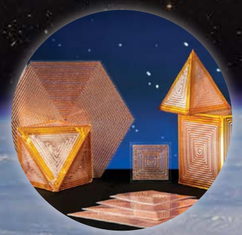
National Aeronautics and Space Administration

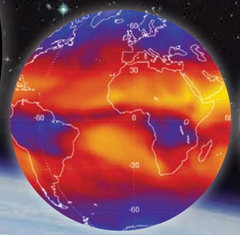
ENDLESS POSSIBILITIES










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

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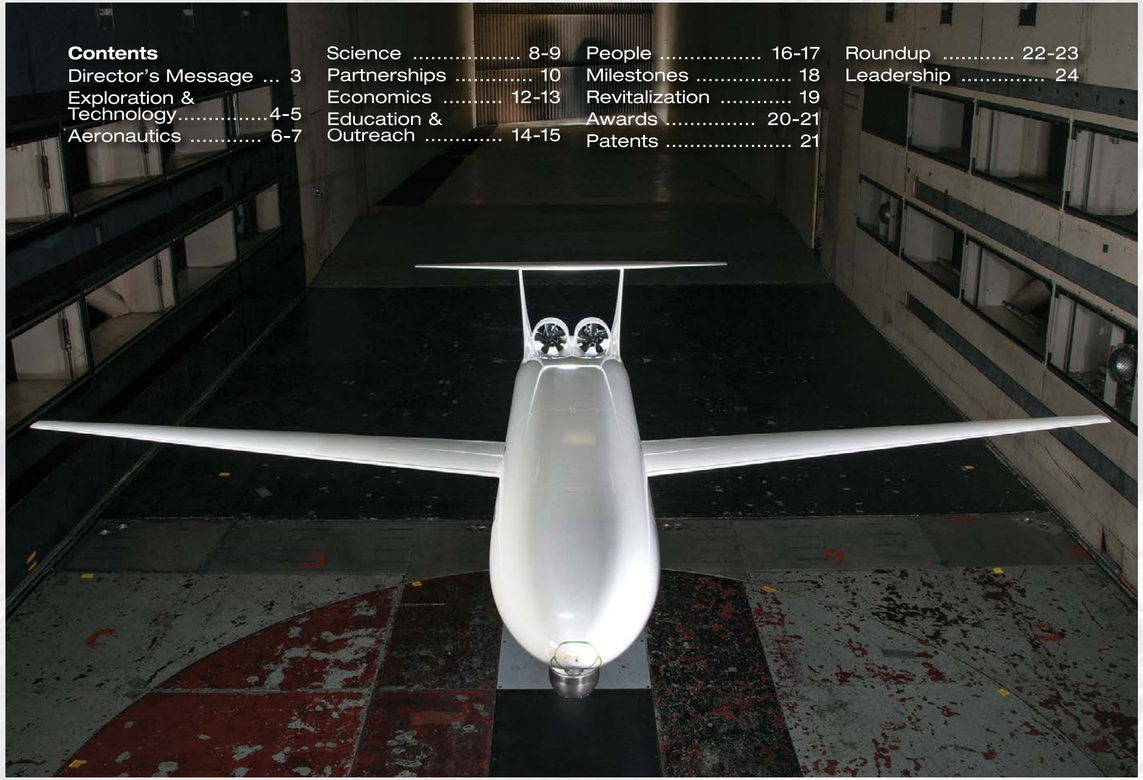
LANGLEY RESEARCH CENTER 2014

Contents



NASA/George Homich

A D8 airliner concept from a team led by the Massachusetts Institute of Technology is tested in Langley's 14 by-22-Foot Subsonic Tunnel. NASA is working with industry and university partners to develop technologies and systems for aircraft that will reduce noise, emissions and fuel consumption.

Photos in this publication are by David C. Bowman of NASA Langley unless otherwise credited.

NASA

With the launch of Orion in December, NASA took the first steps toward the future of human space exploration. Langley contributed critical elements to the mission: a launch abort system, structural impact testing, recovery testing, heat shield validation, and wind tunnel testing. The flight test went flawlessly and met NASA's key objectives.

At right: Space Launch System models have been tested in several Langley wind tunnels, including this one in the Transonic Dynamics Tunnel. The new launch system will enable science missions and human exploration beyond Earth's orbit, to destinations such as an asteroid and eventually Mars.

Below left: Technicians check out a section of a former Marine helicopter crash tested at Langley. The 10-foot drop test was in preparation for a full-scale helicopter crash test later in the year.

Below center: The Integrated Structural Assembly of Advanced Composites (ISAAC) was recently installed in Langley's Advanced Manufacturing and Flight Test Articles Development Lab.

Below right: Sailors from the USS Anchorage attach a towing bridle to NASA's Orion Crew Module off the Pacific coast after a successful test launch and splashdown in December.

NASA/George Homich

U.S. Navy

Director's Message

It's time once again to recognize many of the past year's accomplishments while looking ahead to another year of endless possibilities at NASA Langley Research Center.

The pages of this report highlight steps we've taken and progress toward enabling human exploration of the solar system, as well as our work helping improve the air travel system and learning more about Earth's changing climate.

Our work in space exploration and technology development continues to produce advances that will help NASA build and send spacecraft – some with humans – to destinations including an asteroid and eventually Mars.

As part of that, Langley is helping advance designs for expanded launch capabilities, developing next-generation deployable space structures and partnering with companies to analyze and test the latest class of spacecraft.

In another step toward spaceflight beyond Earth orbit, in December NASA's Orion crew capsule traveled 3,600 miles into space during its first mission, Exploration Flight Test-1. The two-orbit, four-hour uncrewed flight test will help engineers evaluate the systems critical to crew safety, including the heat shield, parachute system and launch abort system – all of which Langley contributed to.

In aeronautics, Langley continues to work on technologies to make commercial flight safer, cleaner and more efficient. That work includes reducing aircraft noise around airports, boosting fuel efficiency, relieving air traffic congestion, and evaluating new aircraft designs.

In 2014, NASA's Environmentally Responsible Aviation program used an innovative manufacturing process to build a 10,000-pound composite aircraft structure for testing at Langley. Composite materials and structures increasingly are being used in aircraft to improve safety and fuel-efficiency.

And our scientists are learning more about how climate change is impacting the planet. Langley researchers are conducting experiments to understand the effect on the atmosphere from volcanoes, industrial pollution and changes in Earth's temperature.

Capping a four-year campaign, NASA research aircraft spent the month of August studying air pollution in the Denver region. The mission was aimed at improving the ability of satellites to better observe and understand air quality in the lowest part of the atmosphere, an effort that will continue with the launch in 2018 of a satellite to measure atmospheric pollution over most of North America.

I hope you'll take a few minutes to go through this report. You'll find a lot more detail about the activities I just touched on and much more.

Stephen G. Jurczyk
Director
NASA Langley Research Center

Leading the Way to the Future

Langley engineers and space architects are leading the way into the future of space exploration, finding the least energy-intensive pathways from Earth to Mars, improving designs for launch vehicles using space age materials, and designing and building hypersonic-entry and autonomous-landing systems. The ultimate goal is to solve the most challenging problems associated with sending humans into deep space beyond low Earth orbit and eventually to the surface of Mars.

Creating Tomorrow's Space Technologies

In 2014, structural and high-temperature testing validated Langley designs for a next-generation Mars entry system and work began on a high-speed orbital re-entry test that will piggyback on a space station resupply flight. Langley also continues to develop advanced lightweight structural concepts for reducing the mass of future launch vehicles, crew modules, and space habitats and providing new capability for long-reach manipulator systems that will lead to longer missions beyond near-Earth space.

With its Autonomous Landing Hazard Avoidance Technology (ALHAT), Langley has collaborated with the Johnson Space Center in Houston to devise ways spacecraft could bypass potentially hazardous terrain on the moon, Mars and even an asteroid. By detecting and evading dangerous obstacles such as rocks, holes and slopes, ALHAT enables planetary landers to touch down precisely and safely on surfaces.

Langley developed robotic concepts that could contribute to NASA's asteroid rendezvous and retrieval mission, demonstrating in the laboratory how asteroid retrieval concepts might work in space. Langley also completed prototype designs for deep space habitats that will protect the crew from solar radiation storms during deep space missions.

A Morpheus prototype lander that uses ALHAT technology.

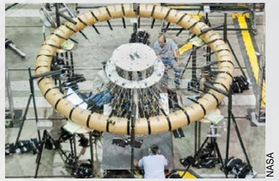
Orion and NASA's Space Launch System

To help mature the design of the Space Launch System (SLS), Langley continued to deliver wind tunnel testing and analysis databases. Langley also delivered Orion's stage adapter diaphragm used to keep exhaust gases away from the spacecraft. The hardware is an integral part of the stage adapter that connected Orion to a Delta IV Heavy rocket during its first flight test and on the first planned launch of NASA's Space Launch System in 2018.

