National Aeronautics and Space Administration

NASA LANGLEY RESEARCH CENTER 2012

THE NEW AGE OF AIR & SPACE

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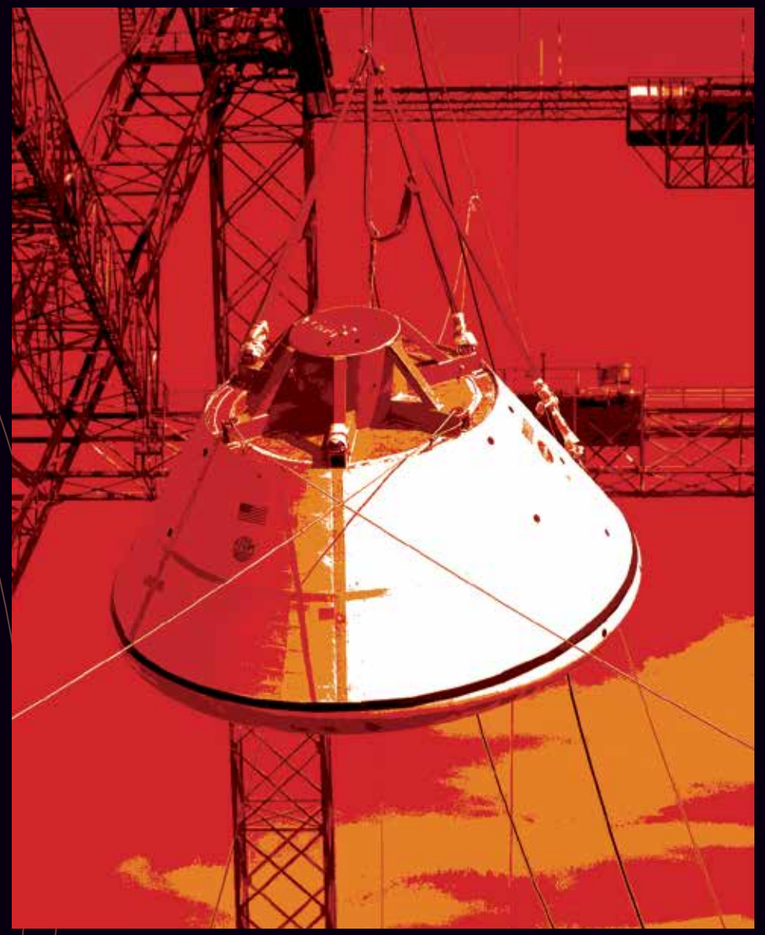

An Orion crew capsule test article moments before it is dropped into a water basin at Langley to simulate an ocean splashdown.

An Atlantis flag flew outside Langley's headquarters building during NASA's final space shuttle mission in July.

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Photos by Sean Smith except where noted.

DIRECTOR'S MESSAGE

Launching a New Era of Exploration

Welcome to Langley

NASA Langley had a banner year in 2012 as we helped propel the nation toward a new age of air and space. From delivering on missions to creating new technologies and knowledge for space, aviation and science, Langley continued the rich tradition of innovation begun 95 years ago.

Langley is providing leading-edge research and game-changing technology innovations for human space exploration. We are testing prototype articles of the Orion crew vehicle to optimize designs and improve landing systems for increased crew survivability.

Langley has had a role in private-industry space exploration through agreements with SpaceX, Sierra Nevada Corp. and Boeing to provide engineering expertise, conduct testing and support research.

Langley Center Director Lesa Roe and Mark Sirangelo, corporate vice president and head of Sierra Nevada Space Systems, with the Dream Chaser Space System model.

Aerospace and Science

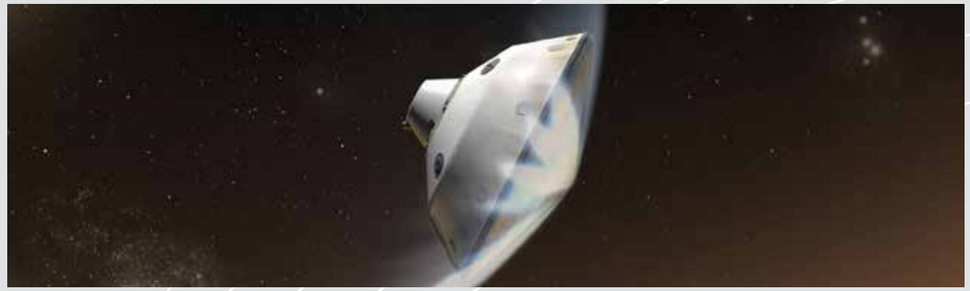
With the rest of the world, we held our breath as the Curiosity rover landed on Mars – with Langley's help. The Langley team performed millions of simulations of the entry, descent and landing phase of the Mars Science Laboratory mission to enable a perfect landing, and for the first time made temperature and pressure measurements as the spacecraft descended, providing data that will reduce risk and improve the affordability of future missions. We also worked to advance technologies to enable larger payloads for planetary missions, provide affordable options for returning cargo to Earth, and allow smart landers for human and robotic missions.

To advance our understanding and the predictive capability of climate and other Earth systems, our orbiting satellites are providing global climate data to the science, aviation, agricultural and energy sectors. Langley flight research campaigns are providing similar data, and also advancing research toward safer, quieter and more fuel-efficient aircraft.

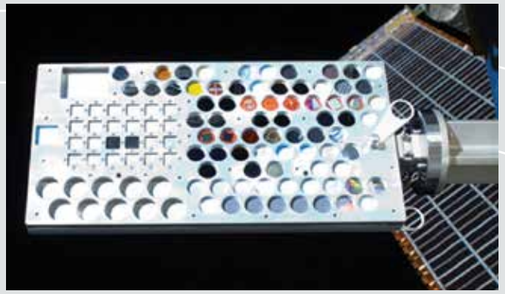
In aviation, Langley continues making significant contributions to all NASA's aeronautics programs and collaborates with government agencies, industry and academia to improve performance, safety, and efficiency of aircraft and the nation's air transportation system. We also continue to address broader national issues and respond to urgent challenges, such as the F-22 hypoxia concern, a V-22 envelope expansion issue, and Kiowa warrior helicopter aerodynamic stability.

While we celebrated our 95th Anniversary with an open house that attracted 10,000 people, we also continued preparing for the future. We broke ground on the New Town Phase 2 building and enhanced capabilities at key facilities, including improvements to the 14 x 22-Foot Subsonic Wind Tunnel, resulting in a premier, nationally recognized facility with the capability to assess noise reduction technologies.

I've touched on just a few of our 2012 accomplishments and invite you to explore the details that are contained in the rest of this report. Please enjoy!



Artist's concept of Mars Science Laboratory entering the red planet's atmosphere.



The latest materials experiment, MISSE-X, will be deployed in 2014.

A Dream Chaser spacecraft model in a Langley wind tunnel.

New Technologies for New Missions

Helping make a successful Mars landing. Testing a next-generation astronaut capsule. Developing laser-based sensors for missions in space. Studying new materials and evaluating a new heat shield.

For Langley, contributions to NASA's space exploration missions are all in a day's work. Langley researchers continue a tradition begun decades ago with rocket development on the Eastern Shore of Virginia, astronaut training for the Mercury, Gemini and Apollo missions, and development of dozens of space-related devices, instruments, satellites and spacecraft.

Not surprising, then, that on August 6, Langley researchers celebrated their participation in the touchdown of the Mars Science Laboratory (MSL) after an eight-month sojourn of 354 million miles.

Revisiting the Red Planet

Langley was among several NASA centers engaged in the Mars mission, and was the agency lead for Entry, Descent, and Landing (EDL) modeling and simulations. Millions of simulations were performed leading up to the spacecraft's approach to Mars.

Contributions included:

• Development of instruments embedded in the heat shield to measure descent temperature and pressure

• Assistance in design of the parachute that slowed the spacecraft during descent

• The Curiosity rover's mini-computer that commands the rock-vaporizing laser for scientists studying Mars geology

Space Launch System

Propelling NASA's deep-space astronauts on future journeys will be NASA's Heavy Lift Space Launch System (SLS).

Drawing on expertise in structures and aerodynamics computational analysis and an extensive complex of wind tunnels, Langley, in collaboration with Marshall Space Flight Center, is overseeing SLS aerodynamics. The center's critical design-process contributions include collecting, analyzing, and documenting aerodynamic data to support rocket development.

Orion Space Capsule Drop Testing

In January, engineers completed the first vertical drop test on a mockup of the 22,000-pound Orion crew capsule. The model was released into Langley's Hydro Impact Basin, at the site where Apollo astronauts trained for moon landing. The vertical drops complement a series of swing tests also conducted at the basin, confirming that Orion could survive water entry at various horizontal angles.

Drop tests continued into September to help determine structural loads that Orion will undergo during ocean landings. Langley studies are also assessing the capsule's aerodynamic and aerothermodynamic performance, guidance, navigation and control, flight software design and structure.

Testing Innovation

In June, researchers in the center's Transonic Dynamics Tunnel tested a 7.9-percent scale model of the Sierra Nevada Corp.'s Dream Chaser spacecraft mated to an Atlas V rocket. The 13-day test examined the aerodynamic forces at play during launch and passage through the atmosphere.

In July 2012, Langley and NASA's Wallops Flight Facility launched and deployed the third iteration of the Inflatable Re-entry Vehicle Experiment – IRVE-3 – to obtain atmospheric re-entry data on an inflatable heat shield that might someday return payloads to Earth and help land large payloads on Mars.

Langley continues its work on the Materials International Space Station Experiment-X Project, intended to provide affordable access to space so experimenters can develop new materials, devices and subsystems critical to future exploration.

Langley researchers are also evaluating autonomous landing and hazard avoidance technologies: a suite of laser-based sensors that one day could enable fully autonomous, reliable, and safe landings, rendezvous, and docking of rockets and spacecraft.

Capturing a Launch

Langley's SCIFLI (Scientifically Calibrated In Flight Imagery) instrumentation captured visual and thermal snapshots of the SpaceX launch of the Falcon 9 rocket and its Dragon capsule to the International Space Station in May.

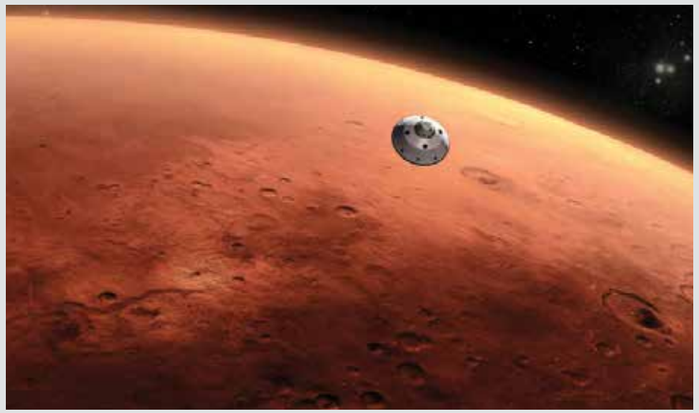
SCIFLI captured release of the capsule and solar panel deployments. The SCIFLI team used optical systems on the ground in Florida and on a ship. The project also recorded space shuttle heat signatures during re-entry on seven missions.

