National Aeronautics and Space Administration

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UP launches technology

By Leslie Williams
NASA Armstrong acting news chief

An UP Aerospace SpaceLoft sounding rocket soared into the sky Nov. 6 from Spaceport America, New Mexico, carrying four technology experiments for NASA's Flight Opportunities Program that funded the launch of these technologies.

The Flight Opportunities Program, part of NASA's Space Technology Mission Directorate, is managed at NASA Armstrong. NASA's Ames Research Center at Moffett Field, California, manages the solicitation and selection of technologies to be tested and demonstrated on commercial flight vehicles.

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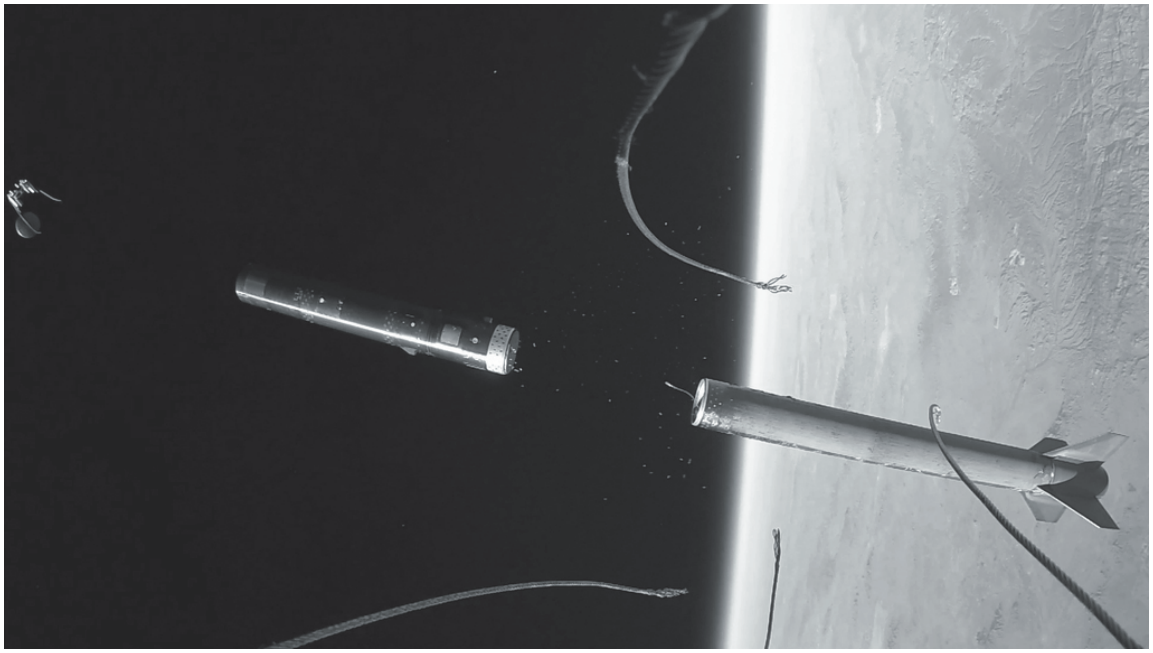

Contributed Photo/UP Aerospace

Nose fairing camera view of an UP Aerospace booster separating in space and ejecting the Maraia capsule.

NASA, Armstrong good places to work

By Jay Levine
X-Press editor

There's no place better to work in the federal government than NASA for the fourth straight year. In addition, government employees at NASA Armstrong indicated they are more satisfied with working at the center than any time in the past five years.

The Partnership for Public Service determines the rankings based on government employees' responses to three key questions in the annual U.S. Office of Personnel Management's Federal Employee Viewpoint Survey. The questions focus on the respondent's willingness to recommend the facility as a good place to work in addition to job and organization satisfaction.

"We continuously work to improve the center and maximize our resources and that starts with the people," said NASA Armstrong Director David McBride. "It isn't just something we say. People are a major part of our success and that was identified in the Armstrong Strategic Plan that we recently introduced. I am pleased that the results of the annual survey show we are making progress."

Overall, the center was ranked 28 of 320 government agency subcomponents. Survey respondents indicated a satisfaction of 74.2, which is a 2.3 percent improvement from the 71.9 percent recorded in the 2014 results.

