National Aeronautics and Space Administration

THE ARMSTRONG

X-PRESS

Volume 62 Number 4 May 2020

AFRC2020-0063-37 NASA/Carla Thomas

Mission critical

Armstrong G-III helps make key deadline

The NASA G-III based at Armstrong was used to enable transport of key staff from NASA's Jet Propulsion Laboratory in California to NASA's Kennedy Space Center in Florida April 28 to meet mission critical deadlines in preparing the Mars Perseverance Rover for its scheduled launch in July. Missing the launch window, which is available for only a few weeks, would delay the mission until September 2022.

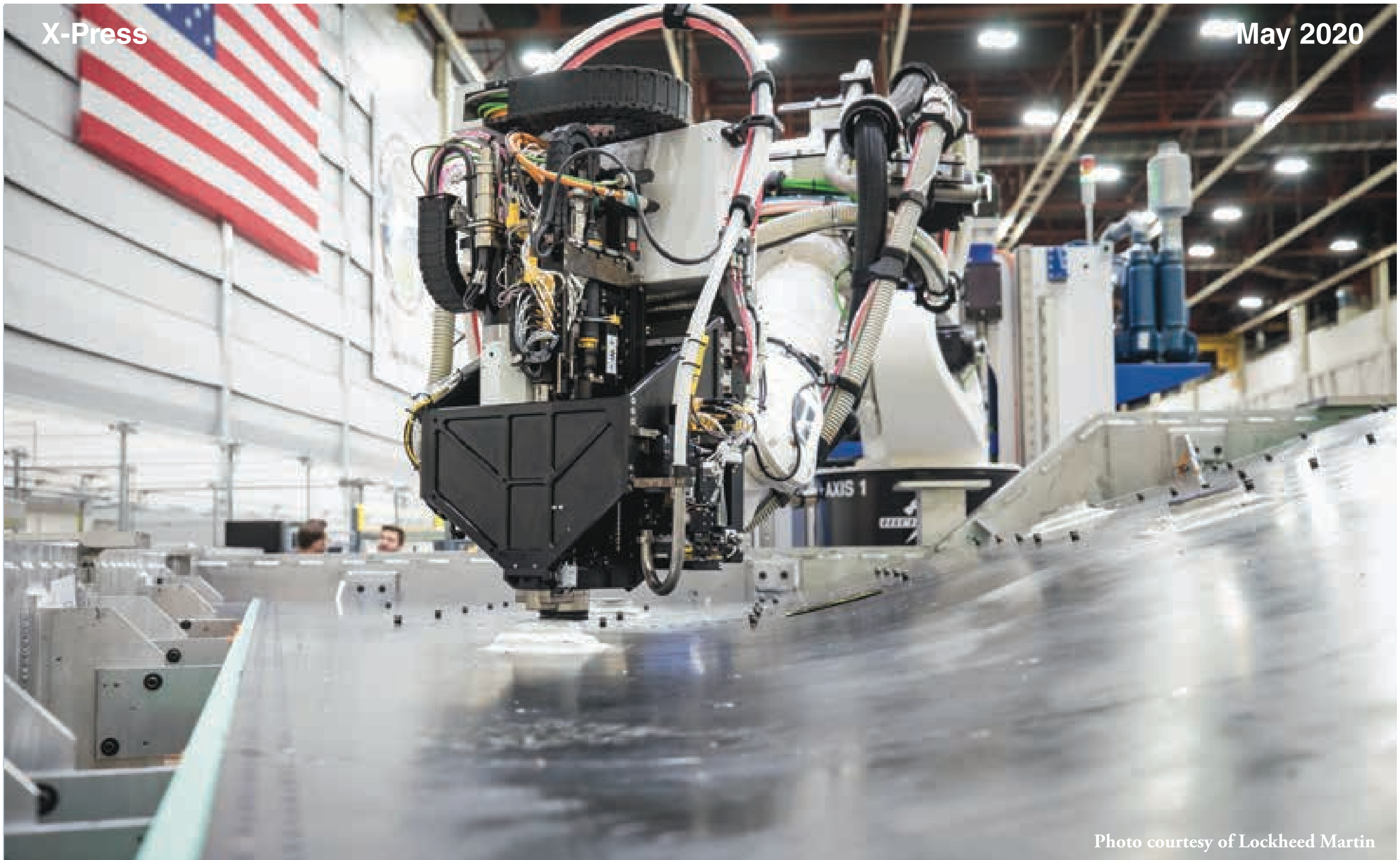


Photo courtesy of Lockheed Martin

X-59 wing nears completion

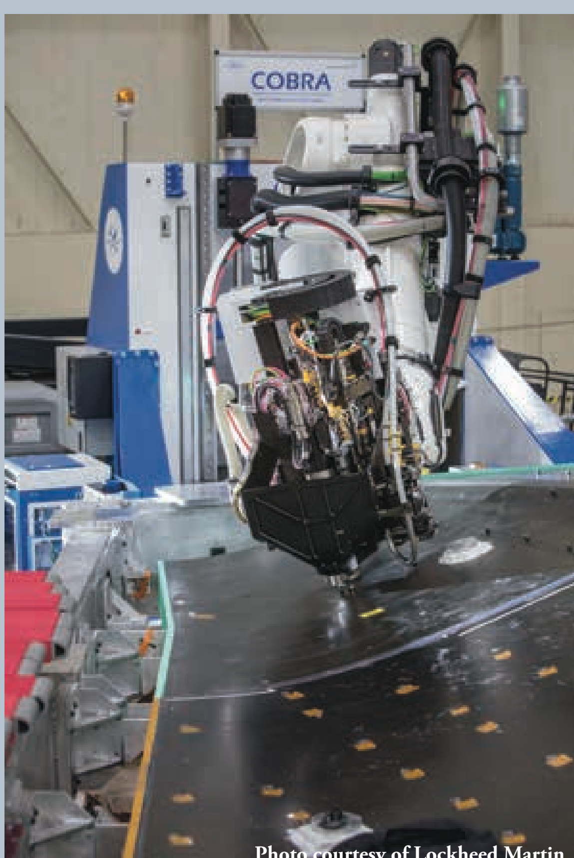


Photo courtesy of Lockheed Martin

Photo courtesy of Lockheed Martin

Assembly work on NASA's X-59 Quiet SuperSonic Technology, or QueSST, aircraft continues at a steady pace, as the main wing nears completion at the Lockheed Martin Skunk Works® facility in Palmdale. Aided by robotic technology, the X-59 team recently finished drilling the composite wing skins by utilizing a Combined Operation: Bolting and Robotic AutoDrill system, or COBRA. The automated robotic system streamlines multistep labor-intensive operations including drilling, countersinking and inspecting holes into a single process. The automated machinery advances manufacturing speed and accuracy of the X-59, as all inspection records are digitally recorded and later reviewed in developing the next stage of precision crafted aircraft parts. NASA and the Skunk Works team are leveraging technology to make the Low-Boom Flight Demonstration a success and are continuing to work on the single piece wing, center fuselage and empennage structural sub-assemblies.

SOFIA science

Top 10 discoveries from a decade of work

By **Felicia Chou**
NASA Headquarters

Ten years ago, NASA's telescope on an airplane, the Stratospheric Observatory for Infrared Astronomy, or SOFIA, first peered into the cosmos. Since the night of May 26, 2010, SOFIA's observations of infrared light, invisible to the human eye, have made many scientific discoveries about the hidden universe.

SOFIA's maiden flight, known as "first light," observed heat pouring out of Jupiter's interior through holes in the clouds and peered through the dense dust clouds of the Messier 82 galaxy to catch a glimpse of tens of thousands of stars forming. The observatory was declared fully operational in 2014 — the equivalent to the launch of a space telescope — but it began making discoveries even while completing the testing of its instruments and telescope.

