National Aeronautics and Space Administration

THE ARMSTRONG
X-PRESS

Volume 60 Number 9 September 2018

AFRC2018-0239-06 NASA/Jim Ross

A T-34 aircraft, foreground, allows researchers to watch the progress of a remotely piloted X-56A flight.

X-56A is on target

By Jay Levine
X-Press editor

The remotely piloted X-56A subscale aircraft has demonstrated with a classic flight controller in flight that flutter can be suppressed at 110 knots, or about 127 mph, in a lower weight configuration.

The flight Sept. 15 at Armstrong was intended to validate and improve aerodynamic computer models as well as determine aircraft characteristics at the higher airspeed, said Cheng Moua, X-56A project manager.

The focus of test flights shifts this month from building good aerodynamic models that predict the speed at which flutter will happen to demonstrating suppression at higher speeds with a modern, robust flight controller.

"Suppressing flutter with this type of aircraft is groundbreaking," Moua said. "This is awesome."

The X-56A is intended to validate enabling technology for designing aircraft with highly

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PAT wing tested in loads lab

By Jay Levine
X-Press editor

Two series of structural tests on a uniquely designed, high-aspect-ratio, lightweight experimental test article could demonstrate a new method of wing design and fabrication.

Karen Taminger, an Advanced Air Transportation Technology project technical lead at the NASA Langley Research Center in Virginia explained the Passive Aeroelastic Tailored (PAT) wing could enable longer, thinner wings that maximize structural efficiency, reduce weight and improve fuel efficiency.

"This is the first time a tow steered composite wing with this complexity has been built," Taminger said. "At 39-feet long, the test wing is 27 percent the scale of a conventional wing and will see a wing tip deflection, or bending, estimated to range from 6 feet to 8 feet. The efficiency is expected to be greater than traditional aircraft wings due to reductions in drag and weight."

The tow steering composite technology, which refers to the way the carbon fibers are laid out, was used to build the wing skins. The idea is to passively control flutter, or vibration on the wings, through a structural design that can also help

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Research focuses on breathing

By Rebecca Richardson
Armstrong Public Affairs

NASA pilot Jim Less climbed into the cockpit of the F/A-18 aircraft, secured his safety equipment, and took in a long and deep breath. It's not every day that NASA is tasked with a mission that could save someone's life, but for the next few months that has become a focus for Armstrong pilots. Managed by the NASA Engineering and Safety Center (NESC) at Langley Research Center in Virginia, the center's newest flight series will task its pilots with the role of simulating a series of in-flight activities to better understand how flight conditions can impact a pilot's breathing during high-performance aircraft flights.

Armstrong began a series of flight tests Aug. 3 that will identify the impacts of flying in high-performance aircraft on the human body. NASA plans to dedicate 160 flight hours during which the NESC will measure the breathing of five NASA pilots across a range of aircraft types, aircrew equipment types and flight conditions. The flight conditions that will be tested include anything from benign environments, typical in instrument proficiency training, to more strenuous environments, such as those found in high altitude, aerobatic maneuvering and combat maneuvering.

Over the past five years, the U.S. Navy and the U.S. Air Force have noticed an increase in pilots experiencing physiological events, or PEs, during flight. PEs can involve several symptoms, including cognitive impairment, numbness, tingling, lightheadedness, behavioral changes and fatigue. While the history of these PEs can be traced back to the early 1990s, the causes for such occurrences remains unknown. Despite the military's analysis and corrective actions to resolve the issue, PEs persist and the root cause remains elusive.

In March 2017, the NESC assembled a multidisciplinary team to perform an independent assessment of the Navy's previous research. The assessment was intended to support the Navy in developing more robust and efficient methods for analyzing how the human body responds in high-performance aircraft during flight. This team consisted of several technical experts in the areas of environmental control systems, oxygen systems, life support systems, aviation systems, systems engineering, flight medicine, physiology, human systems/human factors, analytical chemistry, safety, and data mining and analysis.

AFRC2018-0104-02 NASA/Carla Thomas

Armstrong pilot Jim Less is assisted by Phil Wellner as he is fitted with a Cobham designed VigiLOX pilot oxygen monitoring system. VigiLOX is a sensing system that is attached to a pilot's existing gear to capture real-time physiological, breathing gas and cockpit environmental data.

