National Aeronautics and Space Administration

ARMSTRONG FLIGHT RESEARCH CENTER
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X-PRESS

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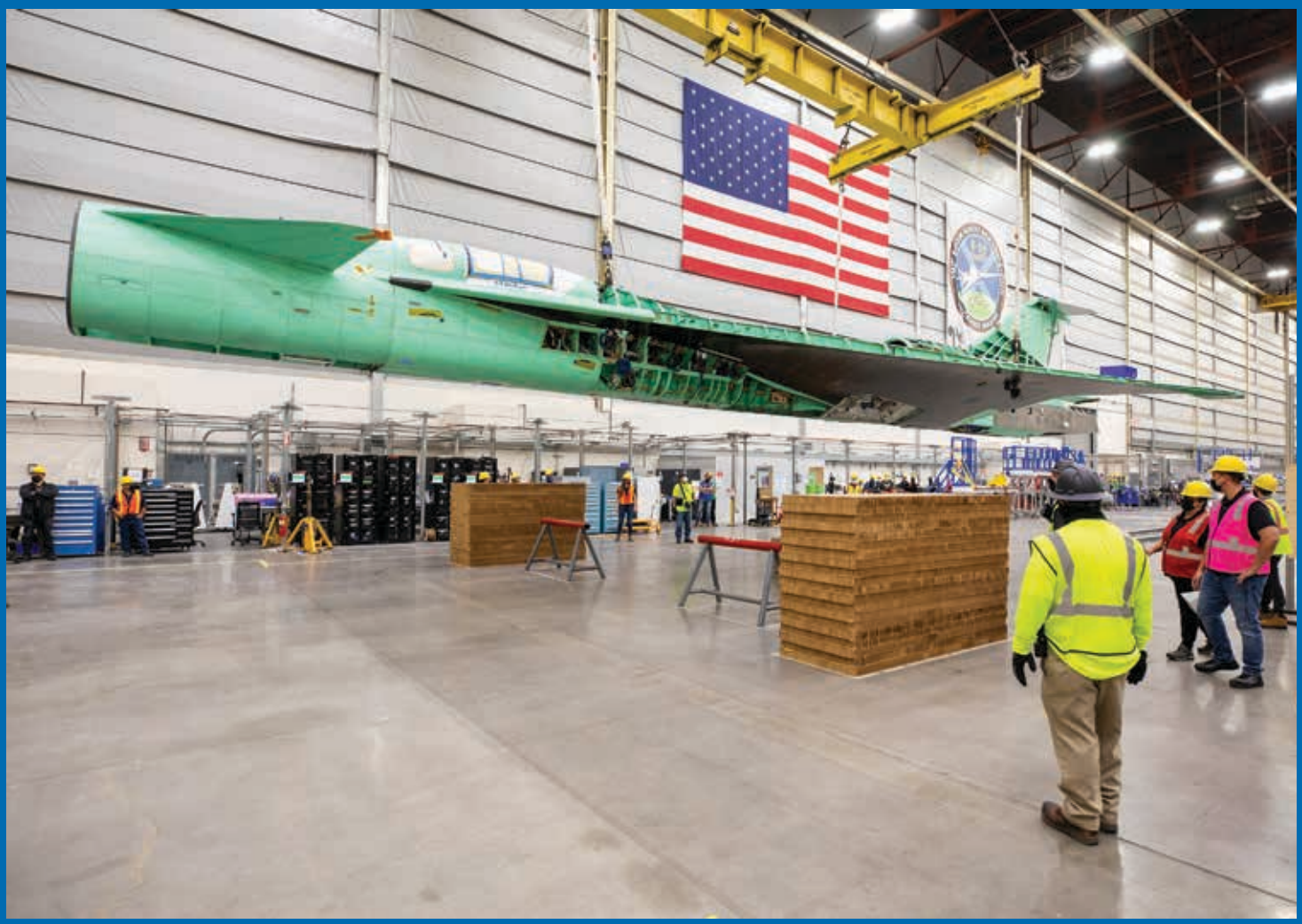
Coming together



Lockheed Martin

The NASA and Lockheed Martin team behind the X-59 Quiet SuperSonic Technology recently removed the aircraft from its jig system, or external supports. The next step is proving the research aircraft is structurally sound and ready for final assembly. *See page 2.*