People responding to the survey have had increasingly positive responses since 2005, when satisfaction was at a low of 60.7 percent. The results are the second highest satisfaction score – the highest mark was a 75.9 satisfaction score in 2010. The current result also is the highest since 2011, when 73.2 percent of survey responders indicated satisfaction.

Strategic plan focus is people

By Jay Levine
X-Press editor

Armstrong delivers on its commitments and has introduced a new strategic plan that will enable the center to continue to excel, said Center Director David McBride.

A major focus of the new plan is the people and how each contributes to the center's success, said Steve Schmidt, assistant director for strategic implementation and the Armstrong Strategic Plan Committee's chairman. In developing the plan, the committee consulted more than 250 people for a document that is clear, concise and has elements of accountability, he added.

"If the center takes care of its people, the mission, process and culture falls in line," Schmidt said. "Everybody should see themselves in the plan and where they fit. It doesn't matter what organization they're with."

A key addition to the Armstrong Strategic Plan is a statement about courageousness in the center's values statement, Schmidt added. The center values courage – "We are courageous in pushing boundaries and have the courage to speak up when our values are compromised."

For the first time, the strategic plan also has an education element. The third objective under the first strategic goal is "advance the nation's STEM (science, technology, engineering and mathematics) education and workforce pipeline by working collaboratively with projects to engage students, teachers and faculty in Armstrong's missions and unique assets."

"The strategic plan is not a cookbook where you add a teaspoon of this and a teaspoon of that," Schmidt said. "It is meant to be flexible and agile to allow us to change with the ebb and flow."

As such, Schmidt said the document will be reviewed annually and monthly management meetings will develop tactics to achieve the plan's goals. He explained the strategic plan is a living, evolving document. "Good ideas are welcomed and will be incorporated into the plan," he added.

ED15-0362-3 **NASA/Lauren Hughes**

Executive Leadership Team members are beginning discussions on implementation of the Armstrong Strategic Plan.

Dana Askins, Human Resource Management and Development Office director and a member of the committee, said she pushed for people to be considered a top priority and was pleased the rest of the panel felt the same way.

"There is passion behind the mission and I came prepared to fight for people and for everyone to be able to see themselves in the plan," Askins said. "I was pleased that I wasn't the one who brought it up. It was enlightening."

David Voracek, Armstrong technologist, agreed that the committee was successful.

"Constructive conflict is OK," he said. "As we worked through the process there were some frustrations in the organizational codes. We aired those and we learned we can come together to work it out."

Center Director David McBride said center staff members are innovators with integrating complex systems and the new plan can be used to refine and better Armstrong's work. For example, Armstrong staff could share expertise with scientists who are developing instruments for flight.

"We can help them build their instruments appropriate to the vehicle they plan to fly it on," McBride said.

A Strategic Plan presented in 2004 and updated in 2013 aimed to shift the center's focus from about 90 percent aerospace to a more diversified portfolio. That commitment resulted in projects like assisting the Exploration Systems Mission Directorate (now Human Exploration and Operations Mission Directorate) with the Orion Launch Abort System and the Stratospheric Observatory for Infrared Astronomy program that meshed with the center's ability to bring complex systems integration to flight.

In the case of SOFIA, McBride said influential people said the NASA 747SP aircraft would never fly. However, the Armstrong team prevailed and the milestones were met. Since then, the airborne observatory has reached full operation.

The Adaptive Compliant Trailing Edge project on a Gulfstream III research aircraft is another example where the center committed to a project and delivered, McBride said. It was completed six-weeks early and on budget.

The strategic plan features a vision statement, a mission statement, four strategic goals and 11 strategic objectives to support the goals.

Armstrong's vision statement remains "To separate the real from the imagined through flight." The mission statement was slightly modified, "We leverage our atmospheric flight expertise to advance technology and science for the benefit of NASA and the nation."

Armstrong shares NASA's core values of safety, excellence, teamwork and integrity. The center also values the contributions of every individual to accomplish the mission safely, through trust, teamwork, professionalism, innovation and courage.

The four strategic goals are intended "to advance our mission in aeronautics, enhance our support of science and partner in space exploration, we must first invest in our people, processes and culture."

The first of the strategic goals is "enhance our leadership and management, and develop our workforce to better accomplish the Armstrong mission. Our goal is a culture that listens, debates, discovers and learns." The three objectives include achieving a center climate that promotes teamwork, diversity, inclusion, creativity and innovation, establishing a management operating structure to drive critical risk-informed decision making and advance STEM education.

