National Aeronautics and Space Administration

NASA Langley Research Center 2017

A New Century Begins

CELEBRATING 100 YEARS

www.nasa.gov

NASA/Sandie Gibbs

NASA Langley employees, many with their families in tow, form a “100” at the research aircraft hangar to help kick off the center’s centennial year. Langley’s 100th anniversary was July 17, 2017.

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At NASA's Langley Research Center, we tackle tough problems and shine light on complex questions as we build a foundation for NASA's mission success.

Think of our center as a factory for new ideas. Langley produces concepts and technologies that help NASA reach its ambitious goals — and that have potential to improve lives.

Today, our researchers are part of an effort to design a supersonic aircraft that won't create a troublesome sonic boom — a project that could lead to faster commercial flights for the public. We're also exploring new concepts for electric aircraft that could result in capabilities unheard of today.

Meanwhile, we're striving to make today's airplanes safer and more environmentally friendly. Even now when you fly on an airplane, it's likely that NASA-inspired technology is onboard.

Langley researchers are also working on an array of ideas and projects that will be important to NASA's Journey to Mars. We are leading an effort to develop a technology that is both a heat shield and a spacecraft decelerator that will enable astronauts to land safety on the surface of the red planet. We're also designing tools and processes that will allow NASA to build spacecraft and human habitats while in space.

With help from industry, we are supporting the development of a Space Launch System, or SLS, which is NASA's next-generation heavy-lift rocket, to carry astronauts into deep space. That work also includes the Orion crew capsule that will sit atop the new launch system.

We also continue to examine Earth's atmosphere from the ground, skies and space. Our teams have been contributing to studies of the marine ecosystems of the North Atlantic, hurricane formation, and the movement of carbon dioxide and methane in our atmosphere.

On the International Space Station, or ISS, our atmospheric scientists are happy to have a new tool. SAGE III, an instrument developed by Langley, was installed on the station in February, and is now monitoring the health of Earth's protective ozone layer.

And in November, the CERES Flight Model 6 was launched on the National Oceanic and Atmospheric Administration's Joint Polar Satellite System-1. CERES observations provide critical data about Earth's "energy budget," the balance between energy received from the Sun and energy emitted by Earth.

In this message, I've been describing our center's present and the future, but NASA Langley has also been reflecting on its past. Langley turned 100 in 2017, and we marked our centennial with a series of events and activities ranging from a symposium and Maker Faire, to art exhibits and an open house. It was a wonderful celebration. We came away with new perspectives on Langley's storied legacy and a renewed sense of purpose as we strive to create a soaring future.

I invite you to turn the page and learn more about how NASA Langley carries forward this great tradition of technical excellence.

Dave Bowles
Director, NASA Langley Research Center

Tomorrow's Space Technologies Today

Birthplace of America's manned space program and home to the nation's first astronaut corps, NASA Langley today is helping vault space exploration into a new century. Partnerships with other NASA centers, industry, academia and government agencies shape mission priorities and fuel the work necessary to make long-term human space habitation a reality.

Langley's space focus includes entry, descent and landing systems; technologies for human and robotic exploration; space habitats; development of lightweight space transportation systems; and techniques for in-space assembly.

Our First Pit Stop

It won't be the biggest, but may become one of the most useful: the proposed Deep Space Gateway — a crew-tended spaceport parked in lunar orbit — would become a pit stop for those traveling to the surface of the Moon and beyond.

Astronauts could refuel, grab a bite to eat, and use the facilities. The gateway could also be a proving ground to evaluate space-borne operations far removed from Earth, and a way to devise new technologies for orbital maintenance. Working with industry, Langley researchers are evaluating design and construction options.

Affordable, Safer Space Construction

Making habitats habitable is perhaps the biggest challenge confronting space-based construction. There's distance from terrestrial parts suppliers, the difficulty of connecting components in microgravity, and the need to protect assembly crews during on-orbit labor. In-space assembly is a NASA initiative to pre-position materials and autonomously assemble and aggregate elements to build human-ready, large-scale structures. The goals: reduce costs, overcome launch volume and mass constraints, and protect astronauts from long-term construction hazards.

As part of this effort, Langley is working on a concept known as the Tendon-Actuated Lightweight In-Space MANipulator, or TALISMAN. It is a robotic device that uses its "tendon" cables — differential capstans and pulleys — and its joints to reach out "arms" to move, adjust and assemble together parts and components. TALISMAN technology could also aid in satellite servicing and repair, Mars spacecraft assembly, large space-telescope assembly, and even spacecraft berthing.

Aeroshell Protection

Flying through an atmosphere and safely touching down on planetary surfaces requires robust protection. Langley has developed a Hypersonic Inflatable Aerodynamic Decelerator (HIAD), a giant, doughnut-shaped "aeroshell" that protects vehicles from the extreme heat of high-speed re-entry. Uninflated, a HIAD can be packed into a small volume, overcoming the size and weight limitations of current rigid systems, and then deployed prior to entry into a planetary atmosphere to protect the payload from heating and slow it for a soft landing.

NASA

Langley also continues to work on the Orion crew capsule, which will carry astronauts atop the Space Launch System vehicle.

NASA/David C. Bowman

Shown above are samples of the Hypersonic Inflatable Aerodynamic Decelerator aeroshell that will protect vehicles from the extreme heat of high-speed re-entry.

Langley is also a critical contributor to the upcoming Mars 2020 mission, which will deliver the next science rover to the surface of Mars. Langley is developing a new suite of engineering sensors that will measure the atmospheric conditions and heatshield performance during the Entry Descent and Landing (EDL) phase. While not part of the core scientific payload, the instrument suite provides crucial engineering data for entry-system designs for Mars and other planetary missions.

NASA/Harlen Capen

Testing Prepares NASA's Space Launch System for Liftoff

Wind tunnel models of NASA's most advanced rocket have undergone a variety of tests at Langley in preparation for development of a vehicle to send astronauts on missions in deep space.

In a recent test, NASA's Space Launch System (SLS) was subjected to wind gusts of up to 70 mph in Langley's 14-by 22-Foot Subsonic Tunnel. Understanding how environmental factors like wind affect the rocket will help NASA maintain a safe and reliable distance away from the launch tower during liftoff.

The guidance, navigation and control team uses the test data as part of their simulations to identify the optimal spacing between the rocket and the tower.

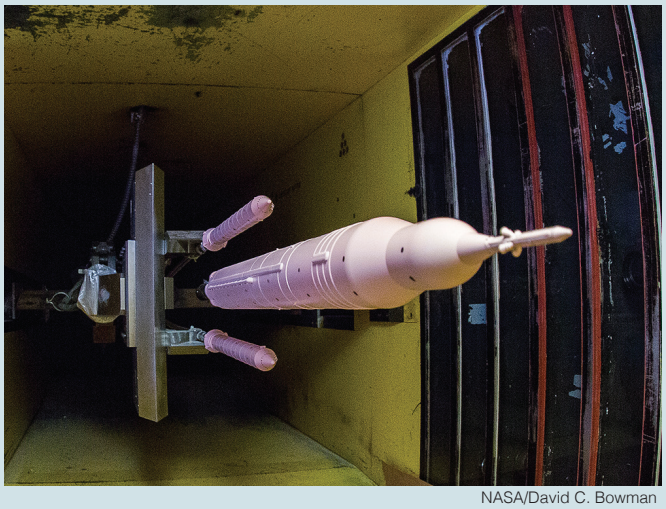
Evolving Design

The SLS is designed to evolve as NASA moves crew and cargo farther into the solar system than ever.

A 10-foot SLS model also was put to the test in Langley's Transonic Dynamics Tunnel. That test focused on understanding how the cargo version of the heavy-lift Block 1B rocket, capable of lifting 105 metric tons, will behave at speeds just below supersonic. The full-size SLS rocket will be more than 300 feet tall.

"Just below supersonic is where shock waves begin to form on the vehicle and can dance and oscillate on the rocket," said Langley researcher Dave Piatak. "The first step of these missions is safely getting above Earth's atmosphere and into orbit."

Another test took place in Langley's Unitary Plan Wind Tunnel and simulated two solid rocket boosters being pushed away from the rocket's core. The model was subjected to speeds of Mach 4, or four times the speed of sound. Those tests were aimed at ensuring crew safety when the boosters fall away.



NASA/David C. Bowman

Above: An SLS model in the Unitary Plan Wind Tunnel.