At Langley's Hydro Impact Basin, the Orion crew capsule test article is subjected to a simulated ocean splashdown.

(Above) The Dragon capsule was launched by a private company, SpaceX, to the International Space Station. (Center) SCIFLI took thermal and visual images of the launch. (Right) Launch of the SpaceX Falcon 9 rocket with the Dragon cargo spacecraft onboard.

Langley Plays Critical Role in Mars Landing

When the Mars Science Laboratory entered the atmosphere of the red planet last August, NASA Langley engineers braced for the thrill-ride of their lives. The next seven minutes would decide whether the spacecraft lived or died.



The Mars Science Laboratory approaches Mars in this artist's concept.

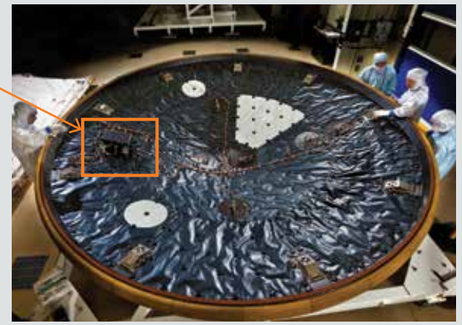
"You get one shot to get the gold medal," Jody Davis, a Langley flight mechanics engineer, said at a news conference before the landing. It was a happy ending, with Davis having the honor of announcing to the world that Curiosity had touched down with the words "tango delta nominal." "Before we knew it, Curiosity had landed on the surface … and we were a successful mission," said engineer Alan Little, a member of the Langley team.

For Davis, Little and about 100 other researchers and technicians who worked on the mission at NASA Langley, their shot at the "gold medal" began shortly after 1 a.m. EST on Aug. 6, 2012. The 7,000-pound, car-sized spacecraft began to decelerate from 13,200 mph to less than 2 mph.

To accomplish that, the onboard computer executed a complex sequence of events, first using atmospheric drag, then a parachute, and finally rocket engines to slow down. NASA Langley played two critical roles. One was in the entry, descent and landing phase – the so-called "seven minutes of terror" when the spacecraft entered the Mars atmosphere and began descending. Langley was in charge of modeling and simulating that phase, and millions of simulations were performed in the eight years leading up to the mission.

The other was the Mars Science Laboratory Entry, Descent and Landing Instrumentation (MEDLI), which recorded heat and atmospheric pressure on the way down. Engineers will use MEDLI data to see how well computer models predicted the spacecraft's path and aerodynamics and to determine the winds and atmospheric density it encountered. The data will also be useful for spacecraft designers – especially when it comes to developing future Mars entry systems.

"It has been an incredible and emotional journey," said Little, who directed the MEDLI project. "It is my unqualified pleasure and honor to work with such a dedicated and talented team." Thanks to a successful landing, Curiosity is now looking for signs that Mars once was – or still is – a habitable place for life as we know it.



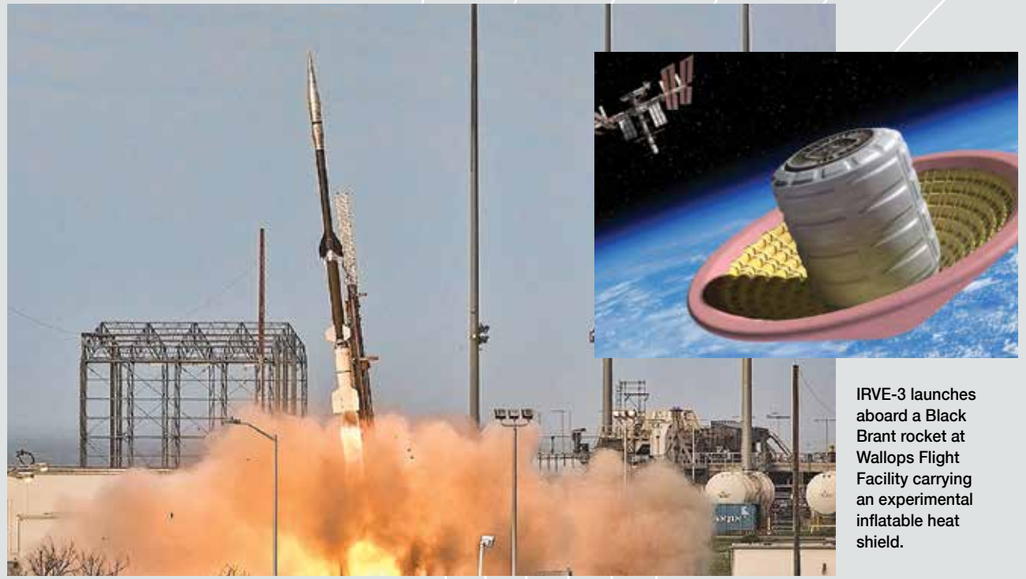
Entry, descent and landing instrumentation is embedded in the heat shield of the Mars Science Laboratory.

"It's kind of bittersweet — you put so much time and work into it, and it's done its job and it's done it well, ... Now you just wish you could get it back because everything is so well built."

— Chris Kuhl, MEDLI Chief Engineer

"Temperatures recorded were as much as 1,000 degrees Fahrenheit and the IRVE-3 experienced forces up 20 G's"

IRVE-3



IRVE-3 launches aboard a Black Brant rocket at Wallops Flight Facility carrying an experimental inflatable heat shield.

Inflatable Heat Shield a Novel Re-entry Concept

Three years of their hard work plunged into the Atlantic Ocean on a Monday in July, and a group of NASA engineers could not have been more thrilled.

They were part of the Inflatable Re-entry Vehicle Experiment (IRVE-3) team that is working to develop an inflatable heat shield. The technology could be used to protect spacecraft when entering a planet's atmosphere or returning here to Earth.

A Black Brant XI sounding rocket launched the IRVE-3, encased in a nose cone, from NASA's Wallops Flight Facility on Virginia's Eastern Shore. The rocket shot 288 miles up and IRVE-3 and its payload were ejected into the atmosphere.

The technology demonstrator inflated and fell back to Earth — cameras and temperature and pressure sensors monitoring its performance all the way down. After 20 minutes from launch, it landed in the Atlantic about 100 miles east of Cape Hatteras, North Carolina.

"Everything went well ... like clockwork. The IRVE-3 performed just as it was supposed to," said Neil Cheatwood, IRVE-3 principal investigator at NASA Langley.

What makes that particularly remarkable is that the IRVE-3 wasn't made of metal or composite materials like most spacecraft heat shields or aeroshells — it was made of high-tech fabric and inflated to create its shape and structure.

"It entered Earth's atmosphere at Mach 10, ten times the speed of sound, and successfully survived the heat and forces of the journey," said Cheatwood. "Temperatures recorded were as much as 1,000 degrees Fahrenheit and the IRVE-3 experienced forces up 20 G's."

A technician works on a hybrid wing body model in a Langley wind tunnel.

Making the Next Generation a Reality

Langley's aeronautical researchers continue to help develop the innovative concepts and advanced technologies needed to create the Next Generation Air Transportation System, or NextGen. This multi-billion-dollar technology modernization effort will make air travel safer, more flexible and efficient, and lead to entirely new classes of aircraft that will be less noisy, use less fuel, and release fewer emissions into the atmosphere.

To make NextGen a reality, Langley is studying advanced composite materials for stronger, lighter airplanes, and developing materials and concepts for advanced aircraft structures. By creating 21st century airframe designs and airframe/engine integration concepts, researchers are leading the way in noise reduction, including methods to virtually eliminate the boom produced by supersonic aircraft.

Unmanned Aerial Systems

One major Langley effort is development of standards and technologies for civilian versions of unmanned aerial systems, or UAS. Unmanned aircraft are increasingly called upon to perform missions of vital importance to science, firefighting, search and rescue, and emergency management.

Langley researchers are studying ways to surmount the technical barriers preventing routine UAS access to the national airspace system.

In September, Langley researchers, in partnership with MITRE Corp. and the University of North Dakota, conducted a flight demonstration of UAS "sense and avoid" technology when confronted by an "intruder" flown by university instructor pilots. The test was part of the Limited Deployment–Cooperative Airspace Project to better integrate unmanned aircraft, equipped with such technology as satellite-based Automatic Dependent Surveillance-Broadcast ADS-B data-link tracking, into the national airspace.

Tomorrow's Airplanes

Langley has provided extensive materials, acoustic modeling, and wind tunnel support for research of hybrid wing body (HWB) aircraft. The latest effort involved modifications to the Boeing HWB X-48C model, including removal of the aircraft's winglets and the addition of twin vertical tails. Two larger fanjet engines replaced three micro-turbojets, and an extended deck area was added underneath and extending aft of the new engines. The changes were made to assess their noise-reduction potential.

Researchers continue to examine ways to fly airplanes using a mixture of fuel and batteries, similar to the approach in hybrid automobiles that use both gas and electricity. Early studies, while incomplete, indicate that long-range fuel reduction goals may be met with such technologies.

Langley researchers also are studying a new type of jet engine called an open rotor, whose fan blades are exposed to the open air. While an airplane with open-rotor engines might at first glance resemble a World War II-era propeller plane, open rotors move much more air than conventional propellers. Tests indicate open-rotor engines would use much less fuel than today's jet engines. While open rotors are as quiet as current jet propulsion, the challenge is to quiet them more to meet or exceed NASA's proposed noise-reduction goals.

Artist's concept of an open-rotor aircraft.

Pushing the Limit: Flight at 7,000 MPH

Being able to fly at hypersonic speeds could revolutionize long-distance flight and provide more cost-effective access to space. This past summer, a team that included NASA Langley launched an experimental hypersonic scramjet research flight from the Pacific Missile Range Facility on the island of Kauai, Hawaii. It was part of a program called HIFiRE (Hypersonic International Flight Research Experimentation) to advance hypersonic flight — normally defined as beginning at Mach 5, or five times the speed of sound.

The program is aimed at exploring the fundamental technologies needed to achieve practical hypersonic flight.

During the experiment the scramjet — aboard a sounding rocket — climbed to about 100,000 feet (30,480 meters), accelerated from Mach 6 to Mach 8 (4,567 to 6,090 miles per hour; 7,350 to 9,800 kilometers per hour) and operated about 12 seconds — a big accomplishment for flight at hypersonic speeds. It was the fourth of a planned series of up to 10 flights under HIFiRE and the second focused on scramjet engine research. "This is the first time we have flight tested a hydrocarbon-fueled scramjet accelerating from Mach 6 to Mach 8," said NASA hypersonics project scientist Ken Rock, who is based at Langley.

