National Aeronautics and Space Administration

Countdown to a New Century

Langley Research Center 2016

www.nasa.gov

Photographs by David C. Bowman
except where noted.

Photo at right: On July 21, 2016, Expedition 48 Commander Jeff Williams of NASA shared this photograph of sunlight illuminating the waters of the Chesapeake Bay, writing, “Morning passing over the Chesapeake Bay heading across the Atlantic.”

Wallops Flight Facility, on the Eastern Shore, can be seen at left and Langley Research Center on Virginia’s peninsula can be seen to the right.

Langley Research Center

Our work at NASA's Langley Research Center is critical to the success of the agency's goals.

With an eye on the sky, we're working to improve the air travel system, which includes making the airplanes you fly on safer and environmentally friendly. Even now when you fly on an airplane, it's likely that NASA-inspired technology is onboard. As part of this effort Langley is evaluating new aircraft designs and developing technologies to reduce aircraft noise around airports, improve fuel efficiency, and relieve air traffic congestion.

For example, the nation's airlines could realize more than $250 billion in savings in the near future through the use of green technologies developed and refined by NASA's aeronautics researchers. These new technologies, created under NASA's Environmentally Responsible Aviation project, could cut airline fuel use in half, pollution by 75 percent and noise to nearly an eighth of today's levels.

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

Among the more visible examples are drop tests Langley is conducting of Orion crew capsule mockups, some with crash test dummies inside, to understand what the spacecraft and astronauts may experience when landing in the Pacific Ocean after deep-space missions. And our scientists continue to investigate Earth's climate.

We also study the Earth's atmosphere from the ground, the skies, and space in an effort to better understand our changing planet. An example of this is the planned launch in 2017 of an instrument to the International Space Station. From a perch on the exterior, the instrument will give NASA a new way to monitor Earth's protective ozone layer. SAGE III on ISS will make ozone measurements by locking onto the sun or moon and scanning the thin profile of the atmosphere from that unique vantage point.

Finally, NASA Langley turns 100 this year, a momentous occasion that you can read and see more about at our centennial web site, www.nasa.gov/specials/nasalangley100.

I invite you to turn the page and join us as we continue our journey into the future.

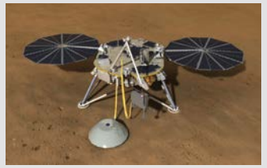
Dave Bowles
Director, NASA Langley Research Center

Boeing and NASA researchers tested a 13-foot-wingspan, six-percent scale blended wing body, or BWB, model in NASA Langley's 14 x 22-Foot Subsonic Tunnel. Boeing is readying the BWB for the next step in maturing the concept — a crewed demonstrator.

NASA/Sandie Gibbs, George Homich

Leading the Way to Deep Space

As humanity reaches well beyond the pull of Earth's gravity, robotic missions to other planets are key to understanding the solar system and paving the way for human exploration. Langley is providing critical expertise in support of the upcoming InSight mission to Mars, now slated for 2018, as well as the Mars 2020 robotic lander mission, including heat-shield sensors to provide a more comprehensive analysis of the Martian atmosphere that will be used to develop descent and landing systems for future missions.



InSight Spacecraft

Living, working, and traveling in space will also require new in-space construction methods. Langley is partnered with U.S. industry to develop key technologies, such as long-reach robotic arms, welding devices, and other mechanisms to demonstrate the feasibility of in-space robotic assembly of large structures and spacecraft.

Enabling Human and Robotic Space Missions

The first step in the Journey to Mars begins with the Space Launch System (SLS) and the Orion Multi-Purpose Crew Vehicle (MPCV). Langley has applied decades of experience to improve the aerodynamic design of the SLS. Using a heat shield already tested in flight, Langley has conducted water impact tests of the Orion crew vehicle to ensure it will safely return crew to Earth. Langley will continue to validate the design of the Orion heat shield so it is ready for the first test flights beginning in 2018.

Langley also leads the development of the Orion Launch Abort System, designed to protect astronauts by pulling the spacecraft away from the rocket to which it's attached should there be an issue during launch. A final flight test of the system is scheduled in 2019. During this test, an uncrewed Orion capsule will launch from a modified Peacekeeper missile to demonstrate a successful abort under the highest aerodynamic loads that could be experienced during a mission.

Developing Next-Generation Concepts

Many challenges remain for the human journey to Mars. To find solutions, Langley is developing mission-critical technology concepts for Mars exploration, such as advanced lightweight materials to dramatically reduce the mass of launch vehicles and spacecraft.

During the past year, Langley designed and tested a prototype airlock concept manufactured from inflatable materials, made advances in high-strength carbon nanotubes, and demonstrated advanced manufacturing techniques for lightweight composite structures.

Langley also leads research to better understand the harsh environment of space, and to develop means and methods of protecting human health during long space journeys. Such efforts in 2016 included experiments to test different types of radiation shielding materials.

Landing humans on Mars will require new technologies to safely navigate through the thin Martian atmosphere and reach the surface. Langley is developing an inflatable aerodynamic decelerator for Mars. Already, engineers have manufactured and tested a prototype design.

And the thermal protection system being developed for this next-generation Mars vehicle was recently demonstrated for a different application here on Earth: providing protection for firefighters battling forest fires.

A scale model of NASA's Space Launch System is tested in the Transonic Dynamics Tunnel.

A heat shield flown in space was tested at NASA Langley and sent to Kennedy Space Center for more study.

Exploration & Space Technology

Jim Corliss, project chief engineer, said that forces absorbed during splashdown determine more than half of the structure of the crew module.

Making a Splash on the Way to Mars

With a sudden "crack!" of pyrotechnics, a mockup of NASA's Orion spacecraft released its grip on a set of cables and began a graceful, deliberate dive toward a pool 14 feet below.

Instead of an Olympic-style feat of athletics, it was a mighty stroke of engineering — and an essential step forward in NASA's journey to Mars.

Onlookers that gathered near the Hydro Impact Basin in August applauded and cheered. They had just witnessed the simulated water landing of a space capsule, through the use of a 7.2-ton mockup covered with sensors capable of detecting forces that the structure and its astronaut crew would experience.

In that sense, spectators caught a glimpse of the future.

"Orion is a one-of-a kind spacecraft, and we're testing it in a one-of-a kind facility,"

— Lara Kearney, Johnson Space Center

"We're very proud of what we do here and we're happy to be making this contribution to Orion," said the project's chief engineer, Jim Corliss. He explained that the forces that hit a spacecraft at splashdown determine the design of more than half of its structure. Understanding those forces is critical for astronaut safety.

Lara Kearney, manager of the Orion Crew and Service Module Office at NASA's Johnson Space Center in Houston, traveled to Langley to watch the August 25 test.

"Orion is a one-of-a kind spacecraft, and we're testing it in a one-of-a kind facility," she said. "Langley has a rich history in impact testing and the Hydro Impact Basin is a world-class facility that gives us the ability to control the specific impact conditions of interest with a high degree of accuracy."

Number Nine

The August 25 drop was the ninth in a series of 10 tests at Langley's Landing and Impact Research Facility. It was designed to simulate one of the Orion spacecraft's most stressful landing scenarios, where one of the capsule's three main parachutes fails to deploy.

Under ideal conditions, the Orion capsule would slice into the water at about 17 mph. The test had it hitting the pool at about 20 mph, and in a lateral orientation. Instead of being pushed down into their seats, astronauts in this scenario would splash down to the side.

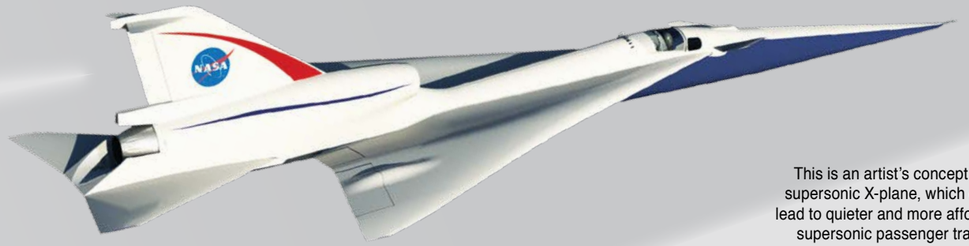
"We're looking at some of the hardest impacts, the ones that could potentially pose the most risk of injury to the crew or damaging the structure," Corliss said. "That's what we've been doing with these 10 tests."

High-Fidelity Data

"We're really ecstatic about the data we're getting and encouraged with how well it's correlating with our computer models," Corliss said.