Left: Another SLS model undergoes wind tunnel testing

Right: Researchers conduct an aerodynamic test on a model of a supersonic passenger jet design in a Langley wind tunnel.

Below: Langley used a series of flight tests to assess how well drones — also called unmanned aerial vehicles — avoid structures, each other, and other hazards at low altitudes.

NASA/David C. Bowman

Making the Best Better

Within the last century, aviation became an integral part of the American economy and an essential component of everyday life. To ensure the national air transportation system remains the world's best while accommodating increasing air travel demand, a multi-government agency effort is underway for a major 21st century upgrade: the Next Generation Air Transportation System, or NextGen.

Langley is among the NASA centers collaborating with the Federal Aviation Administration and industry partners to develop advanced NextGen software to provide air traffic controllers, pilots, and other airspace users with better real-time information about air traffic flow, weather and routing. Improvements translate to shorter flight times, decreased jet fuel use, reduced aircraft emissions, and enhanced on-time performance.

Reducing Backlogs

In February, Langley concluded participation in a final flight test of cockpit software to safely increase the number of airplanes landing on the same runway at busy airports. Flight Deck Interval Management, or FIM, combines NASA-developed computer code with commercially available off-the-shelf hardware, connecting directly to an aircraft's onboard information and navigation systems while precisely managing the time, or interval, between each aircraft arrival.

Today, current air traffic control technology and procedures can predict arrival times within a minute. But FIM should enable controllers and airports to pinpoint predicted arrivals within five to ten seconds. Based on a flight-test series of 18 days, initial analysis indicated the software works as hoped.

Foolproofing Drone Flight

Perhaps the biggest challenge facing air traffic control is the safe airspace incorporation of small unmanned systems, or drones.

This past summer, Langley conducted a series of flight tests assessing how well these autonomous craft avoid structures, each other, and other hazards at low altitudes: the latter a critical concern for commercial aircraft during landings and takeoffs.

The studies addressed the effectiveness of on-board systems reacting quickly to potential dangers, avoiding collisions, and setting down safely as conditions warrant. Also evaluated were built-in constraints to prevent drones from wandering into restricted airspace. Such "geofencing" mandates are necessary if drones of larger size are ever permitted to fly anywhere at any time.

The experiments took place on a small flight range in a northerly section on Langley property, not far from a facility used for structural-impacts testing. CERTAIN — City Environment for Range Testing of Autonomous Integrated Navigation — mimics an urban environment, one where drones can be monitored while safely flying between buildings and over streets with pedestrian and vehicle traffic.

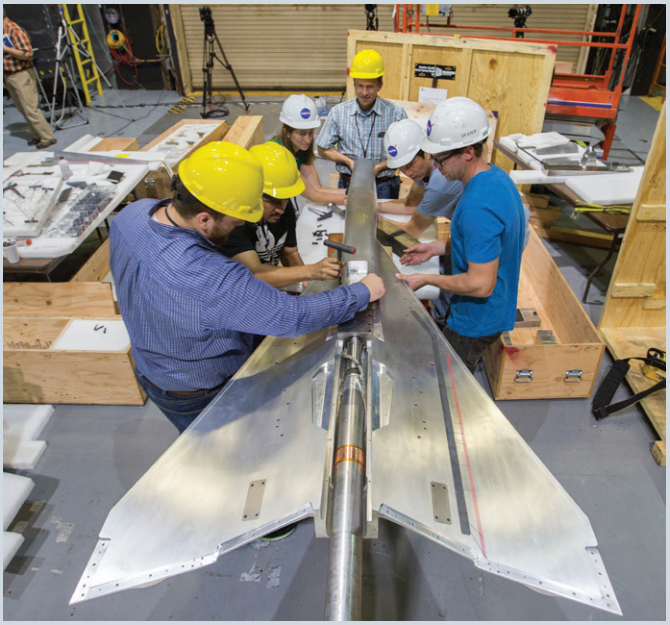
Aeronautics Innovation

Innovation at Langley extends to experiments on designs of future supersonic aircraft. One potential configuration, represented by a 15-percent-scale preliminary "X-plane" model, underwent tests this autumn in Langley's 14- by 22-Foot Subsonic Tunnel. The resultant low-speed data will be used to create an X-plane "demonstrator" that will eventually fly over populated areas to determine if disruptive sonic booms can be sufficiently quieted for approval of overland supersonic flight.

Langley also will be a key player in NASA's new Hypersonics Project, focusing on technology to create ultra-fast aircraft that fly at thousands of miles per hour.

NASA/Chris Giersch

Test engineer Samantha O'Flaherty finalizes the setup of a supersonic aircraft model for wind tunnel testing.



NASA/David C. Bowman

Langley engineers and technicians prepare a supersonic X-plane model for wind tunnel testing.

Faster Than a Speeding Bullet

Can you imagine flying from New York to Los Angeles in half the time?

Commercial flight over land in a supersonic jet would mean less time in-flight, less time in a cramped seat, fewer tiny bags of snacks – and more time at your destination.

The Concorde, which last flew in 2003, used 1950s technology, and flew supersonic only over the ocean because it was too noisy to fly over people. It also burned a lot of fuel and was an expensive ticket – about $15,000 for a round-trip seat in today's dollars.

Since 1973, supersonic flight over land has been forbidden in the U.S. because of the noise from sonic boom. That's the problem NASA's Commercial Supersonic Technology Project is trying to solve.

Beating the Boom

The big near-term step is to show that the sonic boom can be beaten. To accomplish this, an X-plane with distinctive shaping — a long nose and highly swept wings — is being developed. The preliminary design is called the Quiet Supersonic Transport, or QueSST.

To verify the aerodynamic performance predictions of the fuselage shape, control surfaces and engine inlet, a NASA-Lockheed team built a scale model of the QueSST design tested in NASA Langley's 14-by 22-Foot Subsonic Tunnel and in a tunnel at NASA Glenn Research Center in Cleveland, Ohio.

The big near-term step is to show that the sonic boom can be beaten.

NASA partnered with lead contractor Lockheed Martin for a QueSST preliminary design, which has been approved, clearing the way to building a piloted, single-engine X-plane. Flight testing could begin as early as 2021.

"Managing a project like this is all about moving from one milestone to the next," said Langley's David Richwine, manager of the preliminary design effort. "Our strong partnership with Lockheed Martin helped get us to this point. We're now one step closer to building an actual X-plane."

Supersonic Defined

Supersonic flight is one of the four speeds of flight. They are called the regimes of flight and are subsonic, transonic, supersonic and hypersonic.

Vehicles that fly at supersonic speeds are traveling faster than the speed of sound. The speed of sound is about 768 miles per hour at sea level. These speeds are referred to by Mach numbers. Flight faster than Mach 1 is supersonic. Supersonic includes speeds up to five times faster than the speed of sound, or Mach 5.

In 1947, Air Force Capt. Charles E. "Chuck" Yeager became the first person to fly an aircraft faster than the speed of sound.

NASA/David C. Bowman

The Ozone Water-Land Environmental Transition Study used sensors and other instruments to study harmful ground-level ozone in Hampton Roads.

At Langley's Flight Mission Support Center, personnel watch as an Earth-observing instrument called SAGE III is attached to the International Space Station. SAGE stands for Stratospheric Aerosol and Gas Experiment.

Monitoring Earth's Vital Signs

Langley's Science Directorate researchers are devoted to finding out how Earth and its atmosphere interact and change, and what that means for planetary health and overall quality of life. For decades, Langley-developed instruments mounted on satellites, carried on airplanes, or deployed on ground-based stations have tracked planetary vital signs. Today, this equipment continues to monitor, analyze and record observations of the globe's interconnected systems.

Langley manages one of the largest and most comprehensive collections of worldwide atmospheric data

Langley manages one of the largest and most comprehensive collections of worldwide atmospheric data, shaping current and future understanding of our planet. Studies scrutinizing atmospheric transport and chemistry over farms, national parks, oceans, the Arctic, the Amazon, among many other locations, reveal fundamental interactions within the global ecosphere, exposing effects on air quality, public health, agricultural efficiency, energy use, aviation safety, national security, and economic well-being.

Uniquely Useful Datasets

As localities worldwide recognize the need for reduced dependency on non-renewable energy, decision-makers are turning to renewable sources such as solar and wind. NASA's Prediction of Worldwide Energy Resource Program (POWER) identifies specific regions where renewable energy technologies work best by making NASA data publicly available over the internet.

