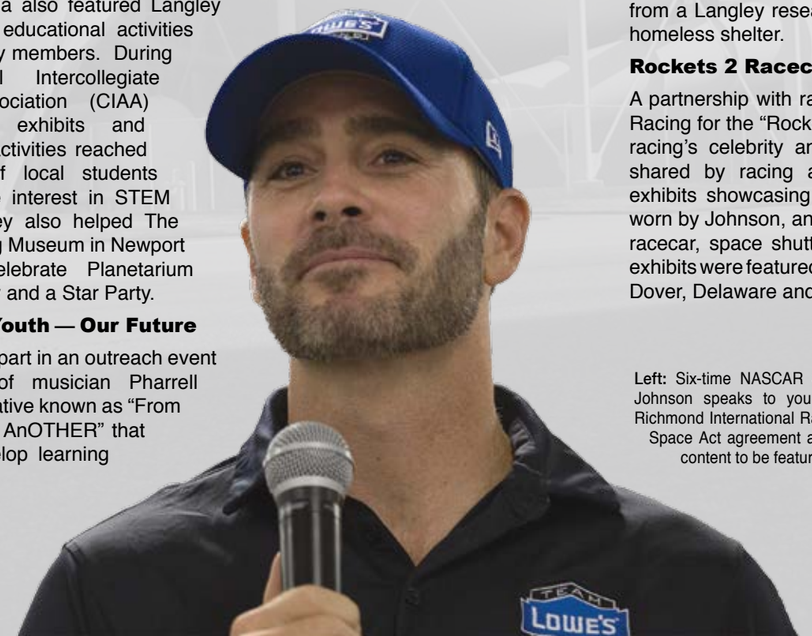
Langley scientists partnered with a Public Broadcasting Service show that highlights bright, curious girls putting science and engineering to work in their everyday lives. In an episode titled, "SkyGirls," PBS SciGirls teamed up with NASA scientists to identify clouds from the ground and compare their data with satellite images. The observation concept is one that is taught year-round internationally to students through Langley's Students' Cloud Observations Online (S'COOL) program. Science educators now use SciGirls as a platform to train other employees. In 2015, they hosted the first SciGirls Role Model Training session at a NASA center.

Science Festivals

Langley supported the second annual Science Festival of Virginia in Roanoke. Langley specialists spoke about NASA missions, space technologies, research and discoveries. Astronomy Days in Raleigh, North Carolina also featured Langley exhibits and educational activities for community members. During the Central Intercollegiate Athletic Association (CIAA) Tournament, exhibits and educational activities reached thousands of local students to encourage interest in STEM fields. Langley also helped The Virginia Living Museum in Newport News to celebrate Planetarium Wellness Day and a Star Party.

Reaching Youth — Our Future

Langley took part in an outreach event in support of musician Pharrell Williams' initiative known as "From One Hand to AnOTHER" that aims to develop learning programs for underserved youth. In July, children and their families attended Langley's Youth Day, which included 30-plus hands-on STEM activities, interactive exhibits and facility tours. To promote careers in STEM, Langley provided displays and activities for Christopher Newport University's Career Day for youth of the surrounding community in Newport News, Virginia. Langley also reached out to children living in a homeless shelter to provide a center tour and encouragement from a Langley researcher, who at one time lived in a homeless shelter.



Rockets 2 Racecars

A partnership with racecar driver Jimmy Johnson's JJ Racing for the "Rockets 2 Racecars" program matches racing's celebrity and excitement with STEM topics shared by racing and spaceflight. Langley staffed exhibits showcasing a racing suit and driving gloves worn by Johnson, and astronaut spacesuits, as well as racecar, space shuttle and planetary rover tires. The exhibits were featured at races in Pocono, Pennsylvania, Dover, Delaware and Richmond, Virginia.

Left: Six-time NASCAR Sprint Cup Series champion Jimmy Johnson speaks to young race fans and their parents at Richmond International Raceway. Johnson and Langley have a Space Act agreement allowing NASA Rockets 2 Racecars™ content to be featured at his appearances.

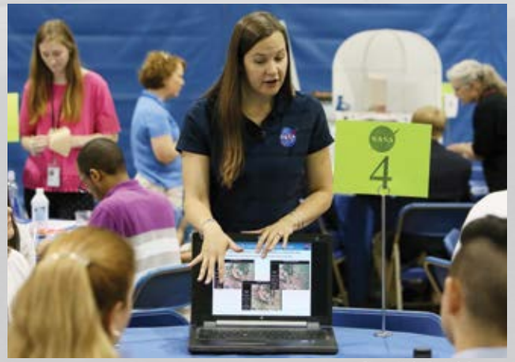
Above: Pictured with their design of an Unmanned Aircraft System, also known as a drone, are participants in a new aeronautics program sponsored by NASA. The program gives aspiring engineers a real-world experience using team-based research. The group designed, built and flight-tested the drone over the summer of 2015.

Top right: A participant in Langley's Virginia Aerospace Science and Technology Scholars (VASTS) focuses intently

Right: Langley employees help the community in a Day of Caring project.