Strategic goal two is to "advance Aeronautics research by expanding our role in green aviation, subsonic efficiency, autonomy and the development of national aeronautics research policy, while leveraging our capabilities in high-performance aircraft research." To support that goal are four strategic objectives including investment in capabilities, invest in capabilities to research autonomous systems, sustain world-

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AFRC tech recognized

By Jay Levine
X-Press editor

NASA's Tech Briefs magazine in November honored two Armstrong technologies and featured an interview with NASA Armstrong's chief scientist.

A team of Armstrong researchers created the Real-Time Fiber Optic Sensing System that was the Tech Briefs winner in the electronics category.

"The fiber optic sensing system, or FOSS, technology represents a major breakthrough in high-speed operational monitoring and sensing. Driven by ultra-efficient algorithms, FOSS can be used to determine, in real time, a variety of critical parameters including strain, shape deformation, temperature, liquid level and operational loads," the magazine reported. The technology has applications for aerospace, the automotive industry and energy sectors.

As part of the award, the team will receive a computer workstation. Team members included Hon "Patrick" Chan, William Ko, Allen Parker, Anthony "Nino" Piazza and Lance Richards.

Mark Skoog, project manager of the ground collision avoidance system, was listed as an honorable mention in the aerospace and defense category of the Tech Briefs annual awards.

"The proven system for preventing ground collisions of aircraft could prevent about 100 deaths a year in the U.S. alone," the magazine reported. The system is designed to keep a pilot from controlled flight into hazardous terrain by automatically taking over the controls to avoid it.

Al Bowers, who is NASA Armstrong's chief scientist and Preliminary Research Aerodynamic Design to Lower Drag, or Prandtl, project manager, was featured in the magazine's Who's Who at NASA feature. The interview included questions about the aircraft, the design inspired by German engineer Ludwig Prandtl, how the wing design is researched and the possibility such a concept could be used for a Mars airplane.

Facilities looking into pipe break

A construction crew worked on a section of four miles of pipe replaced as part of a more than $8 million improvement of the fire water mains on NASA Armstrong's main campus from 2012 to 2014. Shown is the connection of the new 20-inch polyvinyl chloride, or PVC, fire water main to the old 20-inch cast iron pipe. Recently the old 20-inch pipe, seen in the upper part of the trench, failed below the ramp north of 4802. An assessment of the damage is ongoing, but the incident was discovered within 12 minutes and the flow of water was stopped shortly after it was discovered.

Photo courtesy of Randy Davis of Tony Vacca Construction

NASA selects payloads for flight

By Kimberly Williams
Ames Public Affairs

NASA's Flight Opportunities Program has selected eight space technology payloads for reduced gravity flights on board specialized aircraft and commercial suborbital reusable launch vehicles (sRLVs). These flights provide a valuable platform to mature cutting-edge technologies, validating feasibility and reducing technical risks and costs before infusion into future space missions.

The Flight Opportunities Program, part of NASA's Space Technology Mission Directorate, is managed at NASA Armstrong. NASA's Ames Research Center at Moffett Field, California, manages the solicitation and selection of technologies to be tested and demonstrated on commercial flight vehicles.

Five of the newly selected proposals requested parabolic flights, which involve a flight maneuver that uses a dramatic half-

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News at NASA

The force strong with NASA tech

NASA astronauts "use the force" every time they launch … from a certain point of view. We have real-world droids and ion engines. We've seen dual-sun planets like Tatooine and a moon that eerily resembles the Death Star. And with excitement building around the premiere of Star Wars: The Force Awakens, the Force has even been felt on the International Space Station.

Recently returned station astronaut Kjell Lindgren is such a fan that he posed with his station crewmates in a Jedi-themed mission poster and talked to StarWars.com about it. Shortly before leaving the station, Lindgren tweeted about the uncanny resemblance of the station's cupola to the cockpit of an Imperial TIE Fighter.

See NASA.gov for more on the NASA/Star Wars connections

Harris passes

Stephen Harris, a former Dryden (now Armstrong) information technology technician, died Nov. 28. He was 34.

Harris started his career at Dryden in 2001 as a desktop support technician. He worked for several contractors as a Linux administrator, technician and Mac computer engineer.

Smith passes

William "Bill" Smith, who was formerly a manager in the safety office for more than 20 years at Dryden (now Armstrong), died in early November.

Smith was a contractor site manager in the Armstrong Safety Office.