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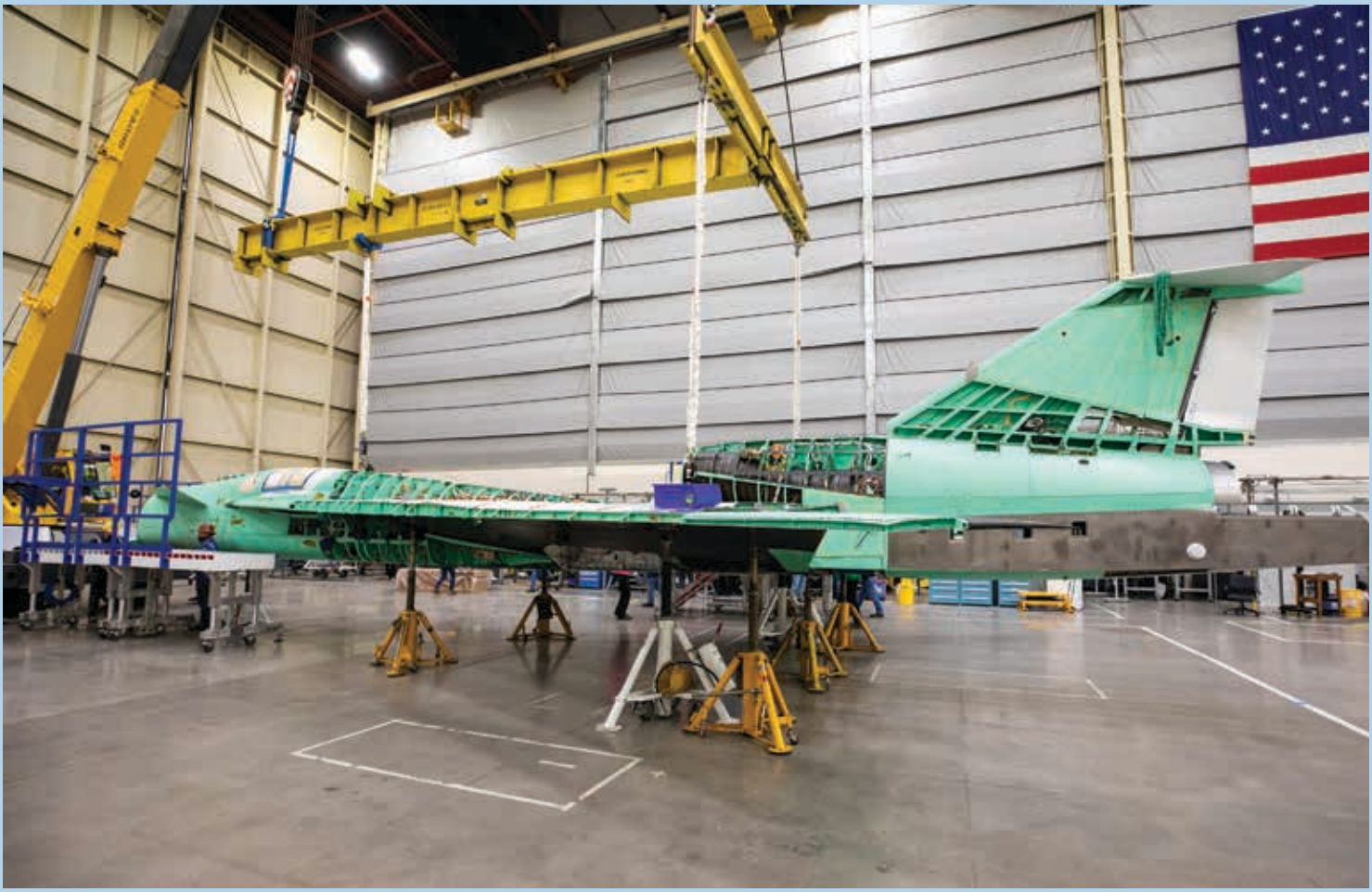


Lockheed Martin

In this view the X-59 is positioned on ground supports in preparation for installation of the landing gear and other hardware required for structural testing.

X-59 ready for next steps

By Tiernan Doyle
NASA Intern

The NASA and Lockheed Martin team behind the X-59 Quiet SuperSonic Technology (QueSST) have recently removed the aircraft from its jig system, or external supports. The next step is proving the research aircraft is structurally sound and ready for final assembly.

The team has made significant progress on the X-59 QueSST assembly. In late October, they pulled the aircraft away from the jig support system. The jig, which is similar to scaffolding, helped ensure all of the aircraft's hardware was placed together correctly throughout the manufacturing process.

"It's pretty simple to move the jig away," said David Richwine, NASA's X-59 deputy project manager for technology. "It's the preparation that's more time consuming."

Most of the preparation for the X-59's construction involved more than a decade's worth of research on quiet supersonic technology. NASA's quiet supersonic mission plans to bring all of the science and technology developed during those years into the spotlight.

For Richwine, seeing the construction of the aircraft feels personal.

"I have been working on supersonics technology, and the predecessor to the concept for the past 15 years," Richwine said. "I have more of an emotional attachment because I have put so many years into this mission."

Initial construction of NASA's X-59 began in 2018 at Lockheed Martin's Skunk Works facility in Palmdale. The X-59 will be flown as part of a mission to collect data on quiet supersonic flight and public reactions to the flights. The plane is shaped in a way that reduces a sonic boom typically associated with supersonic aircraft to a quiet thump to people on the ground. The mission's findings will be sent to regulators to help create new rules regarding speed limitations on supersonic flight over land.

