National Aeronautics and Space Administration

X-PRESS

Armstrong Flight Research Center 1946-2021

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75 years

NASA Armstrong celebrates its past, while developing the technology for tomorrow

NASA's modified Boeing 747 Shuttle Carrier Aircraft with the space shuttle Atlantis on top departed NASA Armstrong and Edwards Air Force Base for its ferry flight back to the Kennedy Space Center in Florida.

ED07-0137-32
NASA/Carla Thomas

Cover: Design by Jay Levine. Lakebed and X-1 images by NASA, X-59 illustration by Lockheed Martin, aircraft cutouts by Kirstin Sharrer.

Inside

Check out the X-Press e-pub and the Flights of Discovery at
https://www.nasa.gov/centers/armstrong/about/75years/index.html

Center's work inspires

Director McBride recalls his past and his NASA journey

Director's column

David McBride
NASA Armstrong center director

As we prepare to celebrate NASA Armstrong's 75th anniversary, I remember what struck me when I first came to the center as a cooperative education student: the focus on mentoring the next generation, while accomplishing the extraordinary.

I grew up in the 1960s with Mercury, Gemini, and Apollo programs, and I saw Neil Armstrong walk on the Moon in black and white. Another inspiration for us in New Mexico was Harrison Schmitt, a New Mexico native, who was the first scientist astronaut and who spoke at my school. I also remember watching the X-15 movie and seeing the B-52 air launch the X-15 rocket plane.

The men and women who were here during the days when NASA was the National Advisory Committee for Aeronautics (NACA) worked on everything from the X-1 to the X-15 and created a legacy. World War II veterans and part of the greatest generation knew aircraft and flight because they learned it through hard knocks. They were the ones who mentored me and my generation.

I didn't realize the NASA center's vast accomplishments, but it all came together when I came here. It's another reason I think NASA not only inspires the next generation, but also provides mentoring opportunities to show how Science, Technology, Engineering and Mathematics (STEM) education can be applied.

In fact, NASA and NASA Armstrong add value to aeronautics and industry that is passed on to every citizen in this country as we make flight safer, more reliable, economical, and an integral part of our life and culture. Whether we are traveling to see family, taking leisure trips or shipment of goods around the world, our research is a part of everyday life in an extraordinary way.

Cam Martin

NASA Armstrong Center Director David McBride shows Jaiwon Shin, then Aeronautics Research Mission Directorate (ARMD) associate administrator and Bob Pearce, then ARMD director for strategy, architecture and analysis, the X-48 Blended Wing Body Aircraft.

I often say people at NASA Armstrong start here on an escalator. As we get on the escalator, we learn from those above us and are ready to explore in their place as they step off the escalator. After my first student experience I returned as a student to the center twice. I then gained experience elsewhere, returned to the center again, and eventually became center director.

I worked on projects like the forward swept wing X-29 and the X-31 research vehicles and in turn mentored those who worked on the hypersonic X-43A. Now that generation is getting to the top of the escalator. They are mentoring a new generation of young engineers, pilots, mechanics, and technicians who are working on experimental aircraft projects like the X-59 Quiet SuperSonic Technology aircraft and all-electric X-57 Maxwell.

I redesigned the X-29 landing system components as one of my first assignments at NASA Armstrong. I had the freedom to work the mechanical design, the electrical changes, and implementation. This work eliminated a hazard that could have resulted in the loss of the aircraft. Everything was like that on the program, you just did it.

I also learned problems are solved one step at a time and by bringing people together from the machine shops, technicians in the calibration and instrumentation labs, avionics aircraft mechanics, and pilots. They have different perspectives on how to solve a problem.

We still do that today. I was on a call about the X-57 program when young engineers on the program were solving the technical challenges. I get a good feeling for the future when I see our young teams tackle technical problems and solve them.

When I first started as center director in 2010, I was the new kid on the block. I learned from people like former NASA Armstrong Associate Director Vince Chacon and his decision-making process and style as well as former center directors like Ken Szalai and his communication skills, Kevin Petersen and his focus on the details, and many others. I see how all areas – engineering, flight operations, budget, finance, facilities, human capital, security, public affairs, and so many other organizations work together to make the center's achievements happen.

During my tenure, we reached a key milestone when

David McBride page 18

Flight advances technology

Former director Petersen recalls his experiences

Guest column

Kevin Petersen
Former center director

AFRC2021-0047-19 NASA/Lauren Hughes

Former Center Director Kevin Petersen greets Maj. Gen. Chuck Yeager, the first man to fly supersonically in the X-1, after Yeager spoke about his career.

I would like to add my congratulations to the NASA Armstrong Flight Research Center during its 75th anniversary celebrations. It is truly a unique place with an unbelievable history of technology contributions. I will always feel honored to have worked there for over 37 years. Working at the center for half of its 75 years, I'd like to share a few memories during my tenure there.

I first arrived at the Flight Research Center (now NASA Armstrong) in July 1971, as a cooperative education student majoring in aerospace engineering from Iowa State University and left in April 2009, after spending the previous 10 years as center director. Three co-op sessions confirmed my interests in aircraft flight control systems, which led to my career as a research engineer and the opportunity to work on some of the world's most innovative and technologically advanced flight research aircraft programs. My years as the center's director were largely focused on positioning the center for the future through diversification of its programs and skills.

I was very fortunate in my early years to work with many exceptional engineers and technicians at the forefront of the earliest developments of digital flight control systems for primary, life-critical aircraft flight control. The Flight Research Center invented and developed much of that technology, proved its safety and flexibility in flight applications, and then worked with government and industry partners to implement that technology in advanced aircraft developments. As a flight controls research engineer, I participated in many flight programs aimed at advancing and maturing these technologies, including the F-8 Digital-Fly-By-Wire, the 3/8th scale F-15 Remotely Piloted Research Vehicle, the Highly Maneuverable Aircraft Technology, and the X-29A Forward Swept Wing aircraft programs. Digital flight controls technology development in the 1970s and 1980s certainly ranks as one of the center's premier "world-changing" technology contributions. Virtually all the world's current aircraft use these technologies.

As I transitioned through various supervisory and management positions in the middle years of my career, I participated and supported work on flight programs continuing to exploit remotely piloted and later autonomous technologies. NASA's Environmental Research and Sensor Technology (ERAST) program sponsored the early development of several remotely piloted aircraft platforms, which contributed significantly to the nation's current Predator and Global Hawk capabilities. ERAST also fostered the development of the first fully solar-electric aircraft platforms, including the world-record breaking Helios aircraft. These early unpiloted aircraft developments in the 1980s and 1990s again led to "world-changing" contributions, as evidenced by today's proliferation of autonomous vehicles.

In the early 1990s, I was heavily involved in the nation's National AeroSpace Plane (NASP) project; a highly ambitious effort to lower the cost of space access through the development of single-stage-to-orbit technologies. These efforts evolved into NASA's Access to Space initiative aimed at the development of a family of rocket-propelled reusable launch vehicles, including the X-33, X-34, X-37, X-38, and X-40A vehicles; some of which made it to flight and future applications. In the latter part of the 1990s, the center explored an alternate air-breathing propulsion concept, called the

Petersen page 19

Incredible people work here

Former director Szalai says be proud to work here

Guest column

Kenneth Szalai
Former center director

The 75th Anniversary is a time to look back for a moment, and then to do even better in the future. When I completed my service to NASA and to the United States at AFRC, I left thinking about the wonderful people I was fortunate to know and work with. Although there were long days and long weeks, the 34 years passed quickly. Note well and make every day a good day.