In addition to delivering the flush-air data system that will measure surface pressures on the Orion heat shield during atmospheric re-entry, Langley has provided critical support to the development of the crew module heat shield that will be used in crewed missions. Langley has also continued to lead the efforts to define and ultimately execute tests to study the response of the Orion crew module during water landings.

Travel to Low-Earth Orbit

In support of development of the commercial space industry, Langley has worked with Sierra Nevada Corp., Boeing, and SpaceX on analysis and wind tunnel support to advance their concepts for spacecraft traveling beyond Earth's orbit.



NASA

Above left: Researchers test a component of an inflatable device that could be used in future missions for spacecraft atmospheric re-entry. *Center:* Technician Rick Hall inside the Unitary Plan Wind Tunnel readying a Dream Chaser model for tests in support of NASA's Commercial Crew initiative. *Above right:* A mock-up to test concepts for capturing an asteroid.

Lockheed Martin's ground test article for Orion prepares for water landing tests at Langley.

Langley Researchers Express Pride as Orion Rushes into Space and Back

As the Orion spacecraft roared out of Earth's atmosphere and punched into orbitin December, NASA's ambitious plans for space exploration lifted right along with it.

The uncrewed launch of Orion atop a Delta IV Heavy rocket from Cape Canaveral Air Force Station in Florida rekindled excitement about the potential for human adventures in deep space.

"I'm stunned. I'd never seen a rocket launch before," said 10-year-old Evan Furniz, who had just watched the big event on the IMAX screen at the Virginia Air & Space Center in Hampton, Virginia. "I was surprised at the size of the rocket and how much propulsion they need for liftoff."

It also instilled pride in those who worked to make the test successful.

NASA Langley researcher Shih-Yung Lin was thrilled by the morning's successful launch, but he didn't immediately start cheering.

As heat shield structure subsystems manager for Orion, he knew that one of the most risky parts of the day's flight was still four-and-a-half hours away: the fiery, high-stakes maneuver called re-entry.

NASA

"My heart was pounding when I saw the launch, but even harder when I saw it coming in," Lin said, smiling. "That's where my stuff was working. I had my own few minutes of terror."

Lin worked more than two years to ensure that Orion's first trip to space didn't end in a destructive inferno. Partnering with Orion prime contractor Lockheed Martin, Lin and his team oversaw creation of a heat shield capable of withstanding the blast-furnace-like conditions of re-entry, with temperatures reaching 4,000 degrees Fahrenheit.

Lin and his team will get to examine that very same Orion heat shield up close. After being detached from the crew module, it will be transported to NASA Langley, where Lin and a team of experts will study it carefully and use their results to improve the next generation of Orion heat protection.

Heat shield validation is one of several NASA Langley contributions to Orion. Researchers led development of its Launch Abort System and conducted an array of essential tests. Wind tunnel work, structural impact testing and refinements to Orion's recovery procedures were all handled by Langley.

What's more, a team at Langley called SCIFLI, which stands for Scientifically Calibrated In-Flight Imagery, captured thermal snapshots of Orion as it blazed back into the atmosphere during re-entry.

"I've worked for the last eight years, almost exclusively, on things related to Orion," said Richard Boitnott, an aerospace engineer who runs tests of the crew module's ability to withstand splashdown impacts. "This is my first real experience with a large project. I wanted to see the whole plan come together. I was very excited to see it go. This is absolutely huge for NASA."

Plenty of folks at Langley expressed that same sense of accomplishment.

"This is one more giant step toward making Orion the safest spacecraft ever developed," said Kevin Rivers, who manages the team overseeing the Launch Abort System. That system is designed to protect astronauts if a problem arises during launch by propelling the spacecraft away from a failing rocket.

Ellen Carpenter, project manager for Orion water impact testing, said she felt humbled to be part of the team. "A lot of people made sacrifices to make this a success," she said. "I have a great feeling of gratitude for their efforts. It's a great day for NASA."

The Next Steps in Aeronautics Innovation

Cleaner fuel, fewer bugs, more aerodynamic helicopters, flexible yet strong airplane wings and smart aircraft skin were all on Langley's 2014 aeronautics research agenda. As in years past, computers were put to the test and results evaluated in the field as Langley scientists and engineers took the next steps in aeronautics innovation.

In one of 2014's most significant developments, results from the Alternative Fuel Effects on Contrails and Cruise Emissions (ACCESS) II study that concluded in late May confirmed that jet biofuel burns at least 50 percent more cleanly than traditional fuels. ACCESS II was the latest in a series of ground and flight tests to study emissions and contrail formation generated by new blends of plant-based, renewable aviation propellants.

ACCESS II — a followup to the 2013 predecessor study ACCESS I – involved Langley researchers and NASA personnel from California and Ohio, as well as collaborators from the German Aerospace Center and the National Research Council of Canada. Because they lay the groundwork for more environmentally friendly aircraft designs and worldwide flight operations, and given the explosive growth forecast for global air travel, ACCESS II data assume key importance.

Research at the End of the Tunnel

A trio of tests in Langley's wind tunnels during 2014 assessed methods of reducing fuel use, decreasing noise and improving structural integrity.

One experiment in Langley's 14-by-22-Foot Subsonic Tunnel involved both NASA and the U.S. Army working together to find ways to smooth the airflow around a helicopter body. Early results indicate that air blown from tiny jets was able to reduce the drag generated by both the helicopter fuselage and its rotors.

Drag also is caused by objects adhering to aircraft surfaces – especially insects – which, when combined with other factors, can increase fuel usage by as much as 30 percent. Continuing work begun in 2013, researchers used a "bug gun" to evaluate a series of nonstick coatings in Langley's Basic Aerodynamics Research Tunnel. Tests proved that certain coatings can shrink the area of insect adherence by as much as 90 percent.

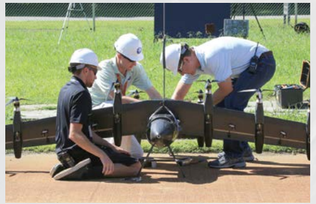
Aircraft fuel consumption could also decrease with widespread use of composite materials. A new NASA effort, the Advanced Composites Project, involves Langley engineers as well as private industry and the Federal Aviation Administration. It is aimed at substantially reducing the time it takes materials to go from laboratory to market, and would accelerate their design, development and certification for both aircraft and spacecraft.

Eventually, embedded sensors could turn an airplane's exterior into a "smart skin." Researchers from Langley have studied the integration of Langley-developed SansEC sensors into composite test panels. The sensors could one-day monitor aircraft structural health, and determine the location and severity of potential damage.

Langley and NASA's Wallops Flight Facility in Virginia also are part of a new effort to advance the technology of unmanned aircraft systems (UAS). Virginia Tech, plans to work with both NASA field centers to conduct UAS failure mode testing and identify and evaluate operational and technical risks areas. NASA Langley uses unmanned aircraft, such as a scaled airliner model, in its own aviation safety research.

Right: Researchers prepare a model of a concept for electric powered flight known as Greased Lightning for a tethered test flight at Langley's LandIR facility.

Far right: A helicopter was drop tested for crashworthiness of the airframe and passenger systems in partnership with the Navy, Army, FAA and industry.



A low-boom demonstration aircraft concept.

Testing Next-generation Aircraft Concepts

More than 736 million passengers flew on U.S. airlines in 2013, according to the Federal Aviation Administration. Every one of those airliners carried at least some NASA-developed technology on board, much of it created at NASA Langley.

Now NASA Langley researchers are working to develop the next two generations of aircraft that could become operational over the next 20 years. These are planes that should be quieter, safer, greener and faster – and flying in an air transportation system that is more efficient than now.

A number of different designs — jets shaped like flying wings, an aircraft with a double fuselage, a plane with truss-braced wings, and low sonic boom supersonic jet concepts — are being tested and studied in Langley wind tunnels and labs.

They represent the possible shape of things to come and a revolution in aviation technology, which aims to keep noise within airport boundaries, reduce fuel emissions, increase fuel efficiency and bring back supersonic passenger travel.

Most current airliners are designed as a tube with wings – a single tube, called a fuselage. But for the future, engineers, in partnership with the Massachusetts Institute of Technology, are looking at the possible benefits of wider, double fuselages with wings.

A model of the so-called "double bubble" D8 airliner concept returned to NASA Langley's 14 by-22-Foot Subsonic Tunnel for further testing in 2014. "The team refined what it did last year, " said Rich Wahls, Fixed Wing Project scientist. "We are getting higher accuracy data and more insight into the flow physics with a new measurement device."

Two questions engineers are trying to answer are whether engines embedded in the fuselage decrease drag, and by how much. Reduced drag helps reduce fuel consumption.

Transonic Dynamics Tunnel engineers at Langley installed a 13-foot semi-span Boeing model to assess the aeroelastic qualities of an unusual truss-braced wing configuration. Aeroelasticity is the study of how an aircraft flexes during flight.