Now that the X-59 is free from the jig, it will move on to the final assembly phase, including the first "power-on" of the aircraft to test its internal systems. Once that is complete, the X-59 will be shipped to Lockheed Martin's facilities in Fort Worth, Texas, where structural tests will be conducted. The first flight of the X-59 is planned for 2022.

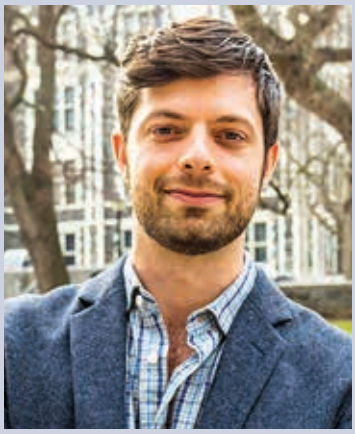
Meet two researchers who won MIRO awards

Sarah Mann
NASA Armstrong Public Affairs

One principal investigator in New York is advancing electrochemical energy storage for space applications. Another in Florida is exploring solar photovoltaics to realize the next generation of highly efficient solar cells, also for space applications. What they have in common is receiving NASA's Minority University Research and Education Project's Institutional Research Opportunity award, or MIRO award.

Managed through NASA's Armstrong Flight Research Center Office of STEM Engagement in California, the awards establish cooperative agreements to universities around the nation to perform research and education. There are currently 17 active MIRO awardees across 12 U.S. states and territories.

All MIRO awards are provided to minority-serving institutions to promote research capacity, expand aerospace research, increase workforce diversity, and strengthen Science, Technology, Engineering and Mathematic (STEM) skills. These awards directly support NASA's mission directorates: Exploration Systems Development, Space Operations, Aeronautics Research, Science, and Space Technology.



Robert J. Messinger

Daniela Radu

Robert J. Messinger, assistant professor, department of chemical engineering for The City College of New York (CCNY) Center for Advanced Batteries for Space (CABS) is a joint research and education center between CCNY, NASA's Jet Propulsion Lab (JPL), Northeastern University, and regional colleges.

The Center was established to create a highly collaborative research network in electrochemical energy storage for space applications as well as train a diverse STEM workforce through a multifaceted student internship program. CCNY is a Hispanic Serving Institution (HSI) and Asian American Native American Pacific Islander (AANAPISI) Serving Institution.

How does your research contribute to the NASA mission directorates?

Our research seeks to design and prototype novel batteries that can withstand the extreme temperatures and radiation environments of future planetary science missions. By doing so, we hope to enable new NASA planetary mission concepts, as electrochemical energy storage plays a vital role in powering the robotic spacecraft that perform these missions.

What led you to this career?

I like exploration! In research, that's exactly what you're doing: pursuing a new frontier. There are many "mountains to be climbed" metaphorically speaking. Also, I like chemistry, physics, math, and engineering. Research combines those disciplines with elements of exploration.

What energizes you at work?

Two things: one, working with smart, interesting, and passionate people, and two, those moments when a new insight, realization, or unexpected result comes in, changing my thinking or giving me a new perspective on a problem or system.

Do you have any unique family traditions?

Yes. Growing up, my family would head north to Butternut Lake every summer, where my grandparents have two cabins built in 1900 and 1901. It's beautiful: fresh water, loons, eagles, and many fish. Even now, there is no cell access or internet access. It's a nice place to be in nature and disconnect, to play and recharge.

MIRO awards page 7

News at NASA

NASA tech is with you when you fly

NASA Administrator Bill Nelson visited Orlando International Airport in Florida Nov. 24 and met with aviation leaders to discuss implementing aircraft flight scheduling technology developed by the agency that will soon improve dependability for passengers – which is especially important during peak travel times.

The technology that was tested in September during NASA's Airspace Technology Demonstration 2 (ATD-2) was transferred to the Federal Aviation Administration (FAA). Large airports across the country – including Orlando International – will soon implement the technology. Nelson discussed the technology transfer with Greater Orlando Aviation Authority CEO Phil Brown.

"NASA's partnership with the FAA is constantly delivering for the American people, improving the efficiency of the commercial airline industry for the environment and passengers across the country," Nelson said. "Our flight scheduling technology, which makes it possible for personnel to better coordinate the movements of aircraft while they're at the airport, will soon help ensure more passengers get off the ground and home for the holidays faster and more efficiently than ever before."

