Virgin Galactic delivers

By Leslie Williams
Armstrong News Chief

Virgin Galactic’s SpaceShipTwo successfully flew to suborbital space Dec. 13 with four NASA-supported technology payloads onboard. SpaceShipTwo separated from the WhiteKnightTwo twin-fuselage carrier aircraft and continued its rocket-powered test flight. The rocket motor burned for 60 seconds, taking the piloted spacecraft and payloads beyond the mission’s 50-mile altitude target.

The flight was Virgin Galactic’s first mission for NASA. The agency’s Flight Opportunities program helped the four experiments hitch a ride on SpaceShipTwo. The program purchased flight services, the accommodation and ride, from Virgin Galactic for the payloads. During the flight, the payloads collected valuable data needed to mature the technologies for use on future missions.

“The addition of SpaceShipTwo to a growing list of commercial vehicles supporting suborbital research is exciting,” said Ryan Dibley, Flight Opportunities campaign manager at Armstrong. “Inexpensive access to suborbital space greatly benefits the technology research and broader spaceflight communities.”

NASA’s investment in the growing suborbital space industry and strong economy in low-Earth

Above, WhiteKnightTwo takes off with SpaceShipTwo. Once at altitude SpaceShipTwo continued its rocket powered flight beyond the mission’s 50-mile altitude target with a NASA payload of Flight Opportunities experiments.

At left, SpaceShipTwo returns from its successful mission.

Photo courtesy of Virgin Galactic

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Flight Opportunities, page 12
The remotely piloted X-56A has a feature that must do not – the pilot and co-pilot are in the front of the room, seen in front at left.

The control room for the remotely piloted X-56A has a feature that no other remotely piloted aircraft has. The pilot and co-pilot are in the front of the room, seen in front at left.

The X-56A aircraft is intended to facilitate the development of tools and techniques to acquire data to validate modeling techniques. The results could enable future airliners to use lighter weight, flexible wing designs to conserve fuel, said Cheng Moua, X-56A project manager.

Taking advantage of calm and sunny skies, the X-56A team flew with the modern controller to expand the flight envelope. The flight also featured the collection of additional data to improve understanding of the aircraft dynamics at a range of fuel levels with the two controllers.

The classical controller is a simpler formulation, which makes it easier to intuitively understand the aircraft behavior and dynamics. The modern controller is more complex and robust. It is expected that the aircraft can operate safely at higher speeds, suppressing flutter deeper into the regions where the aircraft is less stable.

In an effort to prove the effectiveness of the flutter suppression with the modern controller, researchers planned a sequence of flight maneuvers during which the controller was turned off for less than two seconds at a time as the aircraft approached flutter, allowing the flutter mode to grow uncontrolled. When the system reactivated after a set time, it stabilized the flutter mode and lessened the oscillations. The calm conditions allowed the team to clearly see the aircraft dynamics, as well as the effect of the modern controller on flutter suppression.

During these test points we could see the growth of flutter. The team did a really good job of making sure it was a gradual buildup to flutter instability.”

“The flight success means Jeffrey Moua, X-56A project manager. "If the controller works well, you would fly right past flutter and you'd never know it because you don't see a thing," Moua said. "During these test points we could see the growth of flutter. The team did a really good job of making sure it was a gradual buildup to flutter instability."

For now, the team is happy with the milestones and is ready to reach new ones.

“We have been working since 2012 for a flight day like that,” Moua said. “We have had to persevere and go back to the drawing board to overcome major obstacles. These achievements are awesome.”

The next task will be to fine tune the modern controller, which should allow the X-56A to travel faster with a larger safety margin. Other items for the team are data analysis, model validation and a continuation of technology verification through the end of flights in February.

One of those technologies the team would like to explore in a potential X-56A follow-on phase is the Fiber Optic Sensing System. It is possible that the system, because it measures the structural response with such high resolution, could be used to not only collect real time data, but use that data in the flight control system. If that happens, it opens the door to simplifying aircraft control and producing even higher performance and more reliable control system designs.

