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Twistable, flexible wing flaps work

By Matt Kamlet
Armstrong Public Affairs

NASA has conducted a series of flights investigating the benefits of twistable, flexible wing flaps to improve flight efficiency.

The second series of Adaptive Compliant Trailing Edge flights, or ACTE II, was flown recently at Armstrong and continued three areas of research based on knowledge gained from the project's first series, which flew in 2014 and 2015.

The ACTE project began as a joint effort between NASA and the U.S. Air Force Research Laboratory, or AFRL, to investigate the ability of shape-changing surfaces to determine if advanced flexible trailing-edge wing flaps can improve aircraft aerodynamic efficiency and reduce the airport-area noise generated during takeoffs and landings. In 2014, engineers replaced the conventional aluminum wing flap on NASA's Gulfstream-III Subsonic Research Aircraft Testbed, or SCRAT, with a seamless, twistable flap, patented and built by FlexSys Inc. of Ann Arbor, Michigan.

ACTE II advanced several steps from the project's initial phase, including validation of the technology at higher speeds, investigation of the flap's impact on drag and the first flights of a twisted flap configuration.

The completion of a flight with a twisted flap configuration through ACTE II marks a major milestone for compliant structure technology. The flight featured the flap set in such a way that different areas of the flap were deflected in different positions. The purpose was to demonstrate the ability to fly with a twisted configuration.

To accomplish the twisted flap configuration, engineers deflected

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Experimental aircraft in proposed budget

By Jay Levine
X-Press editor

NASA's human-piloted experimental aircraft plan for technology readiness, increasing efficiency, safety, fuel efficiency and reducing supersonic overland travel barriers is included in the Trump administration's proposed $19.1 billion 2018 NASA budget released May 23.

"We are encouraged that the proposed budget includes the continued development of experimental aircraft," said Armstrong Center Director David McBride. "There will be challenges within the budget, but we see the overall proposal as supportive of NASA's missions."

The pace of the proposed human-piloted experimental aircraft in the New Aviation Horizons plan unveiled last year would be modified from concurrent efforts to a new experimental airplane every four years if the budget is approved.

AFRC2016-0268-18 **NASA/Ken Ulbrich**

The X-57 wing integration continues at Scaled Composites in Mojave before it comes to Armstrong for research flights.

Elements of that plan are underway. For example, the X-57 electric demonstration aircraft, the first of the New Horizons experimental airplanes, is expected to arrive at Armstrong later this year. In addition, a contract award is intended this year for construction of a human-piloted low-boom demonstrator that will feature supersonic flight without the thunderous noise that currently limits such travel over land. Lockheed Martin's Skunk Works is working on the preliminary design based on a contract awarded this fiscal year. The demonstrator is scheduled for flight testing in 2021.

The New Horizons Initiative schedule also includes a human-piloted, subsonic, experimental aircraft with a hybrid-wing body shape, on which the familiar tube-and-wing configuration becomes a wing that blends into the body. The remotely piloted X-48 Blended Wing Body aircraft flew at Armstrong in different configurations from 2007 to 2013. Researchers said

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CPEX

NASA mission data could help answer fundamental questions about weather

By Carol Rasmussen
JPL Public Affairs

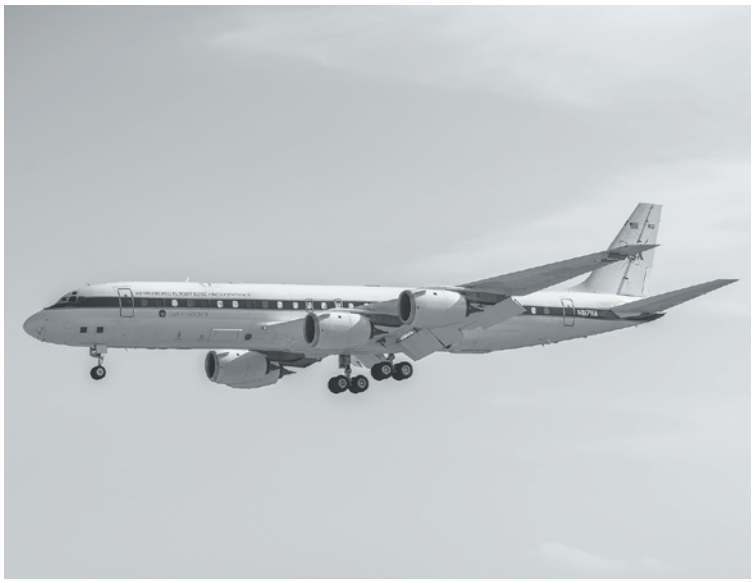
A NASA-funded field campaign began in Florida May 25 that could improve meteorologists' ability to answer some of the most fundamental questions about weather: Where will it rain? When? How much?