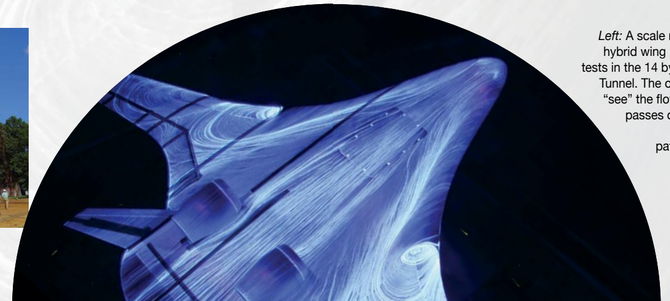
Boeing designed the concept with NASA and studies predict that the truss-braced wing would improve fuel consumption five to 10 percent over advanced conventional wings.

A kind of flying wing called the Hybrid Wing Body shows promise as a quieter, more fuel-efficient airplane design, according to researchers. A number of different versions are being tested in various Langley facilities.

"Some of the technology is not specific to the Hybrid Wing Body," said Russ Thomas, Environmentally Responsible Aviation Project engineer for Vehicle Systems Integration. "It can apply to other aircraft configurations for incremental and significant noise reduction."

Noise is also an issue when it comes to supersonic passenger travel. The Federal Aviation Administration banned supersonic flight over land in 1973, primarily because of concerns that sonic booms are annoying to communities on the ground.

After research done here in wind tunnels and noise labs, NASA Langley and industry engineers say they believe supersonic research has progressed to the point where the design of a practical low-boom supersonic jet is within reach.



Left: A scale model of a futuristic hybrid wing body during oil flow tests in the 14 by-22-Foot Subsonic Tunnel. The oil helps researchers "see" the flow patterns when air passes over and around the model. Those patterns are important in determining crucial aircraft characteristics such as lift and drag.

NASA/Preston Martin

Left: A D8 airliner concept from a team led by the Massachusetts Institute of Technology is tested in Langley's 14 by-22-Foot Subsonic Tunnel.

Right: A Boeing concept for truss-braced wing aircraft in the Langley Transonic Dynamics Tunnel for tests.

NASA/Sandie Gibbs

A Safer Planet, A Better Tomorrow

For almost 40 years, the Science Directorate at NASA Langley has been translating atmospheric discovery into better solutions to protect the Earth and its people through research in climate, active remote sensing, atmospheric composition and air quality.

The Earth is continuously bombarded by high-energy cosmic rays, the primary source of atmospheric ionizing radiation that increases the risk of cancer and other health effects. Commercial aircrews are classified as radiation workers, and are among the most exposed occupational group.

Yet, career and storm exposures are not quantified or documented. This year, Langley made significant progress on the Radiation Dosimetry Experiment, or RaD-X, a high-altitude balloon that will characterize energy deposition by cosmic rays after its launch in 2015.

Natural hazards, like volcanic ash, pose threats to aviation and affect climate. After Indonesia's Mount Kelud erupted in February, a team of NASA Langley scientists ventured to Australia to send balloons aloft to make measurements of the volcanic plume during the Kelud Ash experiment.

Meanwhile from space, measurements from Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) indicated the persistence of ash particles in the plume months after the eruption.

For more than 25 years, the Stratospheric Aerosol and Gas Experiment (SAGE) instruments have made accurate measurements of ozone loss in Earth's atmosphere. Ozone measurements will be extended when SAGE III/ISS is deployed to the International Space Station in 2016.

Nearly 20 years of CERES (Clouds and the Earth's Radiant Energy System) on-orbit performance have produced a long-term record that is critical to detect and understand climate change. These fundamental CERES measurements will continue with two new instruments.

These long-term data records of the Earth's climate system enable earlier and better-informed public policy decisions that provide a large economic benefit to the U.S. and the world.

Improving Satellite Observations

In searching for ways to make more precise measurements of carbon dioxide gas, considered the primary contributor to climate change, NASA envisioned a laser-based carbon dioxide-measuring satellite mission called ASCENDS (Active Sensing of CO2 Emissions over Nights, Days and Seasons).

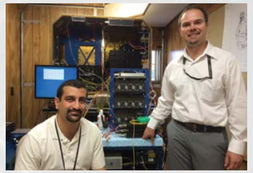
One tool to potentially fill gaps in current knowledge about atmospheric carbon dioxide is the ASCENDS CarbonHawk Experiment Simulator, or ACES. In 2014, Langley conducted six flights over 20 hours aboard NASA's HU-25C Falcon aircraft to measure carbon dioxide over the Atlantic Ocean, and cities and forests in Virginia, West Virginia and North Carolina.

ACES is considered a new-and-improved version of the Multi-functional Fiber Laser Lidar, which was also demonstrated successfully this year aboard NASA's DC-8 aircraft.

In another effort to advance space-based capabilities, Langley participated in a coordinated ship and aircraft observation campaign, NASA's Ship-Aircraft Bio-Optical Research (SABOR).

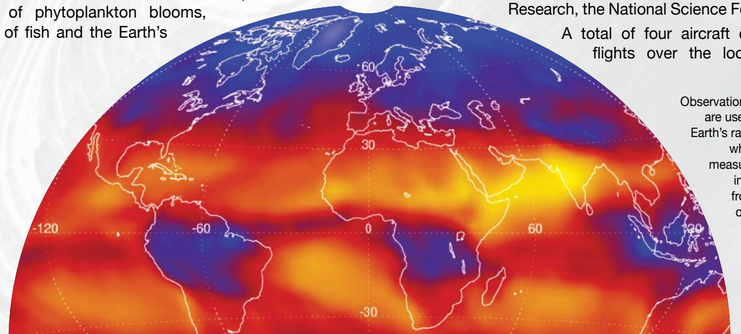
From Langley's UC-12 aircraft, Langley's science team tested a prototype lidar system, the High Spectral Resolution Lidar-1 (HSRL-1), which uses a laser to probe the ocean to a depth of 160 feet. This enables a deeper understanding of the distribution of phytoplankton blooms, which affect the migratory patterns of fish and the Earth's carbon budget.

NASA/Sam McDonald



Tom Glennon/URI

Above left: Amin Nehrir, left, and ACES Principal Investigator Mike Obland pose in front of the workings of ACES. *Above center and right:* Nearly 30,000 feet below Langley's UC-12, scientists aboard the National Science Foundation's Research Vessel Endeavor took ship-based measurements that will help the Langley team validate and improve its data set from HSRL-1.



Observations from CERES are used to determine Earth's radiation budget, which consists of measurements of the incoming energy from the sun and outgoing energy back to space. This balance determines Earth's temperature and climate.

Pollution Study Caps Four-Year Campaign

Final flights were completed in 2014 for a Langley-led series of airborne field studies aimed to improve the ability to diagnose near-surface air quality conditions from space. To do this, it is critical to understand how pollution is distributed at the surface as well as aloft since satellites must peer through the entire depth of the atmosphere.

The project, called DISCOVER-AQ (Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality) has provided the most detailed information ever collected on the distribution of pollutants and the associated factors affecting local air quality.

NASA/Patrick Reddy

The NASA P-3B as viewed from the cockpit of the NCAR C-130 during DISCOVER-AQ testing.

In previous years, deployments focused on the Baltimore-Washington area, California's southern San Joaquin Valley, and Houston, Texas. The final deployment was conducted over Colorado's Northern Front Range/Denver area last July and August. Each location offered unique factors leading to violations of federal air quality standards.

In Colorado, it was the terrain and unique mixture of pollution sources with clearly identifiable chemical signatures associated with urban emissions, oil and gas exploration, and feedlot operations.

A key to the success of DISCOVER-AQ has been partnerships with EPA, local air quality agencies, and communities in each location. In Colorado, another major collaboration was with the Front Range Air Pollution and Photochemistry Experiment (FRAPPÉ) jointly sponsored by the National Center for Atmospheric Research, the National Science Foundation and the state of Colorado.

A total of four aircraft collected observations during joint flights over the local air-quality monitoring network.

The NASA Wallops P-3B and Langley B200 King Air were the main airplanes supporting DISCOVER-AQ, with the P-3B providing in-situ profiles over ground-monitoring sites and the B200 remotely sensing gaseous and particulate pollution from high overhead. The NCAR C-130, fielded by the FRAPPÉ team, served as a second in-situ aircraft able to sample more freely upwind and downwind of the DISCOVER-AQ study region.

A second remote sensing aircraft, the NASA Langley HU-25C Falcon, joined the B200 flying high overhead with an instrument onboard developed at Ball Aerospace to demonstrate the technology that will be used in future geostationary satellite observations of air quality.

Beneath these aircraft, the local air quality network was augmented with an unprecedented array of observations including 10 lidars, 16 trace gas spectrometers, 20 Aerosol robotic network sun photometers, four in-situ trailers, six mobile labs, two tethered balloon operations, and a 300-meter instrumented tower at the National Oceanic and Atmospheric Administration's Boulder Atmospheric Observatory.

DISCOVER-AQ was able to document violations of federal air quality standards during each of the four deployments, and the ongoing analysis of observations is being used to improve satellite algorithms, develop ground-monitoring strategies of the future, and evaluate and improve air quality models.