Langley science researchers are improving POWER by providing free worldwide access to global-scale NASA data on incoming sunlight, wind speed, and a range of meteorological variables. The Langley team has translated these data into formats that can be seamlessly plugged into the software engineers use to develop cost-saving energy-efficient systems — especially important for those most in need in underdeveloped countries.

A Langley-developed hazardous thunderstorm-detection dataset is providing critical real-time information for fishermen living and working in East Africa's Lake Victoria. There, thousands are killed annually by intense tempests that whip up after dark. By culling and incorporating satellite observations into predictive models, meteorologists are improving their ability to warn of hazardous events. Ultimately, forecasters could receive automatic storm-warning messages via Twitter.

The science education team also collects important atmospheric data through the Global Learning and Observations to Benefit the Environment (GLOBE) mobile. Users around the world provide data on sky color, visibility and opacity, cloud properties, and surface conditions.

A Clean Water Focus

The Langley-managed DEVELOP program works with communities to find innovative, practical and beneficial uses for NASA's Earth observational data. DEVELOP conducts 70 to 80 projects annually, involving more than 125 organizations worldwide. Areas of focus include agriculture and food security, disasters, ecological forecasting, energy, health and air quality, urban development, transportation and infrastructure, and water resources.

Water was the focus of two notable 2017 DEVELOP initiatives. One, an effort using remote sensing data to provide a water-clarity estimate, occurred close to Langley itself in the Chesapeake Bay. The cleaner bay water is, the better: if submerged aquatic vegetation flourishes, so too do the many organisms relying on it for nourishment. The second was an investigation of environmental factors hurting or helping oyster populations in the Mississippi Sound. Since oysters purify water via filter feeding, water-quality decline can diminish their numbers, affecting both overall pollution levels and local economies.

CERES Radiation Budget Instrument Launches Aboard JPSS

A bright flash. A streak of light against a dark sky. The roar of the United Launch Alliance Delta II rocket.

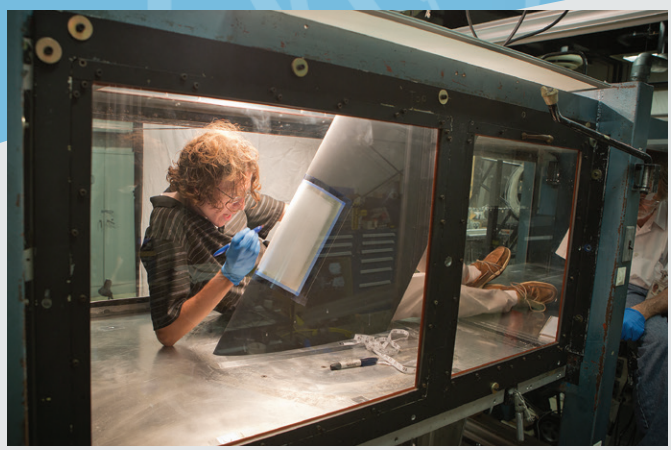
The National Oceanic and Atmospheric Administration's Joint Polar Satellite System-1 (JPSS-1) blasted off the launch pad in November at Vandenberg Air Force Base on the central California coast.

Aboard are five science instruments, including the Clouds and the Earth's Radiant Energy System Flight Model 6 (CERES FM6), a Langley instrument that measures the solar energy reflected by Earth, the heat the planet emits, and the role of clouds in that process.

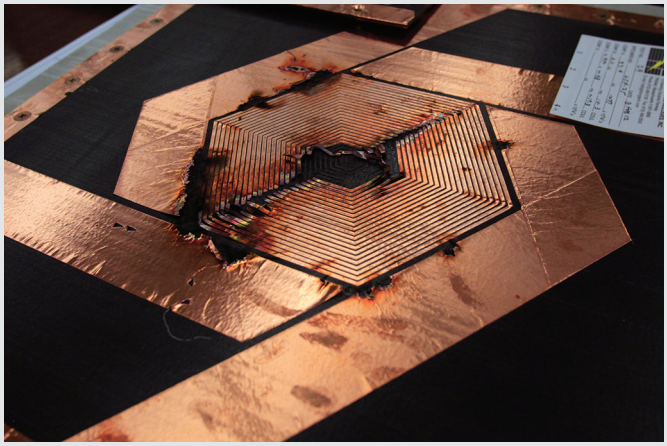
"It's exciting to know the final CERES instrument has made the journey through Earth's atmosphere," said Norman Loeb, principal investigator for NASA's Radiation Budget Science Project. "CERES FM6 will add valuable data to the existing record and improve our understanding of Earth's radiation budget. The data are critical to improving seasonal and longer-term forecasts."

Built by Northrop Grumman and managed by Langley, CERES FM6 is the last in a series of instruments that provide a critical top-of-atmosphere dataset for Earth's radiation budget. At its new home in space, FM6 joins five other CERES instruments orbiting the planet on three other satellites.

CERES FM6, or the Clouds and the Earth's Radiant Energy System Flight Model 6, will contribute to a top-of-atmosphere dataset for Earth's "energy budget."



Special coatings like the one being applied here can prevent the buildup of insect splatters on aircraft wings, and have potential other uses on non-aerodynamic surfaces.



The technology called SansEC, which is short for "without electrical connection," is a sensor that functions using electromagnetic vibrations in the air and does not need to be plugged in or use batteries.

Record-setting Pace Built on Partnerships

Langley uses a variety of mechanisms to both form partnerships advancing NASA's core missions, as well as producing spinoffs that directly benefit the public.

In 2017, Langley oversaw 293 SBIR and STTR active awards worth more than $111 million

NASA research is applied to the development of space exploration tools, our understanding of Earth's climate, and improvements in air transportation. Many of those technologies then translate into down-to-earth uses in surprising ways, from food and beverage making, security equipment and wound treatment, to cancer detection.

All told, Langley has 230 active domestic agreements with industry, other federal agencies, and academia, and another 30 agreements internationally.

On the Fast Track

Matchmaking Langley researchers with industry is the aim of the Fast Track to Market competition, with the goal of maturing market-ready products and processes. Participants are selected from submitted applications and trained to pitch their ideas. A forum features researcher presentations to a panel of industry experts. Winning teams are tapped for development and commercialization awards.

The competition has had immediate payoffs. The past 12 months saw a record-setting pace for Langley licensing to businesses and organizations. Since the beginning of 2017, Langley executed 31 technology licenses.

Beating Bugs

Based on attendance at the Fast Track competition, Maryland-based Prime Manufacturing Technologies became aware of Langley-developed surface-modification coatings. The company became one of four firms seeking a license for the invention.

The coatings, which won a 2016 R&D Magazine Top 100 award, can significantly reduce or prevent the buildup of insect remains on the wings of airplanes in flight. The added drag on the aircraft leads to increased fuel costs and air pollution. The coatings also repel water, which could protect other non-aerodynamic surfaces from debris buildup and eliminate the need for frequent washing or cleaning.

Attracting the attention of five license seekers in 2017 was a unique sensor developed at Langley several years prior. Known as SansEC, or "without electrical connection," the small device can simultaneously measure different physical phenomena — temperatures and fluid levels, for example — and functions even when badly damaged. Potential SansEC applications include monitoring of ice and snow accumulation on surfaces, food and beverage manufacturing, incorporation into security equipment, wound treatment, and perhaps even cancer detection.

Small Business Support

New technology creation can often be traced to small businesses and research institutions. Investment in these organizations occurs through NASA's Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), and Regional Economic Development (RED) programs.

In 2017, Langley oversaw 293 SBIR and STTR active awards worth more than $111 million. Leveraging matching SBIR fund investments, firms are developing and deploying such innovations as an optic fiber-based hybrid spectroscope, a sensor for wind tunnel calibration and characterization, a self-deploying tent array, and high-speed beam-steering components for laser-based instrumentation.

NASA/Sandie Gibbs

SOLAR ECLIPSE

This time-lapse sequence shows the Aug. 21 solar eclipse as seen from the research aircraft hangar at Langley. The eclipse was partial in this area, while in a broad swath across the United States, it was total. The Moon completely covered the Sun from Oregon to South Carolina, and millions of people turned out to see it in events across the country.

Langley gave away 30,000 eclipse viewing glasses so people could look at it safely, and took part in events in South Carolina, Nebraska and locally.

