National Aeronautics and Space Administration

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New X-plane technology aims to reduce emissions

NASA

This NASA illustration shows an advanced subsonic aircraft with an electrified aircraft propulsion system. NASA wants demonstrations to help rapidly mature and transition integrated Electrified Aircraft Propulsion (EAP) technologies and associated EAP vision systems for introduction into the global fleet by 2035. Integrated EAP concepts are rapidly emerging as potentially transformative solutions to significantly improve the environmental sustainability of the next generation of subsonic transport vehicles. EAP electrical systems are being developed to replace or boost fuel-burning aircraft propulsion systems, analogous to how electric or hybrid motors are used in automobiles. *See budget story, page 2.*

www.nasa.gov/

AFRC2021-0040-18 NASA/Lauren Hughes

NASA's all-electric X-57 Maxwell aircraft undergoes high-voltage ground testing at NASA Armstrong. A goal of the X-57 project is to help the Federal Aviation Administration set certification standards for emerging electric aircraft markets.

Lockheed Martin

A dark-colored panel of NASA's X-59 Quiet SuperSonic Technology airplane wing is laid in place. The X-59 is under construction by Lockheed Martin at the company's Skunk Works factory in California.

X-planes, aero research

Proposed budget has new work for NASA Armstrong

By Jay Levine
X-Press editor

NASA Administrator Sen. Bill Nelson, in a State of NASA presentation June 2, highlighted future climate science missions, a robotic and human return to the Moon through the Artemis program, the James Webb Telescope set for launch this year, and two new missions to Venus.

Nelson also gave insight into President Joe Biden's proposed $24.8 billion NASA budget request for fiscal year 2022, an increase of about 6% from the previous year. NASA's Aeronautics Research Mission Directorate (ARMD) budget request is $914.8 million, up from $828.7 million in the previous fiscal year.

The ARMD budget includes $91.2 million for the start of a new experimental aircraft aimed at accelerating the development of an electrified commercial aircraft. The budget request for NASA aeronautics also includes $37.1 million to assist with an industry initiative that brings together NASA, industry, and academia to investigate technologies for greatly reducing commercial aircraft carbon emissions. Armstrong staff are already assisting the agency in bringing those efforts to fruition.

NASA Armstrong's news chief Megan Person was in a video aired during the State of NASA event. She introduced NASA to the X-57 Maxwell, the agency's first all-electric, piloted aircraft. The X-57 will pave the way for future electric aircraft and certification of such vehicles. Person also

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More details

The full State of NASA presentation is located at http://youtu.be/nDem528iNF0

NASA budget details are available at https://www.nasa.gov/sites/default/files/atoms/files/fy2022_budget_summary.pdf

NASA

This is an artist's concept of the transonic truss-braced wing aircraft configuration, one possible design for a new Subsonic Flight Demonstrator.

Photo courtesy of the Lancaster Museum of Art & History

Two attendees of a special event for NASA Armstrong employees at the Museum of Art & History in Lancaster view an exhibit celebrating 75 years of the center's history.

MOAH, Armstrong celebrate

Exhibit honors center's 75th Anniversary

By Jay Levine
X-Press editor

The Museum of Art and History (MOAH) in Lancaster hosted an event for NASA Armstrong staff and family June 12 to view an exhibit on the center's 75th anniversary.

The display includes 50 photos; mission, program and center patches; and historical items. For example, an Apollo flight computer like the one used by Neil Armstrong to land the lunar module on the Moon is on display. The computer in the exhibit was built for the Apollo 15 command module. It was that computer that served as the brains for the center's F-8 Digital-Fly-By-Wire work that led to the controls used in most modern aircraft.

Photo courtesy of the Lancaster Museum of Art & History

Attendees celebrate at a special event for NASA Armstrong employees at the Museum of Art and History in Lancaster.

Another item of interest is the side-arm controller from the Lunar Landing Research Vehicle (LLRV) No. 1. It was that vehicle that was enhanced to become the Lunar Landing Training Vehicle that Armstrong was forced to eject from at Ellington Field in

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News at NASA

Mars copter assists team

NASA's Ingenuity Mars Helicopter, on its ninth flight, provided imagery that will help the Perseverance rover team develop its science plan going forward.