Below right: Langley interns during an interview after working on payloads that launched on a sounding rocket at Wallops Flight Facility

Bottom right: A Langley engineer talks with students during a career day.



Photos: NASA/David C. Bowman

Education and Outreach

NASA-Boeing Partnership Making Flight Safer, More Environmentally Friendly

NASA/David C. Bowman

Boeing flew its ecoDemonstrator 757 research aircraft to Langley in June so employees could tour it and learn how the collaboration between the company and NASA is helping improve the safety and environmental friendliness of future aircraft.

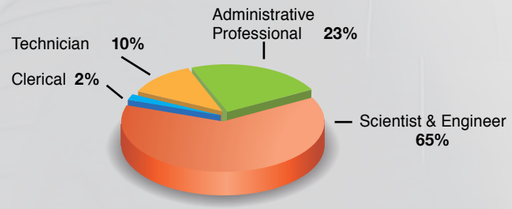
Through the partnership, Langley teams ran a pair of recent experiments aboard the aircraft, a commercial airliner retrofitted to test technologies intended to make future aircraft lighter, smarter and more efficient.

A Diverse Workforce Drives Langley Success

Diversity is key to ensuring that 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.

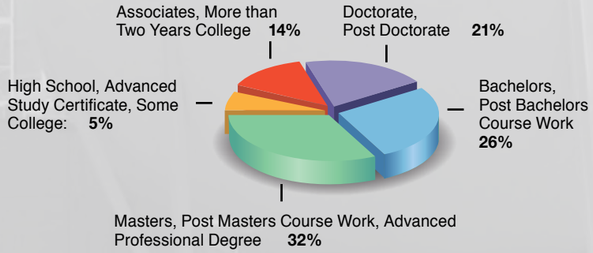
In 2015, approximately 1,900 civil servants and 1,600 contract employees supported NASA Langley. In preparing for the future, the Center strategy for workforce development is to maintain and provide the right skills at the right mix at the right time, while investing in the workforce to build skills in emerging areas for future opportunities.

Occupation Distribution



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

Education Distribution



Kaitlin Liles

Adonis Pimienta-Penalver

NASA/Bill Ingals

Eric Queen

Richard Rawls

Five NASA Women Awarded for Work in STEM Fields

More and more women are pursuing education and careers in science, technology, engineering and math (STEM), and blazing trails for future generations to make their mark in exploration, aeronautics and science. Three Langley employees were among five across NASA recognized for their contributions to STEM.

The Managerial Leadership in Government Award went to Junilla Boatwright Applin, acting Associate Director for Flight Systems in the Engineering Directorate.

"Everything we do, all that we are, encompasses science, technology, engineering and math," Applin said. "This led me to engineering which became my passion. I tell students to embrace their journey of self-discovery, find their passion, and enjoy the journey, because the sky is no longer the limit."

Applin, who has worked at NASA for 25 years, has a bachelor's degree from Old Dominion University in Norfolk and is a graduate of the Simmons Fellowship Program.

The Outstanding Technical Contribution in Government Award went to Mia Siochi, a senior materials scientist who has been with NASA for 25 years.

"Find your passion," Siochi said. "Not everybody is good at the same thing, but we all have strengths that can contribute to STEM — whether it's designing computer animation, teaching, writing stories to help people better understand complex technical content or creating art to illustrate abstract concepts."

Siochi has a bachelor's degree from Ateneo de Manila University in the Philippines, and master's and doctor of philosophy degrees from Virginia Tech.

The Career Achievement in Government Award went to Debbie Martinez, execution manager for the Convergent Aeronautics Solutions Project at Langley.

NASA/Melvin Ferebee

From left, Debbie Martinez, Junilla Boatwright Applin, Langley Director David Bowles, and Mia Siochi.

"Find your passion ... Not everybody is good at the same thing, but we all have strengths that can contribute to STEM"

— Mia Siochi

"There are so many more opportunities now for students in the technical fields than when I was in engineering school. What I tell my daughter, Solimar, and others is to investigate all the different and diverse areas available in STEM," Martinez said. "There are so many options – whether, for example, it's combining biology and mechanical engineering to work in biomechanics or music and engineering to work in acoustics to design quieter aircraft."

Martinez has a bachelor's degree from Embry-Riddle Aeronautical University in Daytona Beach, Florida and a master's degree from Old Dominion University.

Two other women to receive awards were Maria Arredondo, an education program specialist at NASA's Glenn Research Center in Cleveland; and Delene Sedillo, associate director of the Office of Procurement at NASA's Johnson Space Center in Houston.