Called the Convective Processes Experiment (CPEX), the campaign is using NASA's DC-8 airborne laboratory outfitted with five complementary research instruments designed and developed at NASA. The DC-8 aircraft and crew usually are based at Armstrong, but for the mission operations are from Fort Lauderdale, Florida.

The plane also will carry small sensors called dropsondes that are dispensed from the plane and make measurements as they fall. Working together, the instruments will collect detailed data on wind, temperature and humidity in the air below the plane during the birth, growth and decay of convective clouds – clouds formed by warm, moist air rising off the subtropical waters around Florida.

"Convection is simply a column or bubble of warm air rising," said CPEX principal investigator Ed Zipser of the University of Utah in Salt Lake City. That rising air may become the seed of a rainstorm; in the tropics and subtropics, including the U.S. South, convection is the most common way for precipitation to form. Convective clouds can join together to form a major rainstorm or can even become a hurricane.

Even though convection is such a fundamental atmospheric process, the start of convection has proven difficult to predict. Bjorn Lambrigtsen of NASA's Jet Propulsion Laboratory in Pasadena, a member of the CPEX science team, explained why: "Tropical convection flares up quickly. A thunderstorm pops up, does its thing, and goes away in an hour or so. And they're not very large." They're typically less than 6 miles (10 kilometers) across. Satellites can't observe much detail about a feature that small even if they happen to be looking at the right place at the right time. "To understand what makes a thunderstorm form and grow, we need field campaigns. We need to fly to where the storms are, look at them and their environment in detail and measure all the important features at the same time," said Lambrigtsen.



Courtesy Broward County Aviation Departmentt

NASA's DC-8 science laboratory is flying missions for the Convective Process Experiment that could help answer fundamental weather questions.

Zipser is particularly interested in areas of deep convection, with cloud tops higher than jets fly. "If you look at a vacation poster of Hawaii, you see a sky full of little cotton balls," he says. "Those clouds are only a few kilometers deep, and you might get a light shower out of them. The troposphere over the tropics is 14 or 15 kilometers [9 miles] deep, and the top half of deep convective clouds is full of ice particles instead of liquid drops. If these deep clouds become better organized, grow into a large system and move over land, you can have widespread, heavy rainfall for the better part of a day. We need to find out when deep convection is going to form and why."

The CPEX team plans to log 10 to 16 flights in June for about 100 flight hours, weather permitting. They hope to record the entire evolution of convective storms, from birth to decay. They'll fly in whichever direction the weather seems most promising, whether it's the Gulf of Mexico, the Caribbean or the western Atlantic Ocean. The most interesting data should come when the plane is able to penetrate deep but moderate convection without the threat of lightning, collecting data from inside a storm or storm system.

The five NASA instruments are flying together as a group for the first time:

• DAWN, the Doppler Aerosol Wind Lidar, is a relatively new addition to NASA's Earth science toolkit that measures the horizontal wind profile below the plane. It was developed and is operated by NASA's Langley Research Center in Virginia. Lambrigtsen noted that in contrast with dropsondes, which collect data only from the spots where they're dropped, DAWN collects a swath of continuous data along the flight path. "It's one of the most important measurements for understanding tropical convection, and it was not available till DAWN and similar sensors came on the scene," Lambrigtsen said.

• APR-2, the Airborne Second Generation Precipitation Radar, measures precipitation and vertical motion within storms using the same kind of dual-polarization, dual-Doppler technology as the National Weather Service's ground-based radar. Developed and operated by JPL, APR-2 measures the rain or ice particles in a cloud, which reveal the cloud's structure.