A flight Sept. 14 marked the first time the team had suppressed flutter with the classical controller. The flights with the classical controller were intended to allow the team to gather the necessary flight data to precisely determine the open loop flutter speed and understand the dynamics at and beyond flutter onset, before beginning testing with the modern controller.

The program is funded through NASA's Advanced Air Transport Technology project, NASA's Flight Demonstration Capabilities project and the U.S. Air Force Research Laboratory.
Ikhana honored for flight

By Elvia Valenzuela
Armstrong Public Affairs

NASA Armstrong had a remarkable 2018 that included conducting flight operations in support of Commercial Supersonic Technology, modifying the all-electric X-57 Maxwell into its early experimental phase and a unique milestone recognized by a national aviation magazine.

Armstrong’s collaboration with General Atomics, Honeywell and the Federal Aviation Administration resulted in flying the first remotely piloted aircraft, the Ikhana, in the national airspace without a safety chase plane. It is that historic achievement that “Aviation Week & Space Technology” magazine recognized as it selected the Ikhana achievement as a winner of its 62nd Annual Laureate Awards in the category of Commercial Aviation, Unmanned Systems.

“For more than six decades, Aviation Week editors have annually awarded Laureates to great achievers in aerospace and aviation,” said Joe Anselmo, Aviation Week Network editorial director. “This year’s winners exemplify the spirit and innovations that are transforming our industry to meet the challenges of tomorrow.”

The Laureate Awards honor extraordinary achievements in the global aerospace arena in the categories of Business Aviation, Commercial Aviation, Defense and Space.

Ikhana is the first aircraft to achieve a No Chase Certificate of Waiver Authorization (COA) flight without the need for a chase plane or visual observers as it operated in various classes of airspace. The teamwork among the organizations made the Ikhana a success and demonstrated the opportunity for Unmanned Aircraft Systems to be integrated into the National Airspace System.

“The Ikhana represents an extraordinary collaboration among innovative individuals dedicated to bringing Unmanned Aircraft Systems one step closer into our reality,” said Jaywon Shin, NASA’s associate administrator for aeronautics. “We are very grateful to be recognized by this prestigious award. It’s an honor and a privilege to be selected as a recipient.”

The winners of the 2019 Laureate Awards will be honored on March 14, 2019 at the National Building Museum in Washington, D.C. In addition to winning an award in a category, “Aviation Week & Space Technology” will announce a Grand Laureate in each of the four categories.

A visit to the Armstrong Research Library can sometimes uncover sweet data finds, but on Nov. 15 visitors were invited to have a customized cup of co-coa. It was the library’s Second Annual Hot Cocoa Bar, which was a chance for people to discover what’s new at the library and sign up for a library card.

In the photo, library technician Kaylynn Clark welcomes guests.

Library visit turns sweet

A series of new CubeSats are now in space, conducting a variety of scientific investigations and technology demonstrations, following launch Dec. 16 of Rocket Lab’s first mission for NASA under a Venture Class Launch Services (VCLS) contract.

An Electron rocket lifted off from the company’s launch complex on the Mahia Peninsula in New Zealand, marking the first time CubeSats have launched for NASA on a rocket designed specifically for small payloads.

“With the VCLS effort, NASA has successfully advanced the commercial launch service choices for smaller payloads, providing viable dedicated small launch options as an alternative to the rideshare approach,” said Jim Norman, director of Launch Services at NASA Headquarters.

At the time of the VCLS award in 2015, launch opportunities for small satellites and science missions were limited to ridesharing - flying only when space was available on other missions. Managed by NASA’s Launch Services Program at Kennedy Space Center in Florida, VCLS awards are designed to foster a commercial market where SmallSats and CubeSats could be placed in orbits to get the best science return.

This mission includes 10 payloads selected by NASA’s CubeSat Launch Initiative, which seeks to enhance technology development and student involvement.
The 2018 NASA Honor Awards for Armstrong employees included 29 individual honors and four group awards.