Garfield Creary

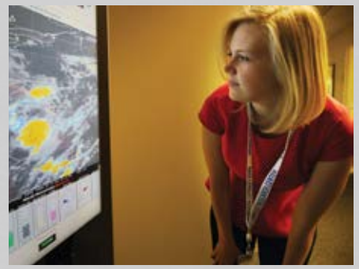
Richard Ferrare

Mark Agate and Bill Fredericks

Alok Schrestha

Brian Stewart

Garry Qualls



Megan McKeown

Photos by David C.Bowman except where noted

Langley People

NASA/George Homich

Top Nonprofit and Education Obligations

National Institute of Aerospace	$23,303,365
Regents of the University of Michigan	8,589,516
City of Hampton	5,862,001
Bermuda Institute of Ocean Sciences	4,609,151
U.S. Army Corps of Engineers	3,597,957
Oregon State University	3,262,837
University of Texas at Austin	3,019,195
Texas State University	2,906,088
Universities Space Research Assoc.	2,356,574
Smithsonian Institution	2,003,778
Georgia Tech Research Corp.	1,679,120
The Aerospace Corporation	1,672,117
Massachusetts Institute of Technology	1,646,058
Department of the Air Force	1,285,000
University of California, San Diego	1,240,721
Regents of the University of Colorado	1,198,681
Pennsylvania State University	985,173
Judiciary Courts of the Commonwealth	865,000
Old Dominion University Research	777,687
University of South Carolina	775,072
University of Maryland	755,015
Purdue University	627,889
University of Maine System	620,910
Christopher Newport University	595,706
City of Newport News	541,865

Top Business Obligations

Jacobs Technology	$70,680,552
Analytical Mechanics Associates	60,606,024
Exelis, Inc.	42,127,349
Science Systems and Applications	39,629,314
Ball Aerospace & Technologies Corp.	38,037,274
The Boeing Company	34,308,982
SGT, Inc.	24,827,298
Gentech Partners Joint Venture	17,635,256
Dominion Virgina Power	9,914,939
Cornell Technical Services, LLC	8,000,117
Unisys Corp.	7,910,000
Mission Technologies, Inc.	5,937,860
Inuteq, LLC	4,546,577
Whitestone Group, Inc.,	3,418,645
Science Applications International	2,982,508
Science and Technology Corp.	2,022,213
Alutiiq 3SG, LLC	1,879,676
Aurora Flight Sciences Corp.	1,814,091
Straughan Environmental, Inc.	1,768,482
NSR-Integrity Joint Venture, LLC	1,638,352
Airborne Systems North America	1,548,547
Lockheed Martin Corp.	1,513,114
Modern Machine and Tool Company, Inc.	1,467,410
HP Enterprise Services, LLC	1,288,699
Dyncorp International, LLC	1,268,257

Economic Impact in 2015

NASA's Virginia operations generated an economic impact of $3.1 billion in 2015, the same as in the previous year. The impact includes the combined effects of activity at NASA's Langley Research Center in Hampton, Virginia, and Wallops Flight Facility on the state's Eastern Shore.

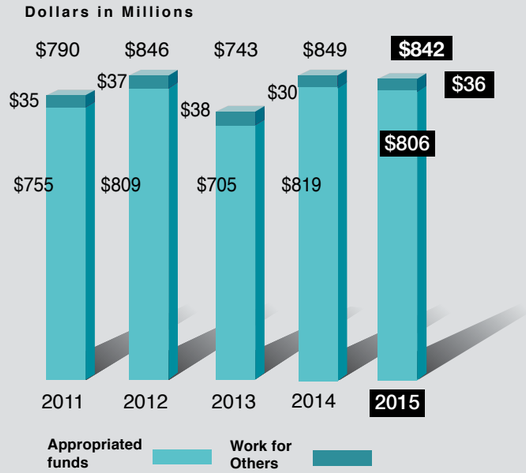
NASA Langley Generated the Following Economic Impacts

- In the U.S., the economic impact was $2.3 billion that supported 17,429 jobs.
- In Virginia, the economic impact was $1.1 billion that supported 8,876 jobs.
- In Hampton Roads, the economic impact was $957.2 million that supported 7,952 jobs.

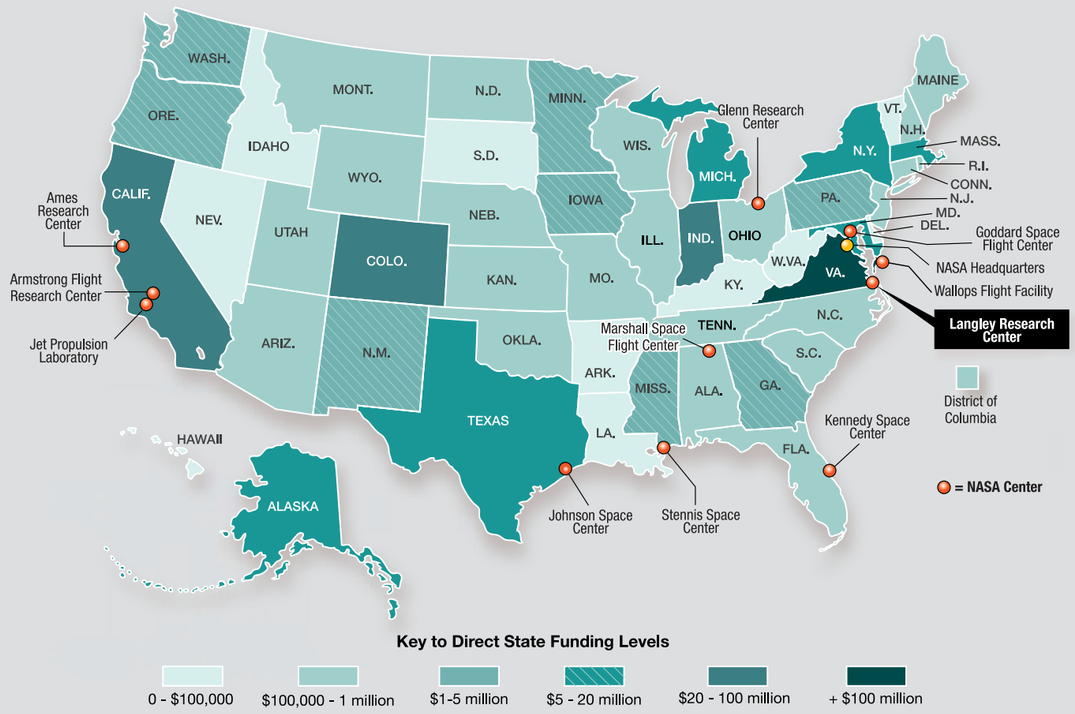
NASA Wallops Generated the Following Economic Impact