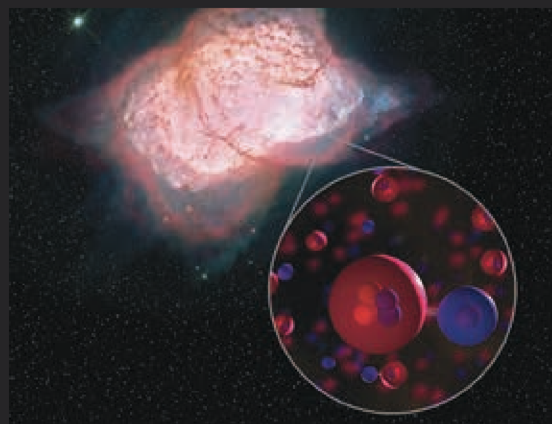
The modified Boeing 747SP, which is based at NASA Armstrong Flight Research Center in California, flies a nearly 9-foot diameter telescope up to 45,000 feet in altitude, above 99% of the Earth's water vapor to get a clear view of the infrared universe not observable by ground-based telescopes. Its mobility also allows it to capture transitory events in astronomy over remote locations like the open ocean. Because SOFIA lands after each flight, it can be upgraded with the latest technology to respond to some of most pressing questions in science.

Using SOFIA, scientists detected the universe's first type of molecule in space, unveiled new details about the birth and death of stars and planets, and explained what's powering supermassive black holes, and how galaxies evolve and take shape, among other discoveries. Here are some of SOFIA's top discoveries of the last decade:

The Universe's First Type of Molecule Found

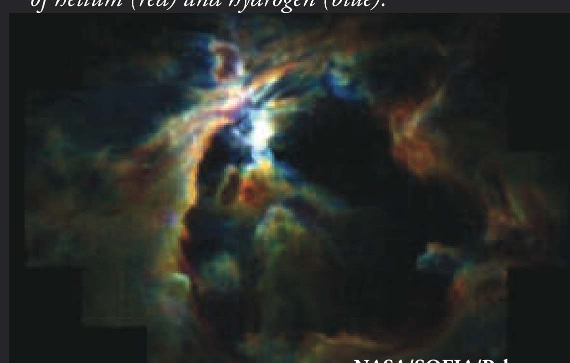
SOFIA found the first type of molecule to form in the universe, called helium hydride. It was first formed only 100,000 years after the Big Bang as the first step in cosmic evolution that eventually led to the complex universe we know today. The same kind of molecule should be present in parts of the modern universe, but it had never been detected outside of a laboratory until SOFIA found it in a planetary nebula

SOFIA science, page 4



NASA/ESA/Hubble Processing: Judy Schmidt

This is an image of planetary nebula NGC 7027 with illustration of helium hydride molecules. In this planetary nebula, SOFIA detected helium hydride, a combination of helium (red) and hydrogen (blue).



NASA/SOFIA/Pabst et. al

The powerful wind from the newly formed star at the heart of the Orion Nebula is creating the bubble (black) and preventing new stars from forming in its neighborhood. At the same time, the wind is pushing molecular gas (color) to the edges, creating a dense shell around the bubble where future generations of stars can form.

NASA/SOFIA; NASA/JPL-Caltech

This composite image of the Cigar Galaxy, or M82, a starburst galaxy about 12 million light-years away in the constellation Ursa Major. The magnetic field detected by SOFIA, shown as streamlines, appears to follow the bipolar outflows (red) generated by the intense nuclear starburst.

News at NASA

WFIRST renamed Roman

NASA is naming its next-generation space telescope currently under development, the Wide Field Infrared Survey Telescope (WFIRST), in honor of Nancy Grace Roman, NASA's first chief astronomer, who paved the way for space telescopes focused on the broader universe.

The newly named Nancy Grace Roman Space Telescope, or Roman Space Telescope, is set to launch in the mid-2020s. It will investigate long-standing astronomical mysteries, such as the force behind the universe's expansion and search for distant planets beyond our solar system.

Considered the "mother" of NASA's Hubble Space Telescope, which launched 30 years ago, Roman tirelessly advocated for new tools that would allow scientists to study the broader universe from space. She left behind a tremendous legacy in the scientific community when she died in 2018.