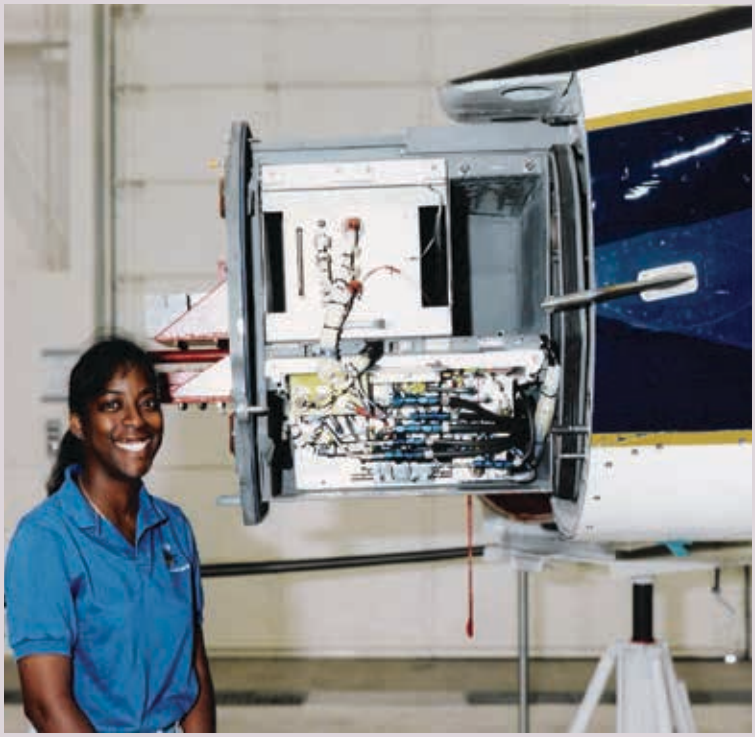
NASA tech page 8

Starting on the cutting edge

Grindle recalls early career at NASA Armstrong

Guest column

Laurie Grindle
Director of Programs and Projects



NASA

Laurie Grindle, NASA Armstrong director of Programs and Projects, is seen early in her career at the center with the F/A-18 Systems Research Aircraft. She worked on the Advanced L-Probe Air Data Integration (ALADIN) probe that utilized the onboard Airborne Research Tests System (ARTS), which computed real-time air data calculations from the probe data.

I was a contractor intern in the summer of 1992 when I first came to Dryden Flight Research Facility (now NASA Armstrong). I returned a little over a year later as a full-time civil servant employee in the aerodynamics branch. In 1994, my branch chief assigned me to the F-16XL-2 Supersonic Laminar Flow Control (SLFC) project. While serving as an aerodynamics researcher on this project, I had many first-time experiences, several of which became the norm for my future projects.

It was the first time that I worked on a project with another NASA center. The principal investigators from NASA Langley Research Center conducted boundary layer transition research for years culminating in this project.

It was the first project on which I worked with women in leadership roles (project manager and chief engineer, respectively) and saw what might be possible for me.

It was the first time I joined a project that was still in its build-up phase. The aircraft's left-wing underwent extensive modifications to make it more representative of the proposed high-speed civil transport wing planform and install a titanium glove optimized to support active laminar flow control. The modifications were finally complete a year after I became a member of the project team, and then we were ready to fly.

It was the first time that I had to work closely with the airplane crew. During the flight phase, we had so much to do that I started coming in at 6:30 a.m. to get a jumpstart on working with the crew.

It was also the first time that I had significant responsibility. One of the project's objectives was to achieve 50- to 60-percent-chord laminar flow on a highly swept wing at supersonic speeds. We used hot-film sensors to make this assessment. I was responsible for analyzing the hot-film data each flight, working with the Langley principal investigators to identify where we should move the sensors between flights, and determining what might be impacting our ability to achieve laminar flow further on the wing chord. It was for this last reason that I became a bug "expert." I bought a book entitled "That Gunk on Your Car: A Unique Guide to the Insects of North America" to help me understand what I was facing. I came up with an approach to classify the bugs that hit the wing in flight and determine their impact on achieving laminar flow.

To ensure that we had a good baseline, the crew cleaned the glove in the morning before each flight. We inspected the wing just before takeoff to ensure there were no insects from tow or taxi. After landing, we performed another inspection to determine what bug hits or excrescences there were and assess what I called "insect acquisition time." That evening, as I poured over the stripcharts analyzing the flight data, I consulted my post-landing inspection chart to assess whether any of these excrescences could cause unexpected boundary layer transition results. Insects acquired during takeoff were tough to link to anomalies because they could have eroded from the surface during the flight and would no longer be present during the post-landing inspection.