The drop tests are the culmination of a three-year collaborative effort among workers at five NASA facilities — Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center, Ames Research Center and Langley — along with help from Orion prime contractor Lockheed Martin.

The tests at Langley are leading up to the first integrated flight of the Space Launch System and Orion known as Exploration Mission-1 (EM-1). For that, Orion will fly atop the Space Launch System, the most powerful rocket in the world. There will be no crew on EM-1, but it will prepare the way for future missions with astronauts as NASA pushes ahead on its journey to Mars.



This is an artist's concept of a supersonic X-plane, which could lead to quieter and more affordable supersonic passenger travel.

A Focus on Future Aviation

As NASA aeronautical engineers prepare to develop a series of greener, quieter, faster aircraft, they are already testing concepts that could be candidates.

One of those is a blended wing body (BWB). A six percent scale model of a Boeing BWB returned to the NASA Langley's 14- by 22- Foot Subsonic Tunnel.

It was one of at least three possible X-planes Langley engineers are actively studying.

With 14 electric motors turning propellers integrated into a unique wing design, NASA's latest X-plane – the X-57 "Maxwell" - will test new propulsion technology.

The Newest NASA X-Plane

The most recent revolutionary design to be officially designated as an X-plane is the X-57 Maxwell — an all-electric aircraft, which uses a series of highly integrated motors, known as distributed electric propulsion (DEP), that could help make planes quieter, more energy efficient and cheaper to operate.

A three-year piloted flight demonstration project will transform a twin-engine light aircraft, removing the wing and piston engines and replacing them with a smaller, lighter, high-aspect-ratio DEP wing, which includes up to 14 electric motors.

Quieting the Boom

Langley, which leads NASA's Commercial Supersonic Technology project, is working with industry and other NASA centers on what could be the next X-plane called QueSST or the Quiet Supersonic Technology flight demonstrator.

A preliminary contract design award to Lockheed Martin is part of the ongoing effort to change the shape of airplane bodies to reduce the noise, rattle and vibrations caused when jets fly at supersonic speeds, creating the shock waves that produce sonic booms.

That research includes Langley's "boom room" where volunteers assess series of sounds and vibrations that mimic what researchers predict future low boom supersonic aircraft shock wave effects will sound and feel like: more like a faint thud, instead of a boom. The results will go to the Federal Aviation Administration and the International Civil Aviation Organization to support development of new noise certification for overland supersonic flight.

Testing Technologies to Increase Drone Use

NASA researchers and drone industry representatives foresee a day when small unmanned aircraft systems (UAS) have all sorts of uses in everyday life, including wildfire spotting, precision agriculture, wildlife monitoring, and small package delivery — to name a few.

NASA Langley engineers are working to help develop concepts and technologies to overcome the challenges, including allowing drones to fly beyond visual line of sight, that are keeping UAS from being able to be more widely used and accepted.

Working with Airlines to Improve Training and Operations

Engineers and scientists at NASA Langley are looking at ways to improve flight training, cockpit displays and other flight deck operations. As a result of an agreement with American Airlines they will have the chance to fly as observers in the cockpit during at least a half dozen round-trip flights each year to get firsthand knowledge of flight crew actions and reactions.

Two other carriers, Alaska Airlines and Virgin America, are in the process of testing an already developed NASA Langley technology, the Traffic Aware Planner, that can help airlines save time and reduce fuel consumption and carbon emissions. It's a cockpit-based software tool that helps pilots determine the most efficient flight paths to their destinations, while they are enroute and flying among other aircraft in the airspace.

(Top) X-plane Image: Lockheed Martin

NASA Research Could Save Airlines Billions

The nation's airlines could realize more than $250 billion in savings in the near future thanks to green-related technologies developed and refined by NASA's aeronautics researchers during the past six years.

These new technologies, developed under the purview of NASA's Environmentally Responsible Aviation (ERA) project, could cut airline fuel use in half, pollution by 75 percent and noise to nearly an eighth of today's levels.

"If these technologies start finding their way into the airline fleet, our computer models show the economic impact could amount to $255 billion in operational savings between 2025 and 2050," said Jaiwon Shin, NASA's associate administrator for aeronautics research.

NASA/Paul Bagby

Materials scientist Mia Siochi (left) and systems engineer Mike Alexander (center), join Boeing technician Felix Boyett in counting insect residue on the wing of Boeing's ecoDemonstrator 757 aircraft as part of NASA's non-stick bug coating research.

Created in 2009 and completed in 2015, ERA's mission was to explore and document the feasibility, benefits and technical risk of inventive vehicle concepts and enabling technologies to reduce aviation's impact on the environment. Researchers focused on eight integrated technology demonstrations in three categories – airframe technology, propulsion technology and vehicle systems integration.

By the time ERA concluded, NASA had invested more than $400 million, with another $250 million in-kind resources invested by industry.

"It was challenging because we had a fixed window, a fixed budget, and all eight demonstrations needed to finish at the same time," said Fayette Collier, ERA project manager.

Summary of the Eight Completed Technology Demonstrations

• Tiny embedded nozzles blowing air over the surface of an airplane's vertical tail fin showed that aircraft can safely be designed with smaller tails, reducing weight and drag. This technology was tested using Boeing's ecoDemonstrator 757 flying laboratory. Also flown was a test of surface coatings designed to minimize drag caused by bug residue building up on the wing's leading edge.

• NASA developed a new process for stitching together large sections of lightweight composite materials to create damage-tolerant structures that could be used in building uniquely shaped aircraft as much as 20 percent lighter than a similar all-metal aircraft.

• Teaming with the Air Force Research Laboratory and FlexSys Inc. of Ann Arbor, Michigan, NASA successfully tested a radical morphing wing technology that allows an aircraft to seamlessly extend its flaps, leaving no drag-inducing, noise-enhancing gaps for air to flow through. FlexSys and Aviation Partners of Seattle already have announced plans to commercialize this technology.

• NASA worked with General Electric to refine the design of the compressor stage of a turbine engine to improve aerodynamic efficiency and, after testing, realized that engines using this technology could save 2.5 percent in fuel.

• The agency worked with Pratt & Whitney on the company's geared turbofan jet engine to a mature design to improve propulsion efficiency and reduce noise. If introduced on the next-generation engine, the technology could reduce fuel burn by 15 percent and significantly reduce noise.

• NASA also worked with Pratt & Whitney on an improved design for a jet engine combustor, the chamber in which fuel is burned, to reduce the amount of nitrogen oxides produced. While the goal was to reduce generated pollution by 75 percent, reductions were close to 80 percent.

• New design tools were developed to help engineers reduce noise from wing flaps and landing gear on takeoffs and landings. Data from wind-tunnel testing, combined with flight tests, were joined for the first time to create simulations that could help mature designs.

• Studies were done on a hybrid wing-body concept in which the wings join the fuselage in a continuous, seamless line and the jet engines are mounted on top of the airplane in the rear. Research included wind-tunnel runs to test how well the aircraft would operate at low speeds and to find the optimal engine placement, while also minimizing fuel burn and reducing noise.

Using Science to Help our Changing Planet

NASA uses the vantage point of space to increase our understanding of our home planet, improve lives and safeguard our future. Langley researchers collect and study data from space, land, sea and air to tackle challenges facing the world today, from improved environmental prediction to natural hazard and climate change preparedness.

World Tour for Science

2016 was a big year for NASA airborne campaigns in regions of critical change across the globe, and NASA Langley played a pivotal role. A priority in the U.S. and around the world is to improve our understanding of air pollution, provide data for decision-makers and communities, and to better preserve public health.

Air quality impacts are larger and often easier to measure over the Korean peninsula than elsewhere. So in May and June, the Korea U.S.-Air Quality study (KORUS-AQ) assessed air quality across urban, rural and coastal areas of South Korea using the combined observations of aircraft, ground sites, ships and satellites. This campaign lays the groundwork for a new constellation of satellite instruments focused on hourly air-quality observations over Asia, North America and Europe.

Ocean Climate

The North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) is a five-year investigation of key processes controlling ocean system function, their influences on atmospheric aerosols and clouds and their implications for climate and change.

In November 2015, and again in May 2016, the team researched seasonal phases of the North Atlantic phytoplankton bloom by ship and aircraft. In addition to the North Atlantic being an ideal location to study the bloom, it also has pristine atmospheric conditions — far from human influences. NAAMES will help us understand forces that control plankton blooms and impact marine life, and how those factors could impact the atmosphere and the climate.