"This test will give us unique scientific data about scramjets transitioning from subsonic to supersonic combustion–something we can't simulate in wind tunnels," Rock said. The data collected is expected to make a significant contribution to the development of future high-speed air-breathing engine concepts and help improve design, and modeling and simulation tools. The success of the three-stage launch system, consisting of two Terrier boost motors and an Oriole sustainer motor, is another important achievement of the HIFiRE 2 mission.

The mission, the first flight of this sounding rocket configuration, opens the door for a new high–performance flight configuration to support future Air Force, Navy, and NASA flight research. The payload was developed under a partnership between the Air Force Research Laboratory and NASA, with contributions from the Navy's detachment at White Sands Missile Range, N.M. and ATK GASL in Ronkonkoma, N.Y.

The Hypersonic International Flight Research Experimentation Program launches an experimental hypersonic scramjet vehicle from the Pacific Missile Range Facility in Hawaii during a recent research flight.

AFRL

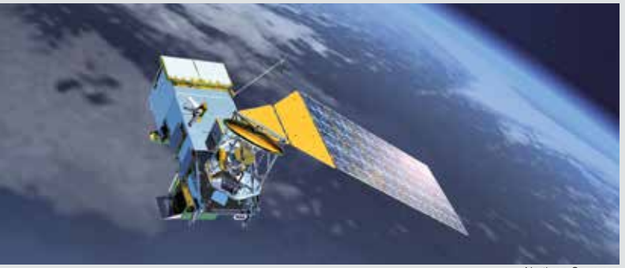
Finding Answers to Big Questions About Earth

Researchers in Langley's Science Directorate are passionate about finding answers to big questions about Earth and how planetary change affects people. What modifies global climate? Is the ozone layer thinning or recovering? How does our world balance incoming solar energy with energy reflected back into space? And how do these changes affect public health, air quality and economic security?

At the Center, we're part of a NASA-wide effort to create ways of measuring and analyzing atmospheric data to better understand and track the effects of human activity on the atmosphere. We develop instruments and measurement techniques for land, air and space. In the process, we've amassed one of the world's most comprehensive collections of climate-relevant information.

The Best Record

One key source of that data is Langley's Clouds and the Earth's Radiant Energy System mission, or CERES. In 1984 NASA began to measure and archive fluctuations in Earth's energy with a Langley-developed satellite instrument known as ERBE, or the Earth Radiation Budget Experiment. Its CERES successor now boasts of six instruments on four satellites and a combined 27 years of data: to date, the longest and best record of Earth's energy balance.



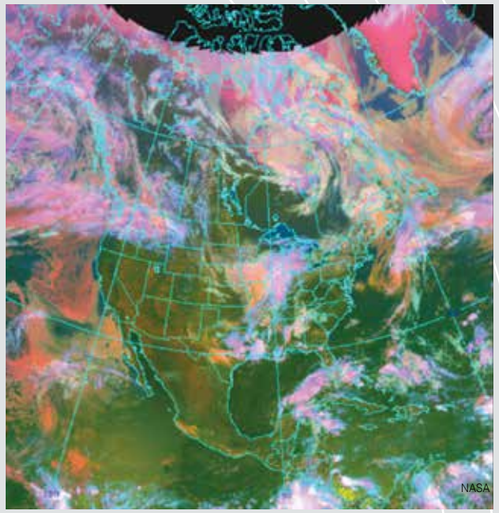
Northrop Grumman

The CERES satellite in this artist's concept studies Earth's clouds and energy system.

This past January, the newest CERES instrument on the Suomi National Polar-orbiting Partnership mission satellite began operation. Plans are already underway for the next generation: a new CERES apparatus is in development for deployment in 2016 to insure continuity of the mission's unmatched climate-data record.

Sky-High Chemistry

Huge thunderstorms are a daily occurrence in many parts of the world. In June, Langley researchers – part of a team of 100 from 29 organizations who participated in a National Science Foundation field campaign – traveled to the Midwest to study how these massive tempests affect atmospheric chemistry.



NASA

False-color images of clouds and snow transmitted by a Langley instrument in orbit around Earth.

They targeted large disturbances with powerful updrafts capable of lofting pollutants and moisture-rich air high into the upper troposphere. This region of the atmosphere is important because it is here that water vapor, ozone, cirrus clouds and dust particles all interact to directly influence climate.

In July, Langley scientists tested and deployed an improved multi-wavelength High Spectral Resolution Lidar instrument – called HSRL-2 – as part of a Department of Energy field mission. HSRL-2 is the airborne prototype for a future space-based mission, and one of the most advanced of its kind. Center researchers also continued work on equipment for an upcoming 2013 mission that will help Earth-observing satellites that measure air quality to better distinguish between pollution high in the atmosphere and that near the surface.

Observing Earth from Space

The International Space Station (ISS) offers a unique vantage point for Earth observation. Langley's Stratospheric Aerosol and Gas Experiment III mission on the ISS is on track to launch in 2014, continuing a long legacy of measuring ozone, a gas found in the upper atmosphere that acts as Earth's sunscreen. This past year, Center researchers also examined options for an ISS climate-focused mission, whose goal would be to produce better data for detecting climate trends and testing and improving climate-prediction models.

Data from Space, Filled Out for the Masses

The place would look like a locker room except for the 1,000 or so tiny green lights that show brightly through grillwork over the stacks upon stacks of computers in the steel cabinets in the server room of the Atmospheric Science Data Center.

Data pours in from space, from instruments on satellites studying Earth from orbit. Data in amounts that challenge the imagination while stretching the vernacular. At the data center, about 1,000 computer cores gather and process that information, of which about 2 petabytes are stored.

John Kusterer with racks of tape holding 16 petabytes of data. He is head of Langley's Atmospheric Science Data Center.

A petabyte is about 13.3 years of HD-TV video. About 50 Libraries of Congress.

That's just the data in. The ASDC gathers lower level data and processes it with codes provided by mission scientists to make higher level data products, reprocesses existing data with new codes provided by the mission scientists to make newer products, and takes already processed data from the missions themselves.

Then the ASDC stores the information. From that storage, requests for information are filled for doctoral candidates, teachers, industry, government and just about anybody else who needs it.

A petabyte is about 13.3 years of HD-TV video. About 50 Libraries of Congress

About 766 terabytes went out to more than 130,000 customers in 160 countries in 2010. A terabyte would hold 1,000 sets of the Encyclopaedia Brittanica.

It goes out in small snippets that students download from a website to prove a hypothesis for their paper. It goes out in huge lots. It's a never-ending data-in-data-out cycle that keeps more than 65 people working.

"Our main charter here is data integrity," said John Kusterer, who is the head of the data center at Langley, one of 13 Distributed Active Archive Centers (DAACs) in NASA's Earth Observation Systems Data Information System. "We have to make sure what we're giving out is just exactly what the science team wants out there."

Make no mistake, the scientists want their data out.

"Scientists are always trying to make their data more useable and useful to the science community," said Kusterer. "The more it's used, the more valuable it is."

It helps that the data center keeps ahead of the technology curve. Where once 12 racks of computers crunched numbers from a mission, it might be done with a single rack of eight machines now. For one of the instrument's data processing, where four "data days" of data could be processed in one day a few years ago, now 48 "data days" can be processed in one day.

"Over the past couple of years, we have architected and implemented a system that is flexible enough to handle the various types of products we're dealing with," said Chris Harris, who is in charge of information technology at the data center. "That means when a new project comes in, we don't have to reinvent the wheel."

SYSTEMS ANALYSIS

The systems analysis experts at Langley have a long history of supporting NASA-wide initiatives. A priority is to provide decision makers with the best possible information available so that NASA's technical, programmatic and budgetary decisions will have a sound and firm foundation in fact.

An artist's concept of a supersonic passenger jet.

Among the factors considered are the feasibility of mission architectures and advanced system concepts; evaluation of system and technology trades; assessments of life-cycle cost and risk analysis; and the viability of approaches to system integration.

In so doing, Langley's system analysts call upon the knowledge and expertise of those at other NASA centers, and in academia and industry, identifying where and how the Center and its partners can realize NASA's vision for aeronautics, and sustainable human and robotic exploration of space.

Achieving New Firsts

During 2012, Langley's aeronautics-related systems analysis achieved a new first with the development and open-source release of Open Vehicle Sketch Pad, a geometry modeling tool for conceptual design. Open Source is the flagship initiative of NASA's Open Government Plan, providing the public with direct and ongoing access to NASA technology.

Langley's systems analysis engineers also continued to study the technology risks associated with development of new complex multi-disciplinary vehicle concepts like hybrid-wing bodies, truss-braced wing/fuselage designs, and open-rotor propulsion concepts. Such concepts have significant potential to achieve major advancements in aerodynamic efficiencies while simultaneously reducing harmful emissions and/or noise levels.

Another significant achievement was in the design of software methods to model and assess low-sonic-boom concepts in supersonic aircraft design. Full-scale aircraft must incorporate dramatic noise reductions before overland supersonic flight can occur.

Langley is maintaining critical support of NASA's hypersonics systems analysis. These studies are critical for national efforts in hypersonic air-breathing propulsion technologies, and related test flights of such vehicles as the Falcon HTV and the X-51 WaveRider. Center experts have also supported the successful Hypersonic International Flight Research Experimentation Program Flight 2 for demonstration of hydrocarbon-fueled engine acceleration from Mach 6 to Mach 8.

Next-Generation Space Technologies

As part of NASA's Commercial Crew Program, Langley has conducted systems analyses support for Sierra Nevada Corporation's Dream Chaser crew transportation vehicle. These reviews included summaries of all subsystems, including launch vehicle integration, ground and mission systems, mission operations, integrated vehicle performance, safety and mission assurance, verification, and risks and mitigation plans.

In 2012, the Center's systems analysts played a significant role in defining reliable space exploration architectures. Center analysts evaluated the feasibility, design, development and fabrication of potential space vehicles and habitats, including the second-generation Space Exploration Vehicle mockup aft enclosure and the Portable Utility Pallet mock-up hardware, both designed and built at Langley and delivered to Johnson Space Center earlier in the year.

Mars and its moons Phobos and Deimos.

Efforts continued on development of scenarios for human exploration beyond low-Earth orbit, including destinations such as cislunar space, near-Earth objects, the moon, and Mars and its moons, Phobos and Deimos. These architectures focused on a systematic, incremental buildup of operational experience and knowledge, developing international partnerships, and enabling world-class scientific return.

NASA/Regan Geeseman

A Space Exploration Vehicle during tests at Black Point Lava Flow in Arizona.

PARTNERSHIPS

Since its founding, Langley has made applied research widely available to the private sector. Today, the Center's Office of Business Development (OBD) coordinates technology transfer and partnership efforts, reaching out to an array of industries and disciplines. Internally, the Office offers marketing-support assistance to Langley researchers for the licensable technology they develop.