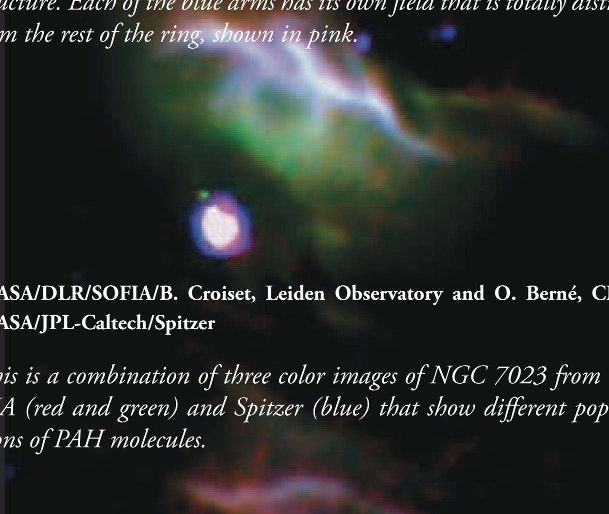
"It is because of Nancy Grace Roman's leadership and vision that NASA became a pioneer in astrophysics and launched Hubble, the world's most powerful and productive space telescope," said NASA Administrator Jim Bridenstine. "I can think of no better name for WFIRST, which will be the successor to NASA's Hubble and Webb Telescopes."

NASA/SOFIA/Lynette Cook

This artist's illustration of the Epsilon Eridani system shows Epsilon Eridani b. In the right foreground, a Jupiter-mass planet is shown orbiting its parent star at the outside edge of an asteroid belt. In the background can be seen another narrow asteroid or comet belt plus an outermost belt similar in size to our solar system's Kuiper Belt. SOFIA observations confirmed the existence of the asteroid belt adjacent to the orbit of the Jovian planet.

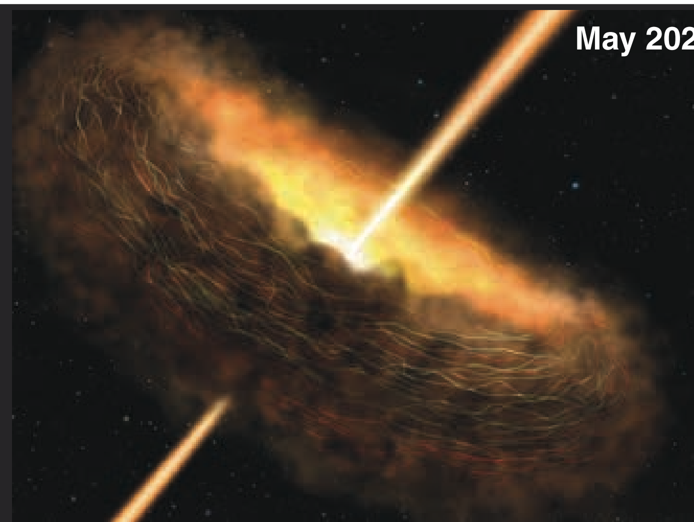
Dust and magnetic fields: NASA/SOFIA; Star field: NASA/Hubble Space Telescope

Streamlines show the magnetic fields layered over a color image of the dusty ring around the Milky Way's massive black hole. The Y-shaped structure is warm material falling toward the black hole, which is located near where the two arms of the Y-shape intersect. The streamlines reveal that the magnetic field closely follows the shape of the dusty structure. Each of the blue arms has its own field that is totally distinct from the rest of the ring, shown in pink.



NASA/DLR/SOFIA/B. Croiset, Leiden Observatory and O. Berné, CNRS; NASA/JPL-Caltech/Spitzer

This is a combination of three color images of NGC 7023 from SOFIA (red and green) and Spitzer (blue) that show different populations of PAH molecules.



NASA/SOFIA/Lynette Cook

This is an artist's conception of the core of Cygnus A, including the dusty donut-shaped surroundings called a torus, and jets launching from its center.

SOFIA science... from page 3

called NGC 7027. Finding it in the modern universe confirms a key part of our basic understanding of the early universe.

Newborn Star in Orion Nebula Prevents Birth of Stellar Siblings

The stellar wind from a newborn star in the Orion Nebula is preventing more new stars from forming nearby as it clears a bubble around it. Astronomers call these effects "feedback," and they are key to understanding the stars we see today and those that may form in the future. Until this discovery, scientists thought that other processes, such as exploding stars called supernovas, were largely responsible for regulating the formation of stars.

Weighing a Galactic Wind Provides Clues to the Evolution of Galaxies

SOFIA found that the wind flowing from the center of the Cigar Galaxy (M82) is aligned along a magnetic field and transports a huge amount of material. Magnetic fields are usually parallel to the plane of the galaxy, but the wind is dragging it so it's perpendicular. The powerful wind, driven by the galaxy›s high rate of star birth, could be one of the mechanisms for material to escape the galaxy. Similar processes in the early universe would have affected the fundamental evolution of the first galaxies.