Images snapped July 5 by Ingenuity offered scientists and engineers working with the agency's Perseverance Mars rover an unprecedented opportunity to scout out the road ahead. Ingenuity provided new insight into where different rock layers begin and end, each layer serving as a time capsule for how conditions in the ancient climate changed at this location. The flight also revealed obstacles the rover may have to drive around as it explores Jezero Crater.

During the flight – designed to test the helicopter's ability to serve as an aerial scout – Ingenuity soared over a dune field nicknamed "Séítah." Perseverance is making a detour south around those dunes, which would be too risky for the six-wheeled rover to try crossing.

The color images from Ingenuity, taken from a height of around 33 feet (10 meters), offer the rover team much greater detail than they get from the orbiter images they typically use for route planning. While a camera like the High-Resolution Imaging Science Experiment (HiRISE) aboard NASA's Mars Reconnaissance Orbiter can resolve rocks about 3 feet (1 meter) in diameter, missions usually rely on rover images to see smaller rocks or terrain features.

Dry run tests over

Preparations begin for air taxi vehicle flight tests

Teresa Whiting
NASA Armstrong Public Affairs

An integrated dry run test using a helicopter for NASA's Advanced Air Mobility (AAM) National Campaign has ended and the project is now preparing for flight tests with Joby Aviation's air taxi vehicle.

The first round, or build I of the NC Integrated Dry Run tests, was completed in early December and this second round, or build II, lasted from March 6-20 at NASA Armstrong.

During build II tests, a Bell OH-58C Kiowa helicopter, provided by Flight Research Inc. in Mojave, California, acted as a representative urban air mobility (UAM) vehicle. Test pilots evaluated several viable UAM flight profiles with the helicopter. The goal was to understand how a future UAM vehicle will need to operate in a congested urban environment.

Data collection focused on basic vehicle characteristics and specific study areas. Included were simulated instrument flight rule approaches to heliports and vertiports, terminal area hover tasks, diverting in the case of flight changes, avoiding buildings, and other flight maneuvers under various wind conditions.

UAM vehicles as air taxis represent one of several operational uses AAM is researching. These vehicles will use advanced design features, which are intended to enable widespread vertical flight capability in and around urban areas.

"By using a helicopter as a surrogate air taxi vehicle, we were able to exercise our data collection systems, scenarios, and test techniques," said Shivanjli Sharma, deputy lead for the National Campaign. "This will inform gaps in policy and standards to enable certification and operation of a wide range of UAM vehicles in the national airspace."

Alongside the flight testing, data was collected by the ATM-X team from NASA's Ames Research Center in California's Silicon Valley. This includes real-time automatic dependent surveillance-broadcast inputs to represent a future third-party airspace provider, a GPS system, and other flight instrumentation that could be onboard a future vehicle.

This collection of flight tests will provide a baseline set of data needed to support evolutions in vehicle, infrastructure, and airspace requirements that will enable the integration of UAM vehicles into the national airspace system.

"This round of flight tests gave the team an opportunity to assess various techniques that are designed to optimize UAM operations in urban terrain," said Scott Glaser, senior vice president of operations for Flight Research Inc. "This project is leading the way to defining requirements to safely and efficiently support expected high-density traffic on a national or global scale."

Next steps include analyzing the data collected in collaboration with the Federal Aviation Administration. This partnership and initial data will be used to build the next steps of the National Campaign.

"The results of these tests are expected to form a cornerstone for subsequent flight and simulator research that will provide valuable data to industry, FAA civil aircraft certification, and NASA," said Dave Webber, FAA research flight test engineer and vehicle characteristics principal investigator for this project.

The team is now preparing to conduct flight tests with Joby's air taxi in the developmental testing phase of the National Campaign. This phase will include activities to prepare for NC-1 in 2022, such as designing flight scenarios for the NC-1 participants to fly, testing acoustics, and exercising range deployment and data collection protocols across operational safety use cases.