Results of this approach are borne out in the number of commercial products generated from the Center's aerospace studies. In 2012, Langley was first across NASA in terms of patents issued, and second in the number of patent applications filed.

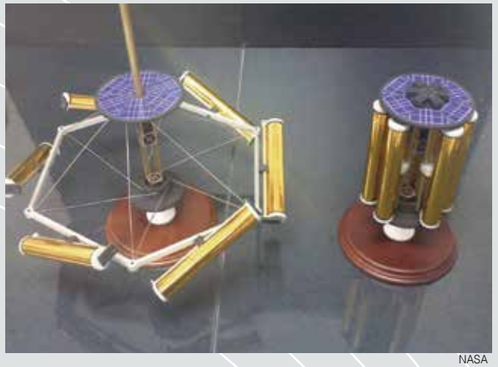
The Small Business Innovation Research Program (SBIR) is also a part of the Office. Last year, 44 SBIR contracts were issued to small technology firms around the country. One such effort involved WxAnalyst, Ltd. in Fairfax, Va., that developed an interactive technology to help visualize and manage data for flight planning, a product now being used by Hawaiian Airlines to plan flight routes over the Pacific Ocean.

The Center's Technology Gateway, at http://technologygateway.nasa.gov/, remains a clearinghouse for information on Langley's technology transfer initiatives. Regionally, OBD has joined with Innovate!HamptonRoads and local governments to assist in technology development, and collaborates with other government agencies, such as the National Oceanic and Atmospheric Administration, and the Departments of Defense and Transportation.

NASA Goes to Market

Unique software developed by Langley researchers directs high-speed cameras in calculating the position and movement of two objects relative to one another. Earlier this year, Magic Leap, Inc., a small business located in Hollywood, Fla., licensed this innovation, announcing plans to develop augmented/virtual reality products for mobile computing, and adapting the Langley software for wearable displays for gaming and general computer use.

Hawaiian Airlines uses interactive technology for flight planning.



NASA

"Rapid prototyping" leads to quick manufacture of engineering models like this prototype of a heliogyro solar sail.

In 2012, a collaboration among NASA Langley, Jefferson Laboratory and the National Institute for Aerospace led to the birth of a new business, BNNT, LLC, whose focus will be the production of fibril boron nitride nanotubes, a structurally similar ceramic analog to carbon nanotubes.

These very strong and versatile submicroscopic cylinders, whose diameter is measured in a single nanometer — or one-billionth of a meter — may find wide use in aerospace applications that require high strength at high temperatures, including as parts for aircraft engines and structural elements. They may also be incorporated as components of next-generation body armor, thin coatings, batteries, electrical insulation, fire-retardant cabling, and sensors. Biomedical uses may include implants for dentistry, materials to aid in nerve and bone tissue regeneration, and in cancer treatments.

New Century Manufacturing

Langley will participate in the National Network for Manufacturing Initiative, an online clearinghouse for news and information on advanced manufacturing programs and related activities. The Center is already applying next-generation manufacturing technologies to "rapid prototyping," quickly fabricating proof-of-concept engineering models for a myriad of experimental applications.

Langley technicians employ additive manufacturing techniques that take relatively small amounts of raw materials, like metallic powders and slender rods of specialty alloys, and build up solid objects layer by layer. This approach results in far less raw-materials waste, more efficient energy use, and the ability to rapidly create a vast array of physical shapes and sizes.

KEY EVENTS IN NASA LANGLEY HISTORY

1916: Land north of Hampton, Va., is purchased for Langley Field to house Army Air Corps and National Advisory Committee for Aeronautics (NACA).

1917: Construction begins on Langley Memorial Aeronautical Laboratory.

1920s

1920: Formal dedication of the Langley Memorial Aeronautical Laboratory.

1922: Variable Density Tunnel opens. The first pressurized wind tunnel enabled tests of scale models that more closely resembled actual flight.

1927: Propeller Research Tunnel completed. The 27-Ft test section tested engine cowling designs and the interaction of full-scale fuselages and propellers.

1929: Collier Trophy, given annually for the greatest achievement in aeronautics in the United States, awarded to Langley for an engine cowling that significantly reduced engine drag while maintaining engine cooling.

1930s

1931: Full Scale Tunnel becomes operational.

1931: Physical Research Division created to computationally study aerodynamics, generation of wing sections, propellers and fundamentals of flutter.

1933: NACA Report 460, describing 10 years of systematic study of airfoils, produced the airfoil numbering system still used by today's aircraft designers.

1936: 8-Ft High Speed Tunnel to study effects of flight approaching the speed of sound becomes operational.

1938-45: Aircraft drag reduction studies conducted in the Full Scale Tunnel to improve the performance of World War II fighter aircraft.

1940s

1941: 20-Ft Spin Tunnel to study alleviating aircraft spin begins operation.

• NACA Report R755 first defines requirements for aircraft handling characteristics.

1945: Congress approves funding for permanent rocket launch facility at Wallops Island, Va. Langley's Pilotless Aircraft Division begins research on transonic flight and rocketry.

• With the Air Force and the Weather Bureau, the NACA flies into thunderstorms for first in situ observations.

1947: Langley shares Collier Trophy with Bell Aircraft and Chuck Yeager for research about supersonic flight.

1949: National Unitary Wind Tunnel Act enabled building supersonic tunnels at NACA Langley, Lewis (now Glenn), and Ames with priority for industry tests.

1950s

1950: First application of horizontal test section slots in 8-Ft High Speed Tunnel, results in more closely modeling actual transonic flight.

1951: Collier Trophy awarded for slotted-throat wind tunnel.

1952: Hypersonic Facilities Complex completed. Eight small wind tunnels with a speed range from Mach 6 to 20 tested concepts for the X-15, Mercury, Gemini, Apollo, Viking, and space shuttle.

1954: Collier Trophy awarded for the development of the Area Rule, which reduces aircraft fuselage area slightly near the wings, thus enabling transonic flight.

1955: Aircraft Landing Dynamics Facility opens to test aircraft landing gear, tires, and runway surfaces. In the '70s and '80s, space shuttle landing gear, tires, and runway surfaces are tested here.

1956: Development of Scout, a 4-stage solid-fuel rocket to boost light payloads.

1958: Langley becomes a National Aeronautics and Space Administration research center.

1958: The Space Task Group at Langley plans crewed space flight with Project Mercury.

• Little Joe test launch vehicle for Project Mercury begins development at Langley.

1959: Development of worldwide tracking network for Mercury.

1960s

1960: First successful launch of Scout rocket from Wallops, Va. Through 1991, Scout had a 96 percent success rate.

• Echo I launched, Langley's first satellite, a high-altitude balloon, allowed scientists to measure the density of the air in the far upper atmosphere.

• First production model of Project Mercury spacecraft launched from NASA Wallops Station to test escape, landing, and recovery systems.

• Transonic Dynamics Tunnel becomes operational and is used to reduce flutter, which can cause aircraft accidents if not detected prior to flight.

• 8-Ft High Temperature Tunnel begins testing. In coming years space shuttle and scramjet engine models are tested here.

1963: The Rendezvous and Docking Simulator for practicing full-scale Gemini and Apollo rendezvous and docking techniques is completed.

1965: The Lunar Landing Facility, which was used to simulate flying the lunar lander the final 150 feet in the moon's gravity, is completed.

1966: Surveyor I lands on moon - first soft landing by an American spacecraft.

1966-67: Langley-led Lunar Orbiters I to V photograph potential Apollo landing sites with a 1.5-meter resolution.

1970s

1970s: Over 60,000 hours of wind tunnel studies of space shuttle.

1973: Office formed to study environmental concerns of supersonic flight, precursor to Langley's Atmospheric Sciences group.

1974: Development of a photochemical model that provided the first detailed timetable for the origin and evolution of ozone in Earth's atmosphere.

• Supercritical Airfoil to reduce drag during transonic flight is developed.

1975: Stratospheric Aerosol Measurement sensor displayed on Apollo-Soyuz.

1976: Langley-led Viking 1 & 2 missions are the first and second spacecraft to successfully land on Mars.

1978: Stratospheric Aerosol Measurements II (SAM II) on Nimbus 7 begins over 20-year record of stratospheric aerosols in polar regions.

1980s

1980: Process for adhering thermal protection tiles to space shuttle developed.

1981: Measurement of Air Pollution from Satellite (MAPS) experiment flown on STS-2 demonstrates that trace gases in troposphere can be measured from space.

1984: National Transonic Facility (NTF) at Langley becomes operational and provides super-cold (cryogenic) testing for results that more closely reflecting flight conditions.

• The Stratospheric Aerosol and Gas Experiment II (SAGE II) sensor launched into orbit aboard the Earth Radiation Budget Satellite (ERBS).

1982: Studies of the HL-20 lifting body begin.

1986-'93: NASA and FAA Wind Shear Program conducted. Results are corrective procedures and technology for safer, smoother flights.

1986: After Challenger accident, study of space shuttle solid rocket booster O-ring materials.

1987-'98: The F-18 High-Angle-of-Attack Research Vehicle flights at Dryden and Langley wind tunnel tests validate Langley-developed computer programs of high angle of attack aerodynamics, flight controls, and airflow phenomena.

1988: Early observations of polar stratospheric clouds helped form an international understanding of the ozone hole and chemical processes at the Earth's poles.

1980s-90s: Study of wake vortex flow physics leads to computer methods to predict aerial application spray and aircraft separation standards at airports.

1990s

1990: Long Duration Exposure Facility, proposed by Langley, is retrieved by the space shuttle after over 5 years in orbit. The cylindrical structure exposed 57 experiments to space to learn its effects on materials.

• Electronic display cockpit technology is developed by Langley researchers.

• Advanced Composites Technology program provides industry with technology for materials, design concepts, structural mechanics, and manufacturing concepts for composite aircraft components.

1991: Launch of the Halogen Occultation Experiment (HALOE), the first atmospheric science instrument to be built in-house, launched, and operated by Langley.

1994: Lidar in Space Technology Experiment (LITE) flies on the shuttle for first lidar in space. An international team of scientists, at over 50 locations, collected data on cloud structure and atmospheric gases.

1995: FAI Diploma D'Honneur, an international honor for outstanding contributions to aeronautics and astronautics, is awarded to Langley for work in wind shear detection.

1996: Mars rover Sojourner lands with entry, descent, and landing calculations from Langley.

1996: FAI Diploma D'Honneur is awarded for demonstration of Langley-led Advanced General Aviation Transport Experiment (AGATE) program, a consortium to develop new technology, standards, and certifications for single-pilot aircraft.

1997: Launch of Clouds and Earth's Radiant Energy System (CERES), the first of four space-based instruments to learn how clouds affect our atmosphere.

2000s

2000: Electronic display cockpit, which Langley pioneered is installed in Space Shuttle Atlantis.