Space batteries

Technology could lead to 30-second charge

By Jay Levine
X-Press editor

Future cell phones and other electronics could have batteries that charge in less than a minute. This new capability will be in part thanks to a space experiment using hard, flexible material as a clean power source.

That potential future launched on the Orbital ATK's S.S. Deke Slayton II Cygnus spacecraft atop a United Launch Alliance Atlas V rocket Dec. 6. A team of students attending Desert Christian School in Lancaster, California, with the support of NASA mentors and the University of California, Los Angeles, developed the experiment.

Three engineers from NASA Armstrong volunteered to assist the students and the funding for the experiment was provided by the center. Allen Parker oversaw the software team, Phil Hamory advised the engineering component and Craig Stephens assisted the public relations staff.

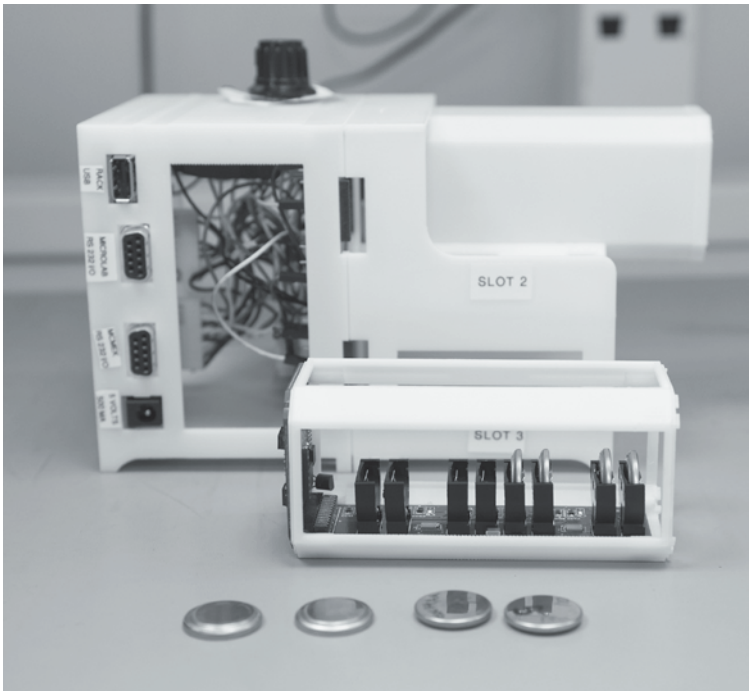
Another key figure is UCLA researcher Richard Kaner, who leads Kaner Laboratory. He has met with both teams of students from Desert Christian and provided the graphene materials and research.

The experiment is designed to see how graphene-based supercapacitors charge, discharge and deteriorate in a microgravity environment. The supercapacitors could offer the best of each with the fast charging of a capacitor, while having slow power discharge like a battery, Stephens explained. In fact, the material is sandwiched between two lithium battery cases.

The advanced space battery may lead to a number of terrestrial uses for the mobile phone industry from charging cell phones to the transportation industry for running large refrigeration units more efficiently – and environmentally clean – for semi trucks, Stephens added.

ED15-0229-1 **NASA/Carla Thomas**

From left, former Desert Christian students Logan Francisco, Kyler Stephens and Jonathan Lokos and NASA Armstrong mentor Allen Parker show the elements of the experiment launched into space on Dec. 6.



ED15-0229-2 **NASA/Carla Thomas**

These are the components of the Desert Christian experiment launched to space Dec. 6 that could one day lead to fast-charging batteries.

Once International Space Station astronauts start the experiment, data collected will be emailed to the students every three days during the 30-day experiment.

It is the second attempt to transport the experiment to space. The first try was June 28 on a Space-X Falcon 9 rocket that was lost shortly after launch. However, the Desert Christian team and its mentors had foreseen the possibility of a challenge and the students created two identical experiments.

Trevor Sattler, who is a senior and was on the team during the formulation and construction of both experiments, remembers the disappointment of the first launch and loss of the experiment, but is happy to be a part of the two ongoing experiments.

"Life doesn't always go perfectly," he lamented. "It will be awesome if these experiments go well. We are using leading-edge technology with super simple methods well suited for our abilities. As a freshman (in high school) I never envisioned working on an experiment that would be transported into space."

Sattler also has gained much from working on this project and said he hopes to apply for a NASA summer internship, as three of his former team members had done this past summer. Jonathan Lokos, Logan Francisco and Kyler Stephens were on the first Desert Christian team and had applied for and received internships at Armstrong.