My principal recollections are about the incredible people that make up this valuable national facility. Women and men in every office, lab, hangar, shop, guard house and cockpit somehow melded together to create a human-powered team that did extraordinary things. Their efforts directly led to flight of experimental vehicles and systems that were brought to life through hard work, very often overcoming daunting challenges that are similar to running an obstacle course never seen before, with human life consequences.

What I saw over and over again was commitment, loyalty, persistence, and passion for the job they had. They had families of course, but passing through the gate, the work they did here WAS their life. The projects, discoveries, advancements, 'firsts' celebrated by these people at the Flight Research Center (now NASA Armstrong) are recorded in history books and in photos on the wall. Every single person who works there now, (or connects electronically from home!) is an essential part of the NASA Armstrong team. When any of you is asked, "What do you do – what is your line of work," your answer should be, "I am in flight research." Your roles vary, but the objective is the same.

EC85-33111-002 NASA

The F-8 Digital Fly-By-Wire aircraft changed the way aircraft were controlled, making them safer, more maneuverable, and more efficient. Some members of the team attended the aircraft's retirement in 1985 including from left Ken Szalai (a former center director), Wilton Lock, Bill Peterson, Jim Phelps, Jim Craft, Leo Lett, Dwain Deets, and Cal Jarvis. Another team member who is not pictured, Kevin Petersen (also a former center director), worked on the program as a research engineer.

I started as a GS-7 engineer from the University of Wisconsin. About 10 days after getting married in 1964, my wife Mary and I set off to the small town of Lancaster (California) in our 1960 Corvette (I should have kept it). I had only talked with two people at 'FRC,' at that time, Jack Fischel (deputy director of Research to Joe Weil) and James Penta, in Personnel. I took home less than $200 every 2 weeks. Even with a furnished 3-bedroom house at $85/month, there was little left after two weeks. Not satisfied with your pay?

But the thrill of being employed at the Flight Research Center was the job of a lifetime. Herm Rediess, was my first Section Chief. He earned his doctorate degree at the Massachusetts Institute of Technology and went on to hold technical and senior leadership positions in industry and government. He continued to influence me, and he still does.

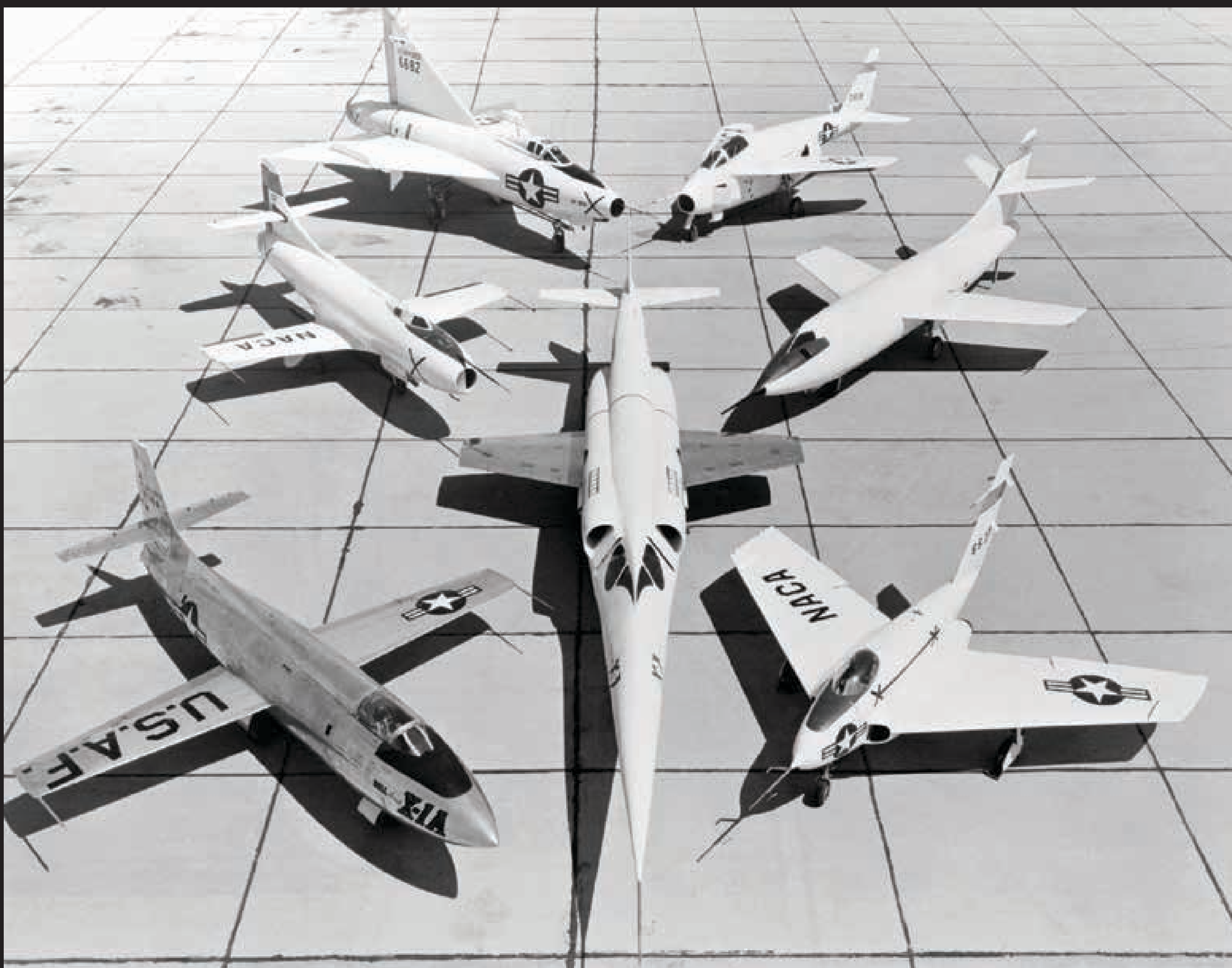
Don Berry was appointed the new chief of the Airborne Simulation Section. He was the model mentor, teaching, guiding, correcting, encouraging, and giving unselfishly of his time and Air Force technical experience. He assisted me in writing my first NASA technical note (report) but refused to have his name on the report. Delores Berry talks with us to the present day. The bonds made in our line of work, taking experimental aircraft to and beyond the boundaries of knowledge and experience is not really a job, it is the exercise of human pioneering and exploration. It is a privilege to be part of it.

Mentors are the unheralded heroes, keeping an unbroken link of technical, process, teamwork, and safety culture at the center. The Henry Arniaz Mentorship award honors Henry and honors today's mentors.

Szalai page 19

In the beginning...

The X-1 started an era of experimental aircraft that quickly ramped up and continues in the modern day



E-2889 NASA

This 1953 photo shows some of the research aircraft at the NACA High-Speed Flight Research Station (now known as NASA Armstrong Flight Research Center in California). The photo shows the X-3 (center) and clockwise from left the X-1A (Air Force No. 48-1384), the third D-558-1 (NACA No. 142), the XF-92A, the X-5, the D-558-2, and the X-4.

By Jay Levine
X-Press editor

As NASA Armstrong began to celebrate its 75th anniversary on Sept. 30, the center is poised to build on its legacy to help NASA and the nation reach new flight milestones.