2002: Successful flight test of 50-percent model of a robotic, powered aircraft, ARES, in conditions similar to flight through the atmosphere of Mars.

2003-06: For space shuttle return to flight, Langley studies aerothermo-dynamic properties of wing damage and insulating foam properties.

• Nondestructive evaluation of the shuttle thermal protection system and wing leading edge repair techniques are developed.

2004: Mars rovers Spirit and Opportunity land with entry, descent, and landing calculations from Langley. The center also contributed to the parachute system and testing of flight hardware.

• X-43 research vehicle with scramjet engine reaches Mach 9.6, setting a speed record for air-breathing engines. Langley led vehicle design and wind tunnel testing.

2005: Langley conducted simulations and thermal analyses for aerobreaking for the Mars Reconnaissance Orbiter spacecraft.

• Small Aircraft Transportation System (SATS) consortium, led by Langley, demonstrates technologies to increase volume at small airports, help pilots land safely in low visibility, and increase single-pilot performance.

• Quiet Technology Demonstrator 2, a joint Langley, industry, and academia project, confirms benefit of engine nozzle chevrons, sound-absorbing liner and redesigned landing gear in reducing interior and exterior aircraft noise.

2006: Cloud Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) launches to study the role of clouds and aerosols on Earth's climate, and air quality.

2008: Langley shares the Collier Trophy for Automatic Dependent Surveillance-Broadcast, which uses GPS information, air traffic data, and real time displays.

2009: Langley shares the Collier Trophy awarded to Commercial Aviation Safety Team (CAST) established in 1997 to reduce the rate of fatal accidents by 80 percent.

2009: Inflatable Reentry Vehicle Experiment (IRVE) successfully demonstrates that an inflatable heat shield can protect spacecraft at hypersonic reentry speeds.

2010s

2010: Orion Launch Abort System, developed by Langley, completes Pad Abort-1 test at White Sands Missile Range, N.M.

• **X-51A** set flight duration record of 200 seconds for scramjet engine – tested in the Langley 8-Ft High Temperature Tunnel.

2011: Hydro Impact Basin added to Landing Impact Research facility. Tests for water landings of Orion spacecraft begin.

• Langley's new headquarters building opens – receives platinum status from U.S. Green Building Council's Leadership in Energy and Environment Design (LEED) program.

• HL-20 lifting body technology transferred to Sierra Nevada corporation as a basis for the development of "Dream Chaser" commercial spacecraft.

2012: Richard T. Whitcomb is inducted posthumously into National Aviation Hall of Fame for his major contributions to aeronautics: Area Rule, supercritical wings, and winglets; all developed at Langley.

• Mars Science Lab-Curiosity rover lands on Mars with calculations from Langley's Entry Descent and Landing Team. The Center also worked on the parachute system.

• MSL Entry, Descent, and Landing Instrumentation (MEDLI) project for the first time measured aerothermal and aerodynamic data as a spacecraft flew through the Martian atmosphere.

Langley's director, Lesa Roe, at Girl Scout Engineering Day at Busch Gardens in Williamsburg, Va.

Langley Reaches Out to Lead and Inspire

During the rover Curiosity's final approach to Mars last August, the public heard the play-by-play firsthand at the Virginia Air & Space Center in Hampton. There, dozens packed the IMAX theater to watch as mission control tracked the spacecraft through entry, descent and landing.

NASA/Jason Lou

Stephen Colbert and his new NASA friends.

And in-person on the IMAX stage, Langley engineer Michelle Munk interjected her own commentary all the way up to touchdown. Munk, a member of the Mars mission team, had volunteered as part of an outreach and education program that connects with tens of thousands of people each year.

In 2012, Langley continued reaching out with events and programs designed to inform the public about NASA's work while educating and inspiring people of all ages.

The largest local event by far was Langley's 95th anniversary open house, which attracted some 10,000 people for six hours of tours and activities *(see story, page 18)*. A similar event for Langley's private-sector partners was held the same week.

The Mars mission was another major event. In addition to activities at the Virginia Air & Space Center, Langley's official visitor center, events were held as far away as the Pocono Raceway in Pennsylvania. At Langley, 30 bloggers from around the country learned about the mission and toured Langley as part of a NASA-wide social media campaign.

Summertime Scholars

Even celebrities got into the act. Recording artist Pharrell Williams and former astronaut Leland Melvin, Associate Administrator for Education, spoke with nearly a thousand middle school students and parents last summer at the From One Hand to Another Summer of Innovation graduation and awards ceremony in Virginia Beach.

Ongoing programs included DEVELOP, an Earth sciences training program; the Virginia Aerospace Science and Technology Scholars (VASTS) program, in which high school students completed online assignments and attended a one-week summer session at Langley. About 25 teachers also participated by attending a summer session that gave them techniques for using science, technology, engineering and math in lesson plans.

Spaced-out costumes were the theme at Yuri's Night Hampton Roads.

Former astronaut Leland Melvin with musician Pharrell Williams in Virginia Beach.

Catherine Jaunezems, an education specialist, talks with 10-year-old Kaylie Strickland of Richmond, Va.

The Langley Aerospace Research Summer Scholars (LARSS) program completed its 26th year of providing internships to college students. Some of its nearly 5,000 alumni now work at NASA.

Sports and Space

And for the seventh year, NASA brought exhibits, educators and motivators to the Central Intercollegiate Athletic Association's annual basketball tournament in Charlotte, N.C. About 2,000 middle school students attended the NASA-sponsored Education Day at the Charlotte Convention Center.

Then there was the Yuri's Night space party at the Virginia Air & Space Center and Girl Scout Engineering Day at Busch Gardens, where Langley's director, Lesa Roe, encouraged the girls with this: "Almost every American woman astronaut that has flown to date has been a Girl Scout, so that's pretty incredible. The first American woman to walk in space is Kathy Sullivan, and she was a Girl Scout as well. So, lots of history and a lot of Girl Scout opportunities are right there in NASA."

Roger Crouch with students from the Virginia Aerospace Science and Technology Scholars program.

Students Also Benefit from NASA Science

Data collection and use isn't limited to just scientists. Students in schools around the world are gathering data for NASA. And NASA data and expertise is used by teachers and students.

The Students' Cloud Observations On-Line (S'COOL) project is a worldwide effort to collect cloud observations from students and citizen scientists to help NASA better understand how clouds affect our weather and climate. Over the past 15 years, more than 1,200 participating K-12 classrooms from 60 countries have submitted more than 100,000 observations to S'COOL.

The MY NASA DATA project works to make NASA Earth Science data accessible to the K-12 and citizen scientist communities. The team creates "microsets" from large scientific data sets and wraps these with tools, lesson plans, and supporting documentation for classroom use. More than 20,000 users access the site each month.

Langley scientist Lin Chambers reads "All About Earth: Our World On Stage" to first-grade students.

Since 2003, NASA Langley has partnered with the Global Learning and Observations to Benefit the Environment (GLOBE) program, a worldwide hands-on, primary and secondary school-based science and education program that promotes collaboration among students, teachers and scientists. In 2012, we hosted 60 teachers as part of GLOBE workshops, training them to conduct inquiry-based investigations about our environment.

Since 2008, the NASA Langley-based NASA Innovations in Climate Education (NICE) program has funded 71 education projects across the U.S. that promote climate and Earth system science literacy, and increase the access of underrepresented minority groups to science careers and educational opportunities.

A Diverse Workforce Drives Langley Success

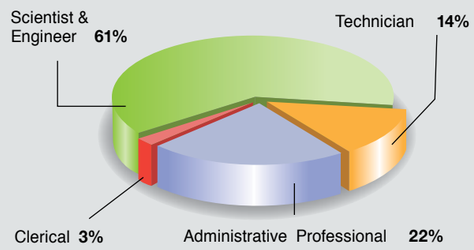
It takes a lot of different people and skills and to make a complex organization like Langley work.

Sixteen percent of Langley employees have a two-year degree, and 27 percent have a bachelor's. Thirty percent have a master's degree, and 20 percent have a doctorate.

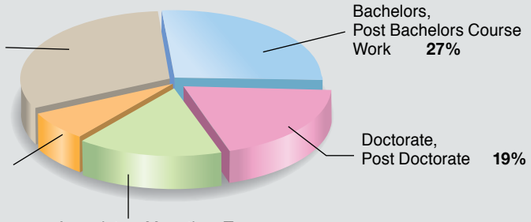
The occupation distribution tells the story, with 75 percent of Langley employees engaged in technical work.

In all, Langley had 1920 civil service positions and 1710 contractors in 2012.

Occupation Distribution



Education Distribution



Education and occupation distribution numbers apply to 1,920 civil servants only.
Data is not collected for contractors.

Living Through Seven Minutes of Terror — or Fun

Last summer, a softball team at NASA Langley was without a second baseman, because she went with another team at the Jet Propulsion Lab in California, helping land a laboratory on Mars.

On two walls in Jody Davis' office, esoteric-looking formulae offer testimony to the years it took a NASA Langley team to determine how to land the Mars Science Laboratory from the point at which it entered the planet's atmosphere.

NASA/Michael Finneran

Jody Davis: "In my high school yearbook, they had me as 'most likely to go to the moon.'"

It was called "seven minutes of terror," because the craft went from 13,000 mph to 2 mph and executed a series of complex and critical maneuvers before landing.

"It's seven minutes of fun," Davis insisted.

Langley claims the "entry, descent and landing" series as a specialty, and others have preceded her in staking that claim, beginning with Mars Viking in 1976.

To accomplish all of that, the Langley team loaded the spacecraft with a set of parameters that allowed it to adjust for variations in the atmosphere through a series of rolls.

"We have run up to 100,000 cases in one simulation," Davis said. "It's a roll of the dice. On any given day at Mars, you'll have a set of dispersed inputs, and you see how the simulation reacts to those dispersed inputs to see if your design is robust."

The tests ran into the millions with one overriding bit of knowledge: you only get one shot at landing the lab on Mars. "Almost" doesn't count.

The pressure was incredible, but it's what Davis bought into when she left her Minneapolis home for Embry-Riddle University in Prescott, Ariz.