These activities are essential to prepare for NASA's launch of TEMPO (Tropospheric Emissions: Monitoring of Pollution), a geostationary satellite to monitor air quality over North America, which is planned to be on orbit by the end of the decade.

NASA

The NASA P-3B taking off from the Rocky Mountain Metropolitan Airport.

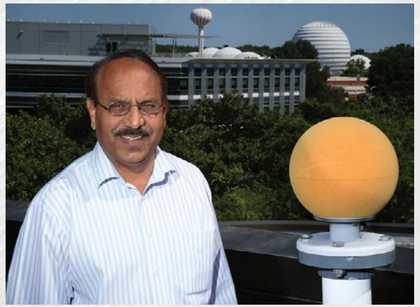
Morgan Silverman and Mary Kleb suit up for a ride to the top of NOAA's 300-meter tower during the final DISCOVER-AQ deployment in Colorado.

NASA

Moving Technologies from Lab to Market

Not only are Langley's efforts in research and technology critical to the success of NASA missions, they likewise generate new private-sector businesses and products in the United States and abroad. A key player is the Office of Innovation, home to Langley's technology transfer initiatives.

The office helps set Langley technologies on a path to commercial viability, beginning with the patenting process, and then to promotion and marketing to enlist external partners. With an understanding of how today's latest innovations connect to business world, the office uses both conventional and new approaches to guide Langley innovation to the marketplace.



Qamar Shams stands next to a protected microphone of the Extreme Low Frequency Acoustic Measurement System. He and the late Allan Zuckerwar received the NASA Commercial Invention of the Year for this technology.

From Concept to Company

In 2014, Langley collaborated with Edison Nation, a company that works with inventors, entrepreneurs, and large industry to shepherd fledgling concepts to viable products. Edison Nation held a NASA Challenge for Langley's MindShift, a technology that uses brainwave activity to help pilots maintain safer flight during autopilot engagement and other automated aircraft functions.

If physiological signals indicate less-than-optimal performance, MindShift alters the speed, strength or steadiness of a monitoring device that alerts users to increase concentration and decrease stress.

The goal of the collaboration is to find new ideas and applications for MindShift that may eventually lead to a license and new commercial products from Edison Nation's inventor community.

In addition, the Office of Innovation maintains relationships with its current licensees, such as Caplan Taylor Enterprises, a local business that licensed SansEC technology from Langley. SansEC, a wireless sensor, can be used for a multitude of measuring applications.

When the firm originally licensed SansEC, it was to manufacture and market measurement products for the boating industry. Because of SansEC's success, Caplan Taylor is now licensing the technology for a new line of products that target the automotive industry.

This past year, the office earned a national honor: Langley's Extreme Low Frequency Acoustic Measurement System garnered the NASA Commercial Invention of the Year Award. The technology detects infrasound, inaudible to the human ear, and can sense clear-air turbulence, tornado activity, and may one day be used as a cardiac monitor.

Small Business Innovation

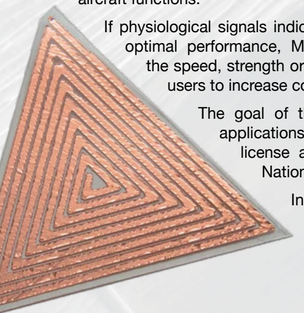
American small businesses and research institutions are critical to technology innovation. In 2014, Langley oversaw more than 90 Small Business Innovation Research (SBIR) and Small Business Technology contracts worth almost $30 million.

To ensure the investments support technology areas that are important to Langley specifically and to NASA as a whole, Langley's SBIR Office works closely with its chief technologist and the Langley Technology Council.

Through their Langley SBIR partnerships, Fibertek Inc. of Herndon, Virginia, and ADVR Inc. of Bozeman, Montana, delivered key laser technologies for Langley's High Spectral Resolution Lidar (HSRL) instrument.

In 2014, the HSRL flew on Langley's UC-12 aircraft to validate measurements made by NASA's Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations mission, as well as measurements of the amount of phytoplankton present in the ocean.

Phytoplankton are responsible for capturing up to 50 percent of the carbon dioxide absorbed by the ocean from the atmosphere, and converting it to oxygen through photosynthesis.



NASA

A sample of SansEC, a highly adaptable and wireless sensing material developed at Langley.

It looks like something out of a Transformers movie – a huge robotic arm that moves and spins to pick up massive heads filled with spools of carbon fibers, then moves in preprogrammed patterns to deposit those fibers onto a 40-foot bed. But instead of transforming from machine to Autobot, it can transform epoxy and fibers into aerospace structures and parts. Its name is ISAAC, or Integrated Structural Assembly of Advanced Composites.

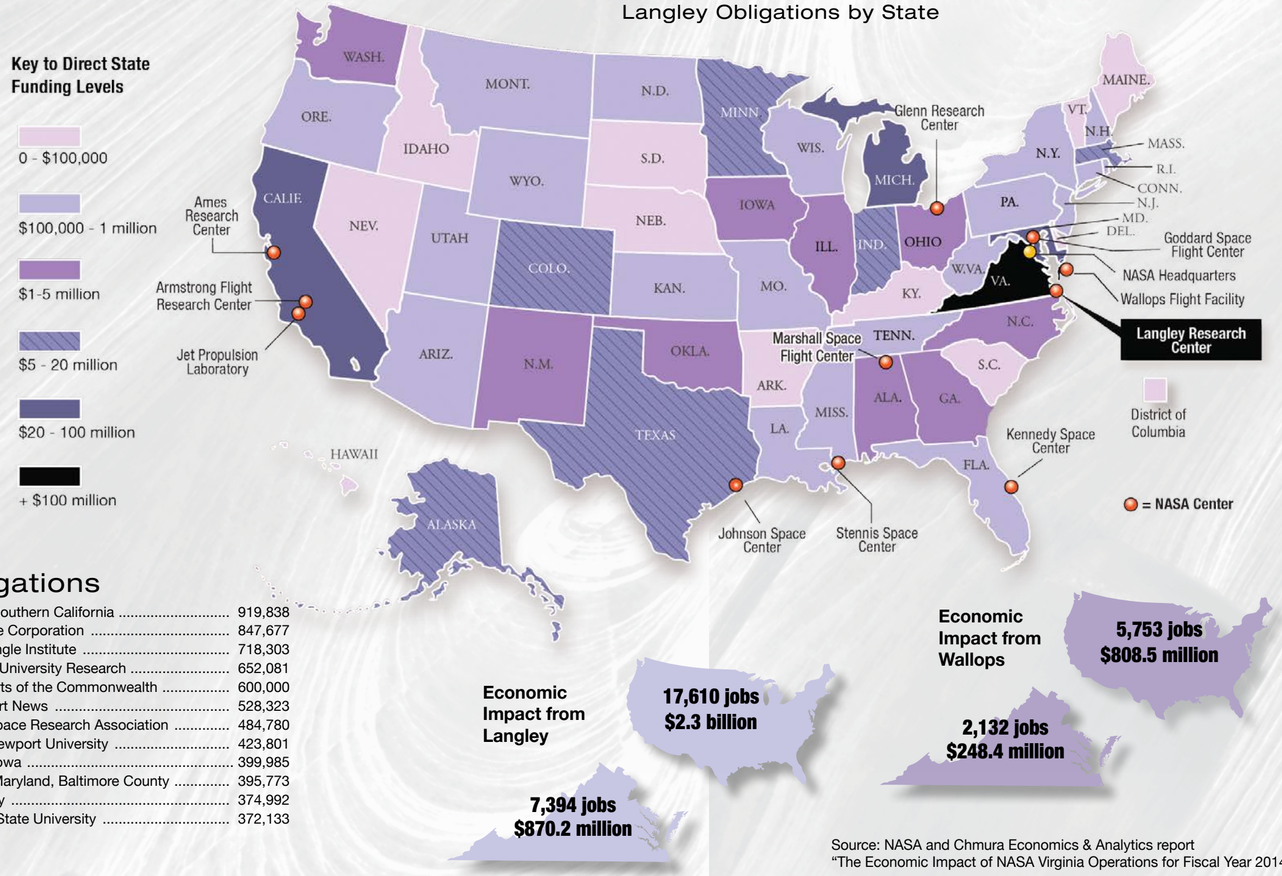
Top Business Obligations

Jacobs Technology	$ 59,255,591
Analytical Mechanics Associates	56,534,171
Science Systems and Applications	45,913,753
SGT, Inc.	27,685,907
Boeing Company	23,659,468
Cornell Technical Services, LLC.	20,288,141
Exelis, Inc.	18,409,371
Ball Aerospace & Technologies Corp.	15,901,406
Gentech Partners Joint Venture	14,123,859
Dominion Virginia Power	9,894,231
Unisys Corp.	6,208,362
Safety & Quality Assurance Alliance	5,338,089
Chugach Federal Solutions, Inc.	4,958,810
Inuteq, LLC.	4,113,282
Lockheed Martin Corp.	3,931,298
Whitestone Group, Inc.	3,349,208
Northrop Grumman Space & Mission Systems	2,871,095
Silicon Graphics Federal, LLC.	2,791,393
Science and Technology Corp.	2,207,954
Straughan Environmental, Inc.	1,738,918
Alutiiq 3SG, LLC.	1,725,300
Science Applications International	1,722,606
Dyncorp International, LLC.	1,650,829
Modern Machine and Tool Company, Inc.	1,502,890
NSR-Integrity Joint Venture, LLC.	1,383,546