Inspiring the Next Generation of Explorers

NASA Langley's education and outreach teams are continuing to inspire the next generation of explorers through dozens of events that directly engage students and the general public.

Thousands of students and educators in Langley's five-state region — Virginia, West Virginia, Kentucky, North Carolina and South Carolina – are reached every year. Teachers from around the world completed online professional development programs to earn digital centennial badges in Earth science, aeronautics and journey to Mars.

Other events and programs include the annual NASA Art Contest, Speaker's Bureau talks, participation in NASCAR events, the Minority University Research and Education Project, NASA Earth Systems, Technology and Energy Education, and NASA internship, fellowship, and scholarship programs that brought in 600 students.

NASA/Dustin Hitt

Hundreds of students took part in NASA Langley's visit to the University of West Virginia in April. Students in grades 4-12 turned out along with faculty, staff and university students.

Ongoing partnerships with the Virginia Air & Space Center, the Virginia Space Grant Consortium, and the National Institute of Aerospace expanded NASA's reach as well, adding programs such as the NASA Out of School Learning project, which provided museum visits for 2,500 kids and professional development for summer teachers.

With a focus on its 100th anniversary, Langley deployed its traveling centennial exhibit trailer to public events throughout the region.

Other events included a visit to the Paducah Challenger Center in Kentucky; the Time for Science Expo in Greenville, North Carolina; the Virginia-Kentucky District Fair in Wise County, Virginia; AirVenture in Oshkosh, Wisconsin; NASA STEM Awareness at the Central Intercollegiate Athletic Association in Charlotte, North Carolina; and the National Conference of State Legislatures in Boston.

Langley also participated for the first time in the Naval Air Station Oceana Air Show in Virginia Beach, Virginia, which drew a crowd of more than 250,000 people.

Langley's reach was also recognized internationally through a NASA aviation exhibit called "Above and Beyond," which traveled throughout the United States, Asia, Europe and the Middle East.

Right here at Langley, teachers attended STEM (science, technology, engineering, and math) professional development. In May, fourth and fifth grade students from the Lumbee Tribe in Lumberton, North Carolina, visited Langley for hands-on experiences.

During a Day of Sharing in July, Langley employees visited more than 40 local summer school programs with hands-on demonstrations and student activities. And in September, students from the Black Girls Code program and Hampton Public Schools met with Margot Lee Shetterly, author of the book "Hidden Figures," and one of its central characters, "human computer" Katherine Johnson.

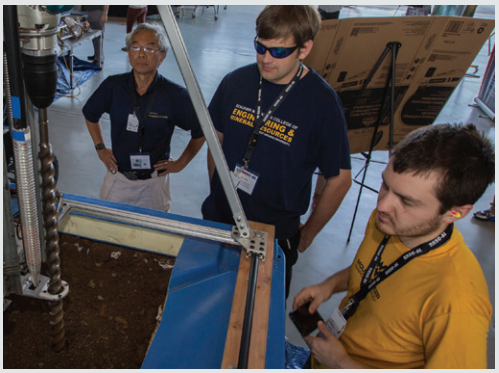
Right: With a focus on its 100th anniversary, Langley deployed a traveling centennial exhibit trailer to public events throughout the region, attracting thousands of visitors.

Far right: Author Margot Lee Shetterly in front of a new facility named for Katherine G. Johnson, the NASA "human computer" featured in the "Hidden Figures" book and movie.

NASA/David C. Bowman

NASA/David C. Bowman

NASA/David C. Bowman



NASA/David C. Bowman

NASA

NASA/David C. Bowman

Top left: A new computing facility named for "Hidden Figures" icon Katherine G. Johnson opened with students in attendance.

Top right: A contest for students to postulate ways of mining water on Mars was held.

Bottom right: Students from across the nation participated in the NASA Community College Aerospace Scholars program in May. They completed online course work related to Mars exploration and then were assigned to a rover-building team

Bottom left: NASA Langley contributed aeronautics models to this …"Above and Beyond" exhibit that traveled to more than a dozen international locations and attracted more than 3 million visitors.

NASA/Harlen Capen

Visitors at Langley's Centennial Open House get a look at the fan blades inside the 14- by 22-Foot Subsonic Wind Tunnel.

From left: The Hampton Holly Days Parade; staff setting up a three-month Langley art show at the Peninsula Fine Arts Center; Richard "Pete" Petersen, Langley's center director from 1985 to 1991, speaking during a centennial gala in July. Center Director David Bowles and Virginia Governor Terry McAuliffe with "human computer" Katherine Johnson; and a photography exhibit at the Chrysler Museum of Art in Norfolk, Virginia.

Langley marked its 100th birthday with a series of events over the year. We held a Centennial Art Contest that drew participants from across the country, and a Langley Hall of Honor ceremony to induct new members. A Centennial Symposium devoted two days to panel discussions and presentations by NASA and aerospace industry representatives — including Buzz Aldrin, the second man to walk on the Moon.

A Centennial Tribute put on by the community included a video message from an astronaut orbiting Earth on the International Space Station. We participated in the Hampton Holly Days Parade, held a 5K Moon Walk, and opened the new Katherine G. Johnson Computational Research Facility honoring the unsung African American "human computers" who worked at Langley.

The Chrysler Museum of Art opened an exhibit of photographs taken by Langley over the last century. Finally, a NASA Langley open house drew 20,000 visitors for a day of tours and activities including a 10K run, activities for kids, and a behind-the-scenes look at wind tunnels and labs usually closed to the public.

Along the way, we never stopped working toward another 100 years of challenge and innovation in the air, space and on Earth.

Guests at Langley's Centennial Open House enjoyed a variety of exhibits and activities.

The Air Force Heritage of America Concert Band performs a tribute to Langley at the Ferguson

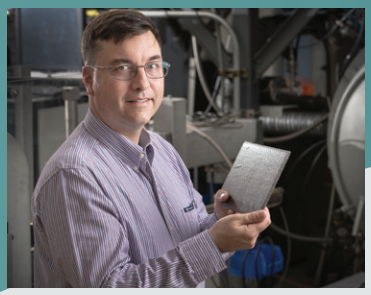
NIA

Center for the Arts.

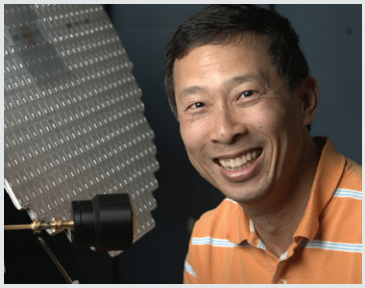
Langley participated in the Maker Faire at the Hampton Roads Convention Center.

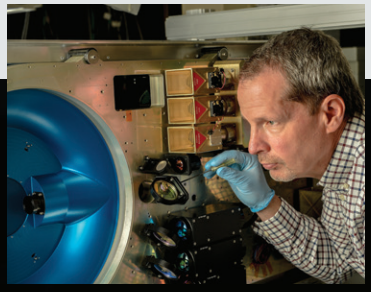
Apollo moon-walker Buzz Aldrin was one of the distinguished guests during the July Centennial Symposium in Hampton, Virginia.

Photos by NASA/David C. Bowman, except where noted.



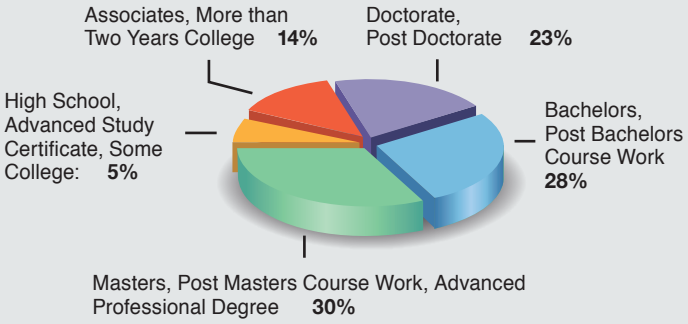
Clockwise from top left:
Larry Tomsen, Kurt Swieringa, Brooke Thornton, Marilé Colón Robles, Yolanda Shea, Tony Cook, and Truong Nguyen.