Outstanding Leadership Medal

Dana L. Askins
For exceptional leadership of Armstrong’s human capital operations in advancing NASA’s aeronautics research and airborne science goals

Charles E. Irving
For exemplary leadership of the Airborne Science mission at the center, which has resulted in numerous extraordinary scientific campaigns utilizing Armstrong science aircraft for the national benefit

Jennifer H. Cole
For demonstrated leadership of Armstrong’s efforts to enable the ND-MAX flight research experiment

Karla S. Shy
For exceptional leadership creating world-class STEM education, research and development in the study of aerospace and establishing the foundation of NASA’s future workforce

Laurie A. Grindle
For exemplary leadership in Unmanned Aircraft Systems Integration in the National Airspace System, enabling new

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Peggy S. Williams-Hayes
For outstanding leadership and contributions to the operational success and safety of Armstrong

Wayne M. Ringelberg
For exceptional leadership in the Airborne Science Program resulting in multiple, highly successful, multi-center science campaigns which significantly advanced NASA’s Earth science objectives

Troy A. Asher
For the outstanding leadership of Armstrong’s organizational planning and research flight execution

Exceptional Achievement Medal

Robert D. Sakahara
For substantial improvement in operation of Unmanned Aircraft Systems Integration in the National Airspace System project through leadership and innovative, rigorous processes

James G. Williams
For consistently demonstrating exceptional performance and key leadership while supporting multiple NASA Aeronautics projects or programs
Exceptional Service Medal
Dave M. Baptiste
For exceptional service while leading Armstrong’s Export Control program in support of NASA’s Aeronautics research and airborne science goals

David B. Dowdell
For sustained excellence as the lead flight instrumentation engineer on high-visibility flight projects

Edward A. Haering
For exceptional contributions toward supersonic research in the areas of measurement, prediction and modeling propagation of sonic booms

Joseph Pahle
For contributions to NASA and the nation in the area of classical controls, handling qualities, optimal control, adaptive control and cooperative flight

John F. Carter
For sustained flight controls research, project management and Center mission leadership in the advancement of science and technology through flight

Kirk Caldwell
For exceptional service and contributions to the operational success and safety of Armstrong flight projects

Timothy Moes
For exceptional service and lasting contributions to the agency and center aeronautics research and Earth science missions throughout an outstanding, highly productive 35-year career

Patricia M. Kinn
For exceptional contributions to NASA AFRC flight operations as flight management specialist and schedule, resulting in more than 27,000 flight hours flown safely during a 12-year period

Early Career Public Achievement Medal
Samantha Hull
For exceptional performance in the Technology Transfer Office and for significant improvements to managing the Space Act Agreement at AFRC

Janeya Griffin
For exceptional performance in executing commercial licenses and technology transfer agreements while helping to manage the Center’s technology portfolio

Jeffrey A. Ouellette
For his novel work in dynamic model development of flexible models for control of flexible aerostructures

Justin D. Reid
For exceptional fire protection program improvements and institutional safety leadership at Armstrong

Jenny Y. Staggs
For substantial improvements in operations, efficiency and service of contracted capabilities necessary to conduct NASA’s mission

Karen M. Green
For making significant impacts as a resource analyst using innovative and analytical approaches supporting multiple high-profile projects at Armstrong

NASA Awards, page 11
By Jay Levine

Structural tests on a uniquely designed, high-aspect ratio, lightweight test wing this fall proved new design and fabrication methods.

The 39-foot-long Passive Aeroelastic Tailored (PAT) wing could eventually enable full-scale longer, thinner wings that maximize structural efficiency, reduce weight and improve fuel efficiency, said Karen Taminger, an Advanced Air Transport Technology project technical lead at NASA’s Langley Research Center in Virginia.

The PAT wing was tested during two phases this September and October at Armstrong. The experimental wing was tested with more than 10,000 sensors, making it one of the most densely instrumented test articles at Armstrong.

The tow steering composite technology, which refers to the way the carbon fibers are laid out, was used to build the wing skins. The concept was expected to passively control flutter, or vibration on the wings, through structural design that can also help minimize gusts for a smoother ride. The wing bent and twisted at the same time during the design load tests to make it more robust and controllable, but there were tense moments.