AFRC2018-0104-09 NASA/Carla Thomas

Armstrong pilot Jim Less sits in the cockpit of a NASA F/A-18 aircraft in preparation for flight tests that will be used to understand the physiological impacts that high-performance aircraft have on pilots.

During a recent congressional testimony, NESC principal engineer Clinton Cragg, described NASA's preliminary evaluation and findings. "We found that there has been very little investigation surrounding the human in the cockpit." To Cragg and the NESC, there were major data points that had yet to be captured from previous PE research. "We don't have the amount of oxygen in his mask, the amount of CO2 in his mask, the pressure you'd want to know about in the cockpit, nor the pilot's breathing rates. Those types of things are what could help us do a full physiological assessment of what's happening to the pilot."

The NESC approach to solving this problem comes from the foundational understanding that PEs do not happen to aircraft, but rather to people - making the problem one that must be approached by considering the pilot and the aircraft as an interwoven system.

Armstrong's F-18A/B aircraft and F-15D aircraft will serve as the testbed for this study; these aircraft still use the legacy technology of a Liquid Oxygen System (LOX), as opposed to newer military aircraft that use an Onboard Oxygen System (OBOGS). Given that the NASA aircraft use a different system, the data collected by NASA will serve as a baseline for comparison to the OBOGS system.

"As a retired Air Force fighter pilot, I understand the military mission and the environment in which our pilots need to operate," said Less. "It is my hope that the data we gather will increase our understanding of the physiology of flying high-performance fighters and will allow the military to resolve the problems they've been having with physiological events. Our military pilots need to have complete confidence in their equipment so they can focus on carrying out their vital missions."

Over the next few months of flight testing, NASA will help to optimize human pilot performance while simultaneously minimizing the potential for these unexplained PEs during flight. It is not every day that people have the chance to explore such life-changing questions. For NASA aviators like Less, it is just another day at the office.

AFRC2018-0227-01 NASA/Ken Ulbrich

Team members who contributed to a winning effort include from left David Faust, Jerry Budd, Chuck Rogers and John Kelly.

TGALS triumphs in contest

At the Hypersonic Technology and Systems Conference in Redondo Beach, Aug. 27-30, the Towed Glider Air-Launch System (TGALS) was selected by the more than 400 attendees as the best poster. The Towed Glider Air Launch System concept uses a glider to launch a rocket that can then boost a satellite to space.

The project was selected from about 50 posters and more than 70 presentations. The selection criteria included technical merit and presentation.

Preparing sensors for AA-2

Brad Grantham, left, and Todd Shaw add a shield to protect the system from electromagnetic interference. The duo, with partner Krit Meekaewschvee, have worked on six system packages for the Orion AA-2 vehicle. Learn more details about Armstrong's role in Orion AA-2 work in the next issue of the X-Press.

AFRC2018-0228-01 NASA/Ken Ulbrich

News at NASA

Sanders is new NASA deputy AA

Melanie W. Saunders has been selected as NASA's deputy associate administrator, the agency's second highest-ranking civil servant position. Saunders has been serving in the position in an acting capacity since June 10, following the retirement of Krista Paquin. In this role, her responsibilities include chairing the NASA Mission Support Council, which serves as the senior decision-making body regarding the integrated agency mission support portfolio.

"Her depth of experience and understanding of NASA will be a great asset as we face the exciting challenges ahead," said Associate Administrator Steve Jurczyk, who appointed her.

Saunders was previously acting deputy center director at the Johnson Space Center in Houston from Feb. 1, 2018 to June 10, 2018. Prior to that, as Johnson's associate director since 2009, she oversaw a broad range of human spaceflight activities.

At Johnson, she also served as associate manager of the International Space Station Program (ISS) from 2005 to 2009, during the most intensive phases of ISS assembly, and deputy manager of the ISS External Relations Office from 2003 to 2005. Saunders began her NASA career in 1994 as the manager for International Policies for the International Space Station Program, where she negotiated international agreements.

During her NASA career, Saunders has received numerous awards.