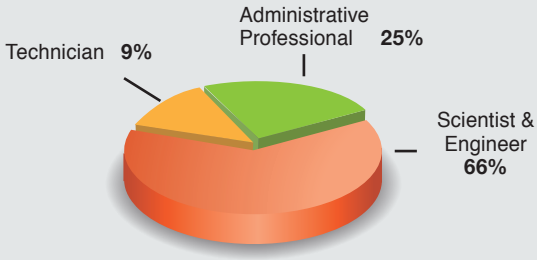


Researcher Steve Harrah inspects an antenna being developed to detect hazardous ice particles in the path of commercial passenger aircraft.

Education Distribution



Occupation Distribution



Education and occupation distribution numbers apply to 1,821 civil servants only. Data is not collected for contractors.

NASA/David C. Bowman, and George Homich.

NASA/David C. Bowman

From left to right: NASA Langley employees Guillermo Gonzalez, Jessica Snyder, Debbie Martínez, Alexander Kwa, Ana Tinetti and Miguel Alvarez organized a supply drive for Puerto Rico hurricane relief.

Employees Pitch in to Help with Hurricane Relief

When Hurricane María swept over Puerto Rico, leaving unimaginable damage in its wake, Debbie Martínez knew she had to do something.

Having family members on the island made it deeply personal for Martínez, a senior manager at NASA. "You're very frustrated from afar — you can't go, you can't call," she said.

"This gives us a sense that you're contributing and helping"

Martinez, along with other employees at NASA Langley held a donation drive for much-needed supplies.

"This gives us a sense that you're contributing and helping," said Guillermo Gonzalez, the Orion avionics lead at Langley's Launch Abort System office and native of Ponce, Puerto Rico.

The volunteers organized bins at locations across Langley and at the nearby National Institute of Aerospace from Sept. 29 to Oct. 10. Donated items include diapers, toiletries, first aid kits, over-the-counter medicines, sanitary products and more. Volunteers included Kara Latorella, Yamira Santiago, Carlos Liceaga, Gonzalez, Jessica Snyder, Julie Williams-Byrd, Linda Goad, Charles Lunsford, Ana Tinetti and Alexander Kwa at Langley and Edna Walters at the NIA.

Helping FEMA

At the same time, 18 other Langley employees deployed to help the Federal Emergency Management Agency, or FEMA, with relief efforts in Florida, Texas, Nevada, Alabama, and California as well as Puerto Rico.

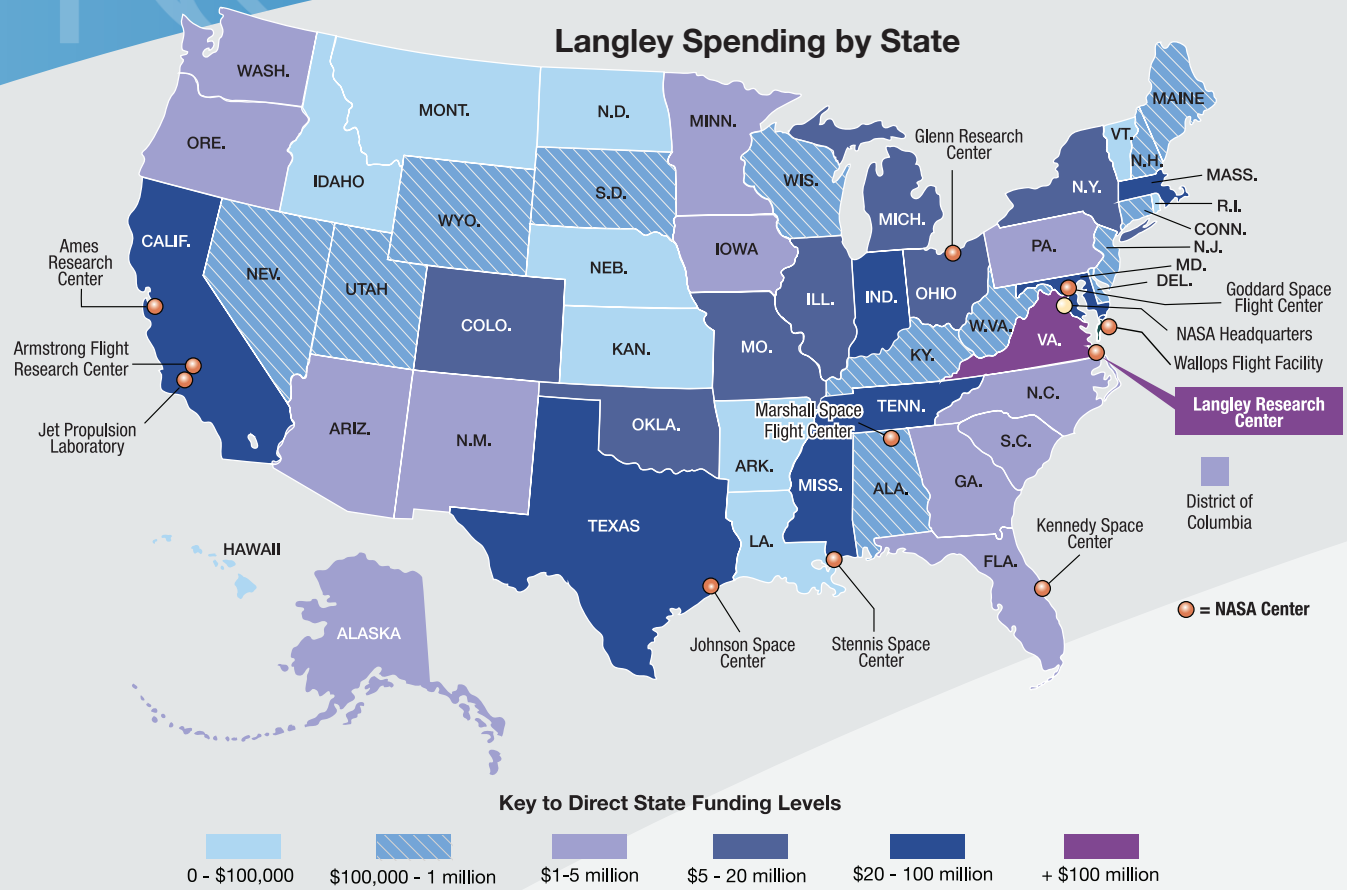
For Martinez's group, donations came in slowly at first, but thanks to the support of Langley management, the response became overwhelming. "It was very humbling for me to see them do that," Martínez said. "That's been a blessing."

The campaign showed Martínez the will and spirit of employees to help those in need — a feeling she won't soon forget.

"People have been very generous. I'm very touched by what they've done," she said. "They have given from the heart as any family does, and I thank them all for their generosity."

Laura Brewer, deputy director of Langley's Systems Analysis and Concepts Directorate, deployed to Puerto Rico in September, where she worked for FEMA as a disaster survivor specialist. As part of a team of federal agency volunteers, she went door-to-door helping homeowners fill out applications for federal assistance.

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 Nonprofits and Educational Institutions

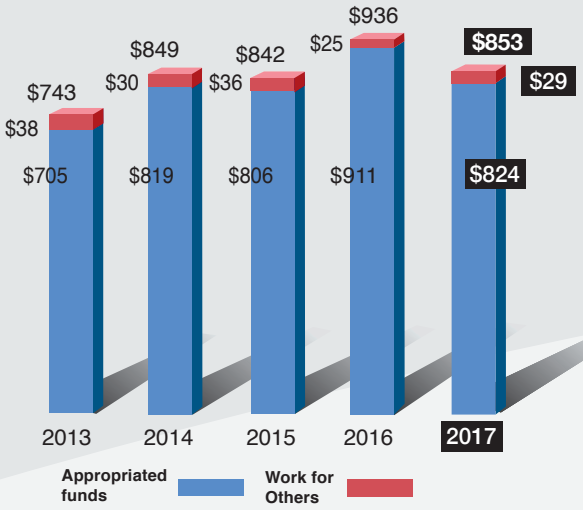
National Institute of Aerospace Associates	$34,364,457
USAF, Life Cycle Management Center	14,312,861
General Services Administration	11,799,302
US Army Corps of Engineers	11,708,852
University of Oklahoma	8,725,761
City of Hampton	6,236,857
Regents of the University of Michigan	6,126,024
Universities Space Research Associates	3,029,121
Texas State University	3,011,725
Oregon State University	2,956,623
University of Texas at Austin	2,936,063
The Aerospace Corporation	2,902,389
Smithsonian Institution	2,820,140
Pennsylvania State University	1,166,456
USAF, Space Missile Test & Evaluation Directorate	1,097,013
USAF, Air Force Space Command	1,043,277
Regents of the University of Minnesota	982,750
Old Dominion University Research Foundation	944,258
Northwest Indian College Foundation	844,357
Regents of the University of Colorado	800,657
University of Southern California	766,827
Judiciary Courts of the Commonwealth	740,000
President and Fellows of Harvard College	716,781
Massachusetts Institute of Technology	676,839
Georgia Tech Research Corporation	533,771