Bug hits weren't the only obstacles we had to mitigate. One of the challenges of conducting flight research on existing aircraft is that you may have to account for aircraft features that could impact your research. Examples of these include the canopy joint between the front and rear cockpits and the engine inlet that yielded

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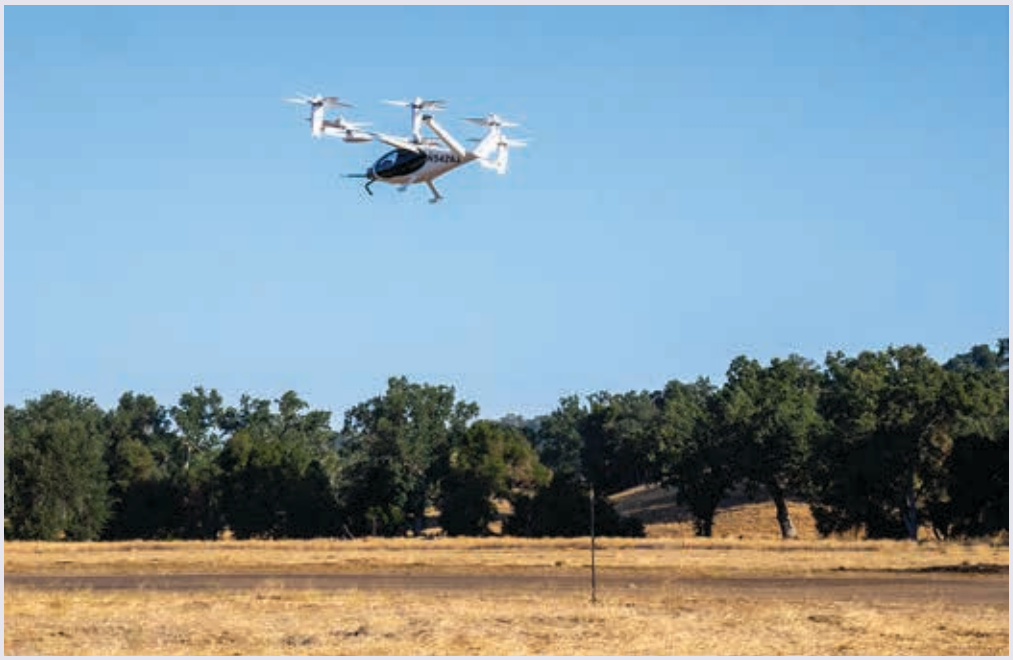
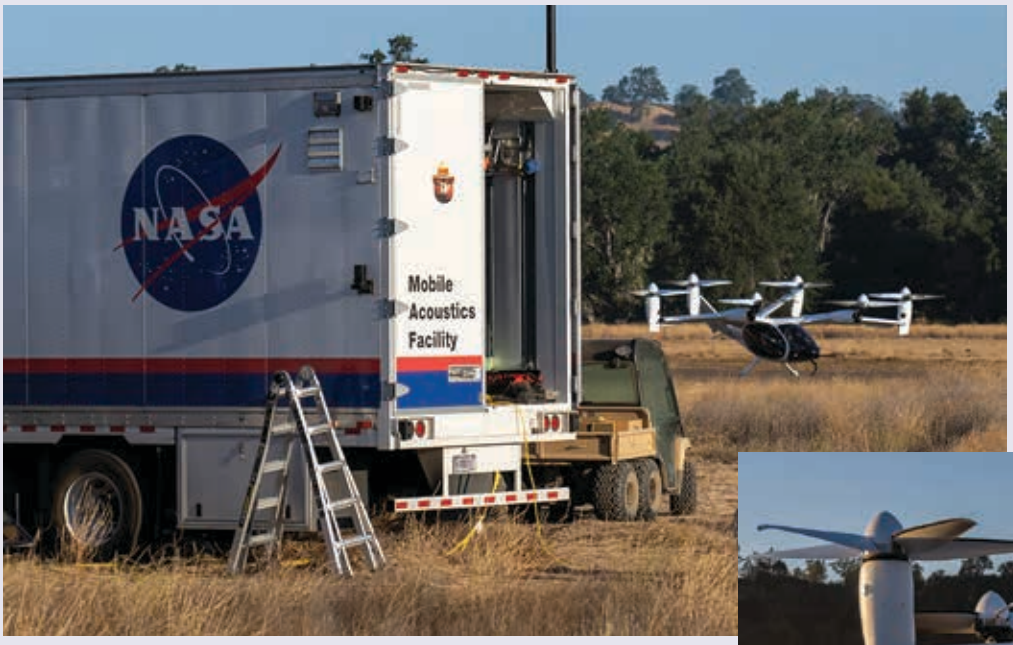
Tests with Joby complete



Joby Aviation

Joby's aircraft flies above one of NASA's microphones, which is one of more than 50 recorders that helped the NASA Advanced Air Mobility National Campaign team measure the acoustic profile of the aircraft in different flight phases. The data was collected during a test at Joby's Electric Flight Base located near Big Sur, California, Aug. 30-Sept. 10.