"My work on this confirms to me that I want to be a mechanical engineer," Sattler said. "I always liked

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Fused Reality

Pilot proficiency in tight situations can be safer

By Peter W. Merlin
Armstrong Public Affairs

There are two ways for pilots to gain proficiency in an airplane and evaluate its handling qualities. The first is to climb into the cockpit and takeoff; the second is to practice in a ground-based simulator. Each method has advantages and limitations. Now, it is possible to combine the best of both through an exciting new technology known as Fused Reality that researchers from NASA Armstrong and the National Test Pilot School (NTPS) in nearby Mojave have tested.

The term Fused Reality was coined by Ed Bachelder, the system's inventor and technical director at Systems Technology Inc. (STI), Hawthorne, California, when the company began development in 2003 under a Phase I Small Business Innovation Research (SBIR) program for Naval Air Systems Command and the US Army. The patented technology combines real world video with interactive computer-generated environments to create a highly immersive training experience for practicing complex tasks such as landing, flying in formation and aerial refueling. While flying, the pilot wears a special helmet with an optical system that combines the real out-the-window view from a camera with computer-generated graphics of an airfield or another aircraft.

In 2012, using SBIR funds, researchers from NASA and STI conducted three evaluation flights on Calspan Corporation's highly modified Learjet in-flight simulator at Mojave. Armstrong research pilots Troy Asher and Jim Less felt that although the Fused Reality system showed great promise for flight-test and training, there were elements that needed improvement. Additional efforts, paid for through Armstrong's Center Innovation Fund, subsequently allowed researchers to correct minor problems and add enhancements.

ED15-0229-1 **NASA/Carla Thomas**

Dave Fedors wears the Fused Reality helmet while flying the Gippsland GA-8 Airvan. NTPS instructor Bryan Olson, in the left seat, served as safety pilot.

In the next phase of flight-testing, beginning in September 2014, the team successfully demonstrated an improved Fused Reality system on board a Gippsland GA-8 Airvan research aircraft owned by the NTPS. A series of nine flights culminated in January 2015 with four flown by Armstrong research pilots Tim Williams, Dave Fedors, Scott Howe and Wayne Ringelberg. Each pilot performed a series of tasks generated by the Fused Reality system and subjectively rated the airplane's handling qualities. These tasks included landing on a simulated runway at altitude, formation flight, and aerial refueling drogue tracking.

Although many ground-based flight simulators include full-motion capabilities to reproduce what it feels like to be in a real aircraft, they lack some of the cues that come with that experience. Fused Reality provides a more realistic experience

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Space batteries... from page 4

seeing how things work and how to make them work better. It would be amazing if I had the opportunity to work at NASA Armstrong."

Hannah Laubach, a junior on the engineering team, also has learned from the opportunity.

"It has been great to work with mentors and learn what it would be like on that career path," she said.

The experiment consists of eight supercapacitors in a housing. Hamory explained that there are four each of the two types of supercapacitors. Every supercapacitor has a metal plate on each side, but it's on the inside that counts. One set will include an acetonitrile material, while the other set will have an ionic liquid. In other words, the experiment will look at the effectiveness of different materials, Hamory explained.

The students are preparing a second experiment, which will look at how the graphene supercapacitors work when heated to 140 degrees. That experiment will be ready in January for an anticipated March launch, he said.

An example of some of the jobs the students do are soldering wires for electrical connections and attaching micro heaters that have less energy than a refrigerator light bulb, Hamory explained. The supercapacitors also are placed in a black material with insulation that essentially forms a "sleeping bag" to keep the supercapacitors warm. In addition, students designed and then printed a housing to contain all of the elements on a 3D printer, where the circuit board, gauges and wires also are integrated.

For the Desert Christian team, the future has been launched.

VIPR

Volcanic ash studies show engines impact when planes fly near volcanic eruption

By Kathy Barnstorff
NASA Langley Public Affairs

According to the U.S. Geological Survey more than 80 commercial aircraft encountered potentially hazardous volcanic ash in flight and at airports from 1993-2008. That was before the big 2010 volcanic eruption of Eyjafjallajökull in Iceland which disrupted hundreds of flights in Europe and the lives of about 10 million airline passengers over six days.