Top Business Obligations

Analytical Mechanics Associates, Inc.	$ 66,214,353
Jacobs Technology, Inc.	59,682,660
Science Systems and Applications, Inc.	54,018,126
Harris Corporation	44,146,273
Science Applications International	27,175,288
GenTech Partners Joint Venture	21,667,451
Boeing Company	13,225,800
Virginia Electric and Power Company	8,615,406
Cornell Technical Services LLC	7,562,438
Lockheed Martin Corporation	7,093,856
Alliant Techsystems Operations LLC	5,899,081
Mission Technologies, Inc.	5,286,089
Unisys Corporation	6,069,757
ISS Action, Inc.	3,446,733
Science and Technology Corporation	3,389,594
Midland GSS JV	2,414,638
Alutiiq Commercial Enterprises LLC	2,374,171
Modern Machine and Tool Company, Inc.	1,789,584
Honeywell International Inc.	1,701,674
Ball Aerospace & Technologies Corp.	1,541,119
Advanced Technologies, Inc.	1,527,241
Avenger Aerospace Solutions, Inc.	1,500,001
Straughan Environmental, Inc.	1,437,082
Aurora Flight Sciences Corporation	1,432,138
GIA Medtrust JV, LLC	1,205,088

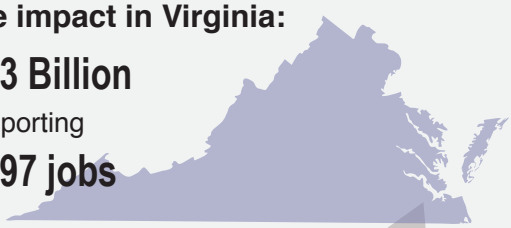
Langley Funding

Dollars in Millions



NASA Langley Generated the Following Economic Impacts:

The impact in Virginia:

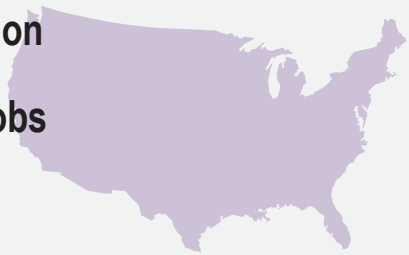


$1.3 Billion
Supporting
7,597 jobs

The impact in Hampton Roads:

$1.1 Billion
Supporting
6,474 jobs

The impact in the U.S.:



$2.8 Billion
Supporting
14,785 jobs

NASA/David C. Bowman

NASA/David C. Bowman

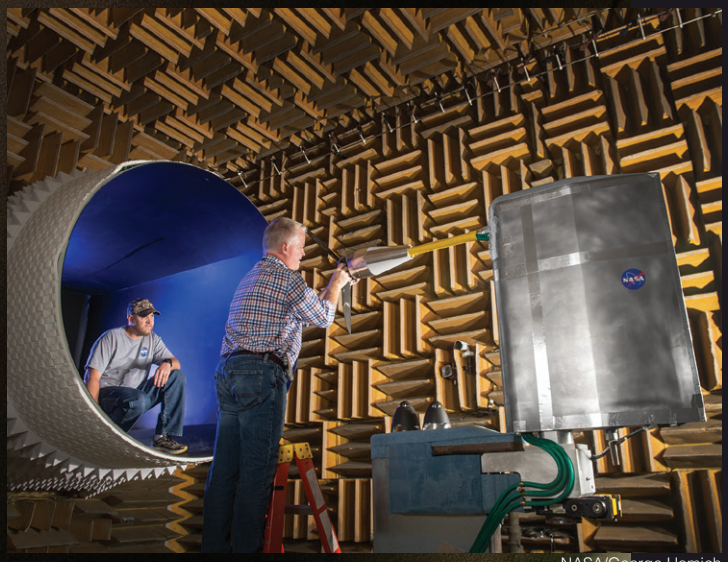
A mockup of the Boeing Starliner spacecraft is prepped for testing at Langley's Landing and Impact Research Facility. A series of droptests simulated what the actual spacecraft and crew may experience when returning to Earth.

NASA/David C. Bowman

NASA Langley's B200 in Shreveport, Louisiana, for the fall flight campaign of the Atmospheric Carbon and Transport–America. The project is aimed at better understanding how weather systems interact with greenhouse gases, carbon dioxide and methane in the atmosphere.

Researchers at Langley are experimenting with autonomous drone flight in a program called City Environment for Range Testing of Autonomous Integrated Navigation, or CERTAIN. The goal is an urban test complex where the vehicles can reliably and safely fly around buildings and people.

Background photo: NASA/David C. Bowman



NASA/George Homich

Technicians install a carbon-fiber propeller on an electric motor in Langley's Low Speed Aeroacoustic Wind Tunnel.

NASA

The Orion Launch Abort System abort motor was successfully test fired at an Aerojet Rocketdyne facility in Sacramento, California in June. Abort-system studies are led by Langley in collaboration with NASA's Marshall Space Flight Center.

One configuration of an SLS rocket scale model mounted in the 14- by 22-Foot Subsonic Tunnel for aerodynamic testing.

2017 Awards and Recognitions

• **Dawn Jegley**, the team primary of the NASA-Boeing Pultruded Rod Stitched Efficient Unitized Structure (PRSEUS) Development and Test Team, accepted the American Institute of Aeronautics and Astronautics 2018 Aerospace Design Engineering Award on behalf of NASA and Boeing team members. The award is in recognition of the team's excellence in developing and demonstrating damage-arresting composites technology on PRSEUS.

• **James Warner** and **Patrick Leser** won the two best paper awards at the Annual Conference of the Prognostics & Health Management Society.

• **Nelson De Carvalho, Ronald Krueger, Mark McElroy** and **Wade Jackson** were awarded best paper for the 31st American Society for Composites Annual Technical Conference.

• **David Wing** was inducted as Associate Fellow-Class of 2018 in the American Institute of Aeronautics and Astronautics.

• **Erica Alston** received the Women of Color STEM Outstanding Achievement Award in the Technology Rising Star category.

• **Sang Choi** won the Tech Briefs "Create the Future" Design Contest 2017.

• **Ed Generazio** won the 2017 TechConnect National Innovation Award.

• **The NASA EDGE team** won a Silver Award in the 38th Annual Telly Awards.

• **NASA's Digital Learning Network team** received a Federal Government Digital Learning Association 5 Star Award.

• **Ronald Krueger** received the AIAA Region 1 2016 Engineer-of-the-Year (EOY) Award.

• **James M. Luckring** received a NATO Panel Excellence Award.

• **Melissa Rivers, Rich Wahls,** and **John Vassberg** received the AIAA 2017 International Cooperation Award.

• **Neal Watkins** received the AIAA Hampton Roads Section Engineer of the Year Award for 2017.

• **Stephen Horan** received the Pioneer Award from the International Telemetering Foundation.

From left: Julie Williams-Byrd, Marlyn Andino, Marilé Colón Robles, Debbie Cook, Bethany Cook, Loretta Kelemen, Michelle Ferebee and Garnise Dennis pose in October at the 2017 Women of Color STEM Conference in Detroit.

• **James Luckring** received the Fall 2017 AVT Panel Excellence Award.

• **Rich Wahls** received the AIAA Sustained Service Award.

• Two Langley teams won R&D 100 awards. **Patricia Glaab, Louis Glaab, Nerissa Monroe, Chester Dolph** and **Parker Lusk** received the award for Safe2Ditch technology, which autonomously steers UAVs to a safe place to crash. Dill received the award for Safeguard, a technology to alleviate hazards posed by UAVs entering no-fly zones. **Evan Dill, Steve Young, Kelly Hayhurst, Anthony Narkawicz, Cuong Quach** and **Kyle Smalling** received the award for Langley's Safeguard technology. Safeguard is an advanced geofencing system that is being developed for small to midsize unmanned aircraft.