Nearby Planetary System Similar to Our Own

The planetary system around the star Epsilon Eridani, or eps Eri for short, is the closest planetary system around a star similar to the early Sun. SOFIA studied the infrared glow from the warm dust, confirming that the system has an architecture remarkably similar to our solar system. Its material is arranged in at least one narrow belt near a Jupiter-sized planet.

Magnetic Fields May Be Feeding Active Black Holes

Magnetic fields in the Cygnus A galaxy are feeding material into the galaxy's central black hole. SOFIA revealed that the invisible forces, shown as streamlines in the Cynus A illustration, are trapping material close to the center of the galaxy where it is close enough the be devoured by the hungry black hole. However, magnetic fields in other galaxies may be preventing black holes from consuming material.

NASA/SOFIA/JPL-Caltech/ESA/Herschel

This is a composite infrared image of the center of the Milky way Galaxy. It spans 600+ lightyears across and is helping scientists learn how many massive stars are forming in our galaxy's center. New data from SOFIA taken at 25 and 37 microns, shown in blue and green, is combined with data from the Herschel Space Observatory, shown in red (70 microns), and the Spitzer Space Telescope, shown in white (8 microns). SOFIA's view reveals features that have never been seen before.

Magnetic Fields May Be Keeping Milky Way's Black Hole Quiet

This image shows the ring of material around the black hole at the center of our Milky Way galaxy. SOFIA detected magnetic fields, shown as streamlines, that may be channeling the gas into an orbit around the black hole, rather than directly into it. This may explain why our galaxy's black hole is relatively quiet, while those in other galaxies are actively consuming material.

"Kitchen Smoke" Molecules in Nebula Offer Clues to Building Blocks of Life

SOFIA found that the organic, complex molecules in the nebula NGC 7023 evolve into larger, more complex molecules when hit with radiation from nearby stars. Researchers were surprised to find that the radiation helped these molecules grow instead of destroying them. The growth of these molecules is one of the steps that could lead to the emergence of life under the right circumstances.

Dust Survives Obliteration in Supernova

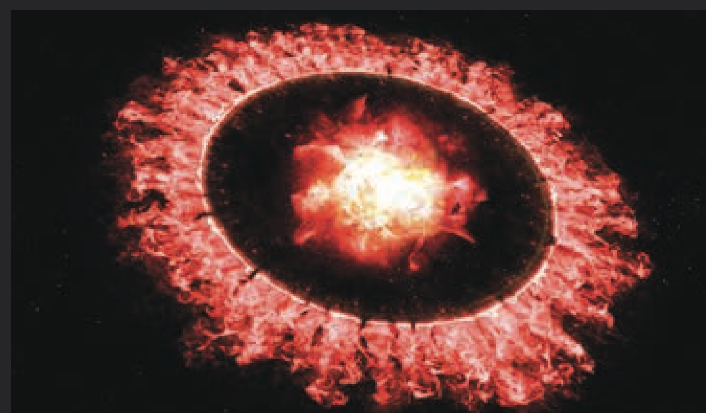
SOFIA discovered that a supernova explosion can produce a substantial amount of the material from which planets like Earth can form. Infrared observations of a cloud produced by a supernova 10,000 years ago contains enough dust to make 7,000 Earths. Scientists now know that material created by the first outward shock wave can survive the subsequent inward "rebound" wave generated when the first collides with surrounding interstellar gas and dust.

New View of Milky Way's Center Reveals Birth of Massive Stars

SOFIA captured an extremely crisp infrared image of the center of our Milky Way galaxy. Spanning a distance of more than 600 light-years, this panorama reveals details within the dense swirls of gas and dust in high resolution, opening the door to future research into how massive stars are forming and what's feeding the supermassive black hole at our galaxy's core.

What Happens When Exoplanets Collide

Known as BD +20 307, this double-star system is more than 300 light years from Earth likely had an extreme collision between rocky exoplanets. A decade ago, observations of this system gave the first hints of a collision when they found debris that was warmer than expected to be around mature stars that are at least one billion years old. SOFIA's observations discovered the infrared brightness from the debris has increased by more than 10%, a sign that there is now even more warm dust and that a collision occurred relatively recently. A similar event in our own solar system may have formed our Moon.