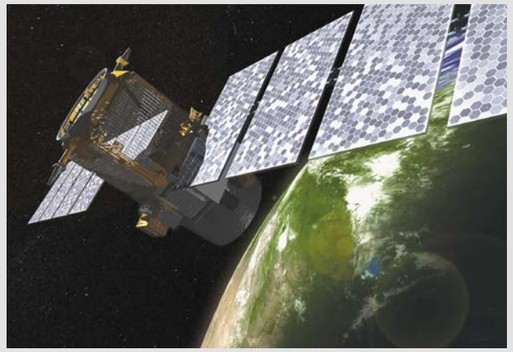
In July and August, the Atmospheric Carbon and Transport–America (ACT-America) campaign, began to measure how weather systems and other atmospheric conditions contribute to the transport of carbon dioxide and methane through the atmosphere over three regions in the Eastern United States. ACT-America will build upon and improve the utility of existing satellites and ground-based tower measurements in these regions, and enable precise estimates of the sources and sinks of these gases.

ACT-America Principal Investigator Kenneth Davis

Also this year, teams from Langley took water vapor measurements for NASA's Atmospheric Tomography Mission (ATom) field campaign, the first mission to survey the atmosphere over the ocean. They also worked to characterize clouds and small particles in the atmosphere for NASA's ObseRvations of Aerosols above CLouds and their intEractionS (ORACLES) mission.

CALIPSO Celebrates 10 Years

On April 28, the Cloud-Aerosol Lidar Infrared Pathfinder Satellite Observation (CALIPSO), marked 10 years in Earth orbit with more than 5.7 billion measurements. CALIPSO provides the first global three dimensional scan of clouds to advance our understanding of how clouds and aerosols affect Earth's weather, climate, and air quality.



An artist's rendering of the CALIPSO satellite.

Earth-Observing Instrument Ready for Journey to the ISS

An instrument that will give NASA a new way to monitor Earth's protective ozone layer and document its recovery is slated to launch to the International Space Station (ISS) in 2017.

The launch will take place at Cape Canaveral Air Force Station in Florida.

After being mounted to the exterior of the space station, the Stratospheric Aerosol and Gas Experiment (SAGE) III instrument will make ozone measurements by locking onto the sun or moon and scanning the limb, or thin profile of the atmosphere, from that unique vantage point.

"This will be the culmination of years of hard work by a great team," said Michael Cisewski, project manager for SAGE III. "It's been immensely gratifying to work on something important like SAGE III that will benefit society for years to come and help protect our planet. There's nothing else like it."

The core of the SAGE III system was developed at NASA Langley and built by Ball Aerospace in the 1990s. Original plans called for the instrument to be mounted on the space station around 2001, but those plans were put on hold.

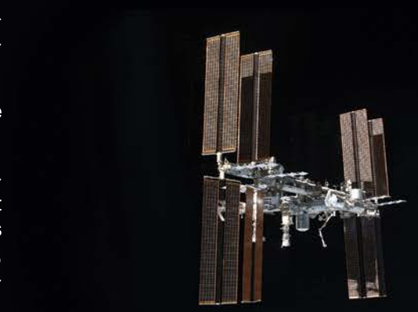
When the project lifted off again seven years ago and scientists pulled the main part of the instrument out of storage, it needed some serious updates. One of the biggest challenges was with the Hexapod Pointing System.

The hexapod, which came from the European Space Agency and Italian companies Thales Alenia Space and Compagnia Generale per lo Spazio, automatically adjusts SAGE III to ensure that it points at the correct angle for the measurements being taken.

"Just as they were about to deliver it, we found out there was an issue with it rebooting at high temperatures," said Brooke Thornton, mission operations manager for SAGE III. "We would probably have to have our pointing system power down for the majority of our mission. That was a huge issue."

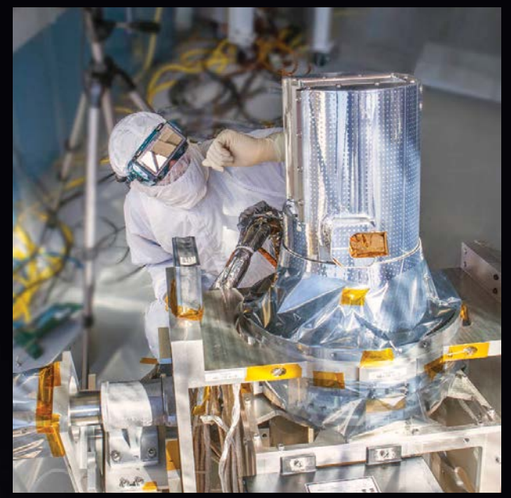
Software engineers at Langley quickly came up with a new way of operating the payload in the event the hexapod had to be turned off. "It was amazing that, in weeks, they took one of the biggest risks that our project had faced and came up with a very good solution very quickly," said Thornton.

The SAGE instrument is equipped with powerful tools. The instrument uses charge-coupled device array detectors that act as a sophisticated camera. Also, it is outfitted with a contamination-monitoring package that measures the amount of dust and fumes floating near the space station. If levels get too high, the instrument can shut itself down to protect its sensitive optics.



It's the sensitive optics that give SAGE the ability to watch out for atmospheric threats to a healthy planet. Defending ozone means defending Earth's habitability.

"This planet is unique," said Joe Zawodny, SAGE III project scientist, "so we've got to take care of it."



SAGE III, shown here in testing, will be attached to the International Space Station to study Earth's atmosphere.

Mutually Valuable Relationships

Langley partnerships have been mutually valuable for both the public and private sectors, leading to reductions in research and development costs, expansion of technology capabilities and solutions, and to the creation of new and uniquely useful products. Regional and national competitiveness has increased, jobs have been added, and the balance of trade improved. Langley's ongoing efforts are ensuring that NASA technologies and capabilities are broadly available to U.S. industry, academia, and other government organizations.

With an eye on tomorrow's innovators, Langley continues to work with colleges and universities through the Technology Transfer University program, which introduces NASA-developed technologies into classrooms where business students create technology-based market assessments and business plans.

Sparking Innovation and Licensing

In 2016, NASA renewed investment in regional economic development, or RED: an effort to spark economic growth by creating, contributing to, catalyzing, and supporting innovative businesses nationwide. Langley's RED involvement was underscored in April, during the first-ever Hampton Roads Unmanned Systems Opportunity Exchange hosted at the Hampton Convention Center. The event brought together for discussion and interactions companies of all sizes, as well as technical, business, workforce and testing-site providers. The gathering's 125-person attendance exceeded projected participation.

The Startup NASA program offers firms the opportunity to license NASA technology with no up-front costs or minimum fees, allowing expedited access to intellectual property necessary to establishment of a competitive market space. In 2016, Langley executed startup-license agreements with three companies.

Advanced Aircraft Company licensed an electric propulsion aircraft design called "Greased Lightning" or GL-10, with potential aerial applications that range from agriculture, to marine science and defense. PrimeBilec Investments, LLC will be commercializing inspection-validations software, a primary use of which would prequalify Transportation Security Administration agents. Dronicar intends to develop and sell small "smart carts," drones, and remotely piloted unmanned aircraft, as well as related software and electronics.

The Greased Lightning GL-10 has a 10-foot wingspan and can take off like a helicopter and fly horizontally like an airplane.

TAP is used to save fuel and flight time while avoiding traffic, weather, and restricted airspaces.

Cockpit Technology a Hot Prospect

Langley's Traffic Aware Strategic Aircrew Requests and an application named the Traffic Awareness Planner (TAP) became perhaps NASA's most significant software-product technology transfer of 2016. When packaged together, the software can be used to assess real-time information about an aircraft's flight path, automatically identifying changes that could save fuel or flight time, and displaying optimal solutions directly to the flight crew. Four different companies have inked non-exclusive evaluation licenses for both, allowing exploration of their potential and fit with iterated business-development goals.

Small Business Support

American small businesses and research institutions are critical to developing innovative technologies. Through the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs, NASA invests in high-tech small companies, helping them to successfully research, develop and demonstrate technologies leading to possible commercialization. In 2016, Langley oversaw research efforts involving 162 SBIR and STTR active awards worth more than $77 million.

Through NASA and industry partnerships, and by leveraging matching SBIR Program fund investments, firms are developing and deploying such products such as a high-resolution autostereoscopic cockpit display, a new type of high-efficiency laser, an air traffic management system, and inspection technologies to assess spacecraft heat shield materials.

NASA Langley's 85,200 square foot hangar hosted not one, but two, C-130 planes from the Wallops Flight Facility during the summer of 2016. Both flew airborne science campaigns in which Langley scientists participated.