• **Jin Ho Kang, Godfrey Sauti, Cheol Park, Vessilin Yamakov, Kristopher Wise, Catharine Fay, Sheila Thibeault**, and **Robert Bryant** received the NIA Bo Walkley Best Research Publication Award.

• **Kurt Swieringa** received the 2017 Doug Ensor Young Engineer of the Year Award for the AIAA Peninsula Engineers Council and the 2017 AIAA Hampton Road Section Robert A. Mitcheltree Young Engineer of the Year Award.

• **Mia Siochi, Chris Wohl, Joe Smith, John Connell,** and **Frank Palmieri** received the R&D 100 Award.

AIAA

On the left: David Bowles, NASA's Langley Research Center director, accepted the 2017 AIAA Foundation Award for Excellence from AIAA President Jim Maser.

• **John Norbury** was inducted into the University of Idaho Hall of Fame.

• **Karen T. Berger** received the AIAA Lawrence Sperry Award.W

• **Karen Jackson** received the 2017 Alexander A. Nikolsky Honorary Lectureship by the American Helicopter Society Board of Directors.

• **Gaudy Bezos-O'Connor** was named AIAA Class of 2017 Associate Fellow.

• **Kenneth Smith** was named to the 2017 Forbes "30 Under 30 for Science."

• **Juan Cruz** was named Associate Fellow for AIAA Lifetime Award.

• **Marlyn Andino** was recognized as a 2017 Women of Color STEM Technology Rising Star.

• **Faye Collier** was inducted into the Academy of Aerospace and Ocean Engineering Excellence at Virginia Tech.

• **Marile Colon Robles** received the 2017 Women of Color STEM Award for Educational Leadership – Corporate Promotion of Education.

• **Ruth Amundsen** received the 2017 Women of Distinction Award for Science/Technology, YWCA South Hampton Roads.

• **Debbie Cook** received the 2017 Women of Color STEM Award New Media/IT Leadership award.

2017 Patents

• **William J. Fredericks, Mark D. Moore, Ronald C. Busan, Paul M. Rothhaar, David D. North, William M. Langford Christopher T. Laws, William T. Hodges, Zachary R. Johns** and **Sandy R. Webb,** U.S. Patent Number 9,475,579 for "Vertical Takeoff and Landing Vehicle with Increased Cruise Efficiency"

• **Robin E. Southward, Donavon M. Delozier , Kent A. Watson, Joseph G. Smith, Sayata Ghose** and **John W. Connell,** U.S. Patent Number 9,475,973 for "Preparation of Metal Nanowire Decorated Carbon Allotropes"

• **Kristopher E. Wise, Cheol Park, Jin Ho Kang, Emilie J. Siochi and Joycelyn S. Harrison,** U.S. Patent Number 9,493,635 for "Nanocomposites from Stable Dispersions of Carbon Nanotubes in Polymeric Matrices Using Dispersion Interaction"

• **George N. Szatkowski, Kenneth L. Dudley, Larry A. Ticatch, Laura J. Smith, Sandra V. Koppen, Truong X. Nguyen** and **Jay J. Ely,** U.S. Patent Number 9,497,846 for "Plasma Generator Using Spiral Conductors"

• **Terryl A. Wallace, Stephen W. Smith, Robert S. Piascik, Michael R. Horne, Peter L. Messick, Joel A. Alexa, Edward H. Glaessgen** and **Benjamin T. Hailer,** U.S. Patent Number 9,499,882 for "Strain-Detecting Composite Materials"

• **William T. Yost, K. Elliott Cramer, Daniel F. Perey** and **Keith A. Williams,** U.S. Patent Number 9,537,277 for "Process for Nondestructive Evaluation of the Quality of a Crimped Wire Connector"

• **K. Chauncey Wu, Donavon M. Delozier, Kent A. Watson, Robert A. Martin** and **Brian K. Stewart,** U.S. Patent Number 9,546,678 for "Structural Joint with Multi-Axis Load Carrying Capacity"

• **Cheol Park, Joycelyn S. Harrison, Negin Nazem, Larry T. Taylor, Jin Ho Kang, Jae-Woo Kim, Godfrey Sauti, Peter T. Lillehei** and **Sharon E. Lowther,** U.S. Patent Number 9,550,870 for "Metallized Nanotube Polymer Composite (MNPC) and Methods for Making Same"

• **Christopher J. Wohl, John W. Connell, Joseph G. Smith, Emilie J. Siochi, John M. Gardner** and **Frank L. Palmieri,** U.S. Patent Number 9,550,911 for "Fluorinated Alkyl Ether Epoxy Resin Compositions and Applications Thereof"

• **Cheol Park, Jin Ho Kang, Keith L. Gordon, Godfrey Sauti, Sharon E. Lowther** and **Robert G. Bryant,** U.S. Patent Number 9,550,873 for "Doped Chiral Polymer Metamaterials"

• **Lisa A. Scott Carnell,** Patent Number 9,557,322 for "3D Biomimetic Platform"

• **Edward R. Generazio,** Patent Number 9,559,616 for "Quasi-Static Electric Field Generator"

• **Yi Lin, Jae-Woo Kim, John W. Connell, Michael R. Funk** and **Caroline Campbell,** U.S. Patent Number 9,567,225, for "Single-Step, Solvent-Free, Catalyst-Free Preparation of Holey Carbon Allotropes"

• **Jin Ho Kang, Cheol Park** and **Joycelyn S. Harrison,** U.S. Patent Number 9,579,867 for "Nanotube Film Electrode and an Electroactive Device Fabricated with the Nanotube Film Electrode and Methods for Making Same"

• **Qamar A. Shams** and **Allan J. Zuckerwar** U.S. Patent Number 9,591,417 for "Extreme Low Frequency Acoustic Measurement System"

• **Cheol Park, Dennis C. Working, Emilie J. Siochi** and **Joycelyn S. Harrison,** U.S. Patent Number 9,587,089 for "Nanotubular Toughening Inclusions"

• **David D. North** and **Mark J. Aull,** U.S. Patent Number 9,599,995 for "Extreme Low Frequency Acoustic Measurement System"

• **Sang H. Choi, Yeonjoon Park, Glen C. King, Hyun-Jung Kim** and **Kunik Lee,** U.S. Patent Number 9,614,026 for "High Mobility Transport Layer Structures for Rhombohedral Si/Ge/SiGe Devices"

• **Qamar A. Shams, Allan J. Zuckerwar** and **Howard K. Knight,** U.S. Patent Number 9,620,025 for "Wake Vortex Avoidance System and Method"

• **Craig A. Brice,** U.S. Patent Number 9,764,386 for "Functionally Graded Metal-Metal Composite Structures"

• **Justin D. Littell,** U.S. Patent Number 9,616,988 for "Energy-Absorbing Beam Member"

• **Alan T. Pope, Chad L. Stephens** and **Nina M. Blanson,** U.S. Patent Number 9,623,324 for "Physiologically Modulating Videogames or Simulations Which Use Motion-Sensing Input Devices"

• **Michael G. Jones, Russell H. Thomas, Douglas N. Nark, Brian M. Howerton** and **Michael J. Czech,** U.S. Patent Number 9,623,952 for "External Acoustic Liners for Multi-Functional Aircraft Noise Reduction"

• **Alan T. Pope, Chad L. Stephens** and **Tyler Habowski,** U.S. Patent Number 9,630,093 for "Method and System for Physiologically Modulating Videogames and Simulations Which Use Gesture and Body Image Sensing Control Input Devices"

• **Mehdi R. Khorrami,** U.S. Patent Number 9,650,127 for "Stretchable Mesh for Cavity Noise Reduction"

• **Eric R. Burke, Stanton L. Dehaven** and **Phillip A. Williams,** U.S. Patent Number 9,651,682 for "Device and Method of Scintillating Quantum Dots for Radiation Imaging"

• **Russell H. Thomas, Michael J. Czech** and **Alaa A. Elmiligui,** U.S. Patent Number 9,669,921 for "Active Aircraft Pylon Noise Control System"

• **Godfrey Sauti, Jae-Woo Kim, Emilie J. Siochi** and **Kristopher E. Wise,** U.S. Patent Number 9,695,531 for "Sucrose Treated Carbon Nanotube and Graphene Yarns and Sheets"

• **Thomas D. McGlone,** U.S. Patent Number 9,696,411 for "System and Method for Multi-Wavelength Optical Signal Detection"