The National Advisory Committee for Aeronautics (NACA) established a unit here in 1946 with a single mission, to support the first U.S. Air Corps experimental aircraft designed to break through the perceived sound barrier.

A 13-person contingent at the desert outpost was tasked to assist in testing and research of the X-1, which was the first aircraft to exceed Mach 1. Mach 1 is achieved at 650 to 750 mph depending on factors such as atmospheric conditions and altitude. An aircraft breaking through the sound barrier results in a loud thunderous sound heard by those on the ground called a sonic boom.

Today, NASA's X-59 Quiet SuperSonic Technology (QueSST) aircraft is taking shape as it approaches construction completion, with a first flight scheduled for 2022. The X-59 will fly to validate the technology to make quiet supersonic flight a reality. The science includes the shape of the aircraft itself reducing the loudness of a sonic boom to a quiet thump.

Once NASA proves the aircraft is as quiet as it's designed to be, the X-59 will begin the third phase of its mission in 2024, where it will be flown above select U.S. communities to gather data from sensors and people on the ground to gauge public perception. That data will help regulators establish new rules that may enable commercial supersonic air travel over land, greatly reducing flight times.

Before the new supersonic experimental aircraft flies, NASA Armstrong worked to assess how people currently perceive sonic booms. Flight series such as the Sonic Booms in Atmospheric Turbulence Flights at NASA's Kennedy Space Center in Florida and the Quiet Supersonic Flights in Galveston, Texas, have focused on that work. NASA Armstrong has even captured images of how shockwaves interact with each other and between supersonic aircraft using a process called Air-to-Air Background Oriented Schlieren Flights.

Aside from work in aeronautics research and contributing to aeronautical technologies and aviation safety, the center also conducts work in space transportation and has a key role in many Earth and space science missions.

Transition to Space

After the X-1 project ended many X-planes followed, designed to find answers related to speed, temperature, structure, control and human physiology, work that continued as the agency morphed from the NACA to NASA in 1958.

One such aircraft was the X-15 rocket plane program that posted a then record 199 flights, including binders of research, and an official record of speed at Mach 6.7, or more than 4,500 mph, and an unofficial altitude record at the edge of space at 67 miles, or 354,200 feet.

The center's initial focus was aeronautics, but the X-15 bridged the worlds of high-speed aircraft with the research needed to reach beyond Earth's atmosphere. The development of reaction control systems for the legendary X-15 was critical for spaceflight, as it provided a way to control a vehicle in the absence of dynamic

History page 8

E50-0382 **NASA**

NACA pilot John Griffith hands his flight gear to Dick Payne as crew members Ed Edwards and Clyde Bailey observe.

Lockheed Martin

The team at Lockheed Martin Skunk Works in Palmdale, California, merged the major sections of the X-59 Quiet SuperSonic Technology aircraft, which includes the wing, tail assembly, and fuselage or forward section.

EC68-1889 **NASA**

The X-15 launches from the B-52 mothership and its rocket engine ignites. An ablative coating protected the X-15 from the high temperatures in flight and was covered with a white sealant coat.

History... from page 7

pressure as is encountered in space.

The Lunar Landing Research Vehicle also was tested at the center. The free-flight aircraft simulated the one-sixth gravity of Earth that astronauts would face on the moon. The research contributed to construction of the Lunar Landing Training Vehicles that were built and sent to NASA Johnson Space Center in Houston (then called the Manned Spaceflight Center). Apollo astronauts used the spindly aircraft to train for landing on the moon. The practice was helpful when Neil Armstrong, for whom the center was renamed in 2014, piloted the Lunar Module manually to the lunar surface to take the first steps.

Lifting body aircraft were designed to validate the shape of a space return vehicle that could land like an aircraft instead of descending under a parachute and landing in the ocean. Sierra Nevada Corporation's Dream Chaser spacecraft completed additional approach and landing tests at NASA Armstrong in November 2017, it continued the center's historic role with lifting body shaped vehicles.

Space Shuttles and Space Contributions

Space shuttle prototype Enterprise's approach and landing tests marked another contribution to space-related technology. A large steel gantry called the Mate Demate Device slowly lifted the shuttle onto the back of a specially modified NASA 747 Shuttle Carrier Aircraft. Enterprise was then launched from the back of the large aircraft to validate the shuttle's performance in atmospheric flight.

The center retained a role with the space shuttles during the 30-year program, often hosting landings. Most early landings and first flights of new orbiters or return to flight operations took place at the center. The shuttles concluded 54 space missions with a landing at Edwards and a return trip on the NASA 747 to NASA's Kennedy Space Center in Florida.

NASA Armstrong also was involved in testing the pad launch abort test capsule for NASA's Orion spacecraft. The capsule's instrumentation and wiring took place at the center, as did its weight and balance, center of gravity and combined systems testing. The center also led the construction of the launch site at White Sands Missile Range in New Mexico where the capsule successfully launched May 6, 2010.

Another center contribution included a number of tasks for the Orion Ascent Abort-2 (AA-2) that launched successfully July 2, 2019, which was a key milestone in preparation for Artemis missions to the Moon. The team was key to data systems for the AA-2 flight test vehicle, ensuring engineers had all the information they need to assess how the spacecraft's launch abort system can pull the Orion crew module to safety in an emergency.

The center has also assisted in testing systems in flight. Software for the agency's Space Launch System rocket, which will launch Orion into deep space, was tested onboard the center's F-18 aircraft that flew nearly vertical to simulate a rocket flight path. A NASA Armstrong F-18 was also used to test a radar system that helped land the Mars Curiosity rover on the surface of the planet in 2012.

NASA's Flight Opportunities program, managed by the center, rapidly demonstrates promising technologies for space exploration, discovery, and the expansion of space commerce through suborbital

EC65-0649 **NASA**

The Lunar Landing Research Vehicle flies with support from a Bell 47 helicopter.

ECN-2359 **NASA**

The wingless, lifting body aircraft were lined up on Rogers Dry Lake at what is now NASA Armstrong. From left to right are the X-24A, M2-F3 and the HL-10.

ED02-0131-10 **NASA/Jim Ross**

Endeavour, mounted securely atop one of NASA's modified Boeing 747 Shuttle Carrier Aircraft, left NASA Armstrong at sunrise.

testing with industry flight providers. The program matures capabilities needed for NASA missions and commercial applications while strategically investing in the growth of the U.S. commercial spaceflight industry.

These flight tests take technologies from ground-based laboratories into relevant environments to increase technology readiness and validate feasibility while reducing the costs and technical risks of future missions. Among other successes, the program supported testing of the technology that helped the Perseverance Rover find a safe place to land on Mars.

The X-15 rocket plane program posted a then record 199 flights, including binders of research, and an official record of speed at Mach 6.7, or more than 4,500 mph, and an unofficial altitude record at the edge of space at 67 miles, or 354,200 feet. The center's initial focus was aeronautics, but the X-15 bridged the worlds of high-speed aircraft with the research needed to reach beyond Earth's atmosphere.

Aeronautics Milestones

Speed isn't only the regime of space vehicles. NASA Armstrong researchers explored the realm of hypersonic speed with the first integrated hypersonic scramjet engine, the X-43. The air-breathing engines propelled the vehicle to speeds of Mach 7, about 4,500 mph, and nearly to Mach 10, or roughly 7,000 mph, during separate flights in 2004, setting a Guinness World Record for air-breathing propulsion.