“There were a lot of unknowns going into the testing,” she said. “We had to make some assumptions and some simplifications in order to be able to do the design and analysis leading up to building the test article and beginning the testing. However, it worked better than I could have imagined. There were a lot of nervous moments as I watched that wingtip pass the 80-inch (bending) mark. It was awesome and scary at the same time.”

Now the analysis begins.

“I didn’t know how much the skins would contribute to the overall response of the wing,” she explained. “That’s why we needed so much instrumentation. We are trying to go back through the huge number of data points to quantify the responses we observed.”

The wing was more flexible than predicted, as was observed from early on in the October testing. To accommodate the increased flexibility the test team made some modifications to the test setup.

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Heather Maliska accepts the Center Director’s Award for the Low-Boom Flight Demonstrator Source Evaluation Board Team from Center Deputy Director Patrick Stoliker.

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Peers recognize center’s best

NASA Armstrong
Center Director’s Award
This award is presented to individuals or teams for exceptional work
Low-Boom Flight Demonstrator Source Evaluation Board Chair
Heather Maliska and team

Pride in NASA (PIN) Award
Given in recognition of an employee’s example, set through their words and deeds, of what pride is within NASA Armstrong
Manny Antimisiaris

James Harris Supervisor/Manager/Leader Award
Recognizes outstanding leadership and/or management qualities that delivers exceptional results
Russell R. Leonardo

Engineer/Scientist/Pilot
Recognizes an employee who applies fundamental principles, develops and tests new technologies or performs other outstanding contributions in their field
David C. Fedor

Mission Support: Administrative
Recognizes significant contributions in administrative or secretarial work
Ronnie Boghosian

Mission Support: Finance/Resources
Recognizes an employee performing exemplary financial or resources management work
Glenda Almeida

Mission Support: IT Support
Recognizes significant information technology support contributions by an employee who is enthusiastic, creative, quick and successful at creating solutions for customers
Debbie Phillips

Mission Support: Education/Volunteer/Outreach
Recognizes an employee who epitomizes the true spirit of outreach through enthusiasm and dedication, for those individuals who give back to Armstrong and our communities through volunteerism and selfless giving
Mary Ann Harness

Henry Arnaiz Mentor Award
Recognizes an employee who demonstrates outstanding performance in mentoring new and established employees
Roberta B. Sherrard

Steven B. Davis Co-op/Student Award
Recognizes a student participating in NASA Armstrong’s sponsored student program who shows exceptional initiative, cooperation, excellence and exemplary performance
Daniel W. Budolak

Peer Awards, page 11
Two ‘new’ hornets arrive

By Jay Levine

Two of Armstrong’s “new” F/A-18B Hornets arrived at Armstrong Nov. 6 and Dec. 7.

The center uses F/A-18s as part of its fleet of research aircraft to accompany other aircraft on missions as a second set of eyes and for pilot training. The B models are two-seat versions of the aircraft, not unlike Armstrong’s F/A-18B No. 846 that also flies photographers and videographers to document research missions.

Although the aircraft Armstrong are receiving are nearing the end of their service life for the Navy, some of the aircraft could have extended use for the center, as there are fewer flight hours on research and mission support aircraft than the frequent flight rates required for the military, said Tim Krall, an Armstrong flight operations engineer.

The first F/A-18B came from the U.S. Naval Air Station Patuxent River in Maryland, a two-day journey as a result of winds along the route. Lt. Cmdr. Mike Shelton made a stop overnight at Kirtland Air Force Base in Albuquerque, New Mexico, before reaching Edwards Air Force Base the following morning.

The second F/A-18B, which also came from the Naval Air Station, was piloted by Lt. Tristan Brandenburg, Krall said. The third Hornet will come from the U.S. Naval Air Joint Reserve Base in Fort Worth, Texas, in early 2019.

Armstrong pilots and support staff will assess the condition of the aircraft to determine if they might replace some of the center’s aging jets. Once the aircraft have been flown and evaluated, the best of the first two aircraft will begin a phase maintenance, which usually takes a few months per aircraft.

Once the third aircraft has arrived and been evaluated, decisions will be made regarding how many of the aircraft will be active and which ones could be used to fortify parts supplies needed to continue flying the F/A-18Bs.