• Three microwave radiometers from JPL measure what Lambrigtsen calls "the bread and butter of convection" – temperature, water vapor and the amount of liquid in clouds:

HAMSR – the High Altitude Monolithic Microwave integrated Circuit Sounding Radiometer;

MTHP – the Microwave Temperature and Humidity Profiler;

MASC – the Microwave Atmospheric Sounder on Cubesat. This experimental instrument will test the possibility of flying a miniaturized microwave radiometer on a tiny satellite called a Cubesat. JPL scientists will assess MASC's performance in CPEX to advance the instrument along the path to space readiness.

P-Card transition starts

The Armstrong Purchase Card (P-Card) program transitioned to the NASA Shared Services Center (NSSC) June 1. Armstrong cardholders will continue reconciling their monthly bank statements and Armstrong approving officials will continue to process approvals of Armstrong transactions. The NSSC P-Card team will now perform the importing and exporting of monthly transactions, as well as account setup and maintenance.

If a cardholder has a specific question relating to reconciliation, or what he or she can or cannot purchase using the NASA Purchase Card, the answer is available at the NSSC Customer Contact Center at 877-677-2123.

Refer to the NSSC's P-Card website for more information about the program at https://www.nssc.nasa.gov/purchasecard. Check back regularly because the webpage will be updated with additional information.

AFRC2017-0101-1 NASA/Lauren Hughes

The NASA Shared Services Center Purchase Card Team recently visited Armstrong. From left in the front row are Shari Trigg, Bobbie Young, Shanna O'Neal, Helen "Dodie" Bullock and Suzanne Honeycutt. In the back row from left are Rhonda Newell, Jim Eastman, Ed Wallace and Cheryl Shastid.

Armstrong pilots visit JetHawks

NASA pilots join KaBoom, the Lancaster JetHawks baseball team's mascot, following the F/A-18 fly over of the stadium for Aerospace Appreciation Day on May 12. From left are Troy Asher, Jim Less, KaBoom and Hernan Posada.

Photo Courtesy of Marshall Murphy

News at NASA

Juno shows complexity of Jupiter

Early science results from NASA's Juno mission to Jupiter portray the largest planet in our solar system as a complex, gigantic and turbulent world. It has Earth-sized polar cyclones, plunging storm systems that travel deep into the heart of the gas giant and a mammoth, lumpy magnetic field that may indicate it was generated closer to the planet's surface than previously thought.

"It was a long trip to get to Jupiter, but these first results already demonstrate it was well worth the journey," said Diane Brown, Juno program executive at NASA Headquarters.

Juno launched on Aug. 5, 2011, entering Jupiter's orbit on July 4, 2016. The findings from the first data-collection pass, which flew within about 2,600 miles (4,200 kilometers) of Jupiter's swirling cloud tops on Aug. 27, were published in two papers in the journal Science, as well as 44 papers in Geophysical Research Letters.

Among the findings that challenge assumptions are those provided by Juno's imager, JunoCam. The images show both of Jupiter's poles are covered in Earth-sized swirling storms that are densely clustered and rubbing together.

"We're puzzled as to how they could be formed, how stable the configuration is, and why Jupiter's north pole doesn't look like the south pole," said Scott Bolton, Juno principal investigator from the Southwest Research Institute in San Antonio.

More on the Juno mission is available at: https://www.nasa.gov/juno

Excellence in silence

Woman learned math before she learned language and marked a major first in the control room

By Matt Kamlet
Armstrong Public Affairs

On April 4, 2017, which was the 34th anniversary of Space Shuttle Challenger's maiden voyage, a modified NASA Gulfstream III took off from Edwards Air Force Base to become the first NASA aircraft to fly with a twisted wing flap configuration.

Meanwhile, inside Armstrong's mission control center were engineers working the flight and validating technology to test improved flight efficiency through the use of a twisted flap. They watched their monitors, analyzed the flight's early stages and all wore headsets to listen in on communications – all except one.

In the front of the room, wearing no headset, sat systems engineer Johanna Lucht. On a day of firsts for NASA, she became the first deaf engineer to carry out an active role in a NASA control center during a piloted mission.

Lucht, who was born deaf, earned the training position of Systems II engineer for the flight. She was responsible for observing and evaluating data related to the aircraft's GPS and Navigation Systems, as well as analyzing inflight data, to monitor how well the aircraft was performing in flight.

The milestone of having a deaf engineer in a major role was not without its challenges. It was the ability to overcome challenges, however, that made NASA and Johanna the perfect fit.