AFRC2021-0023-99 **NASA/Ken Ulbrich**

Flight Research Inc.'s Bell OH-58C Kiowa helicopter hovers over a helipad after completing an urban air mobility approach at NASA Armstrong in March 2021. The Advanced Air Mobility National Campaign studied the viability of various urban air mobility approach options during a second phase called build II.

AFRC2021-0023-101 **NASA/Ken Ulbrich**

Flight Research Inc.'s Bell OH-58C Kiowa helicopter takes off from a research helipad at NASA Armstrong in March 2021. The Advanced Air Mobility National Campaign project utilized several heliports and vertiports to study airspace management evolutions that could enable future urban air mobility operations.

Pilot breathing

NASA sheds new light on known challenges

Teresa Whiting
NASA Armstrong Public Affairs

Pilots who fly high-performance jet aircraft use oxygen masks and other equipment to help them breathe when flying and maneuvering at high altitudes. Breathing problems have been encountered during some of these flights since 2010 but the source of these problems was not understood.

The Pilot Breathing Assessment project set out to discover why pilots were still having breathing challenges by documenting in depth how pilots breathe while in flight. Beginning in early 2018, this was accomplished by using NASA test pilots flying NASA's F-15 and F-18 aircraft based at NASA Armstrong.

The project released its findings in a final report in March 2021, which includes recommendations for users and manufacturers of the aircraft systems. Some of these suggestions include measuring pilot breathing on location and using the results to create future hardware to meet pilot physiological needs, a standardized flight test procedure to evaluate an aircraft's pilot breathing system, and trusting pilot reports of breathing as a significant indication of breathing system performance.

"The project gave us the first real look into how pilots interact and breathe with a high-performance aircraft's breathing system," said Clint Cragg, principal engineer of the NASA Engineering and Safety Center. "Notably, we made a number of discoveries that other researchers and breathing system designers will be able to use for future developments."

AFRC2019-0065-01 **NASA/Carla Thomas**

Phillip Wellner from Life Support conducts a spirometry test on NASA pilot Nils Larson before a Pilot Breathing Assessment flight at NASA Armstrong in 2019. This test measures the volume of air inspired and expired by the lungs and this test was conducted before and after many of the flights.

This report and testing follow a previous assessment in response to a U.S. Navy request made in 2017, to the NESC, located at NASA Langley Research Center in Hampton, Virginia. The request was to conduct an independent review of the Navy's effort to address an increased occurrence of physiological episodes among pilots across its fleet of F/A-18 aircraft.

Pilot physiological episodes can result in cognitive impairment, numbness, tingling, lightheadedness, behavioral changes, and fatigue that may be life threatening for pilots. The extent to how a pilot's lungs transmit oxygen to the brain while breathing through oxygen systems can fluctuate while flying a variety of scenarios, which can sometimes result in these episodes.

"This information matters to the pilot community, and specifically to the test community, because it shows us how important the integration and testing of these systems is to pilot health," said Kevin Hall, Air Force F-35/F-16 test pilot. "It also reinforces the importance of pilots to speak up when they experience trouble with breathing systems."