- In the U.S., the economic impact was $802.1 million that supported 5,693 jobs.
- In Virginia, the economic impact was $221.4 million that supported 1,852 jobs.

Langley Funding



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

Economics

NASA/David C. Bowman

Hall of Honor Members Enshrined

John Becker, at age 101, was one of 19 aerospace legends inducted into the Langley Research Center NACA and NASA Hall of Honor in August. “It’s like a dream,” he said. Becker was recognized for his pioneering contributions to the technology of hypersonic flight.

NASA

Langley Pilot Honored

Former Langley pilot Rob Rivers was inducted into the Virginia Aviation Hall of Fame in 2015. Rivers is the only person in the world to have flown and tested both the Concorde and Russian TU-144 supersonic transports. He was a research pilot at Langley from 1990 to 2004, and also worked at NASA’s Johnson Space Center.

NACA Sign on Display

These wings were presented to Smithsonian National Air and Space Museum’s Director Gen. Jack Dailey by NASA Administrator Charlie Bolden in honor of the 100th Anniversary of the NACA. The wings are on display at the museum.

NASA

50-Year Partnership

As part of a 50-year research collaboration with the U.S. Army, a scale powered model of an advanced Army Kiowa Warrior helicopter was tested in NASA Langley’s 14- by 22-Foot Subsonic Tunnel.

NASA/David C. Bowman

Langley Named Heritage Site

NASA Administrator Charlie Bolden, Langley Center Director Dave Bowles, AHS-International Executive Director Mike Hirschberg and NASA Associate Administrator for Aeronautics Jaiwon Shin show the Vertical Flight Heritage Site plaque awarded to Langley at a ceremony in May,

Employees Recognized for Contributions


Steve Gaddis


Noel Baker


Ali Omar


James Crawford

Noel Baker, Climate Science Branch, was selected to attend the 65th Lindau Nobel Laureate Meeting in Lindau, Germany.

James Crawford, Chemistry and Dynamics Branch, was selected to serve on the International Global Atmospheric Chemistry (IGAC) Scientific Steering Committee (SSC).

Ali Omar, Atmospheric Composition Branch, was elected secretary of the American Geophysical Union (AGU) Global Environmental Change (GEC) Session.

Larry Thomason, Chemistry & Dynamics Branch, served as cochair of the International Stratospheric Sulfur and its Role in Climate (SSiRC) activity under Stratosphere-Troposphere Processes And their Role in Climate, a core project of the World Climate Research Programme.

Steve Gaddis, Program Manager for the Game Changing Development Program office, was elected an American Institute of Aeronautics and Astronautics (AIAA) Associate Fellow.

Mool Gupta, National Institute of Aerospace (NIA) Langley Professor, University of Virginia, has been elected fellow of the Optical Society (OSA).

Lin Chambers, Climate and Radiation Studies, **Ann Carlson,** retiree, and **Lee Beach,** former Assistant Director were inducted into the Hall of Fame for the Mechanical and Aerospace Engineering Department at North Carolina State University.

Guillermo Gonzalez, Electronic Systems Branch, was invited to join the Battery Safety Council of Underwriters Laboratories.

Steve Wilkinson, Flow Physics and Control Branch, was selected to serve on an Air Force Research Lab advisory committee for the Engineered Surfaces, Materials, and Coatings (ESMC) for Aircraft Drag Reduction Program.

Mehdi Khorrami, Computational AeroSciences Branch; **Ehab Fares,** Exa Corporation; **Patrick Moran,** NASA Ames; and **Raymond Mineck,** Analytical Mechanical Associates were honored at the SuperComputing '14 Conference with an HPC Innovation Excellence Award.

Yuan Chen, Electronic Systems Branch, was the technical program chair for 2015 IEEE International Reliability and Physics Symposium at Monterey, CA.

Debbie Martínez, ARMD Projects, received the ODU Batten College of Engineering & Technology's 2014 Pioneer Award and a Career Achievement Award.

Emilie Siochi, Advanced Materials & Processing Branch, received an Outstanding Technical Contribution Award.