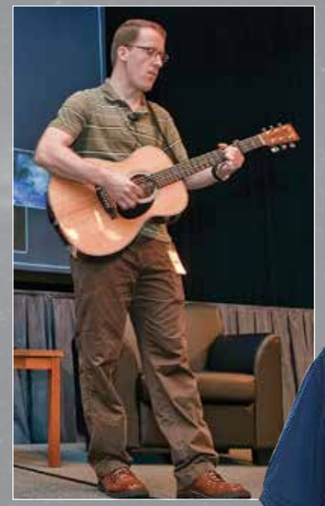
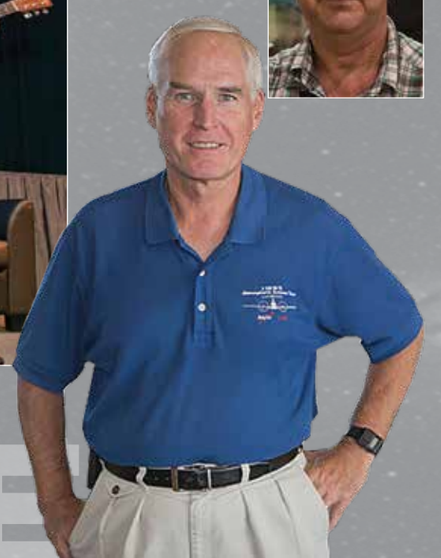
"I have wanted to do this ever since I was 13 years old," Davis said. "I guess I was odd. In my high school yearbook, they had me as 'most likely to go to the moon.' I don't think it will happen in my lifetime, but I think I'm getting close."






Left-right/top-bottom: Bobby Martin; Jill Marlowe; Janet Sellars; Mike Smith and his daughter, Maya, and their robot, Doborg; Kristen May; and Ed Generazio




Left-right/top-bottom: William Hawkins; Jorge Otero; Trevor Grondin; Howie Lewis; Richard Martin; Angel Henderson; and Angela Dyke.

PEOPLE

An inflatable Mars rover was among the many cool things to see.

Kids line up for autographs from astronaut Anna Fisher.

The drop test of the Orion crew capsule test article made a big splash with the crowd.

Langley Opens Doors for 95th Anniversary

Lisa Gibson and her daughter Cassidy made an 11-hour trip from Indiana just to attend NASA Langley's 95th Anniversary Open House. Cassidy, an 8th grader who wants to be an astrophysicist, hoped to meet an astronaut.

"One day, I'd like to discover something that has never been discovered before," Cassidy said.

"And then she'll name it after her mom," Lisa followed up.

Langley last opened to the public in 2007. The next opportunity may not be until 2017, for the 100th anniversary.

About 10,000 people found a reason to attend the free event Sept. 22. Visitors crowded the sidewalks, having the option of 21 tour stops and dozens of hands-on activities and exhibits.

Hundreds waited their turn to meet astronaut Anna Fisher, the first mom in space.

"With the way technology is progressing, who can imagine what will happen in the next 100 years?" Fisher said. "It's an exciting time to be a young person."

Bill Seufzer explains the cost savings associated with using Langley's Electron Beam Freeform Fabrication (EBF3) technology.

Robots and Splash Tests

Guests controlled robots built by students and programmed Lego Mindstorms, Bee-Bots and Roamer-Bots. Many built their own racecars and tried to land on Mars with NASA's Mars Rover Landing game for Xbox. They enjoyed interactive science shows about physics and aerospace and took a trip through the Journey to Tomorrow trailer.

At other facilities, visitors learned about spacecraft entry heating, unmanned aerial vehicles, electromagnetics waves, materials and structures, and fabrication.

In the afternoon, hundreds attended a splash test of Orion, a new crew capsule being developed. Visitors also saw some of the center's historic landmarks, such as the Gemini Rendezvous Docking Simulator used by Gemini and Apollo astronauts to practice docking space capsules with other vessels. It's still suspended from the ceiling in Langley's aircraft hangar.

A Sense of Pride

Such landmarks have made Langley famous in the 95 years since its inception as the nation's first civilian aeronautics research lab. When the doors first opened in 1917 it was called Langley Memorial Field. The staff of 11 worked as part of the National Advisory Committee for Aeronautics. Today, about 3,600 civil service and contract employees work across all of NASA's mission areas to help revolutionize aviation, expand knowledge of climate change, and extend the human presence in space.

"When you leave today, I hope you have a sense of pride in the contributions made by NASA," Langley's director, Lesa Roe, told visitors, "and that you find yourself curious, excited and inspired about the great things that lie ahead."

There were planes to look at up close and computers to play on inside Langley's flight hangar.

NASA/Michael Finneran

Among many attractions, Open House visitors could check out telescopes set up by local astronomers.

Economic Impact of NASA Rises

In the previous fiscal year, NASA's Virginia operations generated an economic impact of $2.7 billion and 21,839 jobs in the United States. That impact rose in 2012 to $3 billion, thanks to higher operational expenditures at both facilities, primarily deconstruction of old buildings and construction of new ones.

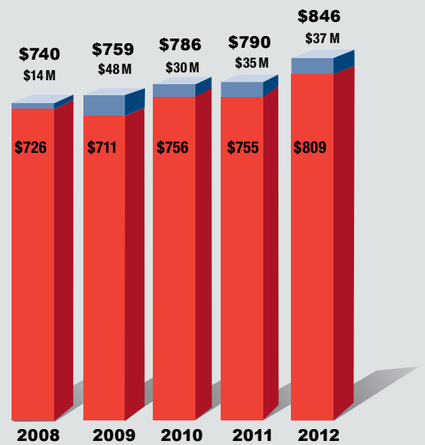
In fiscal 2012, NASA Langley generated the following economic benefits:

- In the United States, the economic impact was $2.3 billion that supported 18,743 jobs
- In Virginia, the economic impact was $989.8 million that supported 8,888 jobs
- In the Hampton Roads MSA, the economic impact was $886.3 million that supported 7,594 jobs

In fiscal year 2012, NASA Wallops generated the following economic benefits:

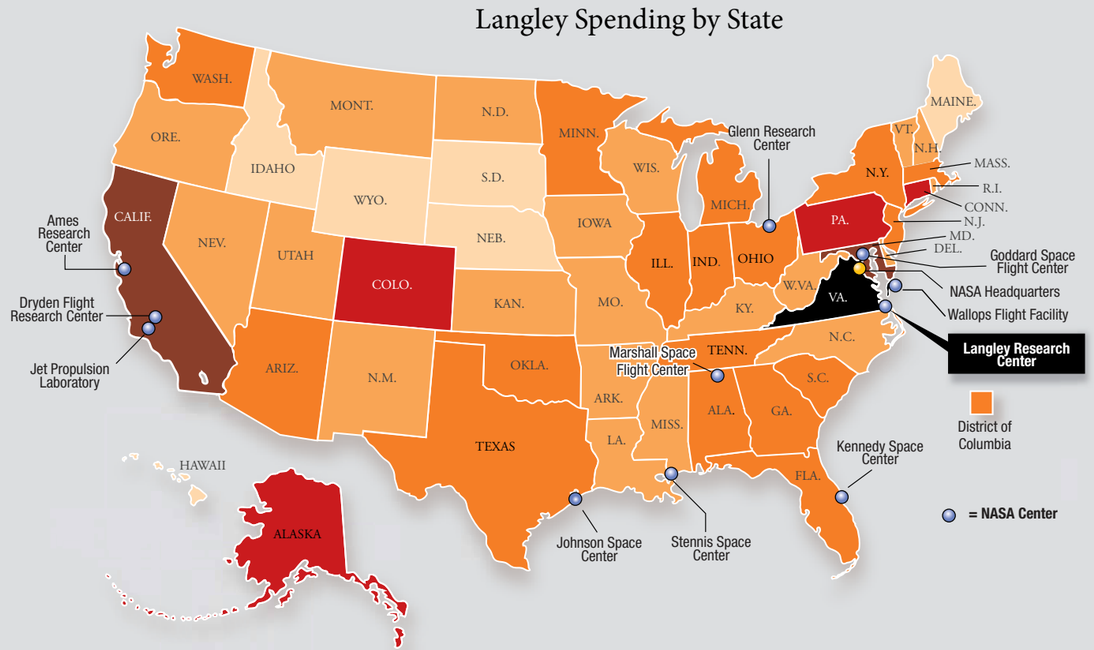
- In the United States, the economic impact was $700.9 million that supported 5,067 jobs
- In Virginia, the economic impact was $227.3 million that supported 1,930 jobs

Source: NASA and Chmura Economics & Analytics report "The Economic Impact of NASA Virginia Operations for Fiscal Year 2012."



Construction of the second building in Langley's revitalization plan.

Langley Spending by State



Top Obligations to Business

Jacobs Technology, Inc.	$ 59,356,189
Analytical Mechanics Associates, Inc.	45,481,572
Science Systems And Applications, Inc.	45,295,808
SGT, Inc.	27,664,023
Boeing Company	14,840,232
ATK Space Systems, Inc.	13,833,851
Tessada & Associates, Inc.	12,600,189
Dominion Virginia Power	10,203,240
Cornell Technical Services, LLC	9,920,344
Unisys Corp.	9,864,002
Analytical Services & Materials, Inc.	7,247,830
Safety & Quality Assurance Alliance	6,652,061
Chugach Federal Solutions, Inc.	6,428,623
Inuteq, LLC	6,383,850
Northrop Grumman Space & Mission Systems	6,229,590
Science Applications International	5,723,567
Lockheed Martin Corp.	5,274,208
Ball Aerospace & Technologies Corp.	4,744,353
Gentech Partners Joint Venture	3,978,940
Honeywell International, Inc.	3,849,720
Intentional Leadership, Inc.	3,253,683
Science And Technology Corp.	2,949,164
Aitech Defense Systems, Inc.	2,757,078
OSU Center for Innovation and Economic Dev.	2,600,473
The Whitestone Group, Inc.	2,286,768

Top Obligations to Non-profits

U.S. General Services Administration	$ 34,734,852
National Institute of Aerospace	24,320,587
City of Hampton	5,896,231
Pennsylvania State University	5,116,648
U.S. Army Corps of Engineers	3,475,093
Georgia Tech Research Corporation	2,542,910
University of Southern California	1,343,032
University of Illinois	1,161,584
Judiciary Courts of the Commonwealth	918,000
Massachusetts Institute of Technology	917,371
Old Dominion University Research Foundation	846,705
University of Wisconsin System	648,666
Regents of the University of Colorado	626,599
NOAA	616,911
Wheeling Jesuit University, Inc.	600,000
City of Newport News	558,400
Virginia Air & Space Center	523,000
Regents of the University of Michigan	517,319
University of Tennessee	517,131
U.S. Army, Department of Treasury	500,000
University of Maryland	495,382
Virginia Tech	444,198
University of Iowa	399,955
Ohio University	374,990
Defense Advanced Research Projects	365,965

Always On the Outlook for Invention

He has or is named on more than 30 U.S. patents for new materials and technology, a result of product of what he calls a "personality trait."

"I can see things from beginning to end," said Rob Bryant. "I can visualize the steps involved."

And he's at NASA Langley, at least in part, because he's been allowed hands-on access to the invention process.

But just over a year ago, Bryant accepted the job of head of the Advanced Materials and Processing Branch, and that took away the laboratory time, the hands-on experience.

He did it, in part, because "people know me as the guy who always stands up … and asks questions," Bryant said. "Part of my taking the job was putting my money where my mouth is."