From Viking to the Future of Mars Exploration

Marking the 40th anniversary of the historic Viking 1 landing on Mars, NASA Langley hosted a symposium in July 2016 covering how that feat of engineering came to be, how it set the stage for Mars expeditions that followed, and how it's influencing missions yet to come.

For "Viking at 40: From NASA's First Soft Landing to Humans on Mars," experts from across the nation converged on NASA Langley to explore topics ranging from Viking's legacy, to protecting Mars from human microbes, to new propulsion technologies that will help astronauts sail toward the Red Planet.

Most of all, the event honored the men and women whose efforts allowed Viking to do what had never been done before — land a probe on Mars and gather tantalizing data from another world.

Heavy Lifting

"They say we stand on the shoulders of giants, well, aren't your shoulders a little sore by now?" said symposium speaker Robert Manning, the current Mars program engineering manager at NASA's Jet Propulsion Laboratory (JPL) in California. He was talking to a group of Viking program veterans sitting in a cluster before him.

"I want to thank you for what happened in 1976," Manning said. "Viking is an amazing accomplishment. Those of us who do it now have a really hard time conceiving how you could build and design this thing before computers were really popular. You did it by hand, with paper, vellum, notepads."

He stressed that many Viking innovations are still being used today in plans for robotic Mars exploration. Landing a spacecraft softly without the aid of a thick atmosphere like Earth's to help slow it down was a huge challenge in 1976 — and remains so.

For Viking, it required a precisely choreographed ballet of heat shields, parachutes and rockets. "What a complicated, Rube Goldberg-ian contraption you guys had to come up with," Manning said. "It's unbelievable."

Lessons Learned

Tom Young, Viking's mission director, shared some lessons learned.

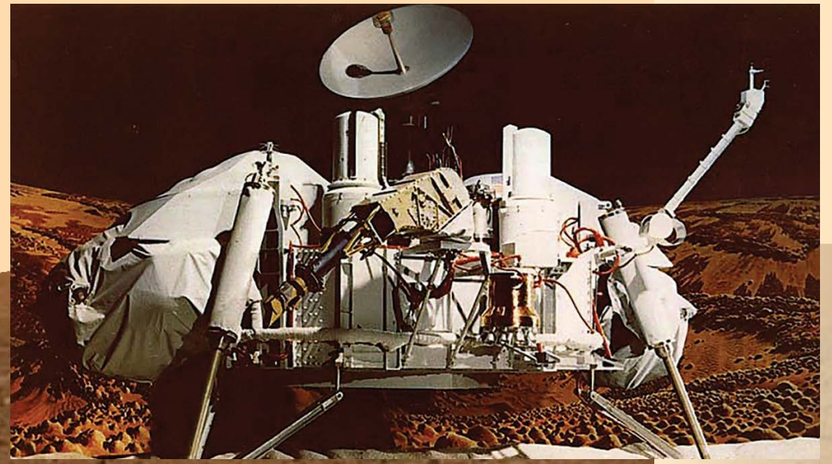
He described how plans originally called for the Viking 1 lander to touch down on July 4, 1976, the climax of America's bicentennial. The spacecraft entered the Red Planet's orbit on June 19 and started snapping photos of the proposed landing site.

"The first pictures were alarming," Young said. The site appeared to be unsafe. Meanwhile, Viking 2 was speeding toward Mars and was scheduled to enter orbit Aug. 7. The team had to make a quick decision. "If Viking 1's landing was delayed too long there would be a traffic jam at Mars that was beyond our capability to manage," he said.

The team had about two weeks to find a better landing site. That meant a July 4 landing wouldn't be possible. It wasn't a politically popular call, but it was the right one, Young said. The first spacecraft landed July 20, 1969.

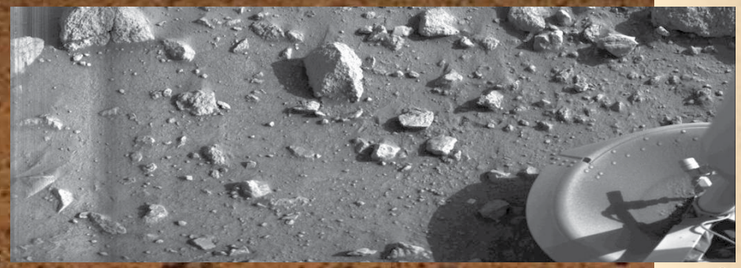
Editor's Note: *The "Viking at 40" events at NASA Langley were the first in a series of activities that will commemorate the center's 100th anniversary through 2017. NASA Langley's centennial is officially July 17, 2017. At that time the facility was called the NACA Langley Aeronautical Laboratory. NACA stands for National Advisory Committee for Aeronautics, which became NASA at the dawn of the space age in 1958.*

Historians Glenn Bugos, Erik Conway, and Roger Launius discuss the legacy of Viking, which was led by Langley and culminated in the landing of two research spacecraft on Mars in 1976.



A Viking 1 model sits on a simulated Mars surface.

NASA



The first photograph ever taken on the surface of Mars July 20, 1976. This photo was taken to determine if the lander had sunken into the Martian surface because at the time, it was unknown how much dust was on the planet's surface.

NASA

NASCAR driver Jimmie Johnson (right) shared the stage with NASA Langley deputy director Clayton Turner to talk about the importance of science, technology, engineering and math and following your dreams at the CIAA Middle School Day in Charlotte, North Carolina.

Inspiring the Next Generation of Explorers

NASA Langley strives to engage students and teachers and delve deep into the world of science, technology, engineering and mathematics (STEM), in hopes of inspiring the next generation of scientists, researchers and engineers.

This entails a collaborative approach, starting with Langley's local partners such as the Virginia Air & Space Center, the Virginia Space Grant Consortium, and the National Institute of Aerospace, as well as museums and public and private school districts across Langley's five-state region - Virginia, West Virginia, Kentucky, North Carolina and South Carolina. STEM education is also enhanced through Langley's Digital Learning Network, a free and interactive virtual connection for students and teachers.

In 2016, Langley partnered with the space grant consortium to begin a new program called the NASA Community College for Aerospace Scholars, which introduces NASA-unique opportunities and careers to underrepresented and underserved community college students with the goal of inspiring them to pursue STEM education and career opportunities.

And the NASA Earth Systems, Technology and Energy Education for Minority University Research and Education Program promotes literacy in climate and Earth systems science and seeks to increase underrepresented minority in science careers and educational opportunities.

A STEM Presence

Langley began a new STEM initiative this year focused on educating and engaging students and teachers in the Summer Program for Arts, Recreation and Knowledge in Newport News Public Schools. Langley also highlighted its aeronautical, space and science research during the annual Air Power Over Hampton Roads event held by our neighbor, Langley Air Force Base.

Lovers of all things aviation turned out by the thousands for the semi-annual Air Power Over Hampton Roads Air Show at Langley Air Force Base. Langley Research Center, just across the airfield from the base, was on hand with a number of space-related displays.

VASTS students are given a tour of the Langley's Structures & Materials Laboratory, where they took a close look at designs for inflatable habitats.

NASA Langley joined in on Orville Wright's 145th birthday celebration at the Wright Brothers National Park in North Carolina.

Expanding on its local STEM engagement, Langley participated in events like the Virginia Living Museum's 1960's Space Race Tribute celebrations in Newport News; Family Science Night at Crossroads Elementary School in Norfolk; Jefferson Laboratory's Open House in Newport News; and the Newport News Shipbuilding's summer science, technology, engineering, arts and mathematics (STEAM) academy.

Langley went beyond its local ties and participated in Astronomy Days in North Carolina, where nearly 16,000 visitors of all ages learned about NASA technologies being developed for deep space missions.

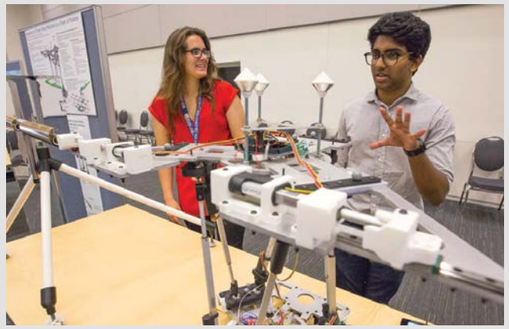
About 15,000 participants from the interactive, film and music industries attended the South by Southwest conference in Texas, where Langley hosted exhibits and presentations on topics such as astrophysics, the journey to Mars, and science communications.