Junilla Boatwright Applin, Systems Engineering & Engineering Methods Branch received a Managerial Leadership Award.

Patrick Taylor, Climate Science Branch, was elected to serve on the Virginia Climate Change and Resiliency Commission and selected to serve as an advisor for the Science Advisory Board for the Hampton Roads Sea Level Rise Pilot Project.

Thomas West IV, Vehicle Analysis Branch; **Eric Walker,** Research Directorate; **William Kleb,** Computational AeroSciences Branch; and **Michael Park,** Computational AeroSciences Branch received a best paper award for "Uncertainty Quantification and Certification Prediction of Low-Boom Supersonic Aircraft Configurations" for Applied Aerodynamics of the AIAA Applied Aerodynamics Technical Committee.

Patricia Sawamura and **Richard Moore,** Atmospheric Composition Branch; **Detlef Muller,** University of Hertfordshire; **Eduard Chemyakin,** SSAI**; Sharon Burton, Richard Ferrare** and C**hris Hostetler,** Atmospheric Composition Branch; **Luke Ziemba, Andreas Beyersdorf** and **Bruce Anderson,** Chemistry & Dynamics Branch; received the best poster award at the 27th International Laser Radar Conference in New York for "Comparison of Aerosol Optical and Microphysical Retrievals from HSRL-2 and In-Situ Measurements during DISCOVER-AQ 2013 (California and Texas)." **Johnathan Hair, Chris Hostetler** and **Yongxiang Hu,** Atmospheric Composition Branch; **Michael Behrenfeld,** Oregon State University; **Carolyn Butler,** Science Systems and Applications Inc.; **David Harperand** and **Richard Hare,** Remote Sensing Flight Systems Branch; **Timothy Berkoff,** Atmospheric Composition Branch; **Anthony Cook**, Electromagnetics & Sensors Branch; **James Collins,** Science Systems and Applications Inc.; **Nicole Stockley,** Harbor Branch Oceanographic Institute; **Michael Twardowski,** Florida Atlantic University; **Ivona Cetinic,** University of Maine, currently at GSFC; **Richard Ferrare,** Atmospheric Composition Branch; **Terry Mack,** Analytical Mechanics Associates; **Kathleen Powell,** Atmospheric Composition Branch; and **Amy Jo Scarino,** Oregon State University; received best oral presentation at the 27th International Laser Radar Conference in New York for "Combined Atmospheric and Ocean Profiling from an Airborne HSRL (High Spectral Resolution Lidar)."

Scott Berry, Aerothermodynamics Branch, received the 2015 thermophysics best paper for "NASA Langley Experimental Aerothermodynamic Contributions to Slender and Winged Hypersonic Vehicles," by the AIAA Thermophysics Technical committee at the AIAA Aviation and Aeronautics Forum and Exposition at Dallas, Texas.

Sean Kearney, Sandia National Laboratories and **Paul Danehy,** Advanced Measurements & Data Systems Branch received the AIAA Aerodynamic Measurement Technology Technical Committee (AMT TC) Best Paper Award at the AIAA Aviation 2015 in Dallas for "Pressure Monitoring using Hybrid fs/ps Rotational CARS."

Richard Moore, Atmospheric Composition Branch, was a cowinner for best oral presentation by a young scientist for "In Situ Measurements of Aircraft Exhaust Measured During the 2013-2014 ACCESS Project," at the 4th International Conference on Transport, Atmospheres, and Climate.

Ann Martin, Chemistry & Dynamics Branch, received best poster presentation at the American Evaluation Association Conference for "Plans, Approaches, Needs, Context, and Reality: Meta-Evaluation of a Portfolio of External Climate Education Projects Funded by NASA."

Nelson De Carvalho, National Institute of Aerospace (NIA) researcher in the Durability, Damage Tolerance and Reliability Branch, won first place in the 2015 Hampton Roads Section AIAA Laurence J. Bement Young Professional paper competition for "Modeling Delamination Migration in Cross-ply Tape Laminates."

Brad Crawford, Systems Engineering & Engineering Methods Branch, received the AIAA Hampton Roads Section (HRS) Allan Taylor Memorial Award for continued outstanding service to AIAA HRS.

Tammy Cottee, Engineering Directorate; **Timothy Wood,** Advanced Fabrication Processes Section; **Carrie Rhoades,** Systems Integration & Test Branch; **James Rosenthal,** Electronic Systems Branch; **Hubert Senter**, Research Directorate; and **Roger Hathaway,** OSACB were recognized at a Newport News School Board meeting for their support for Denbigh High School's Aviation Academy, which earned the Virginia Career and Technical Education Secondary Business and Industry Partnership Award.

Susan Cooper, Office of Education, graduated from the Virginia Peninsula Chamber of Commerce LEAD Institute leadership program.

NASA Langley was recognized as a Vertical Flight Heritage Site by the American Helicopter Society (AHS) International.

NASA Langley received the Governor's Environmental Excellence Award honorable mention for our "Revitalization through Sustainability" program, presented at the 2015 Environment Virginia Symposium.