High speed isn't always the goal, as demonstrated during the Environmental Research Aircraft and Sensor Technology (ERAST) program. One of the aircraft that flew in that program was the Helios Prototype, which cruised at 25 mph powered by solar powered electric motors about as powerful as a hairdryer.

ERAST, which was managed at NASA Armstrong, was a joint NASA-industry initiative to develop and demonstrate aeronautical technologies. The primary objective was to develop and transfer advanced technology to an emerging American industry and to conduct flight demonstrations of those technologies in controlled environments to validate the capability of Unmanned Aerial Vehicles (UAVs) to fly operational science missions. The program also focused on miniaturization and integration of special-purpose sensors and imaging equipment for UAVs.

A major success of the program happened in 2001, when the Helios Prototype reached an unofficial world-record altitude of 96,863 feet and sustaining flight above 96,000 feet for more than 40 minutes during a test flight near Hawaii. Another success was General Atomics technology development that lead to future aircraft NASA used such as the Ikhana (Predator B) that was based at the center for science missions and the SkyGuardian unmanned aircraft that demonstrated potential commercial applications. The legacy of ERAST also includes early efforts at identifying and developing technology for integration of UAS into the National Airspace System.

Christian Gelzer, Elena Johnson, Matt Kamlet, Megan Person, and Teresa Whiting contributed to this report.

Blue Origin

The New Shepard booster lands following the vehicle's flight.

EC04-0029-21 **NASA/Carla Thomas**

NASA's historic B-52 mother ship carried the X-43A and its Pegasus booster rocket on a captive carry flight on Jan. 26, 2004, to check its readiness for launch. The hydrogen-fueled aircraft was autonomous and had a wingspan of approximately 5 feet, measures 12 feet long and weighed about 2,800 pounds.

Nick Galante

The solar-electric Helios prototype flying wing flew near the Hawaiian Islands of Niihau and Lehua during its first test flight on solar power.

What's next

The X-57 and science research aircraft platforms are part of the future, as is the possibility of air taxis

NASA illustration

This illustration imagines what part of the future National Airspace System could look like. NASA's Advanced Air Mobility National Campaign is working to help emerging aviation markets to safely develop an air transportation system that moves people and cargo between places previously not served or underserved by aviation – local, regional, intraregional, urban – using revolutionary new aircraft.

By Jay Levine
X-Press editor

New innovations are part of what NASA Armstrong is known for and one of the latest experimental aircraft, or X-planes, is the all-electric X-57 Maxwell.

The distributed electric powered aircraft fits into an overarching NASA plan for researching regional air transportation of people and cargo. A principal goal of the X-57 project is to share the X-57 design and airworthiness process with regulators and standards organizations. Another goal is to establish the X-57 as a reference platform for integrated approaches of distributed electric propulsion technologies.

AFRC2021-0047-1 NASA/Lauren Hughes

NASA's all-electric X-57 Maxwell continues to undergo high-voltage ground testing with successful spinning of the propellers under electric power at NASA Armstrong. The principal goals of the X-57 Project are to share the X-57 design and airworthiness process with regulators and standards organizations; and to establish the X-57 as a reference platform for integrated approaches of distributed electric propulsion technologies.

Air taxis and autonomy

To help integrate air taxis, cargo delivery aircraft and other new air vehicle concepts into the national airspace system, NASA is working with industry, academia, and other government agencies like the Federal Aviation Administration (FAA). The bulk of this work is happening under NASA's Advanced Air Mobility (AAM) National Campaign.

This multi-event campaign will take place at several locations over a number of years and will include testing innovative aircraft provided by industry partners. Through these test flights, NASA plans to collect data and provide lessons learned to inform FAA policy decisions on AAM safety, certification, operations, and airspace integration. This effort picks up where the Unmanned Aircraft Systems Integration in the National Airspace System, or UAS in the NAS, concluded in 2020.

Continuing NASA's work in autonomy, the Resilient Autonomy project has developed the Expandable Variable Autonomy Architecture, or EVAA, which includes autonomous elements for increased safety on a range of aircraft. The activity ended Sept. 30, but several groups including the U.S. Department of Defense (DoD), the FAA and the Alaska Bushpilot community are looking into how this software could be integrated into a variety of aircraft in the future. Advanced Air Mobility is also looking at potential uses of EVAA.

This software stems from the Automatic Ground Collision Avoidance System (Auto GCAS) that has saved the lives of 11 F-16 pilots. The Auto GCAS system takes control of an aircraft from the pilot at the last possible moment to avoid an imminent ground collision. For this activity, the team modified the algorithms of the F-16 GCAS and the Automatic Collision Avoidance Systems and rebranded them to indicate an improved functionality suitable for non-fighter aircraft. This new version of the software can be used in smaller aircraft like Cessnas and future remotely piloted

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Joby Aviation

Joby's all-electric vertical takeoff and landing aircraft is pictured at the company's Electric Flight Base, located near Big Sur, California. NASA conducted tests with the aircraft as part of the agency's Advanced Air Mobility National Campaign.

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or autonomous aircraft. The Joint Capability Technology Demonstration activity is in partnership with the FAA and the DoD.

Airborne Science

NASA Armstrong operates a fleet of specialized aircraft of varied capabilities to support environmental and Earth science research missions under the Airborne Science program of the agency's Science Mission Directorate.

As part of the directorate's Earth Science Division, NASA's Airborne Science Program uses these unique aircraft and sensors to conduct observations and collect atmospheric data, as well as calibrate and validate satellite data.

A number of the science aircraft are based at NASA Armstrong Building 703 in Palmdale. They include a DC-8 jetliner converted into a flying science laboratory, two high-altitude Lockheed ER-2s (civilian versions of the U-2Rs) and a Gulfstream C-20A (G-III). A Beechcraft B-200 Super King Air is based at Armstrong's main facility.

SOFIA

NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA) is the world's largest airborne astronomical observatory, complementing NASA's space telescopes as well as major Earth-based telescopes. SOFIA features a German-built far-infrared telescope with an effective diameter of 100 inches (2.5 meters). The telescope weighs 19 tons (38,000 pounds) and is mounted in the rear fuselage of a highly modified Boeing 747SP aircraft.

Flying at altitudes of between 39,000 to 45,000 feet (12-14 kilometers) and above 99% of the water vapor in the atmosphere, SOFIA facilitates observations that are unobtainable from telescopes on the ground. Because SOFIA can fly virtually anywhere in the world, change instruments between flights, and implement new capabilities, it provides greater adaptability than any space-based telescope.

The cutting edge

The X-56A suppressed potentially destructive vibration called flutter, which permitted research of the aircraft's lightweight, flexible wings. The results of the research, which also included the Air Force Research Laboratories in Ohio, could enable future airliners to use similar wing designs to conserve fuel. The X-56A team also facilitated the development of tools and technologies and acquired data to validate modeling techniques.

NASA Armstrong engineers are working on an increasingly complex aircraft called the Preliminary Research Aerodynamic Design to Lower Drag, or Prandtl-D. The aircraft features a new method for determining the shape of the wing with a twist that could lead to an 11% reduction in drag. The concept may also lead to significantly enhanced controllability that could eliminate the need for a vertical tail and potentially to new aircraft designs.

Work on the Prandtl-D led to a concept for a potential Mars airplane. If the Preliminary Research Aerodynamic Design to Land on Mars, or Prandtl-M aircraft is successful, it could collect and transmit valuable information back to Earth.