And part was establishing a culture in which the branch's 35-plus employees work in an environment that encourages and rewards creativity and achievement. The number of times per week that people bring in food and treats to share are a sign that it's working.

"I was once asked how I know things are going well in the branch," Bryant said. "I said, we have three main coffee pot areas. I take the number of days in the week, five, and determine how many days that treats show up by the coffee pots. If it's 60 percent of the time, then I know things are going well."

Bryant learned much of that in the 21 years since he came to Langley from the University of Akron's Institute of Polymer Science and Polymer Engineering as a graduate student. He had left electrical engineering for science in undergraduate school at Valparaiso University.

"I'm always looking for applications," he said. "It's good to understand why things work, but you have to be able to find applications. Otherwise, you have very good journal articles and what-not, but you're not really producing a product."

Products drive Bryant. He sees technology on the shelf and wonders what else it could do. That leads to inventions and patents. The same drive at home leads him to distrust handymen and fix his own appliances.

Rob Bryant knows that for technology development, happy inventors are productive inventors.

2012 Langley Employee Patents

Alan T. Pope, David T. Shannon, and Olafur S. Palsson received patent 8,062,129 for Physiological User Interface for a Multi-User Virtual Environment.

Yeonjoon Park, Sang Hyouk Choi, Glen C. King, and Sang-Hyon Chu received patent 8,089,677 for Dynamic Optical Grating Device and Associated Method for Modulating Light.

Daniel Joseph Jobson, Zia-ur Rahman, and Glenn Alan Woodell received patent 8,111,943 for Smart Image Enhancement Process.

Sang Hyouk Choi, Yeonjoon Park, Glen C. King, and James R. Elliott received patent 8,174,695 for Arrayed Micro-Ring Spectrometer System and Method of Use.

Wm. Timothy Elam, Warren C. Kelliher, William Hershyn, and David P. DeLong received patent 8,081,734 for Miniature, Low-Power X-Ray Tube Using a Microchannel Electron Generator Electron Source.

Walter A. Silva received patent 8,060,350 for Method of Performing Computational Aeroelastic Analyses.

John W. Wilson, Ram K. Tripathi, Francis F. Badavi, and Francis A. Cucinotta received patent 8,117,013 for Apparatus, Method and Program Storage Device for Determining High-Energy Neutron/Ion Transport to a Target of Interest.

Thomas F. Brooks and William M. Humphreys received patent 8,170,234 for Deconvolution Methods and Systems for the Mapping of Acoustic Sources from Phased Microphone Arrays.

Lawrence Jacob Prinzel, Alan T. Pope, Steven P. Williams, Randall E. Bailey, Jarvis J. Arthur, Lynda J. Kramer, and Paul C. Schutte received patent 8,164,485 for System and Method for Aiding Pilot Preview, Rehearsal, Review, and Real-Time Visual Acquisition of F.

Yeonjoon Park, Sang Houk Choi, Glen C. King, and James R. Elliott received patent 8,059,273 for Micro Spectrometer for Parallel Light and Method of Use.

Byron L. Meadows, Farzin Amzajerdian, Bruce W. Barnes, and Nathaniel R. Baker received patent 8,112,243 for Forward Voltage Short-Pulse Technique for Measuring High Power Laser Diode Array Junction Temperature.

Stanley E. Woodard and Bryant Douglas Taylor received patent 8,042,739 for Wireless Tamper Detection Sensor and Sensing System.

Yeonjoon Park, Glen C. King, James R. Elliott, and Sang Hyouk Choi received patent 8,094,306 for Micro Ring Grating Spectrometer with Adjustable Aperture.

Mark A. Croom, Stephen C. Smith, Paul A. Gelhausen, Mark D. Guynn, Craig A. Hunter, David A. Paddock, Steve Riddick, and John Edward Teter received patent 8,196,858 for Aircraft Configured for Flight in an Atmosphere Having Low Density.

PATENTS CONTINUED

Russell A. Wincheski and John W. Simpson received patent 8,164,328 for Eddy Current System and Method for Crack Detection.

H. Kevin Rivers, Stephen J. Scotti, Lynn M. Bowman, and Max L. Blosser received patent 8,236,413 for Combination Structural Support and Thermal Protection System.

Stanley E. Woodard and Bryant Douglas Taylor received patent 8,167,204 for Wireless Damage Location Sensing System.

Kennie H. Jones, Douglas M. Nark, Michael G. Jones, Tony L. Parrott, and Kenneth N. Lodding received patent 8,111,832 for Method of Adjusting Acoustic Impedances for Impedance-Tunable Acoustic Segments.

Edward R. Generazio received patent 8,108,178 for Directed Design of Experiments for Validating Probability of Detection Capability of a Testing System.

Stanley E. Woodard and Bryant Douglas Taylor received patent 8,179,203 for Wireless Electrical Device Using Open-Circuit Elements Having No Electrical Connections.

Jan M. Smits, Russell A. Wincheski, JoAnne L. Patry, Anthony Neal Watkins, and Jeffrey D. Jordan received patent 8,147,920 for Controlled Deposition and Alignment of Carbon Nanotubes.

Donald Laurence Thomsen III received patent 8,198,976 for Flexible Thin Metal Film Thermal Sensing System.

Daniel L. Palumbo and Jacob Klos received patent 8,087,494 for Method of Making a Composite Panel Having Subsonic Transverse Wave Speed Characteristics.

AWARDS 2012 Langley Employee Recognitions

• **Phillip Drummond,** Hypersonic Air-Breathing Propulsion Branch, was elected Fellow of the American Institute of Aeronautic and Astronautics (AIAA).

• **Sang Choi**, Advanced Materials & Processing Branch, was elected Fellow of the International Society for Optics and Photonics.

• **Ronald Krueger,** Durability, Damage Tolerance & Reliability Branch, was elected Associate Fellow of AIAA.

• **Jeffery White,** Computational Aerosciences Branch, was elected Associate Fellow of the AIAA.

• **John Davidson,** Dynamic Systems & Control Branch, received the Hampton Roads Section 2012 Engineer of the Year Award from the AIAA Hampton Roads Section.

• **Matthew Wilbur,** Army employee assigned to Aeroelasticity Branch, received the John W. White Engineer of the Year Award from the Hampton Roads Chapter of the American Helicopter Society.

• **Matthew Wilbur,** Army employee assigned to Aeroelasticity Branch, received the Francis A. Roberts Memorial Award for Excellence in Unmanned and Robotics Systems from the Hampton Roads Chapter of the Association for Unmanned Vehicle Systems.

• **Gene Morelli,** Dynamics Systems & Control Branch, received the Hampton Roads Section 2013 Engineer of the Year Award from the AIAA Hampton Roads Section.

• **Jared Grauer,** Dynamics Systems & Control Branch, received the AIAA Hampton Roads Section Laurence J. Bement Award for best paper for "Testing and System Identification of an Ornithopter in Longitudinal Flight" by **Jared Graur; Evan Ulrich,** University of Maryland; **James Hubbard, Jr.,** National Institute of Aerospace; and **Darryll Pines** and **Sean Humbert,** University of Maryland.

• **William Woods,** Aerothermodynamics Branch, received the Allan H. Taylor Memorial Award for sustained service to the AIAA Hampton Roads Section.

• **Neal Frink,** Configuration Aerodynamics Branch, received the North Atlantic Treaty Organization Scientific Achievement Award from the North Atlantic Treaty Organization Research and Technology Organization.

• **Laurence Leavitt,** Research Directorate, received the North Atlantic Treaty Organization Scientific Achievement Award from the North Atlantic Treaty Organization Research and Technology Organization.

• **Dan Vicroy,** Flight Dynamics Branch, received the North Atlantic Treaty Organization Scientific Achievement Award from the North Atlantic Treaty Organization Research and Technology Organization.

• **Thomas Yager,** Structural Dynamics Branch, was selected Government Official of the Year by the International Grooving and Grinding Association for his research in pavement surfaces.

• **Larry Thomason,** Climate & Radiation Studies Branch; **Kuan-Man Xu,** Climate Science Branch; and **Jean-Paul Vernier,** Chemistry & Dynamics Branch, were selected as expert reviewers and authors for the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report by the United Nations' IPCC.

• **Martin Mlynczak,** Climate Science Branch, was selected as an affiliate scientist for the National Center for Atmospheric Research's High Altitude Observatory.

• **Tian-Bing Xu,** Chemistry & Dynamics Branch; **Mia Siochi** and **Ji Su,** Advanced Materials & Processing Branch; **Xiaoning Jiang,** North Carolina State University; **Lei Zuo** and **Wanlu Zhou,** Stony Brook University; and **Paul Rehrig** and **Wesley Hackenberge**, TRS Technologies, were recognized for the Best Technical Development of an Energy Harvesting Device by IDTechEx Energy Harvesting and WSN Awards.

• **Sharon Burton,** Atmospheric Composition Branch, presentation of "Aerosol Classification from Airborne HSRL and Comparisons with the CALIPSO Vertical Feature Mask" with co-authors **Richard Ferrare, Ali Omar, Chris Hostetler, Johnathan Hair, Raymond Rogers, Michael Obland,** and **Carolyn Butler,** Atmosphere Composition Branch; and Anthony Cook, Electromagnetic & Sensors Branch; **David Harper,** Remote Sensing Flight Systems Branch; and **Karl Froyd,** NOAA Earth System Research Lab, received Best Oral Presentation Award at the 9th International Symposium on Tropospheric Profiling in L'Aquila, Italy.

• **Jeffrey Robinson,** Vehicle Analysis Branch, was co-recipient of the Best Hypersonics Program Paper for "An Overview of NASA'S Integrated Design and Engineering Analysis (IDEA) Environment" at the 17th AIAA International Space Planes and Hypersonic Systems and Technologies Conference.

• **Oliver Wong,** Research Directorate, received the 2012 Alfred P. Gessow Award for the best paper of the American Helicopter Society Annual Forum for "Blade Tip Pressure Measurement Using Pressure Sensitive Paint."

• **Maria Consiglio** and **James Chamberlain,** Crew Systems & Aviation Operations Branch, and **Sara Wilson,** Aeronautics Systems Engineering Branch, received a Best of Session Award for the paper "Integration of Weather Avoidance and Traffic Separation" at the 30th Digital Avionics Systems Conference.

• **Amanda Gillespie** and **Mark Monaghan,** NASA Kennedy, and **Yuan Chen,** Electronic Systems Branch, received a Best Paper Award at the 2012 Reliability and Maintainability Symposium for "Comparison Modeling of System Reliability for Future NASA Projects."

Continued on Next Page …

• **Sean Kenny** and **Luis Crespo,** Dynamic Systems & Control Branch; **Lindsey Andrews,** Old Dominion University; and **Dan Giesy,** Dynamic Systems & Con-

trol Branch, received best paper presented on model validation and uncertainty quantification for "Robust Control Design for Uncertain Nonlinear Dynamic Systems" from the Society for Experimental Mechanics, Inc.