Top Nonprofit and Education Obligations

Regents of the University of Michigan	$ 50,505,434
National Institute of Aerospace Association	20,235,270
City of Hampton	6,099,716
U.S. Air Force, Space and Missile System Ctr.	3,467,281
University of Texas at Austin	2,885,437
OSU Center for Innovation and Econ. Dev.	2,479,268
US General Services Administration	2,151,006
Georgia Tech Research Corp.	1,613,687
Regents of the University of Minnesota	1,357,279
U.S. Department of the Air Force	1,125,075
Smithsonian Institution	1,061,900
U.S. Department of the Army	1,000,000
University of Illinois	985,935
University of Southern California	919,838
The Aerospace Corporation	847,677
Research Triangle Institute	718,303
Old Dominion University Research	652,081
Judiciary Courts of the Commonwealth	600,000
City of Newport News	528,323
Universities Space Research Association	484,780
Christopher Newport University	423,801
University of Iowa	399,985
University of Maryland, Baltimore County	395,773
Ohio University	374,992
Pennsylvania State University	372,133

Langley Obligations by State



Economic Impact from Langley
17,610 jobs
$2.3 billion
7,394 jobs
$870.2 million

Economic Impact from Wallops
5,753 jobs
$808.5 million
2,132 jobs
$248.4 million

Source: NASA and Chmura Economics & Analytics report
"The Economic Impact of NASA Virginia Operations for Fiscal Year 2014."

Economic Impact of NASA in 2014

NASA's Virginia operations generated an economic impact of $3.1 billion in 2014. That compares to $2.9 billion last year. The impact includes the combined effects of activity at NASA's Langley Research Center in Hampton, Virginia, and Wallops Flight Facility on the state's Eastern Shore.

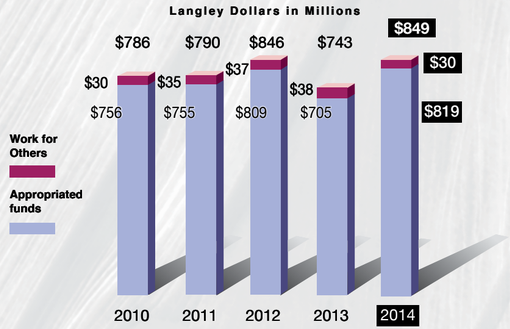
Direct spending rose in 2014, as illustrated by the chart below. The increase was driven primarily by new projects receiving funding.

NASA Langley Generated the Following Economic Impacts

- In the U.S., the economic impact was $2.3 billion that supported 17,610 jobs.
- In Virginia, the economic impact was $870.2 million that supported 7,394 jobs.
- In Hampton Roads, the economic impact was $779.1 million that supported 6,544 jobs.

NASA Wallops Generated the Following Economic Impact

- In the U.S., the economic impact was $808.5 million that supported 5,753 jobs.
- In Virginia, the economic impact was $248.4 million that supported 2,132 jobs.



From Clouds to Science Cafés, Langley Helps Educate

NASA Langley is a strong supporter of science, technology, engineering and mathematics education from preschool through graduate school and shares the latest information about its research at a variety of public events, web sites and social media.

Langley participated in the first Science Festival of Virginia. Organized by the Science Museum of Western Virginia and Virginia Tech, the festival showcased the exciting world of science, technology, engineering and mathematics.

Langley researchers, engineers and scientists partnered with the Virginia Air & Space Center for Home School Appreciation Day. Home-school families saw a moon rock, participated in hands-on activities and learned how to incorporate NASA content into lesson plans and projects.

Members of the Lifelong Learning Society at Christopher Newport University attended a five-part lecture series called "America's Human Space Exploration" presented by Langley staff.

Langley's Clouds and the Earth's Radiant Energy System or CERES team organized a Science Café for the public. The theme of the discussion was big data and climate science projects. Big data is an accumulation of digital information too large and complex for processing by traditional means. CERES scientists have been collecting data on the Earth's ability to absorb and reflect the Sun's light and heat since 1997 to learn more about weather and climate.

Langley's Science Directorate is encouraging the general public and students to become citizen scientists with Students' Cloud Observations Online (S'COOL) and Sky Art. S'COOL participants go to a website to learn when Earth-observing satellites are overhead. They observe the clouds at their location and report the observation online. Sky Art participants take cloud photos and upload them to a website.

A group of Virginia educators participated in a modeling and simulation mathematics teacher professional development program. The teachers learned the difference between modeling and simulation and how each technique is applied to NASA research. The teachers plan to use the experience to inspire students with real-life examples of mathematics in the workplace.

The summer of 2014 saw 260 university students descend on NASA Langley for an intensive 10-week internship. The students worked with mentors on a variety of programs and projects in many of Langley's research areas.

The Virginia Aerospace Science and Technology Scholars academy invited 175 rising Virginia high school seniors to Langley. Students were divided into teams that planned part of a mission to Mars.

More than two-dozen exhibits were set up at the VASC to showcase Langley's most exciting new technologies during Technology Day for families.

A team from the Virginia Governor's School for Science and Technology (GSST) in Hampton won a nationwide Exploration Design Challenge sponsored by NASA, Lockheed Martin and the National Institute of Aerospace. The challenge asked for a design to provide radiation shielding for humans during spaceflight. Their experiment flew into space onboard Orion during its first flight.

Students at GSST also participated in the High School Students United with NASA to Create Hardware (HUNCH) Extreme Science Program to design a robot that could remove dust from surfaces on the International Space Station. A second project worked on a design to break down water into oxygen released to the air and hydrogen that was captured by a fuel cell. The HUNCH team also flew on a NASA-sponsored zero-gravity flight.

NASA Langley teamed up with Newport News Shipbuilding for Career Days. Hampton Roads high school students participated in design challenges and spent the remainder of their time talking with engineers, scientists and researchers about their day-to-day work activities.

Left and above: Home schoolers enjoy the Langley exhibits at the Virginia Air & Space Center's annual Home School Appreciation Day. *Above right:* A student places a programmable robot on a maze for a technology challenge demonstration.

Right: Hampton Roads high school students attend an Engineering Career Day sponsored by Newport News Shipbuilding, NASA Langley, and Jefferson Lab.

Below: NASA summer interns at a poster session presenting the results of their work.

Above: NASA Social media bloggers were invited to Langley for a tour and remote viewing of the Orion launch as part of a campaign to promote the event.

Right: Hampton Mayor George Wallace visited the Langley Child Development Center to share a book and take a photo for the Global Selfie campaign.

Earth: The Ultimate Selfie

On Earth Day this year, NASA asked people all around the world a simple question – "Where are you on Earth Right Now?"

We asked people to answer the question on social media, with a selfie. The goal was to use each picture as a pixel in the creation of a "Global Selfie" – a mosaic image that would look like Earth appeared from space on Earth Day.

The finished image was built using 36,422 individual photos that were posted on social media and tagged #globalselfie on or around April 22. People on every continent – 113 countries and regions in all – posted selfies.

From Antarctica to Yemen, Greenland to Guatemala, Micronesia to the Maldives, Pakistan, Poland, Peru – and on. The image was assembled after weeks of curating more than 50,000 #globalselfie submissions from Twitter, Instagram, Facebook, Google+ and Flickr.

The result is a zoomable 3.2-gigapixel image that people can scan and explore to take a closer look at the variety of pictures. The mosaic is hosted on the web by GigaPan. A few of our local selfies, shown here, made it to the final image.

http://www.gigapan.com/gigapans/155294

His Career Started In 4th Grade

When Patrick Taylor caught the bus to Greenwood Elementary School in Millerstown, Pennsylvania, one spring morning in 1992, little did he know that his life was about to change.

Mrs. Benner, his fourth-grade teacher, asked him to take charge of a daily weather log the class was starting as part of a series of lessons on weather. The task required young Taylor, 10 at the time, to make sure the daily maximum and minimum temperatures were recorded.

“Every day after lunch for that month I would walk to the front left corner of the room and read the temperature, humidity and wind observations from the weather station’s digital display,” he recalled. “Then I would walk to the back right corner of the room and record this data on the bulletin board.”

After that, “my favorite part of the day was always the morning weather forecast,” Taylor said.

“Every morning I would wake up and watch Joe Calhoun on WGAL Channel 8 in Lancaster, Pennsylvania. I would make my own forecasts after watching Joe. I remember one morning that I forecasted that we would get snow from a storm after watching the radar loop, whereas the forecast was for no snow. And it snowed!”

“I’ve been hooked on meteorology ever since,”

said Taylor, a native of Liverpool, Pennsylvania. He has a doctorate in meteorology thanks to Mrs. Benner’s class, and for the last four years has been a research scientist at NASA Langley. He uses his expertise to analyze climate data from an Earth-orbiting instrument called CERES, short for Clouds and the Earth’s Radiant Energy System.