NASA Langley has been accepted as a Virginia Environmental Excellence Program Sustainability Partner for the 2015 calendar year.

The Integrated Engineering Services Building project was awarded the Federal Energy and Water Management Award for energy efficiency.

Patents

Bing Lin and **Yongxiang Hu,** US patent number 8,855,932 for "Method and Apparatus for Measuring Surface Air Pressure"

Alan T. Pope and **Olafur S. Palsson,** US patent number 8,858,325 for "Team Electronic Gameplay Combining Different Means of Control"

Mahyar R. Malekpour, US patent number 8,861,552 for "Fault-Tolerant Self-Stabilizing Distributed Clock Synchronization Protocol for Arbitrary Digraphs"

W. Tom Yost, K. Elliott Cramer, and **Daniel F. Perey,** US patent number 8,875,580 for "Method and Apparatus to Detect Wire Pathologies Near Crimped Connector"

Russell H. Thomas, Michael Z. Czech, and **Ronen Elkoby,** US patent number 8,876,043 for "Aircraft Engine Exhaust Nozzle System for Jet Noise Reduction"

Qamar A. Shams and **Tianshu Liu,** US patent number 8,882,049 for "Airfoil System for Cruising Flight"

Diego F. Pierrottet, Larry B. Petway, Farzin Amzajerdian, Bruce W. Barnes, George E. Lockard and **Glenn D. Hines,** US patent number 8,897,654 for "System and Method for Generating a Frequency Modulated Linear Laser Waveform"

Christopher M. Cagle and **Robin W. Schlecht,** US patent number 8,899,563 for "Flexible Volumetric Structure"

Yeonjoon Park and **Sang H. Choi,** US patent number 8,909,491 for "Multi-Point Interferometric Phase Change Detection Method"

Yeonjoon Park, Sang H. Choi, Glen C. King, James R. Elliott, and **Albert L. Dimarcantonio,** US patent number 8,913,124 for "Lock-In Imaging System for Detecting Disturbances in Fluid"

David D. North and **Mark J. Aull,** US patent number 8,922,041 for "Tethered Vehicle Control and Tracking System"

Mark G. Ballin and **David J. Wing,** US patent number 8,977,482 for "Method and Apparatus for Generating Flight-Optimizing Trajectories"

Sang H. Choi and **Yeonjoon Park,** US patent number 8,982,355 for "Smart Optical Material Characterization System and Method"

Christopher J. Wohl, Marcus A. Belcher, John W. Connell and **John W. Hopkins,** US patent number 8,987,632 for "Modification of Surface Energy via Direct Laser Ablative Surface Patterning"

W. Tom Yost, Daniel F. Perey and **K. Elliott Cramer,** US patent number 9,003,645 for "Ultrasonic Device for Assessing the Quality of a Wire Crimp"

Lisa A. Scott-Carnell, Emilie J. Siochi, Nancy M. Holloway, Kam W. Leong and **Karina Kulangara,** US patent number 9,005,604 for "Aligned and Electrospun Piezoelectric Polymer Fiber Assembly and Scaffold"

Farzin Amzajerdian and **Diego F. Pierrottet,** US patent number 9,007,569 for "Coherent Doppler Lidar for Measuring Altitude, Ground Velocity, and Air Velocity of Aircraft and Spaceborne Vehicles"

Jeffrey Y. Beyon, Grady J. Koch, and Michael J. Kavaya, US patent number 9,007,570 for "Airborne Wind Profiling Algorithm for Doppler Wind Lidar"

Russell H. Thomas, Michael J. Czech, and Alaa A. Elmiligui, US patent number 9,022,311 for "Active Aircraft Pylon Noise Control System"

David R. Schryer, Jeffrey D. Jordan, Ates Akyurtlu and **Jale Akyurtlu,** US patent number 9,044,743 for "Catalyst for Decomposition of Nitrogen Oxides"

Sang H. Choi and **Yeonjoon Park,** US patent number 9,046,418 for "Linear Fresnel Spectrometer Chip with Gradient Line Grating"

Max L. Blosser, Carl C. Poteet, and **Stan A. Bouslog,** US patent number 9,051,063 for "Space Vehicle Heat Shield Having Edgewise Strips of Ablative Material"

Constantine Lukashin and **Bruce A. Wielicki,** US patent number 9,052,236 for "Method for Ground-To-Satellite Laser Calibration System"

Peter A. Parker, Raymond D. Rhew, Thomas H. Jones and **Drew Landman,** US patent number 9,052,250 for "Method of Calibrating a Force Balance"

Ya-Ping Sun, John W. Connell, and **L. Monica Veca,** US patent number 9,067,794 for "Highly Thermal Conductive Nanocomposites"

Cheol Park, Dennis C. Working, Emilie J. Siochi, and **Joycelyn S. Harrison,** US patent number 9,074,066 for "Nanotubular Toughening Inclusions"

Alan T. Pope, Chad L. Stephens, and **Christopher A. Jones**, US patent number 9,084,933 for "Method and System for Physiologically Modulating Action Role-playing Open World Video Games and Simulations Which Use Gesture and Body Image Sensing Control Input Devices"