Another consideration for the new aircraft to be mission ready is for installation of research equipment from the current NASA F/A-18B numbers 850 and 843 in two of the newer Hornets. Additional evaluations within the Armstrong support fleet are needed to make that determination, Krall said.

The Hornets will retain the charcoal gray Navy colors for most of the next year, although the aircraft immediately will receive a new tail number and a NASA logo. For example, one of the newly-arrived Hornets was here less than 24 hours before its new number, N868NA, was added. A NASA logo will appear on the vertical tail soon.

Armstrong first became aware of the Hornets’ availability within the past year when the Navy announced it would be ending active use of a number of aircraft. The center expressed an interest in acquiring some of those aircraft and obtained a list of what would be available. From that list, it was determined that the F/A-18B best fit what the center needed and the process to acquire the three aircraft began, Krall said.

The arrival of the Hornets marks the first time since 2010 that the center has received three aircraft in the same time frame. The center was able to acquire three F-15D aircraft that year from Tyndall Air Force Base in Florida.

John McTigue, a former Armstrong project manager who had a career spanning three decades, died Nov. 15. He was 90.

He came to California in 1952 where he accepted a job with the NACA at the High Speed Flight Research Station at Edwards Air Force Base, now known as Armstrong. During his career at Armstrong, McTigue worked on the Highly Maneuverable Aircraft Technology vehicles, the McTigue, former project manager, dies at 90
Attendees of the Armstrong annual Halloween chili cook-off, bake sale, and costume contest seemed to have a howling good time. The event raised $1,550 for the center’s Employee Exchange Council at the main campus and Building 703.

Chili Cook-off and costume contest winners:

People’s Choice
Brisky Business Chile, Code 700, main campus

Buffalo Meets Brisket Chili, Christian Fischer, Building 703

Judge’s Choice
Basic Chili, Tara McCoy, Susan

Moreno and Olivia Carte, main campus
Nelms Pork Chili, Jeff Nelms, Building 703

Costume Contest Winners

Most creative
Jeremy Helke as Star Lord from Guardians of the Galaxy

Scariest
Kate Squires as a vampire

Funniest
Heather McCoy alien abduction

Honorable mention
Mirela Isic and Erick Castillon as T-Rexes

Above, Heather McCoy is abducted as part of her award-winning funniest costume.

As left, Erick Castillon, left, Mirela Isic, Jeremy Helke and Kate Squires show off their award-winning costumes as T-Rexes, Star Lord and a vampire, respectively.

Chills and chili

Pat and Pam Stoliker served chili at the center’s annual Halloween event.
“We have to go determine why those results are different,” Taminger said. “We expect we will find the answer and it will allow us to add fidelity to our models and then see if we can better match the data we measured.”

Researchers also were pleased by an “unexpected, but hoped for” view of the wingtip turning in on the leading edge as a result of the towed steering concept. From an airflow perspective that would move the loading inboard into the thicker section of the wing where there is more structure that could passively alleviate gusts.

Once the models are refined, Taminger wants to see the approximately 30 percent wing scaled up to full size for a commercial transport to assess the benefits. In the end, the amount of fuel that can be saved by using such a wing will determine where the research will go. A longer wing usually requires more structure, but the tow steering concept could allow researchers the combined benefits of drag and weight reductions which translate to fuel burn advantages.

“We learned how to test highly flexible, high aspect ratio wings,” said Larry Hudson, Armstrong Flight Loads Laboratory chief test engineer. “We also learned how to use a unique overhead loading system to meet our test objectives. When you have highly flexible wings you have a lot of displacement at the tip. The technique we used worked well. We look forward to future opportunities to test other flexible wing designs.”

The project is funded through NASA’s Aeronautics Research Mission Directorate’s Advanced Air Transport Technology (AATT) project. AATT envisions enabling lightweight wings as much as twice as efficient as conventional commercial and military aircraft wings.