On top of that, Taylor received an award this year for – according to the White House – “exceptional early career achievements and innovations that have advanced scientific understanding of the Earth’s climate system.”

President Obama named five NASA researchers, Taylor among them, as recipients of the 2012 Presidential Early Career Award for Scientists and Engineers. The awards are the highest honor bestowed by the U.S. government on scientists and engineers beginning their research careers.

“I knew I had been nominated,” Taylor said, “but I was really surprised when I was selected.”

And then, last summer, he was named to the Governor’s Climate Change and Resiliency Update Commission.

That’s pretty heady experience for a guy who earned his degree just four years ago.

“I really enjoy my job,” Taylor said. “My favorite part is creating new knowledge about how energy flows through the climate system. As a climate scientist, I’m tasked with learning about the climate system, identifying gaps in our knowledge, and then using NASA data to close the knowledge gaps.”

What’s the one piece of advice he would give to kids who want to pursue a career in science?

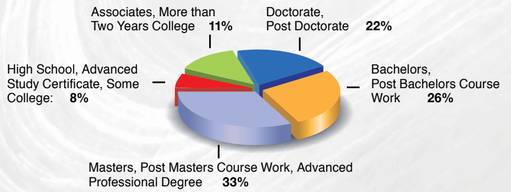
“Pursue your passion. Don’t be afraid to ask the ‘easy’ questions. More often than not, we don’t understand these questions well enough.”

As for Mrs. Benner, “I haven’t seen her since I graduated high school,” he said. “If I saw her again, I would tell her how influential her class was to me, and say thank you.”

The Faces of Langley

From left to right: Toni Viudez-Mora, Luther Jenkins, Marina Moen.

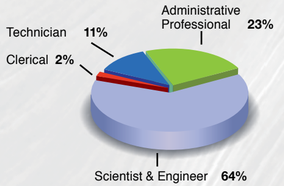
Education Distribution



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

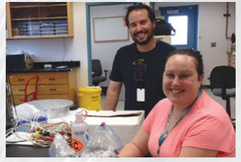
In 2014, 1,900 civil service and 1,700 contract employees supported NASA Langley.

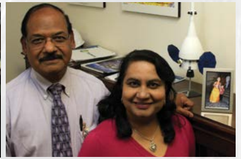
Occupation Distribution



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

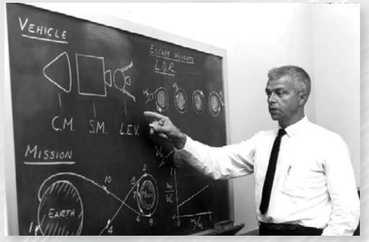
Below: Langley employees promote breast cancer awareness in the Combined Federal Campaign walk/run.





Clockwise from top right: Jeremy Shidner, Andreas Beyersdorf and Chelsea Corr, Ken Dudley, Damodar and Manjula Ambur, Chad Stephens and Kyle Ellis *seated*, David Palmer, Dennis Bushnell, Al Ragsdale, and Noel Baker.

Far left: Lloyd Eldred.



John Houbolt

Were it not for John Houbolt, the United States might never have landed men on the moon.

Houbolt, who died April 15, may have never become a household name, but his ideas and contributions to Apollo made it possible to achieve the goal of landing a crew on the moon and safely returning them.

As a member of the Lunar Mission Steering Group, Houbolt had been studying various aspects of space rendezvous since 1959 and was convinced, like several others at NASA Langley, that lunar-orbit rendezvous (LOR) was not only the most feasible way to make it to the moon before the decade was out, it was the only way.

Before Houbolt began championing LOR as the way to go to the moon, NASA's rocket scientists, including Wernher von Braun, envisioned lunar missions of a type now more often associated with early science fiction.

In the original plan, a large rocket would fly directly from the Earth to the moon, landing on its tail and blasting off the lunar surface for a direct return to Earth.

"They were going to send a vehicle the size of a 100-foot Atlas rocket to the moon with absolutely zero help and land it backwards," Houbolt described in a 2008 interview with NASA. "I said, 'It cannot be done.'"

After a 2-1/2-year debate, Houbolt prevailed, and on July 20, 1969, he watched from the viewing room overlooking NASA's Mission Control as the Eagle, Apollo 11's lunar module, landed on the moon.

"When the landing took place and touchdown was made ...all of us stood up and started clapping," Houbolt recalled in a NASA interview. "And von Braun sat in front of me, and he did the okay sign and said, 'Thank you, John.' That was one of the biggest rewards I've ever had."

Photo credit/ NASA

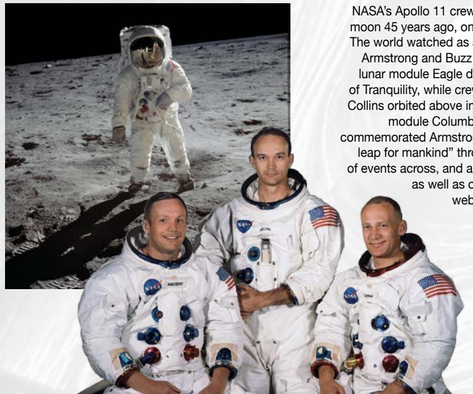
Edgar Cortright

Former Langley Center Director Ed Cortright passed away in May 2014. Under his leadership Langley planned and managed two Viking missions to Mars. Viking 1 and 2, each with an orbiter and lander, sent the first clear photographs of Mars to Earth. The landers were the first human-made objects to soft land on Mars. Cortright was also called upon to lead the Apollo 13 failure review board, which became known as the Cortright Commission. He became center director in 1968 and retired in 1975.

Sid Pauls

Former Langley Associate Director Sid Pauls passed away in October 2014. During his career at Langley he was responsible for the Manned Orbital Laboratory Life Support System, which led to the life support systems for the International Space Station. He worked to establish the Virginia Air & Space Center in Hampton and served on its board of directors. He received the Presidential Rank Award for Meritorious Service and retired from NASA in 1995.

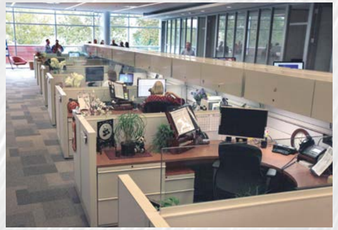
NASA remembers Apollo 11 at 45

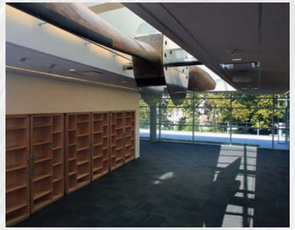


NASA's Apollo 11 crew landed on the moon 45 years ago, on July 20, 1969. The world watched as astronauts Neil Armstrong and Buzz Aldrin set their lunar module Eagle down in the Sea of Tranquility, while crewmate Michael Collins orbited above in the command module Columbia. The agency commemorated Armstrong's "one giant leap for mankind" through a number of events across, and above, the U.S., as well as on the agency's website and NASA Television.

Phase Two

Langley's newly opened Integrated Engineering Services Center is a $52-million, 138,000-square-foot facility housing the Engineering, Research, and Systems Analysis and Concepts directorates. It also serves as the center's premiere collaboration space. The building is the second phase in Langley's revitalization plan, which calls for the construction of eight state-of-the-art facilities and the demolition of several aging structures. Over the life of the plan, officials project savings of $105 million in maintenance and utility costs, and $141 million in deferred maintenance. In Phase One, Langley's Headquarters, the first building in the plan, opened in 2011.





Phase Three

Phase three of Langley's revitalization plan calls for construction of a $23-million, 40,000-square-foot building called the Computational Research Facility, *(not shown)* which will provide a consolidated data center and high-density office space.

Phase Four

The Measurement Systems Laboratory *(left)* is the fourth phase in Langley's revitalization plan. The lab will be a world-class facility for research and development of new measurement concepts, technologies, and systems that will enable NASA to achieve its mission in space exploration, science, and aeronautics. It is the largest of all planned new facilities at 175,000 square feet.

Awards

Patrick Taylor, Climate Science Branch, received the 2012 Presidential Early Career Award for Scientists and Engineers, for exceptional early career achievements and innovations that have advanced scientific understanding of the Earth's climate system. It is the highest honor bestowed by the United States on scientists and engineers beginning their research careers. **Mr. Taylor**, was also selected for the Governor's Climate Change and Resiliency Update Commission.

Rosemary Baize, Science Directorate, was selected as the federal government's representative for the International Women's Foundation Fellowship.

James Crawford, Chemistry & Dynamics Branch, was selected to serve on The International Global Atmospheric Chemistry project's Scientific Steering Committee.

Neil Frink, Configuration Aerodynamics Branch, received the AIAA Aerodynamics Award.

Jeremy Shidner, Atmospheric Flight and Entry Systems Branch, received the Peninsula Engineers Council Engineer of the Year Award, the AIAA Hampton Roads Section Engineer of the Year Award, and the AIAA Region 1 Engineer of the Year Award.