"The primary issue is that volcanic ash forms glass in the hot sections of some engines," said John Lekki, NASA Vehicle Integrated Propulsion Research (VIPR) principal investigator, based at NASA's Glenn Research Center in Cleveland. "This clogs cooling holes and chokes off flow within the engine which can eventually lead to an engine power loss. It is very erosive, which causes damage to compressor blades and other parts in the engine."

The 2010 volcanic eruption came at the same time that NASA was looking at developing engine health management systems and smart sensors for next generation commercial aircraft engines.

"Because of the impact of the volcano in Iceland there was also an increased interest in the aviation community in better understanding the effects of volcanic ash in engines," said Paul Krasa, VIPR project manager, based at NASA's Langley Research Center in Hampton, Virginia.

So NASA partnered with other government agencies and industry, including the Federal Aviation Administration, the U.S. Air Force Research Laboratory, Pratt & Whitney, Rolls Royce Liberty Works, General Electric Aviation and Boeing Research & Technology, to conduct the series of VIPR engine tests - ending with the one in 2015 that actually simulated volcanic ash ingestion.

ED15-0188-1128 **NASA/Ken Ulbrich**

The volcanic ash distribution spider, shown here in the inlet of the engine while running, was used to send the ultra-fine particles of ash through the engine.

ED11-0372-11 **NASA/Tony Landis**

Oil smoke billows from the right inboard engine of the C-17 while a probe collects emissions data during 2011 VIPR engine health monitoring tests.

"We don't know of anybody who has ever attempted to introduce volcanic ash directly into the engine core on the wing of the airplane in a controlled way," said Krasa. "We needed to do that because we really needed to understand the full system effect."

The Air Force provided the plane, a C-17 cargo transport, and two F117 engines that had been slated for retirement, but were overhauled to like new before the test. The F117 engine is a military version of a commercial Pratt & Whitney engine that is used on the Boeing 757.

The first VIPR test on the engine, heavily instrumented with sensors, happened in 2011 at NASA Armstrong and at Edwards Air Force Base. It established engine and sensor performance baselines. The second test, in early 2013, used cereal and crayons, material that wouldn't harm the engines, to verify that the sensors could detect tiny bits of debris. That test established the sensitivity of the sensors.

Both were the building blocks for the real-world scenario - the introduction of volcanic ash, which can and does tear up an engine. Researchers introduced simulated volcanic ash into the engines at low and high flow rates.

"We used real ash that was broken up from a pumice deposit," said Lekki. "The volcanic ash used was from the Mt. Mazama eruption, which took place around 5700 BC."

What makes volcanic ash bad for an engine also complicated how to test just how bad it is.

"One of the things we found out was that the original volcanic ash distribution rig we were using to introduce the ash into the engine ate itself,' said Krasa. "Volcanic ash literally has such an erosive characteristic to it that it was able to cut through fittings, so we had to go through a redesign."

The redesign worked beautifully,

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Technology... from page 1

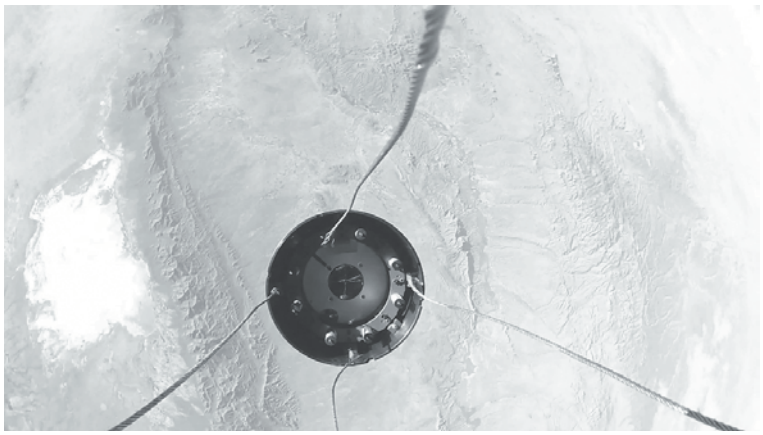
The commercial suborbital space rocket reached a maximum altitude of approximately 75 miles. The experiments were recovered intact 30 miles downrange on the U.S. Army White Sands Missile Range. UP has launched several times from Spaceport but this was the first launch where payloads were ejected separately requiring independent re-entry under individual parachutes into the atmosphere.