The test wing was designed by Aurora Flight Sciences facilities in Ohio and fabricated at the company’s Mississippi plant.
orbit allows the agency to focus on farther horizons. NASA will venture forward to the moon – this time to stay, in a measured, sustainable fashion – in order to develop new opportunities and prepare for astronauts to explore Mars.

The technology demonstrations onboard SpaceShipTwo could prove useful for exploration missions. For Principal Investigator Josh Colwell at the University of Central Florida in Orlando, the Virgin Galactic flight helped further refine the Collisions Into Dust Experiment (COLLIDE). The experiment aims to map the behavior of dust particles on planetary surfaces. Suborbital flights let Colwell and his team gather data useful for designing exploration architectures at the moon, Mars and beyond.

The presence of dust on asteroids and moons with low surface gravity introduces challenges for human and robotic missions. Particles can damage hardware and contaminate habitats. Understanding dust dynamics could help NASA design better tools and systems for exploration missions.

On this microgravity flight, COLLIDE simulated the dusty surface of an asteroid and a surface impact. The experiment collected high quality video of the dust dispersing. “We want to see how dust in microgravity behaves when it’s disturbed. How fast will it fly around? How careful do you have to be to avoid disturbing the surface too much? If you have a hard landing and disturb the surface a lot, how long will you have to wait for the dust to clear?” Colwell explained.

Here on Earth this isn’t as much of a concern. Colwell explained that in space, where the absence of gravity complicates every task at hand, such considerations are significant for mission planning. “If you have a small dust disturbance and can work around it, great. If the dust particles have enough speed, they can contaminate and stick to equipment well above the surface, posing problems for safety as well as mission success,” Colwell said.

COLLIDE data collected on its first mission to suborbital space, as well as data from a related experiment previously tested on NASA-sponsored parabolic aircraft flights, could help future human and robotic explorers throughout the solar system. The other technology payloads on the SpaceShipTwo flight were:

- **The Vibration Isolation Platform**
  - **Flow Experiment for Suborbital Testing** from NASA’s Johnson Space Center in Houston focuses on life support systems that are an integral part of a deep space habitation capability. They typically include processes where liquids and gases interact, therefore requiring special treatment in space. This two-phase system separates gas and liquid in microgravity. The technology could also be applied to in-situ resource utilization, power systems, propellant transfer and more.

- **The Validating Telemetric Biological Imaging Hardware for Crew-Assisted and Crew-Autonomous Imaging Hardware for Crew-Assisted and Crew-Autonomous Biological Imaging in Suborbital Applications** from the University of Florida in Gainesville investigated food growth for future missions in deep space. This experiment studies how microgravity affects plant growth. The experiment used a biological fluorescent imaging instrument designed to collect data on the biological response of a plant, or plant tissue.

- **The Vibration Isolation Platform** developed by Controlled Dynamics Inc. in Huntington Beach, California, looked at the intense launch environment to which spacecraft and payloads are subjected. This mounting interface for orbital and suborbital vehicles is designed to lessen disturbances on payloads during launch, re-entry and landing.

All four payloads are currently scheduled for future flight demonstrations, enabling researchers to gather additional data and mature their technologies.

The Flight Opportunities program is funded by NASA’s Space Technology Mission Directorate at NASA Headquarters and managed at Armstrong. NASA’s Ames Research Center in California’s Silicon Valley manages the solicitation and selection of technologies to be tested and demonstrated on commercial flight vehicles. Virgin Galactic and other U.S. commercial spaceflight providers are contracted to provide flight services to NASA for flight testing and technology demonstration. Researchers from academia, industry and government with concepts for exploration, commercial space applications or other space utilization technologies of potential interest to NASA can receive grants from the Flight Opportunities program to purchase suborbital flights from these and other U.S. commercial spaceflight providers. The next solicitation for potential payloads is anticipated for release in January 2019.

The X-Press is published the first Friday of each month for civil servants, contractors and retirees of the NASA Armstrong Flight Research Center.

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The Vibration Isolation Platform from Controlled Dynamics Inc. had completed five successful Flight Opportunities-sponsored flights on suborbital reusable launch vehicles (sRLVs). The SpaceShipTwo flight marked its sixth.