Stephen J. Hales, Harold D. Claytor and **Joel A. Alexa,** US patent number 9,090,950 for "Abnormal Grain Growth Suppression in Aluminum Alloys"

Leonard M. Weinstein, US patent number 9,091,490 for "Open Loop Heat Pipe Radiator Having a Free-Piston for Wiping Condensed Working Fluid"

Joel F. Campbell, Bing Lin, and **Amin R. Nehrir,** US patent number 9,097,646 for "Modulated Sine Waves for Differential Absorption Measurements Using a CW Laser System"

Mehdi R. Khorrami and **Meelan M. Choudhari,** US patent number 9,132,909 for "Flap Edge Noise Reduction Fins"

Michael W. Smith and **Cheol Park,** US patent number 9,133,032 for "Fine-Grained Targets for Laser Synthesis of Carbon Nanotubes"

Former Langley “Human Computer” Awarded Medal of Freedom

NASA/Bill Ingals

Katherine Johnson is congratulated by President Obama at the White House. Sitting next to her is baseball legend Willie Mays. They were among 17 people who received a Medal of Freedom.

Katherine G. Johnson, a retired Langley mathematician whose computations influenced space exploration efforts from Mercury through the shuttle program, was honored with the Presidential Medal of Freedom by President Barack Obama.

Johnson worked at Langley from 1953 to 1986. She was one of a number of African-American women who worked as human computers for the National Advisory Committee for Aeronautics, the agency that preceded NASA.

“Johnson exhibited exceptional technical leadership and is known especially for her calculations of the 1961 trajectory for Alan Shepard’s flight, the 1962 verification of the first flight calculation made by an electronic computer for John Glenn’s orbit, and the 1969 Apollo 11 trajectory to the moon,” the White House said.

NASA

NASA/George Homich

The Super Guppy aircraft based at NASA Johnson in Houston, hauled a huge fuselage cross-section, known as the Pultruded Rod Stitched Efficient Unitized Structure or PRSEUS to Langley. PRSEUS was tested to the breaking point and beyond to learn more about composite aerospace structures.

NASA/David C. Bowman

Researchers and students in the Langley Autonomy & Robotics Center develop and test technologies that could help allow drones and other vehicles to safely act independently without always needing human control.

New Lab Will Be Third Facility in Langley Revitalization

NASA/David C. Bowman

Leaders broke ground at the site of what will be a 40,000-square-foot Computational Research Facility at Langley. Pictured, left to right, are Shannon Kendrick, district director for the office of U.S. Rep. Scott Rigell; Erik Weiser, acting director of Center Operations at NASA Langley; David Bowles, Langley Center Director; Col. Paul Olsen, commander, Norfolk District, U.S. Army Corps of Engineers; Christian Jahrling, vice president of Turner Construction Co.; and Linda Curtis, vice mayor of the City of Hampton.

Langley’s revitalization plan calls for the construction of eight efficient, state-of-the art facilities and removal of outdated structures. Already, more than 400,000 square feet of older space has been removed.

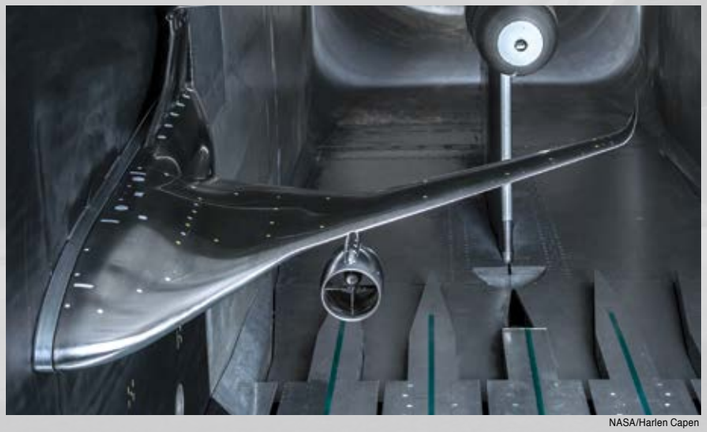
The first new building in the plan, Langley’s Headquarters, opened in 2011. The second new structure completed was the Integrated Engineering Services Building, which opened in 2014.

Construction of Langley’s next laboratory, the Computational Research Facility, as it appeared in November.

The Virginia Air & Space Center

NASA/David C. Bowman

The Virginia Air & Space Center in Hampton is NASA Langley's official visitor center. It features interactive aerospace 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 World War II bomber and experience a 3D IMAX film. Also on display is the Apollo 12 Command Module that went to the moon, the Mercury 14 capsule, the Gemini test vehicle, and the Orion Pad Abort-1 flight test vehicle. Also: 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/Harlen Capen

The National Transonic Facility at NASA Langley tested a Lockheed Martin Skunk Works® /Air Force Research Laboratory Hybrid Wing Body four-percent scale, semi-span model. The test capped a five-year development effort and paved the way for additional research in the aerodynamically efficient design that shows promise for military and commercial cargo applications.

A Powerful Tool Comes Back Online

Photos: NASA/David C. Bowman

Top: Langley technicians refinish wind tunnel fan blades.