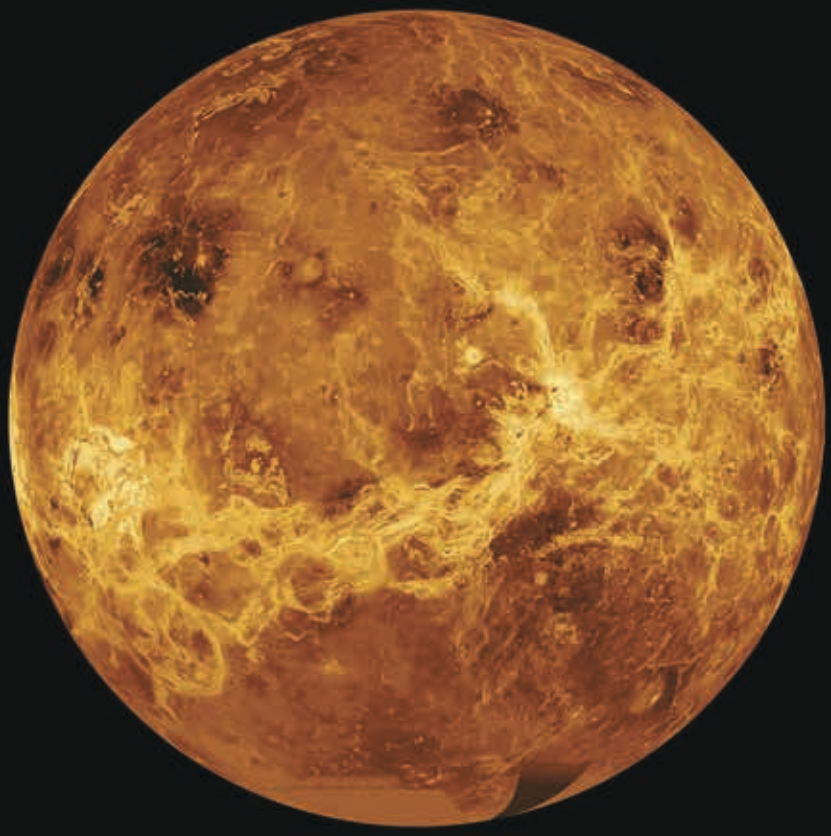
Using five NASA test pilots flying six flight profiles in F-18A/B or F-15D aircraft, the assessment logged more than 100 flights and gathered more than 4,750 minutes of analyzable data about how the pilots interacted with the aircraft while flying.

During the testing, the team made measurements within the pilots' inhalation and exhalation oxygen lines, as well as inside their masks. In addition, spirometry tests to measure the volume of air inspired and expired by the lungs were conducted before and after many of the flights. This measured how much air the pilots were able to breathe out by exhaling as forcefully and for as long as they could. Pilot questionnaires before and after each flight asked about diet, exercise, and other factors that could affect the mission.

Test flight profiles were chosen to be challenging but still within a moderate range to avoid risk of physiological episodes. Although these flights did not reach the full extent of military combat operations, breathing issues did occur during the flights and are described in the report. In support of follow-on work by the U.S. military, this report presents a standardized flight test procedure to establish a baseline of aircraft breathing system performance.

The NESC team noted that data needed to make informed decisions about human and system interactions did not exist prior to this review. The team was also afforded the opportunity to review and analyze a limited amount of F-35 pilot breathing data. Also, F-35 pilots who have experienced physiological episodes were interviewed for the report.

For more about the Pilot Breathing Assessment project, visit: https://go.nasa.gov/2OIelEB



Venus hides a wealth of information that could help us better understand Earth and exoplanets. NASA's JPL is designing mission concepts to survive the planet's extreme temperatures and atmospheric pressure. This image is a composite of data from NASA's Magellan spacecraft and Pioneer Venus Orbiter.

NASA/JPL-Caltech

Venus missions

NASA selects 2 missions to study 'lost habitable' world of Venus

By Alana Johnson and Karen Fox
NASA Headquarters

NASA has selected two new missions to Venus, Earth's nearest planetary neighbor. Part of NASA's Discovery Program, the missions aim to understand how Venus became an inferno-like world when it has so many other characteristics similar to ours – and may have been the first habitable world in the solar system, complete with an ocean and Earth-like climate.

These investigations are the final selections from four mission concepts NASA picked in February 2020 as part of the agency's Discovery 2019 competition. Following a competitive, peer-review process, the two missions were chosen based on their potential scientific value and the feasibility of their development plans. The project teams will now work to finalize their requirements, designs, and development plans.

NASA is awarding approximately $500 million per mission for development. Each is expected to launch in the 2028-2030 timeframe. The selected missions are:

Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging (DAVINCI+)

DAVINCI+ will measure the composition of Venus' atmosphere to understand how it formed and evolved, as

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well as determine whether the planet ever had an ocean. The mission consists of a descent sphere that will plunge through the planet's thick atmosphere, making precise measurements of noble gases and other elements to understand why Venus' atmosphere is a runaway hothouse compared to the Earth's.