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Back to the Future

Armstrong Pilot’s Office recreates iconic images to honor NASA’s 60th

ECN-151 NASA

Research pilots in 1955 included in the front row from left Milt Thompson, Jack McKay and Bill Dana. In the back row from left are Neil Armstrong, Bruce Peterson, Stanley Butchart and Joe Walker.

AFRC2018-0221-02 NASA/Lauren Hughes

The Armstrong Pilot Office recently recreated the photo at left from 1955. From left in the above photo are Brett Thomas, Jim Less, Dean Neeley, Glenn Graham, Bart Henwood, Nils Larson, Frank Batteas and Hernan Posada.

ECN-14188 NASA

X-15 rocket plane pilots included from left U.S. Air Force personnel Col. William J. “Pete” Knight, Maj. Robert A. Rushworth, Capt. Joseph H. Engle and NASA pilots Milton O. Thompson, Bill Dana and John B. “Jack” McKay.

AFRC2018-0221-02 NASA/Lauren Hughes

Hernan Posada, from left, Nils Larson, Glenn Graham, Brett Thomas, Jim Less, Frank Batteas and Dean Neeley view the T-34 as homage to the X-15 pilot’s image at left.

ECN-149 NASA

The research pilots at what in October 1962 was called the Flight Research Center stand in front of the X-1E. From left to right are Neil Armstrong, Joe Walker, Bill Dana, Bruce Peterson, Jack McKay, Milt Thompson and Stanley Butchart.

AFRC2018-0221-02 NASA/Lauren Hughes

Bart Henwood, from left, Hernan Posada, Jim Less, Glenn Graham, Nils Larson, Dean Neeley, Frank Batteas and Brett Thomas recreate a 1962 image.

Photo courtesy of Frank Batteas

E55-1739 NASA

This pilot’s meeting May 11, 1955, was attended by, from left, De Beeler, Joe Vensel, John McKay (standing) Joe Walker, Jake Drake, Stan Butchart and Scott Crossfield.

AFRC2018-0221-02 NASA/Lauren Hughes

***Above,** Dean Neeley, from left, Brett Thomas, Glenn Graham, Hernan Posada, Nils Larson, Frank Batteas and Jim Less recreate a 1955 meeting seen at left. **Above near the headline** is one of the images that inspired the photo recreations.*

NASA space tech tested on UP rocket

By Leslie Williams
NASA Armstrong News Chief

Three NASA technology demonstration payloads launched aboard the UP Aerospace SpaceLoft 12 mission from Spaceport America in New Mexico Sept. 12.

The suborbital rocket carried an umbrella-like heat shield called Adaptable Deployable Entry and Placement Technology (ADEPT). Developed by NASA's Ames Research Center in California's Silicon Valley, the unique design of ADEPT could be used for planetary lander and sample return missions. The flight tested heat shield deployment sequence and entry performance.

Another Ames payload called Suborbital Flight Environment Monitor (SFEM-3) measures the internal environment of suborbital rockets carrying experiments. The system monitored acceleration, temperature and pressure within the payload bay during flight and could benefit future suborbital launches.

The third technology is from NASA's Kennedy Space Center in Florida and is the Autonomous Flight Termination System (AFTS). While the termination device was not active during launch, the payload tested hardware and software performance in the high dynamics of suborbital flight.

The payload flight tests were funded by the Space Technology Mission Directorate's Flight Opportunities program and managed at Armstrong.

AFRC2018-0221-02 **NASA/Lauren Hughes**

UP Aerospace SpaceLoft rocket launched into space Sept. 12 from Spaceport America in New Mexico carrying three NASA technologies onboard to test in microgravity.