Jeremy Pinier, Configuration Aerodynamics Branch, received the Doug Ensor Award for Young Professional of the Year, from the Peninsula Engineers Council and the SLS SE&I Technical Contribution Award.

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

Susan Gorton, Aeronautics Research Mission Directorate Projects, was part of a team that included the US Army, GGA, ONERA and the Georgia Institute of Technology that received the Augusta Westland International Fellowship Award from the American Helicopter Society.

Kathy Dezern, Office of Strategic Analysis, Communications & Business Development, received the Outstanding Technology Transfer Professional Award from The Federal Laboratory Consortium.

Qamar Shams and the late **Allan Zuckerwar**, Aeronautics Systems Engineering Branch, received the Agency's Invention of the Year award for The Portable Infrasound Detection System.

Dan Oostra, Atmospheric Science Data Center, and **Danny Mangosing**, Atmospheric Composition Branch, won a 2014 IT Labs Project Call Award for their proposal, Cloud Based HTML5 Toolkit (CBHT).

Michael Little, Atmospheric Science Data Center, along with two other co-authors from JPL and Ames, won a 2014 IT Labs Project Call Award for their proposal, Cloudbursting– Solving the 3-Body Problem.

Robert Starr, Project Manager for NASA's Digital Learning Network (DLN), was inducted into 2014 class of the United States Distance Learning Association's Hall of Fame.

The Speed Agile Powered-Lift Demonstration Team with members from U.S. Air Force Research Lab, NASA, Boeing, Lockheed Martin, Advanced Technologies, Inc. and Williams International received the 56th Annual Aviation Week Laureate Award in Aeronautics and Propulsion.

Randy Bailey and **Lynda Kramer,** Crew Systems & Aviation Ops Branch, and **Tim Etherington**, Rockwell Collins, were part of the RTCA SC-213 Team that received the 2014 Aviation Week Laureate Award for Avionics and Systems.

Steve Jurczyk receives the Small Business Administrator's Cup from NASA Administrator Charles Bolden and Associate Administrator for Small Business Programs, Glenn Delgado.

David Wing, Crew Systems & Aviation Operations Branch; **Thomas Prevot**, NASA Ames; **Timothy Lewis**, Crew Systems & Aviation Operations Branch; **Lynne Martin**, San Jose State University; **Sally Johnson**, NASA Langley; **Christopher Cabrall**, San Jose State University; **Sean Commo**, Systems Engineering and Engineering Methods Branch; **Jeffrey Homola**, San Jose State University; **Manasi Sheth-Chandra**, NASA Langely; **Joey Mercer**, San Jose State University, and **Susan Morey**, San Jose State University received Best Paper in Session for Pilot and Controller Evaluations of Separation Function Allocation in Air Traffic Management at the USA/Europe Air Traffic Management Research and Development Seminar.

Steve Koczo, Rockwell Collins, Inc., and **David Wing**, Crew Systems & Aviation Operations Branch, were awarded best in session at the 32nd Digital Avionics Systems Conference (DASC) for the paper An Operational Safety and Certification Assessment of a TASAR EFB Application.

Chauncey Wu, Structural Mechanics & Concepts Branch; Bret Stanford, Aeroelasticity Branch; **Glenn Hrinda**, Vehicle Analysis Branch; **Zhuosong Wang**, student intern, Structural Mechanics & Concepts Branch; **Robert Martin**, Engineering Methods Branch and **Alicia Kim**, University of Bath, UK, received the AIAA 2014 Collier Research HyperSizer/AIAA Structures Best Paper Award for Structural Assessment of Advanced Composite Tow-Steered Shells at the 54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference.

Luca Cantu, Emanuela Gallo and **Andrew Cutler**, George Washington University, and **Paul Danehy**, Advanced Sensing & Optical Measurement Branch, received the AIAA Aerodynamic Measurement Technology Technical Committee's Best Paper Award for Dual-Pump CARS Of Air In A Heated Pressure Vessel Up To 55 Bar and 1300 K presented at SciTech2014.

Christopher Wohl, **Joseph Smith**, **John Gardner**, and **Ronald Penner**, Advanced Materials & Processing Branch; **John Connell**, Projects & Engineering Branch, and **Emilie Siochi**, Advanced Materials & Processing Branch, received a distinguished paper award from The Adhesion Society for Novel Epoxy Particulate Composites for Mitigation of Insect Residue on Wing Leading Edge Surfaces at the 37th Annual Meeting of the Adhesion Society.

Martin Mlynczak, David Kratz, and **Jeff Mast**, Climate Science Branch; **Richard Cageao** and **David Johnson**, Remote Sensing Flight Systems Branch and **Harri Latvakoski**, Utah State University received best submission for Earth Observing Technologies for The Far-Infrared Spectroscopy of the Troposphere (FIRST) Instrument; New Technology for Measuring Earth's Energy Balance and Climate Change for the inaugural edition of Earthzine, an online IEEE publication.

Keith Lynn, Aeronautics Systems Engineering Branch, **Ray Rhew**, Laser Remote Sensing Branch, **Michael Acheson**, Technologies Application Branch, **Gregory Jones** and **William Milholen**, Configuration Aerodynamics Branch, and **Scott Goodliff**, Subsonic/Transonic Testing Branch received the AIAA Best Ground Testing Paper by the AIAA Ground Testing Technical Committee for High-Reynolds Number Active Blowing Semi-Span Force Measurement System Development.

D. M. Murphy, S. Solomon, R. W. Portmann, and **K. H. Rosenlof**, NOAA Earth System Research Laboratory; **P. M. Forster**, University of Leeds and **T. Wong,** Climate Science Branch, received the NOAA Oceanic and Atmospheric Research outstanding paper for An Observationally Based Energy Balance for the Earth Since 1950 published in the Journal of Geophysical Research.

Oliver Wong, received best paper at the American Helicopter Society 68th Annual Forum for Blade Tip Pressure Measurements Using Pressure Sensitive Paint.

David Piatak, Aeroelasticity Branch, gave the commencement speech at

AWARDS *continued*

Carbondale Area Jr./Sr. High School in Carbondale, PA, to a crowd of 800 graduates and their guests.

Ann Martin, Chemistry & Dynamics Branch, **Lin Chambers**, Science Directorate, **Margaret Pippin**, Chemistry & Dynamics Branch and **John Baek** NOAA's Office of Education, received best poster for The Meta-Evaluation of NASA Innovations in Climate Education (NICE) at the American Evaluation Association annual conference.

Mary Gainer, Standard Practice & Environmental Engineering Branch, received NASA's Environment and Energy Blue Marble Award.

The Langley Graphic Information System team led by **Brad Ball**, Resource Management Office, received NASA's Environment and Energy Blue Marble Group Award.

NASA Langley was awarded as a Virginia Department of Environmental Quality Environmental Excellence Program Sustainability Partner.

NASA Langley received the Diamond Excellence Award for 10 years of perfect compliance from the Hampton Roads Sanitation District

Patents

Joel Campbell, Narasimha Prasad, Fenton Harrison, and **Michael Flood** received patent number 8,605,262 for Time Shifted PN Codes for CW LIDAR, RADAR, and SONAR.

Dennis Working, **Emilie Siochi**, **Cheol Park,** and **Peter Lillehei** received patent number 8,608,993 for Mechanically Strong, Thermally Stable, And Electrically Conductive Nanocomposite Structure and Method of Fabricating Same.

Lawrence Prinzel III, Alan Pope, Olafur Palsson, and **Marsha Turner** received patent number 8,628,333 for Method And Apparatus For Performance Optimization Through Physical Perturbation of Task Elements.

Stanley Woodard (deceased) received patent number, 8,636,407 for Wireless Temperature Sensor Having No Electrical Connections and Sensing Method for Use Therewith.

Michael Czech, **Russell Thomas,** and **Patrick Taylor,** Climate Science Branch, was selected for the Governor's Climate Change and Resiliency Update Commission.

Samuel Miller and **Kurt Severance** received patent number 8,655,094 for Photogrammetry System and Method for Determining Relative Motion Between Two Bodies.

Michael Vanek received patent number 8,655,513 for Methods of Real Time Image Enhancement of Flash LIDAR Data and Navigating a Vehicle Using Flash LIDAR Data.

Leonard Weinstein and **Karen Taminger** received patent number 8,658,004, for Vapor-Barrier Vacuum Isolation System.

Donald Thomsen III, Robert Cano, Brian Jensen, Stephen Hales, and **Joel Alexa** received patent number 8,661,653 for Methods of Making Z-Shielding.

Tian-Bing Xu, Ji Su, and Xiaoning Jiang received patent number 8,662,412 for Advanced Modified High Performance Synthetic Jet Actuator with Curved Chamber**.**

Arthur Bradley received patent number 8,662,213 for Locomotion of Amorphous Service Robots.

William Yost, K. Elliott Cramer, Daniel Perey, and **Keith Williams** received patent number 8,671,551 for Process for Nondestructive Evaluation of the Quality of a Crimped Wire Connector.