Langley also took part in the USA Science and Engineering Festival in Washington D.C., which attracted more than 350,000 visitors to hands-on science and engineering activities.

Bringing NASA to the Raceway and Court

Langley's initiatives reached a novel audience by leveraging Langley's Rockets to Racecars partnership with Jimmie Johnson's JJ Racing. From the Poconos in Pennsylvania, to the Richmond International Raceway in Virginia, the NASCAR raceway is a unique way for the public to learn about the similarities between aerospace and racing — like how astronaut spacesuits are comparable to the materials worn by racecar drivers.

And Langley engaged with thousands of middle school, high school and university students at the Charlotte Convention Center and Arena in North Carolina during a Central Intercollegiate Athletic Association (CIAA) career fair and education day.



College engineering students Samantha Glassner (left) and Ashwin Kishen spent their summer internships working on a project called Assembly of Solar Array Modules by a Team of Robots.

Dozens of rising high school freshman had an opportunity to learn more about science, technology, engineering and math (STEM) from NASA experts during the Junior Game Changers Camp.

Shelter from the Storm

As Tropical Storm Hermine steamed up the East Coast in September, neighboring Langley Air Force Base reached out to NASA Langley to see if we could shelter a few F-22 Raptors.

Even though the hangar already had a large visitor — a NASA C-130 — and our own research airplanes, it was able to shelter more than a dozen fighters. The facility is rated for at least a Category 2 hurricane.

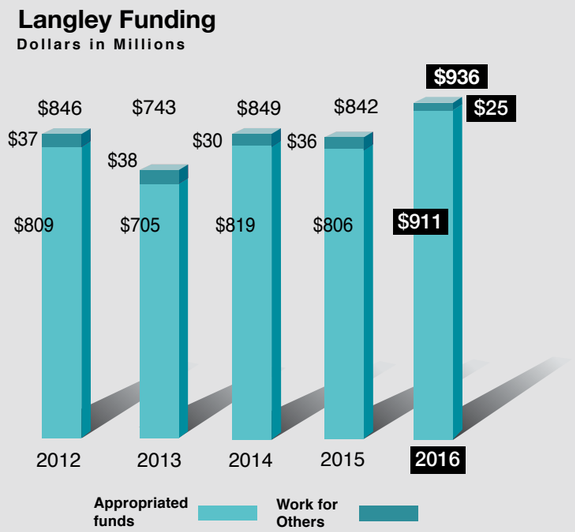
NASA Langley photographer David C. Bowman captured this image using a fish-eye lens while shooting down from the hangar catwalk.

NASA's assist with the F-22s is an example of our close ties with the Air Force, which involves research and testing and responding to urgent requests to solve problems that unexpectedly arise in military aircraft.

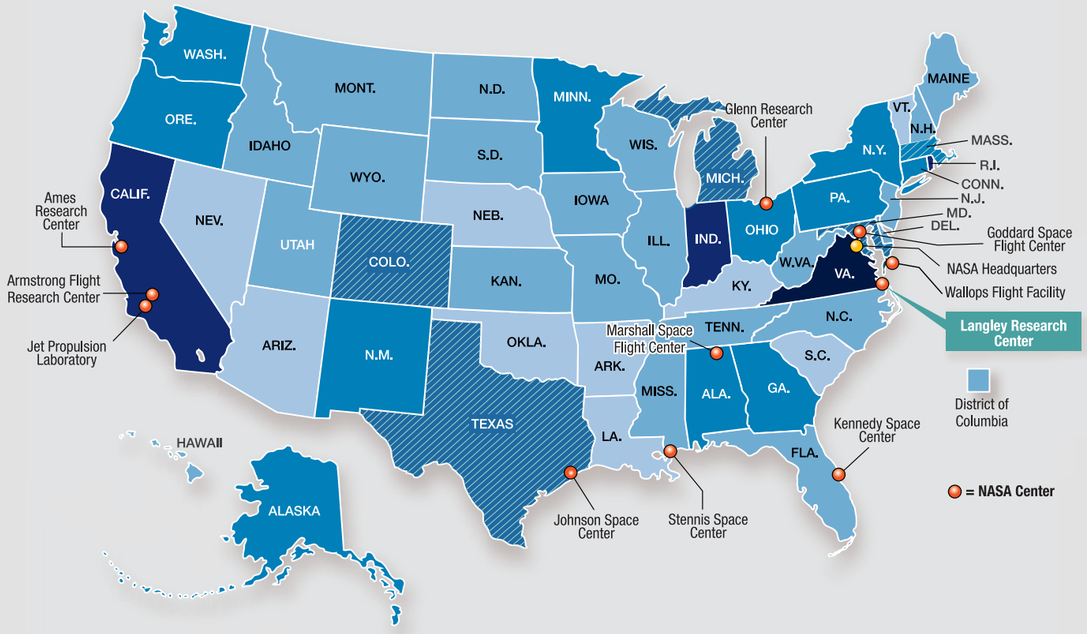
As an economic engine, NASA Langley Research Center's operations generated an overall impact of $2.99 billion nationwide in 2016, an increase from the previous year.

NASA Langley Generated the Following Economic Impacts

- In the U.S., the $2.99 billion supported 15,956 jobs.
- In Virginia, the economic impact was $1.2 billion that supported 7,368 jobs.
- In Hampton Roads, the economic impact was $1 billion that supported 6,515 jobs.



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

General Services Administration	$ 98,117,403
National Institute of Aerospace Associates	28,887,421
Regents of The University of Michigan	14,597,858
City of Hampton	5,511,794
The Aerospace Corporation	3,259,432
Texas State University	3,016,421
University of Texas at Austin	3,016,186
USAF, Life Cycle Management Center	2,868,000
Universities Space Research Associates	2,739,171
Oregon State University	2,285,560
Smithsonian Institution	2,264,000
Pennsylvania State University	2,168,517
Regents of The University of Minnesota	2,117,250
Judiciary Courts of The Commonwealth	1,595,738
Georgia Tech Research Corporation	1,451,661
Regents of The University of Colorado	1,230,192
USAF, Space Missile Test & Evaluation Directorate	1,152,000
University of Texas at Arlington	1,047,406
Old Dominion University Research Foundation	813,675
Virginia Air & Space Center	799,958
Massachusetts Institute of Technology	790,464
University of Southern California	763,797
Christopher Newport University	615,928
Ohio University	599,832
USAF, Air Force Space Command	563,082

Top Business Obligations

Harris Corporation	$ 71,938,823
Analytical Mechanics Associates, Inc.	60,340,696
Jacobs Technology, Inc.	54,108,065
Science Systems And Applications, Inc.	41,026,741
Science Applications International	26,737,264
Lockheed Martin Corporation	22,940,099
GenTech Partners Joint Venture	20,648,273
Cornell Technical Services LLC	17,355,128
Ball Aerospace & Technologies Corp.	8,090,017
Dominion Virginia Power	7,360,526
Axis Global Enterprises, Inc.	6,190,037
Unisys Corporation	6,069,757
Mission Technologies, Inc.	5,286,089
Boeing Company	4,168,077
Whitestone Group, Inc.	3,194,945
Advanced Technologies, Inc.	3,106,770
Convergent Manufacturing Technology	2,930,936
Science And Technology Corporation	2,886,691
Midland GSS JV	2,223,959
Alutiiq 3SG, LLC	1,911,461
Straughan Environmental, Inc.	1,623,275
Inuteq, LLC	1,431,220
Modern Machine and Tool Company, Inc.	1,284,826
Kendall Holdings, Ltd.	1,197,148
Northrop Grumman Space & Mission Systems	1,179,651

NASA/David C. Bowman

Katherine Johnson

A Hidden Figure Comes to Light

"I counted everything. I counted the steps to the road, the steps up to church, the number of dishes and silverware I washed … anything that could be counted, I did."

So said Katherine Johnson, recipient of the 2015 National Medal of Freedom, subject of a recent movie called "Hidden Figures" – and who also has a new research lab named after her at NASA Langley.

Born in 1918 in the little town of White Sulphur Springs, West Virginia, Johnson was a research mathematician, who, by her own admission, was fascinated by numbers. By the time she was 10 years old, she was a high school freshman - an amazing feat in an era when school for African Americans normally stopped at eighth grade.

Her father, Joshua, was determined that his bright little girl would have a chance to meet her potential. He moved his family 120 miles to Institute, West Virginia, where she could continue her education through high school. Johnson's academic performance proved her father's decision was the right one: she skipped through grades to graduate from high school at 14, from college at 18.