Joby Aviation

NASA's Mobile Acoustics Facility is parked in the background of Joby's aircraft at Joby's Electric Flight Base located near Big Sur, California. As the aircraft flew planned test scenarios, the NASA Advanced Air Mobility National Campaign team collected information about how the vehicle moved, how the vehicle sounded, and how the vehicle communicated with controllers. ***At right*** *is a closer view of the Joby aircraft.*

By Teresa Whiting
NASA Armstrong Public Affairs

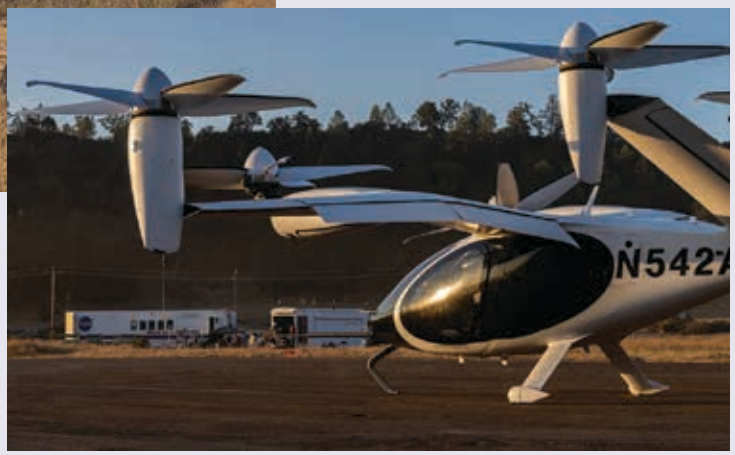
Members from NASA's Advanced Air Mobility National Campaign team were on site at Joby's Electric Flight Base located near Big Sur, California, for two weeks completing tests with Joby's prototype aircraft. With the tests complete, the team is analyzing the collected data.

As announced in a recent news release, NASA's goal is to collect vehicle performance and acoustic data for use in modeling and simulation of future airspace concepts. After the data is analyzed, the test results will also help identify gaps in current Federal Aviation Administration regulations and policies to help incorporate Advanced Air Mobility aircraft into the National Airspace System.

As the Joby aircraft flew planned test scenarios, the NASA team collected information about how the vehicle moved, how the vehicle sounded, and how the vehicle communicated with controllers.

Analyzing this data will ready the National Campaign to accomplish the first set of campaign tests, known as NC-1, slated for 2022, with more complex flight scenarios and other industry vehicles.

When fully integrated into the national airspace, AAM will provide an efficient and affordable system for passenger and cargo transportation, and other applications in the public interest. This system could include aircraft like package delivery drones, air taxis and medical transport vehicles.



Joby Aviation

Autonomy work continues

Successful Resilient Autonomy activity concludes, but work continues on saving people and airplanes

By Teresa Whiting
NASA Armstrong Public Affairs

According to The Bureau of Transportation Safety, there have been approximately 1200 to 1300 general aviation accidents per year since 2013, which is down from the years before. While the improvement is good, NASA is working to decrease the number of aircraft crashes even more.

NASA's Resilient Autonomy team worked together with the Federal Aviation Administration (FAA) and the U.S. Department of Defense (DoD), to create new autonomous aircraft technology that will help in this endeavor.

This technology is called the Expandable Variable Autonomy Architecture, or EVAA, and it could help prevent accidents in retrofit general aviation aircraft and future autonomous aircraft. EVAA is based on an earlier NASA-developed technology that performs a similar function for military aircraft.

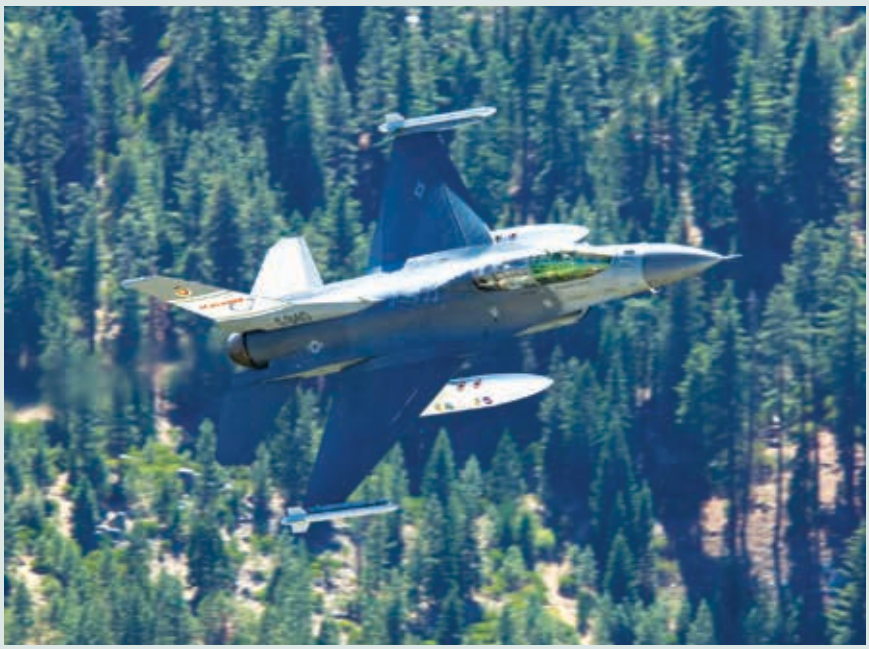
Mark Skoog, principal investigator for autonomy at NASA Armstrong led the project for NASA. He has almost 40 years of experience with autonomous systems including the Automatic Ground Collision Avoidance System, or Auto GCAS, which was developed for the DoD and has saved the lives of 11 F-16 pilots since its introduction.