Students of summer

AFRC2018-0228-01 **NASA/Ken Ulbrich**

Armstrong Education Office sponsored interns included from left to right Robert Bloom, Brittany MacNamara, Zachary Houghton, Tomoki Fukazawa, Macie Kowalski, Thomas Cauvel, Erin Askins, Emily Glover, Ryan Beattie, Todd Coursey, Kai Creason, Jonathan Lokos, Joycelin Orellana, Michael Cantos, Christine Yang, Trevor Parmely, Mark Matlack, Hannah Smith, Daniel Simmons, Anthony Contrado, Daniel Gagnon, Caleb Gott, Josh Barrett, Patrick Noerr, Victoria Hawkins, Stephen Harris, Moises Martinez, Rachel Suitor, Kasai Omar, Nicholas Farrell, Christopher Jensen, Kevin Guerra, Aubrey Coffey, Hannah Stoll, Kyle Barnes, Brooke Losey, Nicholas Cross, Brenden Stevens, Hayden Hollenbeck, Mihai Floarea, Daniel Rosales, Nathaniel Boisjolie-Gair, Mark Noftz, Michael Wallace, Rachel Haering, Max von Hippel, Erin Solomon, Dann Young, Katelyn Hanks, Danielle Meisner, Evan Cusato, Brandon Snyder, Abigail Kosiak, Olivia Alexander, Cole Walls, Kylie Vandenson, Deborah Jackson, Steven Vanderlaske, Abbigail Waddell, Michael Raymer and Jacob Smith.

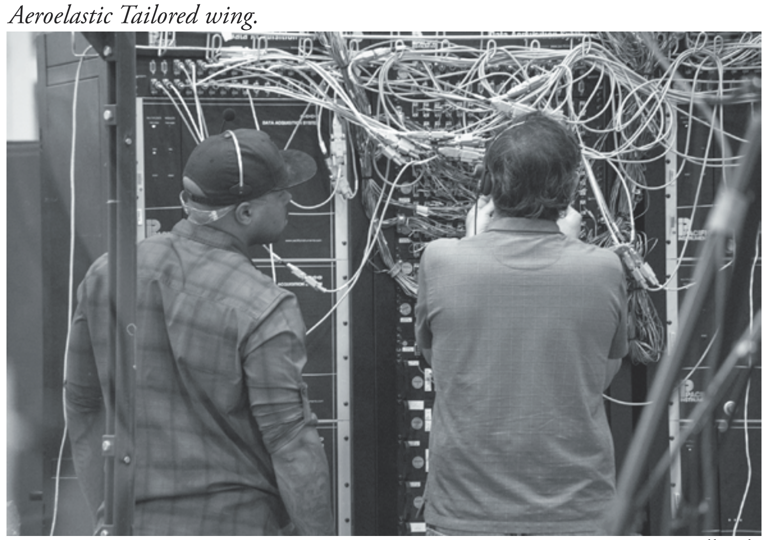
PAT wing... from page 1


AFRC2018-0091-707 NASA/Ken Ulbrich

***At right**, the Passive Aeroelastic Tailored wing is tested in a fixture at Armstrong. **Above**, a big picture of the test apparatus.*


AFRC2018-0091-636 NASA/Ken Ulbrich

Wally Hargis, left, and Ted Powers complete preparations for testing the Passive Aeroelastic Tailored wing.


AFRC2018-0091-580 NASA/Ken Ulbrich

Eric Sinks, left, and Ron Haraguchi work through a challenge with the wiring from the Passive Aeroelastic Tailored wing to the test fixture.

minimize gusts for a smoother ride for passengers Taminger said.

The first phase of the testing wrapped up Sept. 17 at Armstrong, where PAT wing technicians have added 11,000 sensors to the article, making it "the most highly instrumented wing we have ever tested," said Larry Hudson, Armstrong Flight Loads Laboratory chief test engineer.

The test fixture, methodology and instrumentation address a number of testing challenges.

"The capability is fantastic," Taminger said. "We wanted to have that many sensors because we are trying to drive the structure to do something it normally wouldn't do. We wanted a large number of sensors using different techniques, including conventional strain gauges, fiber optic sensors for strains across the entire length of fiber and digital image correlations to measure and understand the strain along the entire wing surface to characterize this complicated test article."

The task is not simple.

"To recreate in the lab what that wing would encounter in flight is a real challenge," Taminger said. "The overhead structure had to be designed to account for these very, very large tip deflections. That makes for another nuance in the loading system that makes this test all the more impressive and challenging."

The PAT wing first arrived in April and lab personnel completed ground vibration tests on the structure in July. The loads testing began in September and the second phase is set to begin in October. The Loads Lab designed a special test fixture and along with a series of underwing actuators, overhead hydraulic actuators and cables, so that loads simulating distributed air pressures can be applied to the wing.