"We had a great launch, all the payloads were exposed to the relevant environments that the researchers were seeking," said Paul De Leon, NASA Flight Opportunities Program campaign manager. "The new payload deployment capability from UP Aerospace was successfully demonstrated, opening the opportunity for future entry, descent and landing technologies to be tested and matured under Flight Opportunities."

Purdue University tested a new, U.S.-made green propellant that is gaining interest from the rocket industry. The experiment called Zero-gravity Green Propellant Management Technology acquired video data of the new propellant interacting with traditional designs of surface tension propellant management devices in near-weightlessness.

Building on data from a previous launch, New Mexico State University performed another suborbital test of its Robotics-Base Method for In-Orbit Identification of Spacecraft Inertia. The goal of the research is to test and verify a robotics-based method for on-orbit identification of satellite inactive properties in a microgravity environment.

NASA's Johnson Space Center, Houston, tested their entry, descent and landing technology for the Maraia Earth Return Capsule. The spacecraft is expected to become an inexpensive, autonomous International Space Station-based vehicle to provide on-demand return of small scientific and engineering payloads, or function as an ISS-deployed entry technology test bed.



An UP Aerospace camera captures the separation in space of the Maraia capsule from the Nose Fairing launch vehicle.

Ames tested its Affordable Vehicle Avionics project, a suite of avionics that will provide early verification of new software and hardware for delivering an affordable and capable Guidance, Navigation and Control (GNC) system and telemetry avionics. The avionics project will be applied to multiple nano-launch vehicles at one percent the cost of current state-of-the-art avionics. Using this new GNC system reduces the cost of launching small payloads into orbit as well as recurring costs of future launches.

The Flight Opportunities Program seeks to advance space technology to meet future mission needs through flight activities that foster the growth of the U.S. commercial spaceflight industry and workforce. NASA will pay for the integration and flight costs for the selected payloads. Limited funds will be provided for other costs to facilitate the flight readiness of these payloads.

Selection... from page 3

minute drop of the aircraft though the sky to simulate weightlessness. Two proposed projects will fly on sRLVs for testing during longer periods of weightlessness. An additional payload will fly on both platforms.

Selected for parabolic flights on aircraft are:

• "Zero Gravity Mass Measurement Device Parabolic Flight Test" – John Wetzel, principal investigator, Orbital Technologies Corporation, Madison, Wisconsin

• "Evaluation of the Biosleeve Gesture Control Interface for Telerobotics in Microgravity" – Christopher Assad, principal investigator, Jet Propulsion Laboratory, Pasadena, California

• "Flight Demonstration of a Gravity-Insensitive, Microchannel Membrane Phase Separator" – Weibo Chen, principal investigator, Creare Inc. Hanover, New Hampshire

• "PRIME-4.0: Miniaturized and Reusable Asteroid Regolith Microgravity Experiment for Suborbital and Orbital Use" – Josh Colwell, principal investigator, University of Central Florida, Orlando, Florida

• "Testing of a Novel IVA (Intra-Vehicular Activity) Space Suit" – Ted Southern, principal investigator, Final Frontier Design, LLC, Brooklyn, New York

• "Evolved Medical Microgravity Suction Device" – Charles Cuttino, principal investigator, Orbital Medicine, Inc., Midlothian, Virginia

Selected for flights on sRLVs are:

• "Suborbital Evaluation of an Aqueous Immersion Surgical System for Reduced Gravity" – George Pantalos, principal investigator, University of Louisville, Louisville, Kentucky

• "Suborbital Particle Aggregation and Collision Experiment-2 (SPACE-2)" – Julie Brisset, principal investigator, University of Central Florida, Orlando, Florida

• "Evolved Medical Microgravity Suction Device" – Charles Cuttino, principal investigator, Orbital Medicine, Inc. Midlothian, Virginia

The selectees' experiments are expected to take to the skies in 2016 and 2017 on flights with U.S. commercial providers arranged by the proposers. The selected proposals requested parabolic flights from Integrated Spaceflight Services Inc. and ZeroG Corporation. Suborbital reusable launch vehicle flights were requested from Blue Origin, EXOS Aerospace Systems & Technologies and Virgin Galactic.

This selection was made through the agency's Space Technology Mission Directorate Research, Development, Demonstration and Infusion (REDDI) announcement, adding to more than 160 payloads that NASA has chosen for test flights through the Flight Opportunities Program.