The Auto GCAS system, which EVAA is derived from, avoids an imminent ground

EVAA page 7

NASA Video

This screen grab taken from the video shows the Common Integration Tool (CIT) simulator at work. An element of the Expandable Variable Autonomy Architecture software system called the Automatic improved Ground Collision Avoidance System or Auto iGCAS takes over from the pilot to guide the aircraft to safety. The pilot in this case is flying a small remotely piloted aircraft.



ED09-0290-32 **NASA/Carla Thomas**

In 2009, the F-16D aircraft tested the Automatic Ground Collision Avoidance System in areas of potentially hazardous terrain, including canyons and mountains.

EVAA... from page 6

collision by taking control of an endangered aircraft from the pilot at the last possible moment. This life-saving system warns the pilot, and if no action is taken, it locks the controls and performs an automatic recovery maneuver. Full control is returned to the pilot once the aircraft has cleared the near terrain.

With EVAA, the team changed the algorithms used in the F-16 version of Auto GCAS to make them suitable for non-fighter aircraft like Cessnas or remotely piloted aircraft.

"Given what we have seen in the improvement in F-16 safety from the Auto Ground Collision Avoidance System, this technology also could help prevent a loss of life in general aviation and especially the bush pilot community," Skoog said.

EVAA includes functions to prevent smaller airplanes from diving into a canyon, into the side of a mountain, or into the ground by avoiding obstacles and guiding the plane to a safe landing area. An element in the software, called the Moral Compass, helps decide which moves to make by switching control to the highest priority task based on weighing the odds of safety.

While the pandemic kept the team from completing flight tests, the software was extensively tested on multiple types of aircraft using a flight simulator. The results from the simulator tests showed great promise – test and analysis showed that the system avoided mid-air collisions at a rate greatly exceeding current standards currently under consideration for small, unmanned aircraft. The forced landing system of EVAA was also evaluated in multiple ways, many inspected in the field, and results met or exceeded human pilot line of sight safety capabilities in rural and wilderness areas.

The DoD, the FAA and other groups such as the Alaska bush pilot community are looking into how this software could be integrated into a variety of aircraft in the future. Other NASA projects such as Advanced Air Mobility are looking at potential uses of EVAA as they investigate how to help the FAA integrate air taxis, cargo delivery, and small package delivery aircraft into the national airspace.

The EVAA software is managed under the NASA Armstrong Flight Research Center Technology Transfer office. For more on this technology, contact afrc-tto@mail.nasa.gov. Future availability and capability enhancements of EVAA will be managed by an extended potential collaboration between NASA, the DoD and the FAA.

If EVAA could help reduce the number of fatal general aviation accidents per year, the goal of the project and one of NASA's, the DoD's and the FAA's missions to increase aviation safety would be complete.

MIRO Awards... from page 3

What's the last book you read?
Well, recently, too many research papers! I'm hoping to soon begin (once again) the Wheel of Time fantasy series by Robert Jordan, beginning with Eye of the World; I read the first eight books when I was younger, then life dictated other things! For non-fiction, currently, I'd recommend Atomic Habits by James Clear.

Daniela Radu, who has a doctorate in Chemistry; is the principal and center director for the NASA MIRO Center for Research and Education in 2D Optoelectronics (CRE2DO). She is the Associate Professor in the Mechanical and Materials Engineering department for Florida International University.

The Center for Research and Education in 2D Optoelectronics (CRE2DO) at Florida International University, a Hispanic Serving Institution (HSI), explores two-dimensional (2D) materials to be integrated in sensors, wearable electronics, optics/photonics, and small satellites (CubeSats) for space applications.

How does your research contribute to the NASA mission directorates?
Our NASA MIRO contributes to the development of sensors, optoelectronics, wearable electronics space-resilient composites, and CubeSats infrastructure, which are all supporting the NASA mission directorates in basic research. My personal research focuses on solar photovoltaics contributing to the Space Technology Mission Directorate, and I am collaborating with NASA Glenn researchers to realize the next generation of highly efficient solar cells, in support to the Artemis Mission.

What led you to this career?
My father was an engineer and every now and then when he was tinkering around the house, I would join him and soon I became a little apprentice. The love for engineering was therefore induced in my early years; as far as my academic career, it was driven by the desire to inspire young minds in meaningful research.