To prepare for working with the PAT Wing, Hudson said a Calibration Research Wing, or CREW Wing, was tested to verify the hardware and procedures. The CREW wing was from a MQ-9, which is similar to a previous


AFRC2018-0091-708 NASA/Ken Ulbrich

NASA remotely piloted Ikhana aircraft flown at Armstrong. The CREW wing was provided by Davis-Monthan Air Force Base in Arizona. The two wings shared a similar instrumentation layout and collected similar data, Hudson explained. The biggest difference in testing the two wings was the test architecture in the overhead loading system that was modified to handle the significantly larger wing tip bending expected on the PAT wing.

The next step after completing the tests is to compare the actual results to those that were predicted and use that information to create a full-scale wing design for a commercial aircraft, Taminger said.

"After completing the tests, what we learned will compare weight and stiffness, back to a baseline aircraft," she explained. "We will take what we learned here, refine it and further optimize the structure for the next generation wings. To make this more realistic, we want to go to a full aircraft design study and look at drag and weight and a whole suite of efficiencies to see where the technology can take us."

The project is funded through NASA's Aeronautics Research Mission Directorate's Advanced Air Transportation Technology (AATT) project. AATT envisions enabling lightweight wings that are up to two times the efficiency of conventional wings on commercial and military aircraft.

The test wing was developed by Aurora Flight Sciences facilities in Dayton, Ohio, and fabricated at the company's manufacturing plant in Columbus, Mississippi.

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flexible, lightweight wings. The use of less structurally-rigid wings could be critical to future long-range, fuel efficient airliners. The experimental aircraft is investigating the destructive vibration known as flutter, to which such wings can be susceptible.

A combination of ground vibration tests and loads testing helped improve models, but it is the flight data that is significantly refining the models as the classical controller was modified and tuned.

"We want to understand the airplane and how it behaves," Moua explained. "When we had flown the modern controller earlier in the program, it didn't perform as we expected because the models were not as accurate as we thought. The modern controller relies on a highly accurate model of aircraft."

In the new phase of flights, the tests will begin at 70 knots, or about 81 mph, and progress in increments of 10 knots, or about 11.5 mph, to build confidence in the models and advance toward the flutter suppression goal.

He likened the controllers to high-performance sports cars where one is good, but the other is better.

"We are close to suppressing flutter with the new controller, we are almost there," he added. "There is more uncertainty as you approach flutter with the classical controller, while the new controller is more robust."

Many factors lead to flutter, but changing fuel weight during flight is a key. When the aircraft is heavier, it doesn't encouter flutter until it reaches a higher speed. However, as it becomes lighter, it can experience flutter at a much slower speed.

Lockheed Martin developed the X-56A aircraft for the U.S. Air Force Research Laboratory and transferred the aircraft to Armstrong for flight research.

AFRC2017-0246-45 NASA/Lauren Hughes

The X-56A flies a research mission. The project focus is shifting from building aerodynamic computer models to demonstrating flutter suppression.

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.

Cassini data show dust storms on Titan

Data from NASA's Cassini spacecraft have revealed what appear to be giant dust storms in the equatorial regions of Saturn's moon Titan. The discovery, described in a paper published on Sept. 24 in "Nature Geoscience," makes Titan the third Solar System body, in addition to Earth and Mars, where dust storms have been observed.

The observation is helping scientists to better understand the fascinating and dynamic environment of Saturn's largest moon.

"Titan is a very active moon," said Sebastien Rodriguez, an astronomer at the Université Paris Diderot, France, and the paper's lead author. "We already know that about its geology and exotic hydrocarbon cycle. Now we can add another analogy with Earth and Mars: the active dust cycle, in which organic dust can be raised from large dune fields around Titan's equator."

Titan is an intriguing world, in ways quite similar to Earth. In fact, it is the only moon in the Solar System with a substantial atmosphere and the only celestial body other than our planet where stable bodies of surface liquid are known to still exist.

There is one big difference, though: On Earth such rivers, lakes and seas are filled with water, while on Titan it is primarily methane and ethane that flows through these liquid reservoirs. In this unique cycle, the hydrocarbon molecules evaporate, condense into clouds and rain back onto the ground.

The weather on Titan varies from season to season as well, just as it does on Earth.

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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