The Flight Opportunities Program seeks to advance space technology to meet future mission needs through flight activities that foster the growth of the U.S. commercial spaceflight industry and workforce. NASA will pay for the integration and flight costs for the selected payloads, and limited funds will be provided for other costs to facilitate the flight readiness of these payloads. The next REDDI Flight Opportunities call for proposals will be released in early 2016.

Fused Reality... from page 5

because the aircraft is real and only some external elements are virtual. Scott Howe was quite impressed with his experience flying formation with a simulated KC-135.

"I'm seeing the real world through my camera, so I'm seeing mountains and clouds and the aircraft control panel, but I'm flying formation with a virtual tanker," he said. "I was just trying to keep station with that tanker and practice aerial refueling with the [Fused Reality] system."

The evaluation pilots noted that this system did not interfere in any way with obtaining actual handling qualities of the aircraft.

"I think what you gain here," said Howe, "is the benefit of taking the simulator into the air, where you are exposed to the actual flying environment, but with the ability to superimpose a realistic simulation on top of it."

For test pilots, Fused Reality can be used to develop handling qualities evaluation tasks for rating various aircraft configurations, advanced flight control law algorithms, pilot displays and aircraft modifications. The system can also be used to train test pilots how to do these evaluations.

The next phase of testing will be integrated into the curriculum of the Air Force Test Pilot School's Test Management Program in March 2016. Student test pilots will design and execute a flight test program using the school's C-12 (Beechcraft King Air), and compare ratings of conventional handling qualities tasks with results acquired using the Fused Reality system.

"Fused Reality allows all pilots to learn how to fly difficult and dangerous tasks such as aerial refueling, aircraft carrier landing, formation flight and aerial firefighting, which are usually taught in a ground-based flight simulator, by putting the simulator in flight in the actual aircraft," said Armstrong project manager Bruce Cogan. "Virtual images of runways, aircraft carriers and tanker aircraft are presented to the pilot in a helmet mounted display that reacts with the actual dynamics of the aircraft being flown."

Cogan also noted that the Navy is investigating the use of Fused Reality for aircraft carrier landing training and that NASA is looking into potential use of the system to enhance astronaut training.

VIPR... from page 6

even though the researchers said the volcanic ash was so fine they could never actually see it blowing into the engine.

"What you could see was the erosion on the inside of the blades - a cleaning of the blades," said Krasa. "The ash never really degraded the blades, but you could see how they were really clean the first couple of inches."

The test engineers saw more than erosion damage to the actual engine.

"As the powder comes through the hot section, it actually turns into very, very small volcanic glass droplets," said Krasa. "You see a huge amount of this glass accumulating on the inside of the engine."

"There was erosion in the compressor and 'glassification' in the turbine," added Lekki.

But those were preliminary observations, the kinds of things the researchers could actually see, not the kinds of results that make good science.

That is why the VIPR team will study the data and then publish results once the group can make solid scientific conclusions on just how volcanic ash can affect an airplane engine. Results are expected to be publicly released in summer, 2016.

Strategic plan... from page 2

class supersonics and high-speed research capability and expand the center's engagement in the development of national aeronautics policy.

A third strategic goal is to "enable world-class scientific research and inspire confidence throughout the scientific community through reliable flight operations, effective fleet life-cycle management and enabling new research capabilities and opportunities." The two objectives associated with the goal include integration/partnership and early engagement with the scientific community and convergence – applying aeronautical research expertise to science.

The final of the four strategic goals is to "advance space exploration technology and enable space commercialization through the application of convergent aerospace solutions and innovative partnerships." The two strategic objectives with that goal include enabling safe and affordable commercial spaceflight and becoming a trusted partner in the development and test of space technology.

The Armstrong Strategic Planning Committee included 14 members including, Askins, Erik Becker, Al Bowers, Greg Brierly, Jonathon Brown, Keri Eliason, Gemma Flores, Stephen Jensen, Nils Larson, Schmidt, Roberta Sherrard, Joel Sitz, Voracek and Val Zelmer.

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Address: P.O. Box 273,
Building 4800, MS 1422
Edwards, California, 93523-0273
Phone: 661-276-3449
FAX: 661-276-3167

Editor: Jay Levine, Jacobs, ext. 3459

Managing Editor: Steve Lighthill, NASA

Chief, Strategic Communications:
Kevin Rohrer, NASA

National Aeronautics and Space Administration

NASA Armstrong Flight Research Center
P.O. Box 273
Edwards, California, 93523-0273

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