Lucht was born in Germany, where resources for deaf people were, at the time, limited. As a result, she was unable to communicate through much of her childhood. In fact, Lucht developed an understanding of mathematics before she acquired language. At the age of nine she learned her first true language, which is American Sign Language, or ASL, followed by English.

It was that passion for math and the ability to face challenges that led Johanna to her eventual studies of science, technology, engineering and mathematics, or STEM, and began her road to NASA.

AFRC2017-0076-03 **NASA/Lauren Hughes**

Johanna Lucht, observing data from the Mission Control Center at Armstrong received flight communications from an interpreter, seen on Lucht's monitor, through American Sign Language. Two-way visual communication was established between Lucht and the interpreter, located at NASA's Langley Research Center in Virginia, for the flight. Lead systems engineer Keith Schweikhard is at left.

"Math was the first thing I really understood in school, so I always had a love for it, growing up," Lucht stated. "It was something I worked at understanding, and it became my favorite subject. I grew up skilled in math."

Lucht moved to Alaska, where there were more accessible programs for deaf individuals, as well as exposure to the deaf community. This allowed her not only to mature her communication skills, but to expand her studies in STEM. One program, Summer

Academy 2008, introduced Johanna to computer science, and she began to immerse herself further into this study.

As a computer science student at the University of Minnesota – Twin Cities, Lucht began receiving emails about a NASA internship program. Initially, she had no intention to apply for the program, but finally, on the third email, she gave it a try. Shortly after, she was accepted to intern at NASA Armstrong.

"NASA offered me the opportunity, and I was shocked," Lucht recalled. "When I was a kid, I used to learn about Challenger and the shuttles. It was interesting, but I never really thought I'd be a part of NASA. When I read the offer in the email, I closed my laptop, went for a walk, came back, re-read it, cleaned my glasses and read it again. I pinched myself and decided this was really happening."

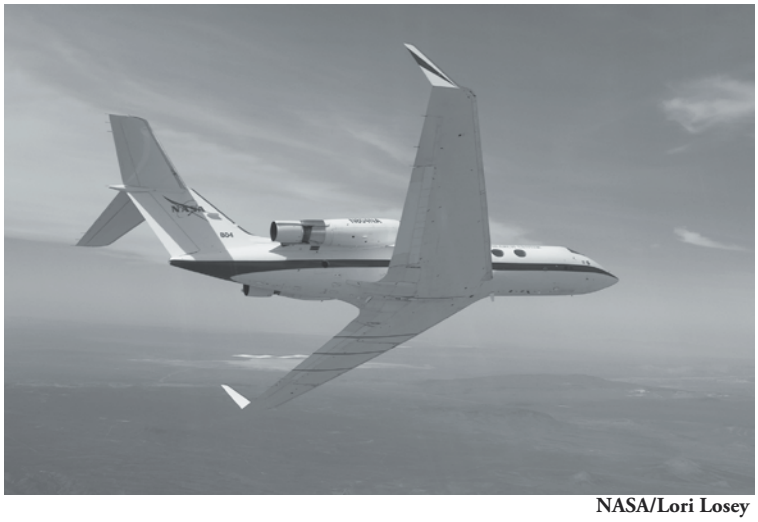
As an intern in NASA Armstrong's research and engineering department, Lucht worked on the interface for a mobile app version of the Ground Collision Avoidance System, meant to alert pilots to the detection of potentially hazardous terrain.

Lucht's talent and ability to meet challenges efficiently and analytically were evident to NASA, and she was offered a permanent position shortly following her internship.

Lucht joined NASA Armstrong's Sensors and Systems Development branch, before transferring to the center's Vehicle Integration and Test branch in 2016, which designs, integrates and tests research systems onto airborne platforms.

Lead systems engineer Keith Schweikhard says it didn't take long to notice the magnitude of Lucht's talent.

"Johanna was given an assignment to run environmental testing with the lab technicians. It could have been a challenge, because she had to communicate with a group of strangers she didn't know," Schweikhard remembered. "Under normal circumstances, I expect it to take four to five days to complete. Johanna did it in two days. She quickly worked out a way to communicate with the team to conduct the tests."



NASA/Lori Losey

For the first phase of ACTE flights, the experimental control surfaces were locked at a specified setting. Varied flap settings on subsequent tests are now demonstrating the capability of the flexible surfaces under actual flight conditions.