In 1953, after years as a teacher and later as a stay-at-home mom, she began working for NASA's predecessor, the National Advisory Committee for Aeronautics, or NACA. The NACA had taken the unusual step of hiring women for the tedious and precise work of calculating the results of wind tunnel tests in the mid 1930s.

In a time before the electronic computers we know today, these women had the job title of "computer." During World War II, the NACA expanded this effort to include African-American women.

After the war, women continued to work as computers at NACA, some even after getting married and starting families. In 1953, Katherine joined the West Area Computing Pool. Work came to the pool from wind tunnel and theoretical research groups from across the Center. The exceptional quality of Katherine's work soon came to the attention of the Flight Mechanics Branch, which researched the physics of flight. The branch requested to have Katherine join them.

With the dawning of the NASA era and the growing demands of early space research, the Flight Mechanics Branch found itself supporting the Space Task Group and the development of a program to put Americans in space. Johnson's mathematical skills were put to work for the new frontier of space.

She calculated the flight trajectory for Alan Shepard, the first American in space. Even after NASA began using electronic computers, John Glenn requested she personally recheck the calculations made by the new electronic computers before his flight aboard Friendship 7 – the mission on which he became the first American to orbit the Earth.

She continued to work at NASA until 1986, combining her math talent with electronic computer skills.

Medal of Freedom

Johnson was awarded the Presidential Medal of Freedom, the nation's highest civilian honor, by President Barack Obama on November 24, 2015.

This prestigious award honored her work in calculating early spaceflight trajectories, verifying the calculations made by early electronic computers of John Glenn's 1962 launch to orbit and the 1969 Apollo 11 trajectory to the moon. Johnson also worked on the Space Shuttle Program and the Earth Resources Satellite and encouraged students to pursue careers in science and technology.

Hidden Figures

Johnson is the subject of the movie "Hidden Figures." The film stars Taraji P. Henson as Katherine Johnson, the African-American mathematician who calculated flight trajectories for Project Mercury and the 1969 Apollo 11 flight to the Moon. The film also features Octavia Spencer, Janelle Monáe, Kevin Costner, Kirsten Dunst, and Jim Parsons.

The 20th Century Fox film recounts the story of Johnson and her two colleagues, Dorothy Vaughan and Mary Jackson. It is based on the book "Hidden Figures" by Margot Lee Shetterly, which also features colleagues Christine Mann Darden, Kathryn Peddrew, Sue Wilder, Eunice Smith and Barbara Holley.

A Lab in Her Name

On May 5, 2016, Johnson returned to NASA Langley, on the 55th anniversary of Shepard's historic flight, to attend a ceremony where a $30-million, 40,000-square-foot Computational Research Facility was named in her honor.

As part of the event, Johnson also received a Silver Snoopy award from Leland Melvin, an astronaut and former NASA associate administrator for education. Often called the astronaut's award, the Silver Snoopy goes to people who have made outstanding contributions to flight safety and mission success.

The Katherine G. Johnson Computational Research Facility is the third building in NASA Langley's 20-year revitalization plan. The 40,000-square-foot structure will provide a consolidated data center and high-density office space. It is scheduled to open in 2017.

Johnson also was honored February 22, 2016, with a bench that sits in a small park outside the Virginia Air & Space Center, the official visitor's center of NASA Langley in Hampton, Virginia.

Even after NASA began using electronic computers, astronaut John Glenn requested she personally recheck the calculations made by the new electronic computers for the flight in which he became the first American to orbit Earth.

NASA

A new Langley laboratory under construction – the Computational Research Facility – is named after Johnson and scheduled for completion in 2017.

Johnson at Langley with former astronaut Leland Melvin.

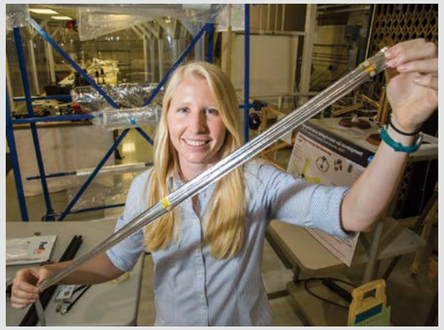
President Obama awards Johnson the Medal of Freedom. That's baseball legend Willie Mays on the right.

NASA/Bill Ingalls

Learning the Language of Math and Science

Between the different worlds of linguistics and aerospace, you could say Sarah Cook's choice for a career pulled at her like gravity.

During her senior year at high school in Boulder, Colorado, during a physics class, Cook saw a simulation of the gravitational forces between the Earth, the sun, the moon and how that changes the orbit of spacecraft around Earth.



Sarah Cook holds up a strand of heliogyro solar sail.

"I just thought it was so cool," she said. "I just remember I had a 'wow' moment when I was sitting in class."

From then, the gravitational pull of space determined her destiny.

Cook, who began working at NASA Langley as an intern in the summer of 2014, always had an interest in math and science growing up. She could also be classified as a renaissance woman, with her aerospace engineering interests paired with her foreign languages learned in high school – Spanish, French, Arabic and Latin.

"Nobody else went the engineering route" in her family, she said.

Cook used old-fashioned networking in applying for a NASA fellowship to work on solar sails.

"I was able to get my foot in the NASA door, if you will," she said.

Her advisor at the University of Colorado Boulder worked on solar sails and had collaborated with Keats Wilkie, the Structural Dynamics Branch head at NASA Langley. That connection helped put Cook on her current path.

Cook, who is working toward her Ph.D. in aerospace engineering at the University of Colorado Boulder and hopes to finish by 2019, plies her trade working on a new form of space travel and exploration – solar sails.

"This is the place to come for this type of research," she said.

Solar sails are a form of space propulsion that could enable a host of missions, including flying an advanced space-weather warning system to more quickly and accurately alert satellite operators and utilities on Earth to geomagnetic storms caused by coronal mass ejections from the sun.

"It's kind of like this huge helicopter in space," she said.

There are three types of solar sail designs: spinning disc, traditional stabilized square and heliogyro — which is a mix of the first two. Cook works on the heliogyro type.

Heliogyro solar sails are composed of several vanes, extending directly from a central hub, which "roll out" because of the spinning motion of the spacecraft.

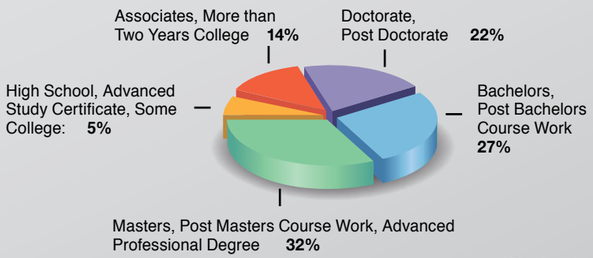
Since they do not need onboard propellant like rocket fuel, solar sails weigh less, are built with lighter materials and are cheaper to manufacture and operate, using the plentiful energy of sunlight as fuel.

"The sun is already up there," Cook said. "It's free energy."

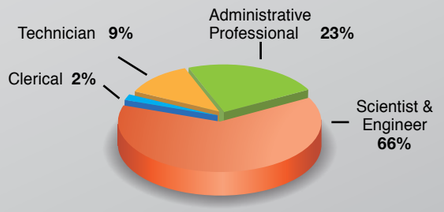
Once launched, a solar sail can unfurl to catch the sunlight it needs to operate in space.

"It's the next big step to reducing the cost of interplanetary space travel and exploration," she said.

Education Distribution

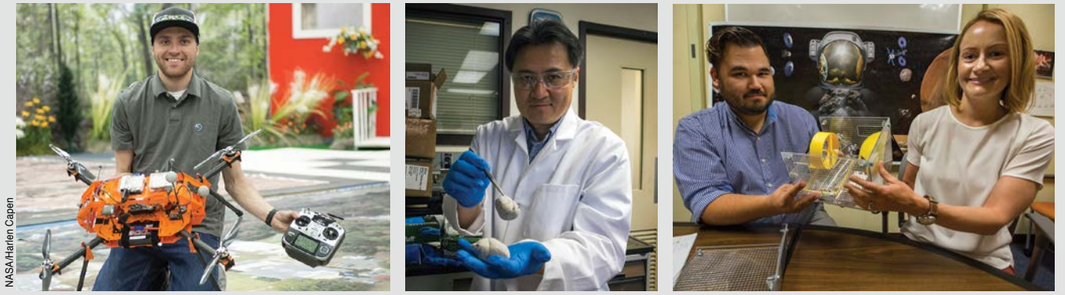


Occupation Distribution

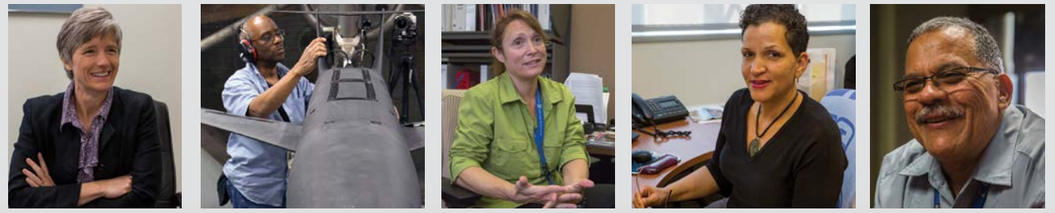


Education and occupation distribution numbers apply to 1,895 civil servants only. Data is not collected for contractors.