• **Michael J. Logan, Mark A. Motter, Richard DeLoach, Thomas L. Vranas, Joseph M. Prendergast** and **Brittney N. Lipp,** U.S. Patent Number 9,708,059 for "Compound Wing Vertical Takeoff and Landing Small Unmanned Aircraft System"

• **Keith L. Gordon, Jin Ho Kang, Cheol Park, Peter T. Lillehei** and **Joycelyn S. Harrison,** U.S. Patent Number 9,734,932 for "Negative Dielectric Constant Material Based on Ion Conducting Materials"

• **Kenneth L. Dudley, George N. Szatkowski, Stanley E. Woodard, Truong X. Nguyen, Jay J. Ely, Chuantong Wang, John J. Mielnik, Sandra V. Koppen** and **Laura J. Smith,** U.S. Patent 9,708,075 for "Lightning Protection and Detection System"

• **Yeonjoon Park** and **Sang H. Choi,** U.S. Patent Number 9,711,680 for "Integrated Multi-Color Light Emitting Device Made with Hybrid Crystal Structure"

• **Diego F. Pierrottet, Larry B. Petway, Farzin Amzajerdian, Bruce W. Barnes, George E. Lockard** and **Glenn D. Hines,** U.S. Patent Number 9,712,250 for "System and Method for Generating A Frequency Modulated Linear Laser Waveform"

• **Wade C. Jackson** and **Gregory T. Shanks,** U.S. Patent Number 9,719,901 for "Impact Tester Device"

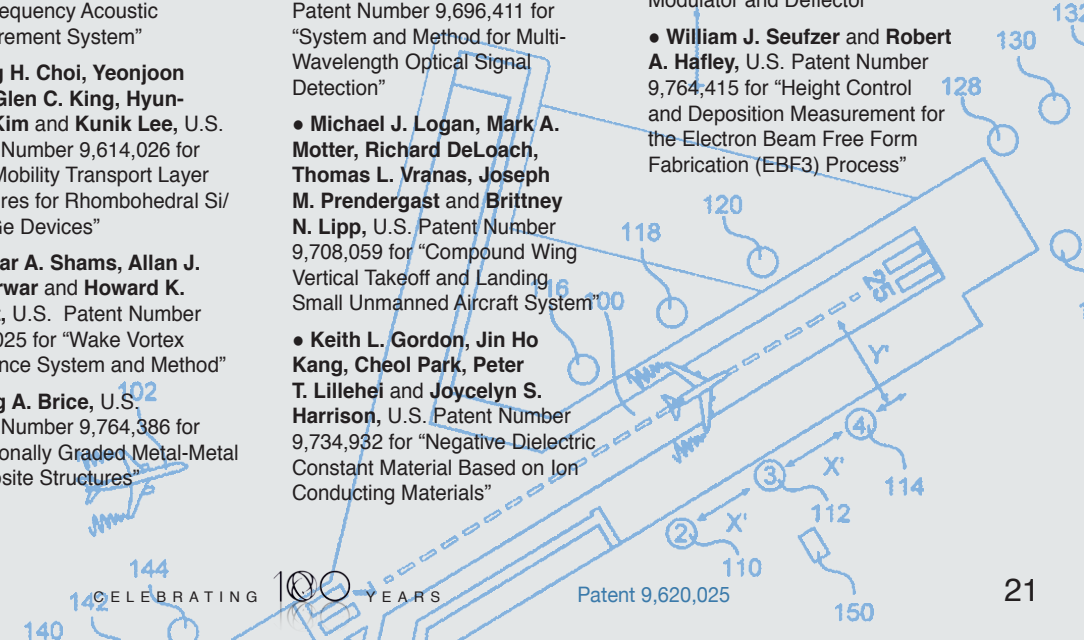
• **Stanley E. Woodard, Donald M. Oglesby** and **Bryant D. Taylor,** U.S. Patent Number 9,733,203 for "Wireless Chemical Sensing Method"

• **William K. Wilkie, Robert G. Bryant** and **Christopher S. Lynch,** U.S. Patent Number 9,741,922 for "Self-Latching Piezocomposite Actuator"

• **Lisa Scott Carnell, Emilie J. Siochi, Nancy M. Holloway, Kam Leong** and **Karina Kulangara,** U.S. Patent Number 9,758,761 for "Aligned and Electrospun Piezoelectric Polymer Fiber Assembly and Scaffold"

• **Paul M. Danehy,** U.S. Patent Number 9,759,907 for "Rapid Optical Shutter, Chopper, Modulator and Deflector"

• **William J. Seufzer** and **Robert A. Hafley,** U.S. Patent Number 9,764,415 for "Height Control and Deposition Measurement for the Electron Beam Free Form Fabrication (EBF3) Process"



Patent 9,620,025

Langley's Katherine G. Johnson Computational Research Facility was opened on Sept. 22, honoring Johnson for her many years at NASA as a "human computer" and her role in calculating trajectories for America's early spaceflights.

NASA

Construction continues on the Measurement Systems Laboratory, slated for completion in late 2019. The 175,000-square-foot facility will host 40 modular spaces and clean rooms for such research and development equipment as electronics, lasers and specialized instrumentation.

A technician at Langley works on the new antenna system that provides tracking, command and control, and telemetry for aircraft, orbital spacecraft and celestial objects.

Photos: NASA/David C. Bowman

A Young Boy's Dream Come True

Top photo: Little did seven-year-old Austin Bowman know that when his parents took him to Langley's 75th anniversary open house 25 years ago, the experience would inspire him to become an Army aviator and an airplane builder when he grew up. While at Langley, he met aircraft hangar employee Dale Bowser, who strapped him into a cockpit seat that was on display.

Bottom photo: He revisited us this year to relive the childhood memory with the same Dale Bowser, in the same airplane hangar, at the same Langley, during our 100th anniversary open house.

1992

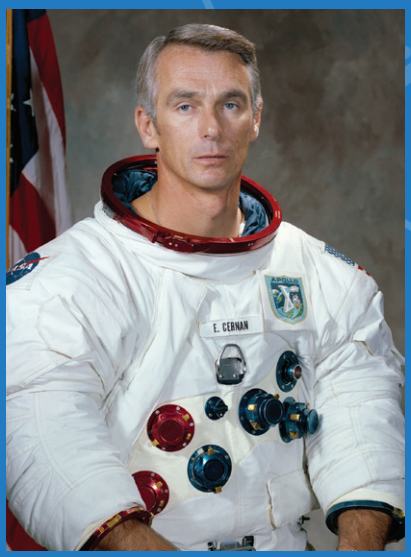
NASA/David C. Bowman

2017

A New Career Turn

Langley's former director Lesa Roe retired in September 2017 and now serves as chancellor of the University of North Texas. Roe left Langley in 2014 after nine years as director to serve as NASA's associate deputy administrator. Prior to Langley, she served as manager of the International Space Station Research Program at Johnson Space Center in Houston.

Three of NASA's Early Astronauts Passed Away in 2017



Eugene Cernan

Paul Weitz

Richard (Dick) Gordon Jr.

Gene Cernan, the last Apollo moonwalker, died in January at 82. He walked on the lunar surface in 1972 during the Apollo 17 mission. Astronaut Paul Weitz, who commanded the first flight of the space shuttle Challenger in 1983, passed away in Flagstaff, Arizona, in October. He was 85.

Astronaut Richard (Dick) Gordon Jr. died in November at his home in California. He was 88. Gordon orbited the Moon on Apollo 12 in 1969 while two other astronauts walked on it. The Apollo 12 crew capsule can be seen at Langley's official visitor center, the Virginia Air and Space Center in Hampton.

NASA photos except as noted.

NASA/David C. Bowman

From left to right: Langley's leadership team: Associate Director Cathy Mangum, Deputy Director Clayton Turner and Director Dr. David Bowles.

How to Contact Us

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http://technologygateway.nasa.gov/

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

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

A 25TH ANNIVERSARY

The Virginia Air & Space Center is celebrating 25 years of educational excellence as the official visitor center for NASA Langley. Located in Hampton, Virginia, the birthplace of America's space program, the Virginia Air & Space Center features interactive aviation exhibits spanning 100 years of flight, more than 30 historic aircraft, a hands-on space exploration gallery, unique space flight artifacts, and more. The center is home to the Apollo 12 Command Module and the Orion PA-1 Test Vehicle.

NASA/M.S.Walsh

LOOKING FORWARD

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

NP-2017-11-026-LaRC