Lucht continued working software management, developing instrumentation systems and support testing and occasionally giving presentations to audiences on how to work with deaf people.

Another challenge was to find an interpreter with technical skills in the language. Many interpreters have liberal arts backgrounds, and may sometimes struggle to verbalize correct terminology and interpret highly technical content in sign, where some of the technical terminology does not exist in ASL. Instead, the terminology often has to be spelled out by hand.

As a result, deaf clients and interpreters have to work together to invent some signs in order to ease communication. It becomes a challenge when the technical interpreter who has been trained in the terminology is not used consistently. This results in the deaf client being forced to teach each new interpreter the technical terminology repeatedly, in a limited time before, during and after meetings."

To address these issues for a mission control setting, a system was established in which an interpreter from NASA's Langley Research Center in Virginia assisted Lucht. The interpreter, who worked with Lucht regularly during project meetings, was present during the mission from her location at Langley. She listened to flight communications as they happened and a two-way visual communication between Lucht and the interpreter was established.

As the interpreter, who was completely visible to Lucht on one of her two monitors, listened in on flight communications, she was able to convey those communications to Johanna, using American Sign Language. After successfully practicing the communication, it was decided that Lucht was ready to take on the training Systems II role for the actual flight.

On the day of the actual flight, Lucht says she was more excited than nervous. She settled into her seat, next to Schweikhard and prepared for the flight.

From the moment the flight took off, Johanna focused on her monitors, began analyzing data and the communications proceeded seamlessly.

Lucht discussed one moment during the flight, in which she was seemingly one of the few people to pick up on a particular flight maneuver before it had even been communicated.

The pilot was to perform a maneuver, called a Pushover-Pullup. In the maneuver, the pilot dips the nose of the aircraft, to produce low gravitational forces, and then pulls up, to create higher g-forces on the aircraft to test structural integrity. The maneuver was scheduled to be coming up, but as it had not yet been stated, it was not yet expected to be done.

Lucht noted a change in the data coming in from the aircraft. She looked over to the interpreter, but since no communication had been made about the maneuver, there was nothing for the interpreter to sign over to Johanna. She then looked around the control room, and no one seemed to notice or commented on the maneuver. Then the pilot communicated that he had completed the maneuver.

"The communication was a bit mixed-up at that point, and I noticed someone placed their hand on their forehead, so I wrote down on paper and passed it to Keith, asking if the pilot jumped ahead and had done the maneuver. He nodded his head," Lucht recalled.

Johanna was not only adequate in her role during the flight, but she excelled, showing that she can work in a fast-paced environment as effectively as other engineers in the room without any unnecessary complications.

Lucht says the challenges she faced while growing up as a deaf person in the hearing world have prepared her for her role at NASA.

"When I was a child, I essentially missed my schooling between preschool and third grade. The catch-up was of course overload, but that really helped me in being able to work here and handle moderate to large information on a daily basis. My special education teacher in Germany taught me to always try, and to never give up."

Lucht also points out that she does not consider deafness itself to be a challenge. Rather, she says, the challenge is presented through the environment.

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the inboard and outboard sections of the flap in opposite directions. In this test series, the flap was arranged so that the inboard section was deflected 2.5 degrees down, while the outboard edge was deflected 2.5 degrees up.

The potential advantage of such a configuration is the ability to change where the center of lift is on the wing, such as how and where the wing responds to wind gusts. This flexibility can lead to future wing designs that are much lighter, making the aircraft more efficient, explains SCRAT chief engineer Ethan Baumann.