NASA Armstrong's built the foundation for a busy future as the next chapter of the center's history unfolds.

Christian Gelzer, Elena Johnson, Matt Kamlet, Megan Person, and Teresa Whiting contributed to this report.

AFRC2021-0106-06 NASA/Joshua

NASA's DC-8 heads to St. Croix in support of the Convective Processes Experiment - Aerosols and Winds campaign.

AFRC2021-0059-33 NASA/Carla Thomas

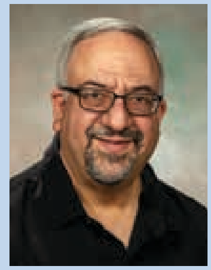
Flight crews at NASA Armstrong flew the Sub-Mesoscale Ocean Dynamics Experiment (S-MODE) installed in the B-200 King Air.

ED13-0220-127 NASA/Carla Thomas

A rainbow frames the Stratospheric Observatory for Infrared Astronomy NASA 747SP during its first Southern Hemisphere deployment in Christchurch, New Zealand, in July 2013.

Center has great value

The view from here



Jay Levine
NASA Armstrong
X-Press editor

NASA Armstrong began celebrating its 75th anniversary Sept. 30 and will continue through the Aerospace Valley Air Show at Edwards Air Force Base in October 2022. This publication and its companion electronic publication, or e-pub, are part of that celebration.

From the 13 National Advisory Committee for Aeronautics employees sent to begin the outpost here in 1946, NASA Armstrong now numbers 1,354 employees.

The technology developed and/or proven here provides value to the nation and the world that has and will continue to change people's lives for the better. The center has been involved in concepts to save fuel and fly more environmentally sound commercial aircraft like winglets and the supercritical wing shape. New aviation concepts seek to reduce emissions, increase efficiencies, and lead to new markets and good jobs.

Aerodynamics extends to vehicles and truck research at NASA Armstrong literally changed the shape of 18-wheelers. The research resulted in lower aerodynamic drag, which resulted in 20-24% fuel savings depending on the winds.

In addition, NASA Armstrong's support of science missions with the B-200, C-20, DC-8, and ER-2 continue to shed light on items such as atmospheric chemistry, storms, and natural disasters. That data informs federal agencies and the U.S. Congress on environmental policy.

When the X-57 Maxwell flies from Armstrong, currently scheduled in 2022, it will help validate the technologies necessary for an all-electric aircraft. The X-57, along with other research such as the Electrified Powertrain Flight Demonstration (EPFD), could prove that electric aviation is viable. EPFD is a NASA funded effort using commercially available aircraft for NASA research to rapidly mature technologies through ground and flight demonstrations.

Supersonic flight will also be back in the spotlight in 2022 when the X-59 Quiet SuperSonic Technology aircraft takes to the skies. These flights will eventually prove aircraft can travel faster than Mach 1 – which is between 650-750 mph depending on factors such as altitude and atmospheric conditions – without producing a thunderous sonic boom for communities below. Success could lead to lifting the Federal Aviation Administration ban on supersonic flight over land.

While we may be a way from the bubble car used by George Jetson in the 1960s cartoon, riding in an air taxi might be closer than people think. NASA's Advanced Air Mobility (AAM) and its National Campaign are working to make the air transport of people, packages, and sensitive medical deliveries a reality.

In the background, but equally important, are the people who work here every day to advance technology and science through flight. This issue features columns by NASA Armstrong Center Director David McBride and two former center directors, Kenneth Szalai and Kevin Petersen, who served before him. They share their experiences from their time at the center. I have been privileged to work with these fine individuals who graciously agreed to share their stories.

Finally, everything changes over 75 years and this publication, starting with this issue and going throughout the 75th anniversary celebration, showcases a new masthead designed by Kirsten Sharrer. I hope you enjoy this publication and the companion e-pub (see the NASA Armstrong 75th anniversary page for more details). The pages of the X-Press will contain guest columns to showcase different perspectives of the center's past, modern day, and perceived future in every issue throughout the anniversary year.

Flashback!

EC80 37946 **NASA**

This group earned a Highly Maneuverable Aircraft Technology back-up control system team award in 1980. Two members of the group, Kenneth Szalai, front from left, and Kevin Petersen, front row, at right, became center directors. Front row from left is Szalai, Bob Kempel, and Petersen. In the back row from left are Bob Noscoe, Larry Schilling, and Dick Larson.

Time capsule

NASA agency and center officials unpack treasures that were sealed in 1996 for employees of next generations

By Jay Levine
X-Press editor

A 25-year-old mystery to most people was solved Oct. 13 at NASA Armstrong.

A time capsule sealed during the center's 50th Anniversary in 1996 was opened to unveil the treasures left there for this generation. NASA Administrator Bill Nelson, NASA Deputy Administrator Pam Melroy, and NASA Armstrong officials reviewed the contents of the capsule as part of the center's ongoing 75th anniversary celebration.

NASA Armstrong's origins date back to 1946, when a small group of National Advisory Committee for Aeronautics engineers were sent to Muroc Army Air Field (now Edwards Air Force Base in Edwards California). They began preparations to support the X-1 rocket plane and piercing the sound barrier. The center continues advancing technology and science through flight and makes flight safer, more economical, and environmentally friendly.

NASA Armstrong Center Director David McBride provided background on the capsule, as Walt Kondracki, center aviation maintenance crew chief, opened it up. The time capsule was placed in the cockpit of the X-1E that is displayed outside the center's main building in 1996. Each organization was asked to contribute to the capsule before it was sealed in 1996.

AFRC2021-0128-79 NASA/Joshua Fisher

NASA Administrator Bill Nelson shows a picture of the X-3 to NASA Armstrong Center Director David McBride on Oct. 13.

AFRC2021-0128-77 NASA/Joshua Fisher

NASA Deputy Administrator Pam Melroy shows NASA Administrator Bill Nelson and NASA Armstrong Center Deputy Director Patrick Stolicker a floppy disk, one of the treasures contained in a time capsule opened Oct. 13. The capsule was sealed on the center's 50th anniversary and opened to commemorate its 75th anniversary. At left is Kevin Rohrer, chief of the NASA Armstrong Strategic Communications Office.

Items in the time capsule included budgets from fiscal year 1997 from the Comptroller's Office, an aerial photo of the center from Research Facilities, an 8-inch floppy disk and punch card from Information Services, a research aircraft fleet image from Flight Operations, a VHS video from Aerospace Projects, and photos of research aircraft from Projects.

Also in the capsule were research papers from Research Engineering, an earthquake response plan from Safety, an Hispanic Heritage Program photos, the Flights of Discovery book, and the center's strategic plan from the Office of the Center Director. Perhaps one of the most valuable items was a collection of about 30 entries that included text and drawings from local school children, called Aeronautics 2020, on what they thought the future would look like.

In addition, the time capsule included a newspaper front page article on the center's 50th anniversary, coins commemorating the 20th anniversary of the F-8 Digital-Fly-By-Wire and the F-8 Supercritical Wing projects, and a photo of the center's staff behind the 4802 Hangar.

A new effort is underway to select items for a time capsule that will be opened during the center's 100th anniversary.

While it was Nelson's first visit to the center as NASA administrator, he had been at the center before. He was a payload specialist on space shuttle Columbia's STS-61-C mission, which landed at Edwards on Jan. 18, 1986. Also

History page 20

Needed: Time capsule

Blua, Whitfield recall construction

By Jay Levine
X-Press editor

A time capsule was needed in 1995 at NASA Armstrong. Machinists Andy Blua and Tom McMullen, and welders Ed Swan and Don Whitfield, were instructed to follow engineering drawings and build the container that would securely hold artifacts for a quarter century.