In addition, DAVINCI+ will return the first high resolution pictures of the unique geological features on Venus known as "tesserae," which may be comparable to Earth's continents, suggesting that Venus has plate tectonics. This would be the first U.S.-led mission to Venus' atmosphere since 1978, and the results from DAVINCI+ could reshape our understanding of terrestrial planet formation in our solar system and beyond. James Garvin of Goddard Space Flight Center in Greenbelt, Maryland, is the principal investigator. Goddard provides project management.

Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy (VERITAS)

VERITAS will map Venus' surface to determine the planet's geologic history and understand why it developed so differently than Earth. Orbiting Venus with a synthetic aperture radar, VERITAS will chart surface elevations over nearly the entire planet to create 3D reconstructions of topography and confirm whether processes such as plate tectonics and volcanism are still active on Venus.

VERITAS also will map infrared emissions from Venus' surface to map its rock type, which is largely unknown, and determine whether active volcanoes are releasing water vapor into the atmosphere. Suzanne Smrekar, of NASA's Jet Propulsion Laboratory in Southern California, is the principal investigator. JPL provides project management. The German Aerospace Center will provide the infrared mapper with the Italian Space Agency and France's Centre National d'Etudes Spatiales contributing to the radar and other parts of the mission.

"We're revving up our planetary science program with intense exploration of a world that NASA hasn't visited in over 30 years," said Thomas Zurbuchen, NASA's associate administrator for science. "Using cutting-edge technologies that NASA has developed and refined over many years of missions and technology programs, we're ushering in a new decade of Venus to understand how an Earth-like planet can become a hothouse. Our goals are profound. It is not just understanding the evolution of planets and habitability in our own solar system, but extending beyond these boundaries to exoplanets, an exciting and emerging area of research for NASA."

Zurbuchen added that he expects powerful synergies across NASA's science programs, including the James Webb Space Telescope. He anticipates data from these missions will be used by the broadest possible cross section of the scientific community.

"It is astounding how little we know about Venus, but the combined results of these missions will tell us about the planet from the clouds in its sky through the volcanoes on its surface all the way down to its very core," said Tom Wagner, NASA's Discovery Program scientist. "It will be as if we have rediscovered the planet."

In addition to the two missions, NASA selected a pair of technology demonstrations to fly along with them. VERITAS will host the Deep Space Atomic Clock-2, built by JPL and funded by NASA's Space Technology Mission Directorate. The ultra-precise clock signal generated with this technology will ultimately help enable autonomous spacecraft maneuvers and enhance radio science observations.

DAVINCI+ will host the Compact Ultraviolet to Visible Imaging Spectrometer (CUVIS) built by Goddard. CUVIS will make high resolution measurements of ultraviolet light using a new instrument based on freeform optics. These observations will be used to determine the nature of the unknown ultraviolet absorber in Venus' atmosphere that absorbs up to half the incoming solar energy.

Established in 1992, NASA's Discovery Program has supported the development and implementation of over 20 missions and instruments. These selections are part of the ninth Discovery Program competition.

The concepts were chosen from proposals submitted in 2019 under NASA Announcement of Opportunity NNH19ZDA010O. The selected investigations will be managed by the Planetary Missions Program Office at NASA's Marshall Space Flight Center in Huntsville, Alabama, as part of the Discovery Program. The Discovery Program conducts space science investigations in the Planetary Science Division of NASA's Science Mission Directorate. The goals of the program are to provide frequent opportunities for principal investigator-led investigations in planetary sciences that can be accomplished under a not-to-exceed cost cap.

Exhibit... from page 3

Houston on May 6, 1968.

The exhibit also features a tire that was used on a space shuttle mission, a Stratospheric Observatory for Infrared Astronomy scale model, an LLRV concept model, and a windowpane from the Controlled Impact Demonstration aircraft. Rounding out the exhibit are a pair of pink boots worn by research pilot Bill Dana and an F-15 cockpit where people can sit and imagine themselves as pilots.