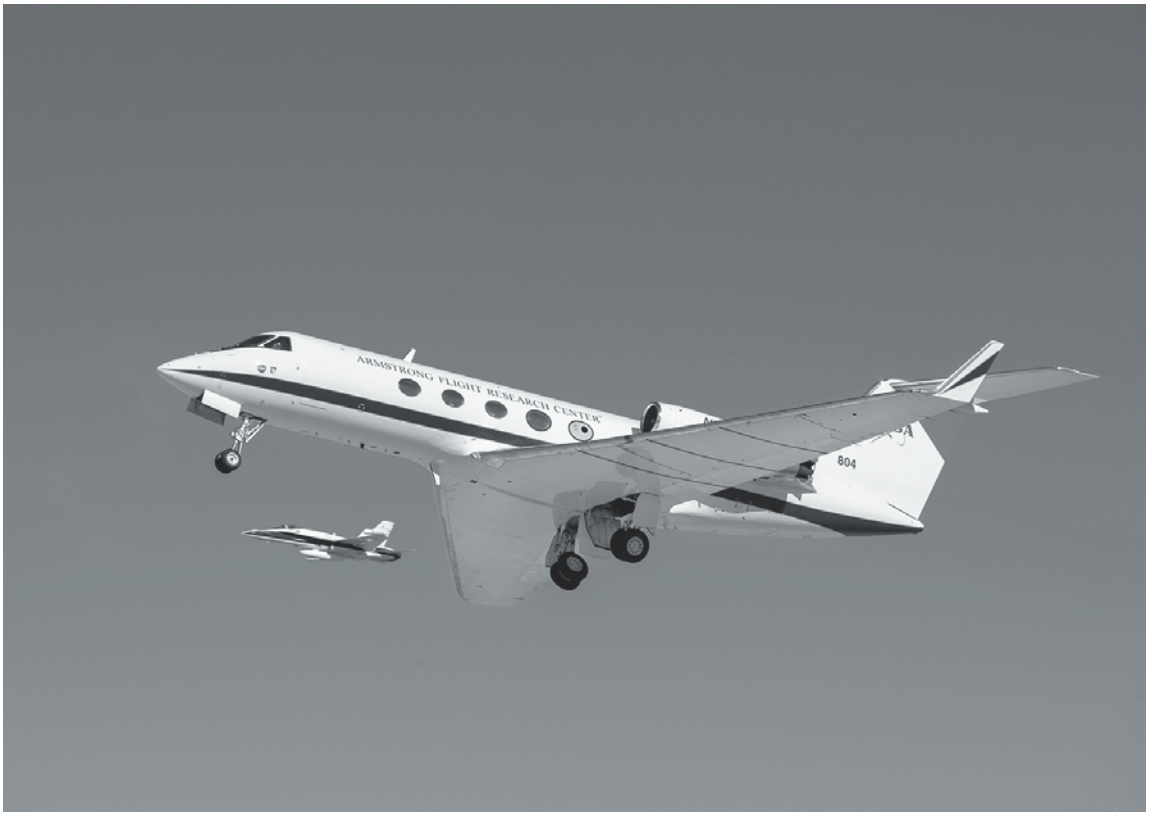
"We're twisting the inboard and outboard sides of the flaps in order to show that we can move the center of lift inboard or outboard," Baumann said. "You can use a technique like this for gust load alleviation. Wing structure is designed for a worst-case gust loading condition, so if you can quickly change the curve of your wing and respond to a gust, then you can theoretically get away with designing lighter wings."

Initial flights with the ACTE flaps in a twisted configuration were limited to a maximum speed of 250 knots and 20,000 feet altitude in order to demonstrate the concept in flight.

Another successful milestone of ACTE II was the completion of Mach extension flights, which allowed researchers to observe the ability of the technology to safely fly at speeds more accurately representing those of a commercial airliner. While flight tests in ACTE's first phase were performed at a maximum speed of Mach .75, or approximately 570 miles per hour, ACTE II saw that speed increase to Mach .85, which is the maximum cruise Mach number of the G-III.

This allowed researchers to observe the structural stability of the technology at common cruising speeds.

"In ACTE I, we were limited to Mach .75 due to structural concerns," recalled Baumann. "Based on what we learned from those first sets of flights, we've extended out to Mach .85."



AFRC2017-0338-081 **NASA/Lauren Hughes**

NASA's Subsonic Research Aircraft Testbed, or SCRAT, is a modified Gulfstream III that operates from Armstrong. SCRAT is the test bed aircraft for the ACTE flexible-flap research project, which examines the benfits of flexible wing flap technology to aerodynamic efficiency.

The third area of investigation dealt with performance flights, for which the aircraft was instrumented to be able to monitor fuel flow. By comparing how much fuel the aircraft uses with the flap deflected at different angles, NASA researchers will be able to better understand how different flap deflections influence drag.