Above: A crane hoists a massive motor back into Langley's 14- by 22-Foot Subsonic Tunnel after it was repaired. The motor turns nine wooden fan blades that form a 40-foot diameter fan, which creates the tunnel's wind stream.

NASA Langley Leadership

NASA/David C. Bowman

Clayton Turner, Langley's deputy director; David Bowles, director, and Cathy Mangum, associate director, in the 14- by 22-Foot Subsonic Tunnel.

How to Contact Us

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Government Relations: 757 864-2505

Doing Business with Langley: 757 864-5704
http://technologygateway.nasa.gov/

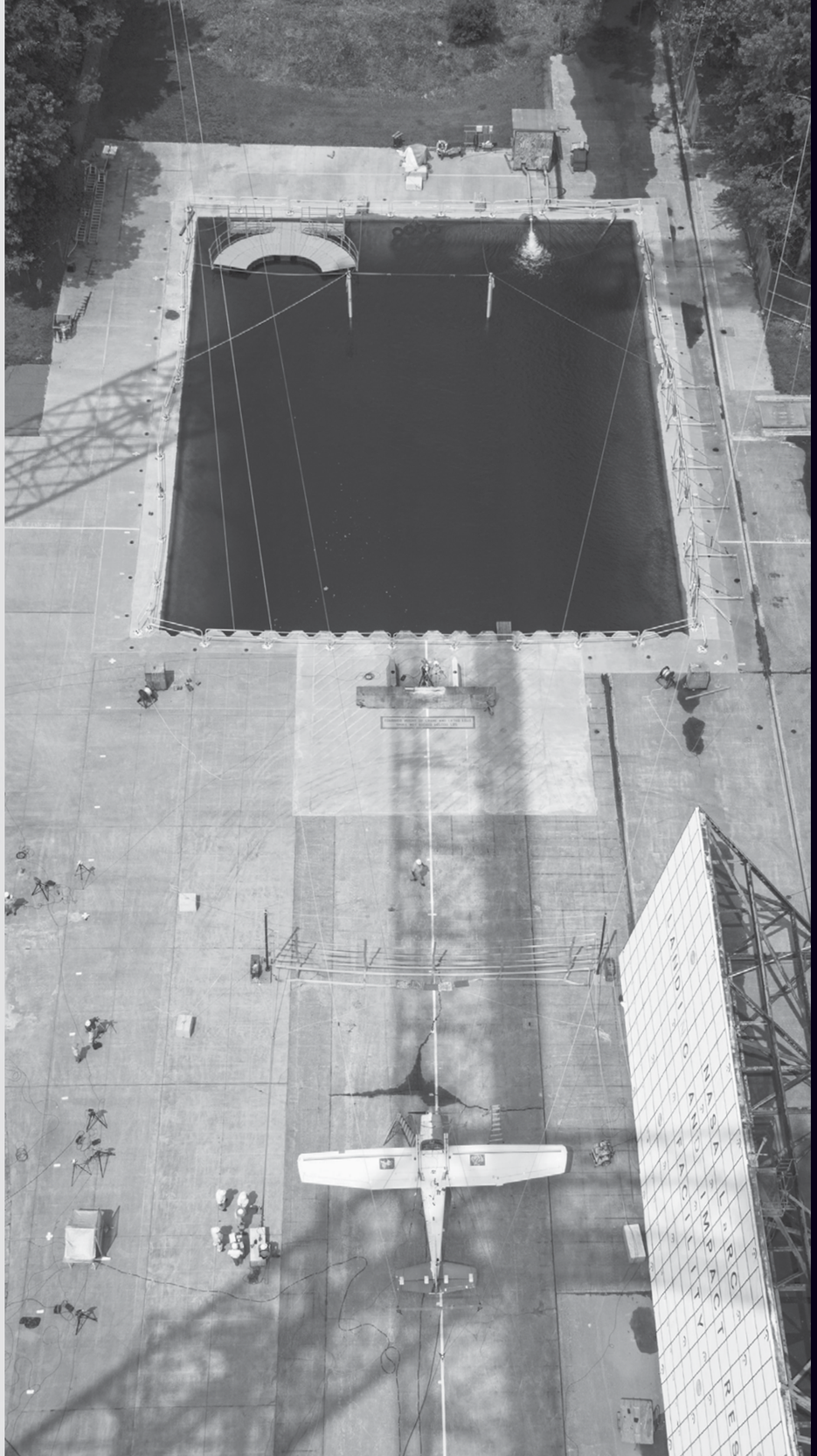
Website: http://www.nasa.gov/langley

facebook: https://www.facebook.com/nasalarc

twitter: https://twitter.com/nasa_langley

youtube: https://www.youtube.com/nasalangley

flickr: https://www.flickr.com/photos/nasa_langley



Looking down on the Landing and Impact Research Facility, better known as the "gantry," during an airplane crash test. The facility was built in 1963 to train astronauts to land on the moon. Since then the 240-foot high, 400-by-265-foot structure has been used to provide test data on the crashworthiness of aircraft and the landing loads of space vehicles.

NASA/Sandie Gibbs