Armstrong employees purchased tickets through the NASA Armstrong Exchange Council website to attend the event that included viewing the exhibit, food, and entertainment.

People who were unable to attend the event will still have an opportunity to see the exhibit at the museum through Sept. 5. A description of the NASA Armstrong exhibit and some of the images are also featured on the MOAH website.

Budget... from page 2

mentioned the remotely piloted and autonomous aircraft work at the center that will help set standards for air taxis, package delivery and work in the national airspace system.

The proposed 2022 budget includes $310.6 million for NASA Armstrong to continue preparing the X-57 and the X-59 Quest SuperSonic Technology aircraft for flight, Flight Opportunities Program work, NASA Earth Science airborne research, and integrating unmanned aircraft systems into the national airspace system.

There is some bad news for the center, as the proposed budget is $32.9 million less than the enacted 2021 budget. The main difference is the proposed budget calls for discontinuing the Stratospheric Observatory for Infrared Astronomy (SOFIA), which would reduce the science budget from the 2021 enacted budget of $56.4 million to $23.5 million.

NASA Armstrong Center Director David McBride said at a June 2 Town Hall that nothing is final until the budget is passed and similar proposals in the past to cancel the SOFIA were unsuccessful.

"Budgets are proposed every year, but never has one been approved as it was proposed," McBride said. "Congress determines how taxpayer money is spent. Reductions, or elimination of SOFIA has been proposed before, but Congress has decided to fund it. It enjoys great bipartisan support."

The new Electrified Powertrain Flight Demonstrator initiative also represents a major NASA Armstrong effort and is budgeted at $48.8 million.

NASA Armstrong Aeronautics is proposed at $172.3 million for fiscal year 2022, which is $25.5 million less than the enacted 2021 budget. The decrease is primarily due to completion of some of the developmental work and the transition to flight research operations for the X-57 and X-59.

However, the proposed NASA Armstrong 2022 budget includes $9.1 million for the Sustainable Flight Demonstrator. The national partnership includes a NASA, industry, academia, and other government agencies for a full-scale technology demonstration. Testbed aircraft will integrate, and test new technologies aligned with aviation's aggressive goal to reduce aviation carbon emissions by half by 2050, compared to 2005, and net zero emissions by 2060.

NASA plans to solicit industry in early 2022 for preliminary designs of aircraft configurations that could be tested, with the potential for first flight of the demonstrator no earlier than late 2026.

"The current vision is that the aircraft would be NASA operated in partnership with industry, but we really need to see what comes out of the solicitation," said NASA Armstrong Aeronautics Research Director Brad Flick. "We have a small team involved in the planning and the procurement is being managed by our acquisitions office."

The new Electrified Powertrain Flight Demonstrator initiative also represents a major NASA Armstrong effort and is budgeted at $48.8 million in the fiscal year 2022 budget.

"The goal is to accelerate the development of electrified commercial aircraft, targeting a 1-megawatt class powertrain," Flick said. "We have a few folks working that one as well and that number is likely to grow. It's different than the Subsonic Flight Demonstrator, in that industry will be developing and operating the demonstrator(s), most likely at their locations. NASA will have technical insight and oversight to make sure the work is being done to our safety and mission success requirements and expectations. NASA Armstrong is also doing the procurement work for that one. There will be multiple awards and the proposals are under review."

Here are a few other facts on the NASA Armstrong budget:

- Exploration Technology is proposed at $21 million, which is up from $20.9 million in the enacted 2021 budget.
- The Office of STEM Engagement is proposed at $12.7 million, which is $300,000 less than the enacted 2021 budget.
- Safety, Security and Mission Services is steady at $25 million.
- Included is $17.7 million for Construction and Environmental Compliance Restoration. The revitalization projects include $8.6 million for a fire suppression system and $8.4 million for Electrical Substation No. 1.
- Low Earth Orbit and Spaceflight Operations is proposed at $100,000. Conclusion of Orion support was the main reason for the decrease from $400,000 in the enacted 2021 budget.

Josh Martin, deputy chief financial officer for Resources, contributed to this article.

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

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