NASA/Harlen Capen



NASA/Harlen Capen



Photos by NASA /David C. Bowman except where noted

From top left: Tori Bates, Stephen Provost, of Boeing, Ed McLarney; Jim Crawford; Yuan Chen; Zachery Johns; Cheol Park; Matt Simon and Erica Rodgers; Loretta Kelemen; Clinton Duncan; Angie Bynum; Sharon Reyes; and Guillermo Gonzalez.

NASA/Harlen Capen

NASA astronaut Suni Williams *(fourth from left on top of capsule)*, NASA engineers, and Air Force pararescue-men pause for a group portrait on top of a Boeing CST-100 Starliner test article after simulating an astronaut rescue.

Lasers in NASA Langley's 14- x 22-Foot Subsonic Tunnel map how air flows over a Boeing Blended Wing Body model – a greener, quieter airplane design under development. Smoother flow over the wing means less fuel to power the aircraft.

Engineer Keith Johnson inflates a 9-foot diameter test article of the Hypersonic Inflatable Aerodynamic Decelerator, or HIAD. HIAD could give NASA more options for planetary missions because it would let spacecraft carry larger and heavier scientific instruments.

Technician Christopher Rex puts final touches on an 8-foot diameter NASA logo fabricated at Langley. It is one of two built for use on the Katherine G. Johnson Computational Research Facility.

Engineering technician Clinton Duncan inspects a D8 "double bubble" model in Langley's 12-Foot Low Speed Tunnel.

Dennis Bushnell, Chief Scientist, was named an American Institute of Aeronautics and Astronautics (AIAA) Fellow.

Lin Chambers, Science Directorate, was named Fellow of the American Association for the Advancement of Science (AAAS).

Norman Loeb, Climate Science Branch, was named American Meteorological Society Fellow.

Patrick Taylor, Climate Science Branch, was named Kavli Fellow, National Academy of Sciences and gave the keynote address at the Florida State University Meteorology Honors Society Banquet.

Karen Jackson, Structural Dynamics Branch, was selected for the Alexander A. Nikolsky Honorary Lectureship by the American Helicopter Society International.

Gaudy Bezos-O'Connor, Aeronautics Research Mission Directorate Projects, was named an AIAA Associate Fellow.

Melissa Carter, Configuration Aerodynamics Branch, was named an AIAA Associate Fellow.

Jennifer Heeg, Aeroelasticity Branch, was named an AIAA Associate Fellow.

Florence Hutcheson, Aeroacoustics Branch, was named an AIAA Associate Fellow.

Gregory Jones, Configuration Aerodynamics Branch, was named an AIAA Associate Fellow.

William Kimmel, Systems Analysis & Concepts Directorate, was named an AIAA Associate Fellow.

Mark Moore, Aeronautics Systems Analysis Branch, was named an AIAA Associate Fellow.

Craig Nickol, Aeronautics Systems Analysis Branch, was named an AIAA Associate Fellow.

Hiroaki Nishikawa, Computational Aerosciences Branch and the National Institute of Aerospace (NIA), was named an AIAA Associate Fellow.

William Tomek, Configuration Aerodynamics Branch, was named an AIAA Associate Fellow.

Karen Berger, Supersonic/Hypersonic Testing Branch, received the Lawrence B. Sperry Award from the AIAA.

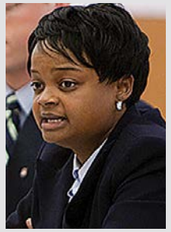
Anthony Washburn, Research Directorate, was named an AIAA Associate Fellow.

David McGowan, Chief Engineer, was named Vice Chair of the AIAA Adaptive Structures Technical Committee.

Rich Wahls, Configuration Aerodynamics Branch, was selected for a sustained service award by the AIAA.

Erica Rodgers, Space Mission Analysis Branch, was selected as a member of the AIAA Space Systems Technical Committee and as its secretary.


Dennis Bushnell


Devin Pugh-Thomas


Christopher Mertens


Guillermo Gonzalez

Marie Ivanco, Space Mission Analysis Branch, was selected as a member of the AIAA United Nations Committee on Peaceful Uses of Outer Space Working Group.

Kurt Swieringa, Crew Systems & Aviation Operations Branch, received the Robert A. Mitcheltree Young Engineer Award from the AIAA-Hampton Roads Section.

Colin Britcher, Liaison Professor at Old Dominion University and Director of Programs at the National Institute of Aerospace (NIA) was selected as a fellow by the Royal Aeronautical Society.

Dimitri Mavris, NIA Langley Distinguished Professor at Georgia Tech was selected as a fellow by the Royal Aeronautical Society.

Martin Mlynczak, Climate Science Branch, was reappointed affiliate scientist at the National Center for Atmospheric Research.

Devin Pugh-Thomas was appointed to the Virginia Council on Women to serve on the Science, Technology, Engineering, and Mathematics Committee and received the Technology Rising Star Award at the Women of Color Conference.

Paul Holloway (posthumous), Doug Dwoyer, retiree, and Charlie Harris, retiree, were inducted into the Virginia Tech Aerospace & Ocean Engineering Department Academy of Excellence.

Rob Bryant, Advanced Materials & Processing Branch, was inducted into the Space Foundation's Space Technology Hall of Fame for Medtronic LaRC-SI polymer.

Victoria Chung, Simulation Development & Analysis Branch, received the Outstanding Technical Contribution Award from the Women of Color STEM Awards.

Sharon Monica Jones received the Technology All Star Award at the Women of Color Conference.

Yolanda Shea and Erica Alston received the Technology Rising Star Award at the Women of Color Conference.

Darlene Baxter, Aero Research Program Analysis Office, received the Managerial Leadership Award from the Women of Color Stem Awards.

Guillermo Gonzalez, Electronic Systems Branch, received the Luminary Award from the HENAAC Great Minds in STEM awards.

Bryan Barmore, Crew Systems & Aviation Operations Branch, received outstanding leader from RTCA, Inc. for leadership in producing DO-328A, Safety, Performance and Interoperability Requirements Document for Airborne Spacing - Flight Deck Interval Management (ASPA-FIM).

Sang Choi, Advanced Materials & Processing Branch, gave the keynote talk and presented on a panel at the International Conference of Quantum, Nano and Microtechnologies in Nice, France.

Lawrence Huebner, Space Technology & Exploration Directorate, was presented with the Airbreathing Propulsion Subcommittee Sustained Contribution Award "in recognition of outstanding dedication, service, and leadership to the JANNAF Airbreathing Propulsion Subcommittee from 1997- 2016."

Christopher Mertens, Durability, Damage Tolerance & Reliability Branch received the Small Business Technology Council's 2016 Champion of Small Business Commercialization Award for incorporating small business in the Nowcast of Atmospheric Ionizing Radiation for Aviation Safety (NAIRAS) effort.

John Leckey, Remote Sensing Branch, was selected as a 2016 Aspen Ideas Festival Scholar.

Xiaomei Lu, Yongxiang Hu, Patricia Lucker, and Charles Trepte, all of the Atmospheric Composition Branch, received an outstanding paper award at the 4th International Symposium on Atmospheric Light Scattering and Remote Sensing, in Wuhan, China for Forest Canopy Height Estimation from CALIPSO Lidar Measurement.

Jason Welstead, NASA Langley and James Felder, NASA Glenn, received best paper for Conceptual Design of a Single-Aisle Turboelectric Commercial Transport with Fuselage Boundary Layer Ingestion, AIAA 2016-1027 from the AIAA Aircraft Design Technical Committee at the AIAA Aerospace Sciences Meeting 2016.