"With these flights we were able to measure the flow of fuel through the engine, and we'll be able to analyze that data to get accurate estimates on the drag of the aircraft at various speeds, altitudes and weights," ACTE project manager Kevin Weinert said.

NASA researchers will now begin data analysis on the fuel burn, which will provide better understanding of how twistable wing flaps may affect fuel efficiency.

"ACTE is a technology that when incorporated with new wing designs will make airplanes more efficient, quieter, and lighter weight, which helps reduce the overall fuel burn for future designs," Weinert said.

ACTE II was flown as part of NASA's Aeronautics Research Mission Directorate's Flight Demonstrations and Capabilities project.

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"Imagine yourself in a deaf world instead of a hearing world, where nearly everyone uses American Sign Language. Also imagine anything you can hear through sound, like public announcements, customer services, festivals, work, movies, but this time they all are conducted in American Sign Language via video. Unless you know ASL, you will experience most of the challenges we deaf people experience. We all meet the challenges that are presented in the environment, and do what we can to overcome it."

Indeed, in an agency where overcoming challenges is considered the status quo, Johanna Lucht fits in entirely.

Lucht has advice for people who are growing up facing those challenges.

"I never thought I would work for NASA, until they offered me a spot. You must always keep an open mind for opportunities. You never know when one might come by. If it's not NASA, then maybe other areas, some of them might still entail working with NASA. Keep an open mind, and do what you enjoy.

"Follow your motivation."

APPEL development opportunities set

By Jay Levine
X-Press editor

Armstrong is providing training opportunities through NASA's Academy of Program/Planning & Engineering Leadership (APPEL) for government and contract employees.

APPEL offers more than 60 courses, workshops, programs and services, said Mike Raymond, Armstrong training and development specialist and APPEL contact. Each of the centers requests courses based on its needs. This year Armstrong was approved for 10 classes and workshops, with another four added recently, he added.

"APPEL courses and workshops are focused on the development of individuals, teams and organizations in support of center and agency missions," Raymond said. "The courses are developed specifically with the NASA workforce in mind and most of the APPEL courses provide continuing education credits for various certifications."

Registration is open for all courses/workshops available to Armstrong through this fiscal year. To participate in APPEL, employees can go to the schedule and register at https://appel.nasa.gov/courses/

AFRC2017-0108-02 **NASA/Ken Ulbrich**

APPEL offers a number of training opportunities at all of the NASA centers to develop individuals, teams and organizations to carry out the agency's missions.

• The focus of Cost Estimation for Project Managers is to familiarize employees with aspects of cost estimation principles, which is a process for arriving at a total cost for a project or program. Understanding and proper use of those tools can help avoid cost overruns. Registration closes June 27 for the course scheduled for July 11-12.

• Requirements Development and Management provides a fundamental understanding of how project teams can develop winning products. The course is July 25-27 and registration ends July 4.

• Assertiveness Training for Technical Professionals shows participants how to use powerful and highly participative techniques to help master critical people skills needed for technical success. Registration closes July 18 for the course scheduled for Aug. 1-2.

• Foundations of Aerospace is limited to civil servants and focuses on a fundamental understanding of NASA's mission, aeronautics, astronautics, technical writing and team work to support excellence in NASA's technical workforce. The course is Aug. 7-9 and registration ends July 24.

•Managing Virtual Teams teaches participants how to overcome obstacles of geography, isolation, and history and to establish trust and motivation to bring people together. Registration closes Aug. 1 for the course scheduled for Aug. 15-16.

APPEL, page 8

Armstrong recognized for technology transfer

The Federal Laboratory Consortium for Technology Transfer (FLC) selected Armstrong to receive a 2017 Award for Excellence in Technology Transfer for expanding the skies for unmanned aerial systems (UAS) through technology transfer of the NASA Sense-and-Avoid System with ADS-B Avionics by Oklahoma-based Vigilant Aerospace Systems.

The system is a combination of hardware and software that enhances aircraft command-and-control operations and communications. The technology offers improved traffic situational awareness, conflict/collision detection and correction, real-time weather monitoring and navigation.

Its sophisticated display options include a three-dimensional view of collision threats and an operator display of real-time aircraft location and condition.

Team members said this technology's capabilities bring UAS closer to flying in the National Airspace System.