Allan Zuckerwar (deceased) and **Qamar Shams** received patent number 8,671,763 for Sub-Surface Windscreen for Outdoor Measurement of Infrasound.

Thomas Ivanco received patent number 8,672,107 for Compact Vibration Damper.

R. Roy Whitney, Kevin Jordan, and **Michael Smith** received patent number 8,673,120 for Efficient Boron Nitride Nanotube Formation via Combined Laser-Gas Flow Levitation.

Stanley Woodard (deceased), **Donald Oglesby,** and **Bryant Taylor** received patent number 8,673,649 for Wireless Chemical Sensor and Sensing Method for Use Therewith.

Stephen Smith, John Newman, Robert Piascik, and **Edward Glaessgen** received patent number 8,679,642 for System for Repairing Cracks in Structures.

Tian-Bing Xu, Xiaoning Jiang, and **Ji Su** received patent number 8,680,749 for Piezoelectric Multilayer-Stacked Hybrid Actuation/Transduction System.

Travis Turner, Roberto Cano, Richard Silcox, Ralph Buehrle, Christopher Cagle, Randolph Cabel, and **George Hilton** received patent number 8,683,807 for Jet Engine Exhaust Nozzle Flow Effector.

Hyun-Jung Kim, Sang Choi, Glen King, Yeonjoon Park and **Kunik Lee** received patent number 8,691,612 for Method of Creating Micro-Scale Silver Telluride Grains Covered with Bismuth Nanoparticles.

Stanley Woodard (deceased) received patent number 8,692,562 for Wireless Open-Circuit In-Plane Strain and Displacement Sensor Requiring No Electrical Connections.

Joel Campbell received patent number 8,693,002 for Fourier Transform Spectrometer System.

Michael Jones, Mehdi Khorrami, Meelan Choudhari, and **Brian Howerton** received patent number 8,695,915 for Flap Side Edge Liners for Airframe Noise Reduction.

Keith Gordon, Jin Ho Kang, Cheol Park, Peter Lillehei, and **Joycelyn Harrison** received patent number 8,696,940 for Negative Dielectric Constant Material Based on Ion Conducting Materials.

Mehdi Khorrami, David Lockard, James Moore, Ji Su, Travis Turner, John Lin, Karen Taminger, Seun Kahng, and **Scott Verden** received patent number 8,695,925 for Elastically Deformable Side-Edge Link for Trailing-Edge Flap Aeroacoustic Noise Reduction.

Stanley Smeltzer III and **Eric Lundgren** received patent number 8,697,216 for Systems, Apparatuses, and Methods for Using Durable Adhesively Bonded Joints for Sandwich Structures.

Robin Southward, Donavon Delozier, Kent Watson, Joseph Smith, Jr., Sayata Ghose, and **John Connell** received patent number 8,703,235 for Preparation of Metal Nanowire Decorated Carbon Allotropes

Michael Jones, Brian Howerton and **Thomas Van De Ven** received patent number 8,708,272 for Landing Gear Door Liners for Airframe Noise Reduction.

Russell Wincheski and **John Simpson** (deceased) received patent number 8,717,012 for Eddy Current Probe for Surface and Sub-Surface Inspection.

Brian Stewart received patent number 8,704,423 for Asymmetric Dielectric Elastomer Composite Material.

Matthew Rogge and **Jason Moore** received patent number 8,746,076 for Shape Sensing Using A Multi-Core Optical Fiber Having an Arbitrary Initial Shape in the Presence of Extrinsic Forces.

Michael Smith and **Kevin Jordan** received patent number 8,753,578 for Apparatus for the Production of Boron Nitride Nanotubes.

Noah Schiller, Randolph Cabell and **Daniel Perey** received patent number 8,760,039 for Compact Active Vibration Control System for a Flexible Panel.

Constantine Lukashin and **Bruce Wielicki** received patent number 8,767,210 for Method for Ground-To-Space Laser Calibration System.

Travis Turner, Mehdi Khorrami, David Lockard, Martin McKenney, Raymond Atherley, and **Reggie Kidd** received patent number 8,763,958 for Multi-Element Airfoil System.

Kenneth Dudley, Holly Elliott, John Connell, Joseph Smith, Jr., Sayata Ghose, Kent Watson, and **Donovan Delozier** received patent number 8,790,773 for Tailorable Dielectric Material with Complex Permittivity Characteristics.

Alan Pope, Chad Stephens, and **Nina Blanson** received patent number 8,827,717 for Physiologically Modulating Videogames or Simulations Which Use Motion-Sensing Input Devices.

Eliott Radcliffe, Ahmed Naguib, and **William Humphreys** received patent number 8,848,942 for Acoustic Beam Forming Array Using Feedback-Controlled Microphones for Tuning and Self-Matching of Frequency Response.

NASA/Sandie Gibbs

Above: A simulated aircraft accident was staged at Langley. It was a Multiple Agency Response Exercise involving the Emergency Operations Center, Joint Base Langley–Eustis, and the City of Hampton. The crash site involved a controlled fire, loud noises, and smoke as well as a couple of simulated casualties.

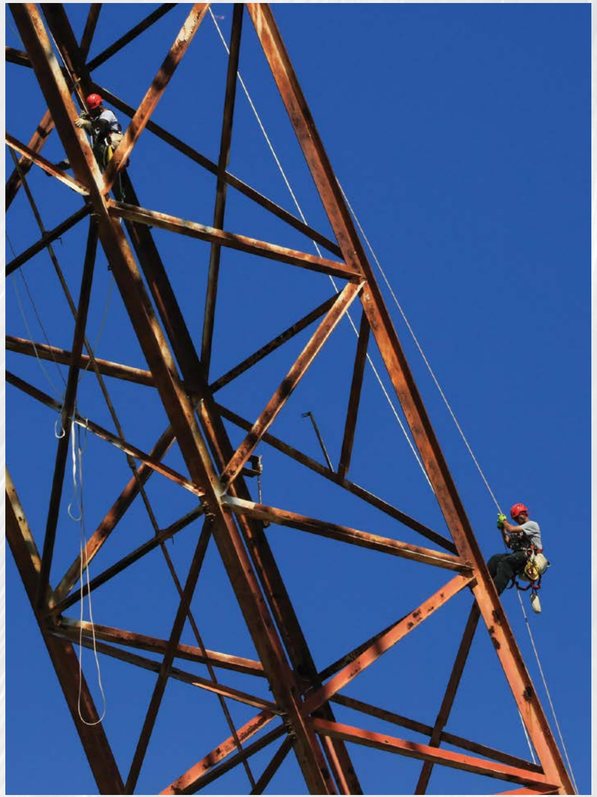
Above right: These various shapes and forms are made up of a highly adaptable sensor material referred to as SansEC. It's an open-circuit, resonant sensor developed by the late Langley researcher Stanley Woodard. SansEC needs no electrical connections, can simultaneously measure different physical phenomena — temperature and fluid level, for example — and functions even when badly damaged.

Right: Can an aircraft with electric motors that hovers like a helicopter and flies like a plane revolutionize air travel? Engineers at NASA Langley are studying the concept with models such as the unmanned aerial system GL-10 Greased Lightning, shown here. The GL-10, with a 10-foot wingspan, recently flew while tethered. Free-flight tests are planned.

Above: The aerodynamics team at Langley tested a model of the 70-metric-ton Space Launch System—NASA's heavy-lift launch vehicle that will carry crew, cargo and science missions into deep space.

Right: Technicians perform a structural inspection of Langley's Landing and Impact Research Facility. The National Historic Landmark is used as a vehicle structural testing complex. Better known as the gantry, it was built in 1963 to train astronauts to land on the moon. Since then, the 240-foot-high structure has been used to crash test aircraft so changes can be made to improve crashworthiness. Orion crew capsule mock-ups also are tested here and in the adjacent Hydro Impact Basin.

Left: Langley engineer Mike Logan thought it would be a good idea to use drones to spot wildfires after a 2011 fire in the Great Dismal Swamp that lasted four months and cost more than $10 million to extinguish. Langley now has an agreement with the U.S. Fish and Wildlife Service to test a drone for that purpose.



Leadership

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

Twitter: https://twitter.com/NASA_Langley

YouTube: https://www.youtube.com/user/NASALANGLEY

Flickr: https://www.flickr.com/photos/50196521@N03/

From left to right: Associate Director Virginia Wycoff, Center Director Stephen Jurczyk, and Deputy Director David Bowles.

VASC

Virginia Air & Space Center

Four astronaut crew capsules went on display this year at the Virginia Air & Space Center, Langley's official visitor center.

From left: an Orion mock-up, (partially hidden) the Apollo 12, the Mercury 14, and a Gemini test capsule. This is the first museum collection to exhibit all four U.S. space capsules.

http://www.vasc.org

Above: Kids test the new Space Racers exhibit at the Virginia Air & Space Center.

U.S.Navy

A combined U.S. Navy and NASA team recovered the Orion capsule and transferred it to the USS Anchorage after splashdown in the Pacific Ocean on Dec. 5.