Once complete, the time capsule was loaded with the items provided by the center's organizations and sealed on the center's 50th anniversary in 1996.

Fast forward to Oct. 13 when the center is celebrating its 75th anniversary and the capsule items were unloaded. NASA Administrator Bill Nelson, NASA Deputy Administrator Pam Melroy, NASA Armstrong Center Director David McBride, and Deputy Director Pat Stoliker reviewed the treasurers stored for a new generation of center employees.

Blua and Whitfield, who still work at the center, were there as the artifacts they helped safely store were unpacked.

"I don't often realize what I am working on, or its significance," Blua said.

In fact, the men had forgotten all about the time capsule until recently when it was announced it would be opened. Whitfield added that they also had no idea what was in it.

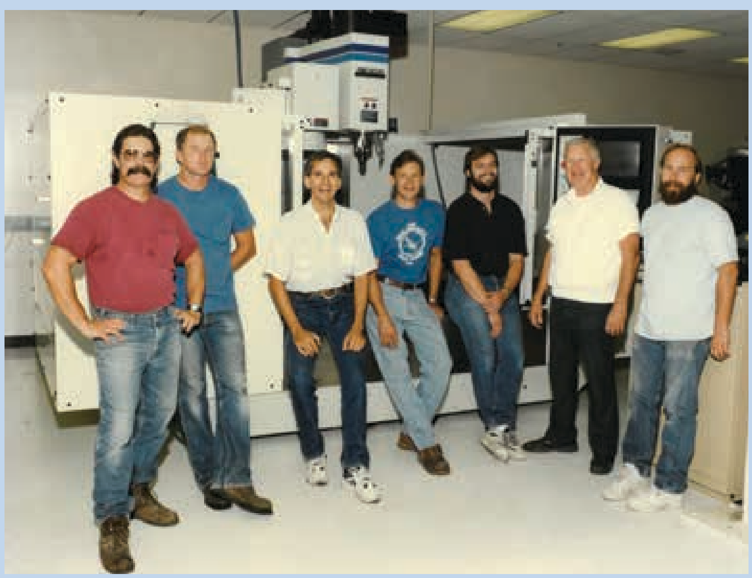
"I was caught off guard," Blua said. "I can't believe it's been 25 years."

Budgets, plans and technical papers were in the capsule, which also included an aerial photo of the center, an 8-inch data storage floppy disk that was no longer in use by the late 1970s, a punch card last seen routinely in the mid 1980s, a research aircraft fleet image, a VHS video, photos of research aircraft, and a staff photo from behind Hangar 4802.

In addition, other encapsulated items included Hispanic Heritage Program photos, the Flights of Discovery book, and the center's strategic plan. Perhaps the most treasured part of the collection was about 30 entries that included text and drawings from local school children, called Aeronautics 2020, on what they thought the future would look like.

AFRC2021-0128-85 NASA/Joshua Fisher

Andy Blua and Don Whitfield stand by the time capsule they helped construct 25 years ago at NASA Armstrong during the center's 50th anniversary.



NASA

The team that built the time capsule for NASA Armstrong included from left Andy Blua, David Oates, Greg Poteat, Tom McMullen, Aric Warner, Joe Pengilley and John Breiding.

While the time capsule has secured items for 25 years and will be doing so again to open on the center's 100th anniversary, Blua and Whitfield agreed they'd like to make improvements.

The original designer of the time capsule did not account for the diameter measurement of the container. It did not fit well into the X-1E cockpit, which is where it was stored just outside the center's main administration building. In fact, it was hard to squeeze in and it was just as hard to get it out.

The men propose a minor redesign to cut the lid off, make the cylinder shorter, refurbish it and anodize (a process of adding a protective layer) it like the original to keep it in pristine condition. Once complete, Blua proposes adding a new plaque to recognize the additional people contributing to the time capsule's longevity. Another idea Whitfield suggests is to check that it fits well before reloading it with new items for a future generation.

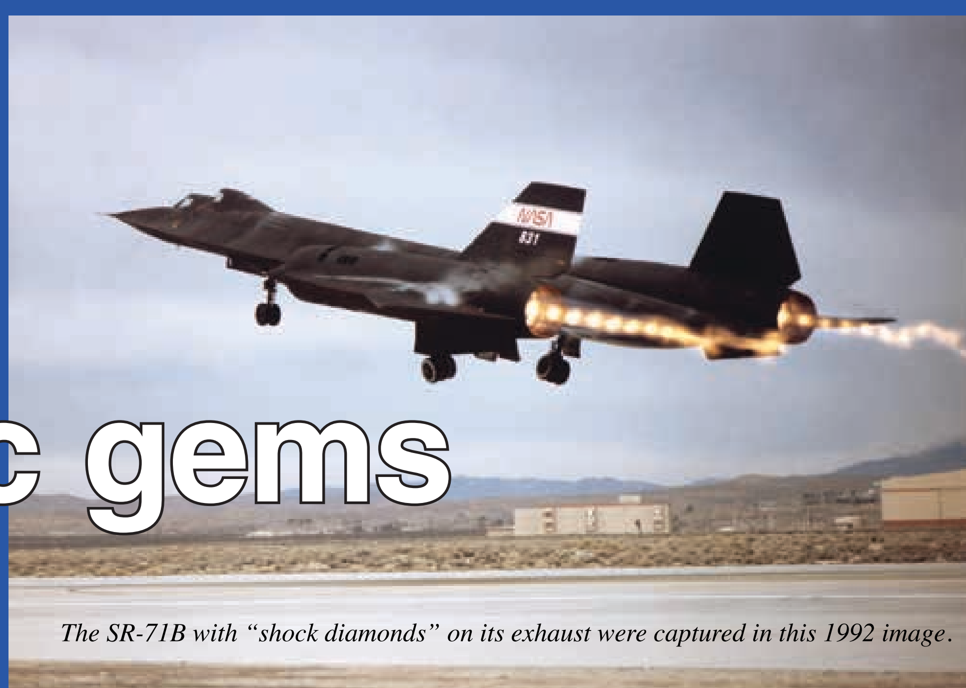
They also want the Fabrication Branch, which did not exist as it does 25 years ago, to add an item to the capsule. While it is uncertain what items might be selected for the time capsule, one thing is sure – it will stand the test of time.

This classic 1969 photo shows the workhorse NASA B-52B flying over the HL-10 lifting body aircraft and its pilot Bill Dana.

ECN-2203 NASA

These images are just cool. Enjoy!