The FLC presents the annual award to recognize outstanding work in transferring federally developed technology. The Armstrong team was honored at an award ceremony April 26 at the FLC national meeting in San Antonio, Texas.

Photo courtesy of the Federal Laboratory Consortium for technology transfer

Accepting the 2017 Award for Excellence in Technology Transfer are from left NASA Technology Transfer program executive Dan Lockney, Armstrong Technology Transfer team members Laura Fobel, Samantha Hull and Janeya Griffin (team member Earl Adams not pictured) and researchers Mike Dandachy, Ricardo Arteaga and Vigilant Aerospace Systems' Kraetti Epperson.

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one demonstrator based on that shape could potentially test the most advanced technologies in one aircraft to increase fuel efficiency by as much as 50 percent and significantly reduce noise and emissions.

The president's proposed budget calls for winding down the NASA Office of Education, cutting six Earth science missions and the Asteroid Redirect mission. Still slated to go forward are a number of space and Earth science missions and the James Webb Space Telescope, continuing plans for human exploration of space and a proposed long-term mission to Mars with astronauts in the 2030s.

As part of that vision, the NASA proposed budget includes continuing development of the Orion spacecraft and the Space Launch System and Exploration Ground Systems that are required to meet the challenges of sending astronauts on deep space exploration missions in the 2020s and beyond.

The proposed NASA Aeronautics budget is $624 million. Included in the budget are investments in air traffic management improvements that will safely increase air traffic capacity, reduce flight delays and enable safe, robust operation and integration of unmanned aircraft systems in the same airspace as commercial aircraft.

Armstrong's proposed budget is $228.2 million. Aeronautics, Safety, Security and Mission Services and Science comprise the biggest portions of the proposed budget with $72.1 million, $61.6 million and $53.7 million respectively. Rounding out the funding are $13 million for Space Technology, $17.7 million for Human Explorations and Operations (HEO) and $10.2 million for Construction and Environmental Compliance Restoration.

Proposed reductions in NASA's overall budget focus on Earth science satellites, but not NASA's airborne science mission aircraft such as the Global Hawk autonomous aircraft, the DC-8, the ER-2 high-altitude aircraft and the C-20A, which are all based at Armstrong. If the cancellation of the satellites called for in the proposed budget occurs, McBride said the center might be asked to bridge the gap that would be created in the need for data collection.

The Stratospheric Observatory for Infrared Astronomy also is funded through 2019, when the result of a senior science review is expected to factor into the program's future. Armstrong operates the airborne astronomical observatory that is capable of observing a wide variety of astronomical objects and phenomena. In addition, the center will continue to support the Flight Opportunities Level 2 Program Office.

Armstrong's HEO support includes testing of the Orion spacecraft and the Advanced Exploration Systems Ascent Abort-2 work. Armstrong is also providing support to Orion development by assisting in the photo and video documentation of the testing of the parachute landing system to be used for the return of the vehicle from space.

The center's Construction and Environmental Compliance Restoration funding permits capital repairs and improvements to NASA's infrastructure and cleans up pollutants released into the environment in the past. Planned minor revitalization and construction projects include the revitalization of mission control electrical systems.

Following the budget announcement, each center sponsored a Facebook Live event. Armstrong's event focused on the X-57 simulator for the distributed electric propulsion experimental aircraft and discussions in front of one of the center's F/A-18 aircraft about the anticipated Commercial Supersonic Transport.

Details of the NASA budget are available at NASA.gov/news/budget/index.html

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• Crucial Accountability seeks to develop skills for improving team reliability and effectiveness. The course is scheduled for Aug. 29-30 and registration closes Aug. 15.

• Crucial Conversations will enable students to learn skills needed for creating consensus by encouraging open dialogue. Registration for the Sept. 19-20 course ends Sept. 5.

Civil service workers have priority for registration, with limited seats available to contract employees. Contract employees may register for most APPEL courses/workshops and will be on a waiting list until registration closes and available seats are determined.

Based at Kennedy Space Center in Florida, APPEL's roots are in the Program and Project Management Initiative Training that began in 1988. APPEL was part of NASA's response to the Space Shuttle Challenger disaster.

Although it has gone through a number of changes since its inception, the APPEL focus remains on placing greater emphasis on promoting learning through curriculum and hands-on training and development programs. NASA's Office of the Chief Engineer funds APPEL courses and workshops.

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