• **Gene Morelli,** Dynamics Systems & Control Branch, received the Best Paper Award for "Flight Test Maneuvers for Efficient Aerodynamic Modeling" at the 2011 AIAA Atmospheric Flight Mechanics Conference.

• **Gene Morelli,** Dynamics Systems & Control Branch, received the Best Paper Award in Flight Mechanics for "Efficient Global Aerodynamic Modeling from Flight Data" at the 2012 AIAA Aerospace Sciences Meeting.

• **Gaetano Magnotti,** George Washington University, **Andrew Cutler,** Hypersonic Air Breathing Propulsion Branch; and **Paul Danehy,** Advanced Sensing & Optical Measurement Branch; received a Best Paper Award for "Development of a Dual-Pump CARS System for Measurements in a Supersonic Combusting Free Jet" from the AIAA's Aerodynamic Measurement Technology Technical Committee.

• **Taumi Daniels** and **Phillip Schaffner,** Electromagnetic & Sensors Branch; **E. Tom Evans**, Flight Software Systems Branch; **Robert Neece,** Electromagnetic & Sensors Branch; and **Steven Young,** Safety-Critical Avionics Systems Branch, received the Best Paper Award in the Flight Deck Systems Track for "Creating a Realistic Weather Environment for Motion-Based Piloted Flight Simulation" at the 31st Digital Avionics Systems Conference.

• **Daniel Palumbo** and Jacob Klos, Structural Acoustics Branch, received the Martin Hirschorn IAC Prize for Best Paper for "The Effects of Voids and Recesses on the Transmission Loss of Honeycomb Sandwich Panels" from Institute of Noise Control Engineering.

• **Allan White,** Safety-Critical Avionics Systems Branch, received Best Paper of Session at the 31st Digital Avionics Systems Conference for "An Initial Examination for Verifying Separation Algorithms by Simulation" by Allan White, **Natasha Neogi**, National Institute of Aerospace, and **Heber Herencia-Zapana**, National Institute of Aerospace.

• **Timothy Lewis,** Crew Systems & Aviation Operations Branch; **Nipa Phojanamongkolkij,** Aeronautics Systems Engineering Branch and **David Wing**, Crew Systems & Aviation Operations Branch, received Best Paper at the Integrated Communication, Navigation & Surveillance Conference for "The Effects of Limited Intent Information Availability on Self-Separation in Mixed Operations."

• **Lucas Horta, Mercedes Reaves, Martin Annett and Karen Jackson,** Structural Dynamics Branch, received the Best Paper award for "Multi-Dimensional Calibration of Impact Dynamic Models" from the Society for Experimental Mechanics, Inc.

• **Lesa Roe,** Center Director, received the Gator Engineering Leadership Award from the University of Florida.

• **Bryan Barmore,** Crew Systems & Aviation Operations Branch, received a Significant Contributor Award for his efforts and impact as the concept lead for the Airborne Spacing-Flight Deck Interval Management (ASPA-FIM) application from the Radio Technical Commission for Aeronautics Symposium.

• **Kelly Hayhurst,** Safety-Critical Avionics Systems Branch, received an Outstanding Leader Award from the Radio Technical Commission for Aeronautics.

• **Jennifer Keyes,** Space Mission Analysis Branch, was presented with the 2011 Rensselaer Alumni Association Director's Award.

• **Michael Smith,** Safety & Mission Assurance Branch, received the 2012 Engineering Alumni Award from Southern Illinois University–Carbondale, Science and Engineering Department.

• **Sheri Beam,** Office of Strategic Analysis, Communications, & Business Development, was invited to speak at Mansfield University graduation brunch.

• **Debbie Martinez,** Aeronautics Research Mission Directorate Projects, received the Hispanic in Technology Government Award at the Society of Hispanic Professional Engineers (SHPE) Conference.

• **Michael Walther,** Security & Program Protection Branch, completed the Commonwealth of Virginia State Police Fusion Liaison Officer Class.

• **Bryan Wade,** Security & Program Protection Branch, completed the Commonwealth of Virginia State Police Fusion Liaison Officer Class.

• **Junilla Applin,** Engineering Directorate, was selected by the Society of Women Engineers (SWE) as a panelist for The View Inside of NASA – Women Engineers who ROCK at the annual SWE conference.

• **Janet Sellars,** Equal Opportunity Office, received the Woman of Distinction-Government Award from the Virginia Peninsula YWCA.

• **Lindsay Rogers,** Science Directorate, received the 2012 Young Woman of Distinction Award from the Virginia Peninsula YWCA.

• **Bill Kluge's,** Media Solutions Branch, painting "HELIOS Ascending" was one of 36 pieces selected for the American Society of Aviation Artist's Retrospective Exhibition at the Arts Center in Battle Creek, MI.

• **Thomas Pinelli,** Education Office, received a meritorious service citation from the Virginia Children's Engineering Council.

• **Dollie McCown,** Education Office, received the 2012 Women of Color Corporate Promotion of Education Award, from the Career Communications Group and Northrop Grumman.

• **James Batterson,** retiree, received the Mid-Atlantic Regional Science, Technology, Engineering, and Mathematics Tech Transfer Award from the Federal Laboratory Consortium.

• **James Batterson,** retiree, and **Behzad Raiszadeh,** Atmospheric Flight & Entry Systems Branch, were recognized by Virginia Governor Bob McDonnell for their roles in creating "Modeling and Simulation for High School Teachers: Principles, Problems, and Lesson Plans," a crowd-sourced flexbook.

• **Ray Comstock,** Crew Systems & Aviation Operations Branch, received a certificate of appreciation for judging the All-City Science, Engineering & Technology Fair in Newport News, VA.

• **Zhaoyan Liu,** Atmospheric Composition Branch, was cited for excellence in refereeing by the editor of the Journal of Geophysical Research-Atmospheres.

• **Paresh Parikh,** Orion Multi-Purpose Crew Vehicle Office, was recognized for 5 years of judging the U.S. Army Cybermission Challenge.

• **Stephen Bollman,** Jacobs Technology; **Michael Croft**, **Sierra Lobo; Wesley Wigginton,** Maintenance & Utilities Branch; and **John McDonald** and **Bill Leonard,** City of Hampton, received a Federal Energy and Water Management Award from the Department of Energy for "Trash-Powered Research: Optimizing Biomass Energy at NASA Langley Research Center."

• **Bruce Bishop,** Projects & Engineering Branch; **Anthony Dell'Arciprete,** GSA; **Edward Weaver,** AECOM Design; **Jim Beckett,** Hill International; and **Eric Murphy,** Whiting-Turner; received the Federal Energy and Water Management Award for Better Buildings from the Department of Energy for "Langley Headquarters Building-New Town Phase I."

• **Langley Research Center** received the 2011 GreenGov Presidential Lean, Clean, and Green Award.

• **Langley Research Center** received the 2012 [Virginia] Governor's Environmental Excellence Award.

• **NASA Langley Headquarters Building** was selected as number 3 in the top 10 List of Leadership in Energy and Environmental Design Projects by the Interiors and Sources Trade Magazine.

• **Langley Research Center,** including National Advisory Committee for Aeronautics buildings now owned by Langley Air Force Base, was listed in the Virginia Landmarks Register.

• **Paresh Parikh,** Orion Multi-Purpose Crew Vehicle Office, was recognized for serving as a Combined Federal Campaign Loaned Executive.

• **Frances DeMarco,** Office of the Chief Information Officer, received a 2012 Volunteer of the Year award from the American Red Cross Coastal Virginia Region.

• **Linda Woodman,** IT Infrastructure Branch, was recognized for outstanding executive committee performance for Hampton Bay Days.

• **NASA EDGE** was selected as a finalists for the Sir Arthur Clarke Award, best space media broadcast category, by The British Interplanetary Society.

Orion Spacecraft Has New Home at Virginia Air & Space Center

The Virginia Air & Space Center in Hampton is NASA Langley's official visitor center. It features interactive aviation exhibits spanning 100 years of flight, more than 30 historic aircraft, a hands-on space gallery, unique space flight artifacts, and more.

New on display this year is an 18,000-pound test version of an Orion space capsule built at Langley. While at the air and space center, you can launch a rocket, pilot a space shuttle, program Mars rovers for a mission, become an air-traffic controller, fly an airplane, climb aboard a WWII bomber and experience a 3D IMAX film.

Also on display is the Apollo 12 Command Module that went to the moon, a Mars meteorite, a three-billion-year-old moon rock, a DC-9 passenger jet and a replica 1903 Wright Flyer.

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

Langley Leadership

Lesa B. Roe
Center Director

Stephen G. Jurczyk
Deputy Director

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MILESTONES

Whitcomb a Hall of Famer

Aeronautics engineer Richard T. Whitcomb, whose legendary NASA research contributions made supersonic flight practical, has been inducted into the National Aviation Hall of Fame. Whitcomb died in 2009 at age 88. The National Aviation Hall of Fame, at the National Museum of the U.S. Air Force in Dayton, honors individuals who have uniquely contributed to the nation's aviation achievement. Inductees include the Wright Brothers, Amelia Earhart, Charles Lindbergh and astronauts John Glenn, Neil Armstrong and others. Whitcomb's insight into aerodynamics and his practical solutions led to three of the most significant and practical contributions to aeronautics in the 20th century — the "area rule," supercritical wing, and winglets.

Shuttle's Last Ride

(Above) Space Shuttle Enterprise on its way to the Intrepid Museum in New York City. (Right) Space Shuttle Endeavour on a two-day crawl through Los Angeles to its retirement at the California Science Center.

Top Secret Tests

Research recently uncovered top-secret tests that were conducted at NASA Langley on a captured Japanese "Zero" fighter plane. The characteristics of the Zero, which outclassed all U.S. aircraft early in the war, were unknown prior to its capture. After it was flown against American aircraft in California to determine flaws in the design and develop tactics to defeat the Zero, it was sent to Anacostia Naval Air Station in Washington, D.C. for further evaluation by the Navy. The Navy asked that Langley instrument the Zero for the tests, and flew it to Langley, where it was tested in the Full-Scale Tunnel.

8-Foot Transonic Pressure Tunnel

Built in 1953 as the 8-Foot High Speed Tunnel, Langley's 8-Foot Transonic Pressure Tunnel was the site for much of Richard Whitcomb's ground-breaking aeronautics research. The tunnel was demolished this year.

"That's one small step for man, one giant leap for mankind."

With those words, Neil Alden Armstrong became the first human to walk on the moon, at 10:56 p.m. EDT on July 20, 1969. Mr. Armstrong died Aug. 25, 2012. He was 82.

Neil Armstrong next to the Lunar Excursion Module simulator in February 1969, four months before Apollo 11 touched down on the lunar surface. He and 23 other astronauts learned how to land on the moon at this NASA Langley Research Center facility.

National Aeronautics and
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