Historic gems

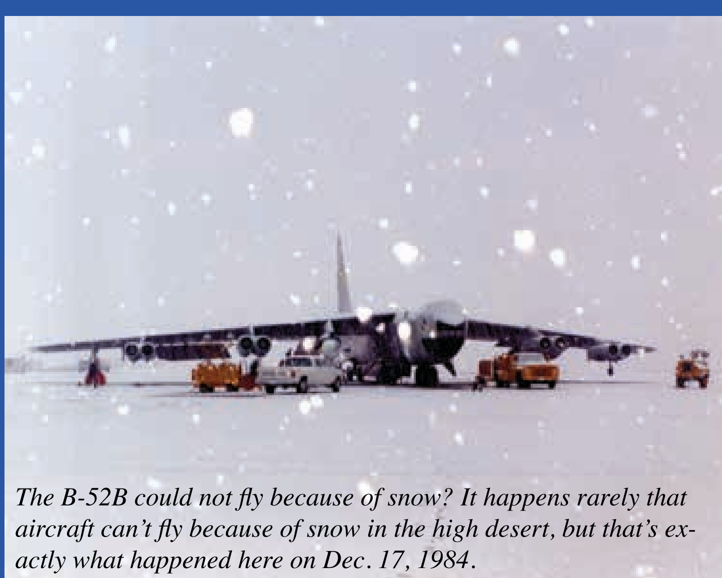


The SR-71B with "shock diamonds" on its exhaust were captured in this 1992 image.

EC92-1284-1 NASA

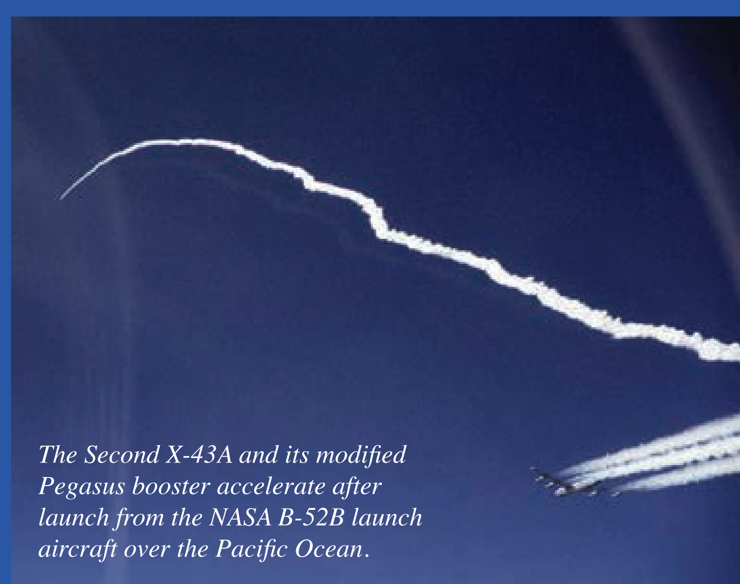
The XB-70 and its contrails streak across the sky during this 1967 flight.

AFRC2021-0128-79 NASA



The B-52B could not fly because of snow? It happens rarely that aircraft can't fly because of snow in the high desert, but that's exactly what happened here on Dec. 17, 1984.

AFRC2021-0128-79 NASA



The Second X-43A and its modified Pegasus booster accelerate after launch from the NASA B-52B launch aircraft over the Pacific Ocean.

AFRC2021-0128-79 NASA/Jim Ross

David McBride... from page 3

the Stratospheric Observatory for Infrared Astronomy (SOFIA) began full operational capability and proving its ability to collect science safely. Another achievement was successfully advocating for the next generations of research flight experiments with former and current Aeronautics Research Mission Directorate leadership Jaiwon Shin and Bob Pearce, respectively.

Where I think the next focus will be is on a single-aisle commercial transport aircraft that is more efficient and will reduce carbon emissions. We flew the X-48 Blended Wing Body aircraft and advocated for that type of aircraft as one possibility. Several other designs, such as the Transonic Truss-Braced Wing transport, also can improve aircraft efficiency in the 20%, 30%, 40%, or maybe even 50% over today's standard aircraft. That will impact everyone who flies.

One of the biggest long-term legacies that will touch more people than we understand now is electrified flight. I believe that the next generation of flight will be electrified to some degree, whether it is 100% electric like the X-57, or a hybrid design with an electric generator running electric motors that will increase aircraft efficiency and simplify aircraft maintenance, much like an electric car is now. Application of the technology and proving it works is NASA's role.

Like digital fly-by-wire control led the way on digital control, pioneered validation testing tools, and is used on most modern aircraft in the world, I believe we will lead the way in guiding the aerospace industry forward with some standards for electric flight. That also could reduce costs to enable a whole new market in Urban Air Mobility, urban air taxi services. Transportation and the businesses needed to support those industries will have a huge impact on people's lives and the environment.

ED09-0253-040 NASA/Tom Tschida

Space shuttle Discovery crew made the final space shuttle landing at Edwards Air Force Base and NASA Armstrong on Sept. 11, 2009. The crew are greeted from right by then acting NASA Armstrong Center Director David McBride (shaking hands with Commander Rick Sturckow), U.S. Air Force Flight Test Center Commander Maj. Gem. David Eichhorn, NASA Armstrong Space Shuttle Operations project manager George Grimshaw and Strategic Communications Chief John O'Shea.

NASA's efforts to go back to the Moon and explore the cosmos expands our knowledge and is already enabling U.S. companies to develop new businesses for testing new technologies, resupplying the International Space Station, and providing new opportunities in space. We manage the Flight Opportunities program, which matures capabilities needed for NASA missions and commercial applications while strategically investing in the growth of the U.S. commercial spaceflight industry.

We have a role in the Orion spacecraft and the Artemis missions as well. First, in 2010 we conducted the ground Pad Abort test (an abort on the launch pad prior to launch) and then in 2019, we conducted the in-flight Ascent Abort test (an abort post launch). These tests used the Launch Abort System, which will ultimately be installed on the Orion spacecraft, to validate in those two conditions that we can safely get the crew and crew capsule to a safe distance in an emergency.

Orion and SOFIA are complex vehicle and system integration challenges that leverage our expertise in instrumentation, flight dynamics, structures, and mechanical, and we pull it all together for a successful flight experiment. Our main goal is to publish the data we gather for the benefit of the aerospace industry to then go out and develop new aircraft and industries.

For science – astrophysics and Earth science – we enable scientists to get their payloads into the atmosphere. We operate world-class Earth science and astrophysics vehicles for the agency and the world. It takes all NASA Armstrong organizations to make these vehicles successful in flight, to conduct science data from within the atmosphere safely.

Every first flight of a new technology has its own defining moment and point of validation. From the X-1 to the X-59, a first flight proves something. It's not just the first flights. Every step along the way of completing the flight test plan extends our knowledge.

NASA Armstrong began on Sept. 30, 1946, with assisting the U.S. Army Air Corps to break the sound barrier a year later. The technology we are now validating in the X-59 will demonstrate the ability to decrease the intensity of those sonic booms first created when the X-1 succeeded.

The X-59 will provide data that could lead to the Federal Aviation Administration ending the prohibition on supersonic flight over land in the United States. Such a change could lead the way to new business opportunities and greatly reduce travel times.

Until you validate technology through flight, it is not ready for the market. A lot of people think you can design on computers, models, and simulators then you are done. We have learned that to really validate and prove something, you must take it to flight in the real world.

NASA and Armstrong are top places to work and that will continue. We are honest with each other, we are small enough so we can easily talk to each other, and we can disagree with each other and still accomplish great things.

I have every confidence in the next generation of leaders at the center, young engineers and people working in every area. They are going to do well in the future if we allow them to run and demonstrate their capabilities. We have a great team that will continue to inspire, train the next generation of professionals, and provide value to the nation.

Kevin Petersen... from page 4

supersonic combustion ramjet (Scramjet), and developed the X-43A (or Hyper-X) vehicle to prove its viability. The successful third flight of the X-43A did just that in 2004, while shattering world speed records in achieving a top speed of Mach 9.6 and creating unique data and knowledge for future technologists. That flight was another key "milestone of flight" in the center's long history.