Keats Wilkie, Jerry Warren, Lucas Horta, Karen Lyle, and Jer-Nan Juang all of the Structural Dynamics Branch; Chad Gibbs and Earl Dowell, Duke University; and Daniel Guerrant and Dale Lawrence, University of Colorado Boulder, received the best paper award at the Second AIAA Spacecraft Structures Conference for Recent Advances in Heliogyro Solar Sail Structural Dynamics, Stability, and Control Research.

Jesse Quinlan, Aeronautics Systems Analysis Branch and Frank Gern, Vehicle Analysis Branch, received best paper at the AIAA Engineering Session for Conceptual Design and Structural Optimization of NASA Environmentally Responsible Aviation (ERA) Hybrid Wing Body Aircraft, AIAA 2016-0229 at the AIAA Aerospace Sciences Meeting 2016.

Timothy Etherington, and Lynda Kramer, Crew Systems & Aviation Operations Branch; Kurt Severance, Flight Software Systems Branch, Randall Bailey, Steven Williams and Stephanie Harrison, Crew Systems & Aviation Operations Branch, received best of track paper for Human Factors Track for Enhanced Flight Vision Systems Operational Feasibility Study using Radar and Infrared Sensors at the Digital Avionics System Conference 2015.

Bryan Barmore, NASA Langley; Kurt Swieringa, NASA Langley; Matthew Underwood, NASA Langley; Terence Abbott, SGT; and Robert Leonard, Virginia Commonwealth University, received best presentation in session, AIAA 2016 Guidance, Navigation, and Control Conference for Development of an Interval Management Algorithm for Delayed Traffic.

William Doggett and John Dorsey, Structural Mechanics and Concepts Branch; George Ganoe, Electromagnetics and Sensors Branch; Bruce King, TEAMS2, Thomas Jones, Structural Mechanics and Concepts Branch; Charles Mercer, Lites; and Cole Corbin received first place in the International Create the Future Design competition in the Machinery/Automation/Robotics technology category for "The Tendon Actuated Lightweight In-Space MANipulator (TALISMAN)". The competition was sponsored by COMSOL, Mouser Electronics and Tech Briefs Media.

Paul Leser, Durability, Damage Tolerance & Reliability Branch and NIA graduate student, was selected for the inaugural International Council of the Aeronautical Sciences (ICAS) and the International Forum for Aviation Research (IFAR) award for an individual who has made a significant contribution to Aeronautical Science within his/her doctoral thesis.

Robert Baurle, Hypersonic Airbreathing Propulsion Branch, was selected co-winner of the best paper award for Analysis of Facility Thermodynamic Non-Equilibrium Effects on HIFiRE Ground Tests by the JANNAF (Joint Army-Navy-NASA-Air Force) Airbreathing Propulsion Subcommittee.

Karen Jackson, Structural Dynamics Branch, Edwin Fasanella of the National Institute of Aerospace and Michael Polanco, who is currently a graduate student at ODU, received a best paper award for Simulating the Response of a Composite Honeycomb Energy Absorber: Part 1. Dynamic Crushing of DEA Components and Multi-Terrain Impacts from the Journal of Aerospace Engineering.

Jared Grauer, Dynamic Systems and Control Branch, was awarded first place in the 2016 Laurence Bement Young Professionals Paper Competition by the AIAA Hampton Roads Section for Generic Global Aerodynamic Model for Aircraft, which was coauthored by Gene Morelli.

Mark McElroy, Durability, Damage Tolerance, and Reliability Branch, received the best paper award at the 30th American Society for Composites Annual Technical Conference for An Enriched Shell Element for Delamination Simulation in Composite Laminates.

Patents

Keith L. Gordon, Emilie J. Siochi, Brian W. Grimsley, Roberto J. Cano, and Michael W. Czabaj, US Patent Number 9,156,957 for "Puncture-Healing Thermoplastic Resin Carbon-Fiber Reinforced Composites"

William R. Doggett, John T. Dorsey, George G. Ganoe, Bruce D. King, Thomas C. Jones, Charles D. Mercer, and Cole K. Corbin, US Patent Number 9,168,659 for "Tension Stiffened and Tendon Actuated Manipulator"

Jeffrey Y. Beyon, Grady J. Koch, and Michael J. Kavaya, US Patent Number 9,201,146 for "Airborne Doppler Wind Lidar Post Data Processing Software DAPS-LV"

Mehdi R. Khorrami, US Patent Number 9,227,719 for "Reactive Orthotropic Lattice Diffuser for Noise Reduction"

Arthur T. Bradley, US Patent Number 9,229,451 for "Locomotion of Amorphous Surface Robots"

Travis L. Turner, Reggie T. Kidd, David P Lockard, Mehdi R. Khorrami, Craig L. Streett, and Douglas Leo Weber, US Patent Number 9,242,720 for "Autonomous Slat-Cove-Filler Device for Reduction of Aeroacoustic Noise Associated with Aircraft Systems"

Douglas M. Nark and Michael G. Jones, US Patent Number 9,245,089 for "Statistically Based Approach to Broadband Liner Design and Assessment"

Christopher J. Wohl, Jr., Joseph G. Smith, Jr., Emilie J. Siochi, and Ronald K. Penner, US Patent Number 9,278,374 for "Modified Surface Having Low Adhesion Properties To Mitigate Insect Residue Adhesion"

Edward R. Generazio, US Patent Number 9,279,719 for "Electric Field Quantitative Measurement System and Method"

Lawrence J. Prinzel III; Alan T. Pope, Olafur S. Palsson, and Marsha J. Turner, US Patent Number 9,283,468 for "Method and Apparatus for Performance Optimization Through Physical Perturbation of Task Elements"

John V. Foster and Kevin Cunningham, US Patent Number 9,285,387 for "In-Flight Pitot-Static Calibration"

Stanley E. Woodard, Donald M. Oglesby and Bryant D. Taylor, US Patent Number 9,329,149 for "Wireless Chemical Sensor and Sensing Method for Use Therewith"

Stanley E. Woodard and Bryant D. Taylor, US Patent Number 9,329,153 for "Method of Mapping Anomalies in Homogenous Material"

Mehti Koklu, US Patent Number 9,333,517 for "Fluidic Oscillator Array for Synchronized Oscillating Jet Generation"

Michael G. Jones, Douglas M. Nark, Earl Ayle and Fumitaka Ichihashi, US Patent Number 9,334,059 for "Acoustic Panel Liner for an Engine Nacelle"

Mehti Koklu, US Patent Number 9,339,825 for "Fluidic Oscillator Having Decoupled Frequency and Amplitude Control"

Sean A. Commo, Keith C. Lynn, Drew Landman, and Michael Acheson, US Patent Number 9,354,134 for "In-Situ Load System for Calibrating and Validating Aerodynamic Properties of Scaled Aircraft in Ground-based Aerospace Testing Applications"

Joseph N. Zalameda and Patrick H. Johnston, US Patent Number 9,354,206 for "Floating Ultrasonic Transducer Inspection System And Method For Nondestructive Evaluation"

Tak-kwong Ng and Carl S. Mills, US Patent Number 9,354,880 for "Processing Device for High-Speed Execution of an xRISC Computer Program"

Brian M. Howerton and Michael G. Jones, US Patent Number 9,355,194 for "Graphical Acoustic Liner Design and Analysis Tool"

Stanley S. Smeltzer and Eric Lundgren, US Patent Number 9,370,918 for "Methods for Using Durable Adhesively Bonded Joints for Sandwich Structures"

Russell W. Smith, H. Kevin Rivers, Joseph G. Sikora, Mark C. Roth, and William M. Johnston, US Patent 9,400,237 for "Optical Method For Detecting Displacements and Strains at Ultra-High Temperatures During Thermo-Mechanical Testing"

The Virginia Air & Space Center

NASA/M.S.Walsh

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, a Gemini test vehicle, and the Orion Pad Abort-1 flight test vehicle. You can also view: 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 **vasc.org**

Langley Leadership

Cathy Mangum, Associate Director; David Bowles, Center Director; Clayton Turner, Deputy Director.

How to Contact Us

Office of Strategic Analysis, Communications and Business Development: 757 864-3000

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

"Godspeed" John Glenn

Glenn, the last of the original Mercury 7 astronauts, died Dec. 8, 2016, at the age of 95. In the early years of the space program, Glenn spent a lot of his time at NASA Langley Research Center, which led Project Mercury, and he became the first American to orbit Earth.

Employees who worked with Glenn during the 1950s and 60s remembered him as exceptional but quiet, and said you could ask him to do anything, and he would do it right.

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

NP-2016-11-857-LaRC