What energizes you at work?
The success of those whom I mentor, whether it is an undergraduate student who landed a dream job and wrote back to thank me, a Master's student who got an "A" on a term paper, a Ph.D. student who passed candidacy, or a junior faculty who was awarded a new grant.

Do you have any unique family traditions?
We like Disney cruises, and while that might not be that unique, the fact that we as a family are without cellphones, emails, and hooked to the internet otherwise, allows for unique and undisturbed quality time.

What's the last book you read?
I have a peculiar habit: I read multiple books at the same time. So, it is unfair to say that I just finished re-reading F. Scott Fitzgerald's "The Great Gatsby" when I am getting to the finish line with one of the Neil Gaiman's masterpieces, Norse Mythology, and I passed the middle of Angela Duckworth's "Grit". I guess I need that combination of fiction and non-fiction and something in between.

This past August, the annual MIRO principal investigators meeting provided an opportunity for MIRO awardees to learn more about MIRO, to hear more about agency programs, promoted team building, and provided an opportunity to discuss topics that are important to the awardees, MIRO and NASA.

MUREP Institutional Research Opportunity (MIRO), was established to strengthen and develop the research capacity and infrastructure of Minority Serving Institutions (MSIs) in areas of strategic importance and value to NASA's mission and national priorities. Systems Development, Space Operations, Aeronautics Research, Science, and Space Technology.

Grindle... from page 4

what we called "unique shock systems." Luckily, we had some very creative people at NASA Dryden, which allowed us to mitigate some of the unique shock systems. For the shock coming off the canopy joint, the lead mechanic had the idea of using foam and tape on top of the rear canopy to eliminate the step that was causing the shock. Eliminating the step allowed us to continue with our research without the canopy joint shock impingement transitioning the flow.

Forty-five flights were conducted at NASA Dryden from October 1995 to November 1996 in support of this experiment. Boundary-layer transition data was obtained on the titanium glove primarily at speeds of Mach 2.0 and altitudes of 50,000-55,000 feet. The most successful laminar flow results, which were more than 46-percent wing chord, were not obtained at the glove design point (Mach 1.9 at 50,000 feet); but at Mach 2.0 at 53,000 feet. The project team achieved this amount of laminar flow by looking beyond the glove design point, exercising a methodical process requiring changes to test conditions and suction settings, and using creativity to mitigate the F-16XL-2 unique shock systems and monitor in-flight insect acquisition. It wasn't easy but overcoming challenges to achieve success is the nature of flight research.

NASA tech... from page 3

NASA and the FAA completed nearly four years of surface operations research and testing to calculate gate pushbacks through time-based metering at busy hub airports, so that planes can roll directly to the runway to take off and avoid excessive taxi and hold times, reducing fuel use, emissions, and passenger delays.

"As we deploy this software, the travel experience gets better for passengers all the while aviation's emissions decrease. It's a win-win," said FAA Administrator Steve Dickson.

The FAA plans to deploy NASA's surface metering technology initially to 27 airports, including Orlando International, as part of a larger investment in airport surface management technology called the Terminal Flight Data Manager (TFDM) program. Improved efficiency and shifting departure wait time from the taxiway to the gate saves fuel, reduces emissions, and gives airlines and passengers more flexibility in the period prior to leaving the gate.

NASA's ATD-2 team first put their aircraft scheduling technology to the test with real-world users in September 2017 at Charlotte-Douglas International Airport. By September 2021, the integrated arrival and departure system (IADS) tools had saved more than 1 million gallons of jet fuel. Those savings were made possible by reducing jet engine run time, which also decreases maintenance costs and saved airlines an estimated nearly $1.4 million in flight crew costs. Overall, passengers were spared 933 hours in flight delays and saved an estimated $4.5 million in value of time.

Ann Odenthal, support specialist, dies at 74

Anne Odenthal, a NASA Armstrong support specialist, died Nov. 26. She was 74.

She had worked at NASA Armstrong for 13 years for the Scientific and Commercial Systems Corporation and then Logical Innovations as a support specialist. In that role she worked for Projects and Science Mission Directorate, supporting aircraft such as the Global Hawk, the C-20A, the DC-8 flying laboratory and the ER-2 high-altitude aircraft.

People who knew Odenthal said she had a deep and unconditional love for her family and was one of the kindest and most caring people they knew.

Oscar 'Bosco" Perez, safety lead, dies at 60

Oscar "Bosco" Perez, a key member of the NASA Armstrong safety team, died on Oct. 5. He was 60.

Oscar led the safety team for many years as the center's safety support contract site manager for MEC[x] Inc. Perez recently became a NASA government employee on Sept. 27.

People who knew him said he expressed becoming a NASA government employee was the highlight of his career, and that his family was very proud of him.

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

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

Editor: Jay Levine,
Logical Innovations, ext. 3459

Managing Editor: Steve Lighthill, NASA

Chief, Strategic Communications:
Kevin Rohrer, NASA

National Aeronautics and Space Administration

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