As I transitioned to the position of center director in 1998, my focus turned to positioning the center's programs and workforce to be both relevant and successful in the future, while ensuring the proper execution and accomplishment of ongoing activities. Diversifying the center's programmatic assignments and facilities to support a broader portfolio was a strategy deployed to ensure long term center viability. Expanding beyond the center's traditional roles in NASA's aeronautics became more of a focus.

New opportunities were created at the center with the transitioning of the DC-8 and ER-2 aircraft within NASA's airborne science program. Other existing aircraft were modified to support the expanding airborne science requirements, including the center's Gulfstream III, Ikhana, and various support aircraft. Partnering with industry, the center acquired multiple Global Hawk aircraft to expand and support earth science applications. All these changes helped secure the center's involvement in NASA's airborne science programs for the future.

In the mid-2000s, the center secured the aircraft development and operations role for the agency's Stratospheric Observatory for Infrared Astronomy (SOFIA) project, a large science platform, greatly expanding the center's long-term responsibilities supporting NASA's space science efforts. The center also greatly expanded its facility capabilities to support these expanded roles in airborne and space science with the acquisition of a major aircraft operations facility in Palmdale.

The center also secured a significant role in the agency's Crew Exploration Vehicle (CEV) program, supporting the development and test of the CEV launch abort system. This program provided for the center's involvement in another major NASA effort.

In the late 2000s, early planning for a resurgence of several X-planes within the aeronautics program was underway, which has now matured into some of the center's most exciting current programs.

It's hard to imagine career opportunities like this anywhere else in the world. None of these things would have been possible without the extraordinary talents of the dedicated people at the center. I feel extremely honored and blessed to have played a part in the center's history of success.

Kenneth Szalai... from page 5

I remember well each of my section office mates. They were all first-class people at the center and in subsequent nationally important jobs. Joe Baumbach told me how things "really worked" at the FRC, influenced me to get a private pilot's license, and introduced me to many people that I should get to know.

A senior simulation engineer, John Perry, spent hours with me explaining real-time aircraft simulation, essential to my first project assignment on the JetStar Airborne Simulator. I got to do research experiments under the guidance of Don Berry and long-time supervisor, Dwain Deets. I also flew as flight test engineer, mentored by fantastic pilots, Stan Butchart, Don Mallick, and Fitz Fulton. JetStar Crew Chief Gene Dymowski taught me so much about airplanes, safety, and procedures...that I never forgot.

Today I treasure every day I spent at the center. The film 'Carpe Diem' is a favorite. **'Seize the day.'** There are new frontiers to explore. You can be proud of your technical accomplishments. But I can say from long experience that what you will take with you most, are the friendships and memories of the people that you worked with to 'push the outside of the envelope.'

One personal note about the center's two namesakes, Dr. Hugh Dryden, and Neil Armstrong. Dryden died the year after I arrived at the center. I have read some of his National Advisory Committee for Aeronautics reports. He epitomizes the devotion to understanding the most difficult aspects of compressible aerodynamics and was a foremost advocate of flight research. I did get to know Neil pretty well. He had personal loss in his life, and some harrowing flight experiences (read about Gemini 8, an X-15 flight over Los Angeles and a Lunar Landing Training Vehicle flight). But this former FRC pilot was incredibly smart and was an excellent pilot. All who knew him, agree that on July 24, 1969, there was no one better you would have taking control of the Lunar Module for a lunar landing. Also, he had the best guy in the 'right seat,' Buzz Aldrin. They were the first crew on the Moon. AFRC contributed to that too. One more thing for all the 'Type A' people out there – Dryden and Armstrong were genuinely humble.

The Flight Research Center could not have succeeded without strong NASA Headquarters support. I remember well Bill Aiken, Jack Levine, Cecil Rosen, John McCarthy, and Bob Whitehead; and Administrators Beggs, Fletcher, Truly and Goldin, and Deputy Administrator Jack Dailey. The cooperation and collaboration of the Air Force Flight Test Center/Air Force Test Center at Edwards Air Force Base was also essential to the center. I especially thank Gen. Roy Bridges and Gen. Richard Engel for their support of the center.

Some of the uncountable people I was just plain lucky to work with are in the retiree's spreadsheet maintained by Carol Reukauf. I have been saddened by the loss in this life of many colleagues. These people led us to victory in the air, in war, and in flight research.

I may not be able to make personal contact with the hundreds on the list, and many others. But if you read this, know that I remember you and your indelible part in bringing the NASA Armstrong Flight Research Center to its 75th year. I also salute David McBride and Patrick Stoliker and wish them and the center ... GODSPEED.

NASA selects companies for EPFD

NASA

This is a NASA illustration of an advanced subsonic aircraft with an Electrified Aircraft Propulsion system.

NASA has selected two U.S. companies to support its Electric Powertrain Flight Demonstration (EPFD) that will rapidly mature Electrified Aircraft Propulsion (EAP) technologies through ground and flight demonstrations.

Through the EPFD program, NASA seeks to introduce EAP technologies to U.S. aviation fleets no later than 2035, supporting short-range and regional commercial air travel, as well as single-aisle seat transports.

The awards under the EPFD project announcement are hybrid firm fixed-price/cost-share. The total combined value for the awards is $253.4 million and the work will be conducted over the next five years. The companies that received awards and their award values are GE Aviation of Cincinnati, $179 million and MagniX USA Inc. of Redmond, Washington, $74.3million.

Over five years, the selected companies will conduct ground and flight test demonstrations of their EAP technologies applicable to commercial aircraft transports. They will collaborate with other NASA projects on EAP development, flight test instrumentation, and data analysis. And they will stimulate spiral developments of megawatt-class EAP systems and technology.

Time capsule... from page 14

on that shuttle mission was pilot Charlie Bolden, who also was a NASA administrator from 2009-2017.

Nelson noted the time capsule was opened in the same hangar that houses the F-15 that will chase the X-59 Quiet SuperSonic Technology aircraft.

Nelson highlighted upcoming major NASA missions including crewed missions to the International Space Station, the Lucy spacecraft is set to begin a 12-year mission later this month to travel to eight asteroids, the Double Asteroid Redirection Test is set for launch in November, and December features the scheduled launch of the James Webb Space Telescope.

Deputy NASA Administrator Pam Melroy is familiar with Edwards Air Force Base and NASA Armstrong, having graduated from the U.S. Air Force Test Pilot School and becoming a test pilot on the C-17. She was the pilot on space shuttle Discovery when it landed at Edwards Air Force Base on Oct. 24, 2000. She later became the second woman to command a space shuttle in 2007 with the space shuttle Discovery.

Melroy believes the X-59 and the X-57 Maxwell electric aircraft could have enormous impact. The X-59 Quiet SuperSonic Technology aircraft will show that an aircraft can travel supersonically without the loud booms, which could provide information to the Federal Administration for Aviation for permitting supersonic flight over land. The X-57 Maxwell electric propulsion aircraft will be validating distributed electric propulsion.

Nelson, Melroy and the NASA Headquarters visitors visited the center's Building 703 in Palmdale, California, to get updates on the DC-8, ER-2, and the Stratospheric Observatory for Infrared Astronomy science aircraft on Oct. 12. While in the area, they also visited Lockheed Martin in Palmdale, where the X-59 is under construction and traveled to NASA's industry partner Masten Space Systems in nearby Mojave, California.

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

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

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