NASA/SOFIA/Symbolic Pictures/The Casadonte Group

This illustration shows a supernova as the powerful blast wave passes through its outer ring before a subsequent inward shock rebounds. SOFIA found the material produced from first outward wave can survive the second inward wave and can become seed material for new stars and planets.

NASA/SOFIA/Lynette Cook

This artist's concept illustrates a catastrophic collision between two rocky exoplanets in the planetary system BD +20 307, turning both into dusty debris.

Mars airplane

Sam maximizes NASA Armstrong internship

By Jay Levine
X-Press editor

When Nathan Sam accepted an internship at NASA Armstrong he didn't know what to expect, but he knew he would be working on an aircraft prototype that could one day fly on Mars.

Sam, a mechanical engineering student from California State Polytechnic University, Pomona, modified computer-aided drawings that had been developed by previous interns to make molds. From those molds the Preliminary Research Aerodynamic Design to Land on Mars, or Prandtl-M, version 6.0 was fabricated.

Resin, fiberglass, carbon fiber and foam were layered in the molds and the aircraft was sealed airtight overnight. In the morning internal structures and systems were installed in the molds and sealed for a second time overnight to join the two halves of the aircraft.

The next day the aircraft was removed from the mold and additional electronics were added, flight control surfaces were developed and weight and balance and other checks were performed. In addition, a Tech Brief was prepared for permission to fly. Mentors and Armstrong's Dale Reed Subscale Flight Research Laboratory staff guided and assisted Sam.

Everything was looking up on lucky Friday the 13th in March when the morning rainstorms abruptly stopped and the clouds parted long enough for initial test flights. The first flight was challenging, as can be expected when testing a new version of an aircraft, but the Prandtl-M flew better and better in response to

AFRC2020-0039-20 NASA/Lauren Hughes

Above, Nathan Sam and Robert "Red" Jensen lay material into a Prandtl-M aircraft mold at NASA Armstrong. The aircraft is the second of three prototypes of varying sizes to provide scientists with options to fly sensors in the Martian atmosphere to collect weather and landing site information for future human exploration of Mars.

AFRC2020-0039-42 NASA/Lauren Hughes

At left, Nathan Sam shows the Prandtl-M aircraft he helped fabricate at NASA Armstrong.

AFRC2020-0054-03 NASA/Ken Ulbrich

From left Eric Becker watches as Nathan Sam, Robert "Red" Jensen and Justin Hall attach a Prandtl-M aircraft onto the Carbon Cub aircraft that air launched it at NASA Armstrong.

adjustments on the ground that were made before most of the flights. The Prandtl-M 6.0 aircraft, which is the second of three vehicles that are expected to be researched, has a 13-inch wingspan and was air launched from the remotely piloted Carbon Cub aircraft at more than 300 feet altitude.

"It was super exciting to see it fly," Sam said. "I didn't think I would get to see a test flight of a prototype. All of the projects I have worked on before were in the design phase and I was finished before the manufacturing and testing."

The internship, and several of the tasks he had to perform such as programming the flight controller, brought Sam outside of his comfort zone.

"As a mechanical engineering student, the electrical aspects of the project are unfamiliar," Sam explained. "I watched and kept notes on the electrical installation, but I was unable to work on those systems because we began working from home. However, when we fabricate the next Prandtl-M, I will begin working on the electrical tasks independently."

After completing a successful test flight, he and the team were ready to continue the flight series when life intervened. Just a few days after the test flight, Sam found himself Monday dealing with circumstances unknown to his predecessors – COVID-19 and the requirement to work remotely during an experience that was intended to introduce him to Armstrong. The transition from flight test to telework was an adjustment.

"I definitely was sad that I had to leave the center after having such a high with experiencing the flight test," Sam said. "To be honest, the transition from flight test to teleworking was pretty hard. Most of the days, I just kept remembering the fun experience that I had on-site and wishing that I had been able to work quicker so that I could have experienced multiple flight tests."

But Sam chooses not to dwell on what could have been and has dived into his other project tasks.

"Dave (mentor Dave Berger) asked to perform aerodynamic

Sam, page 7

AFRC2020-0054-70 NASA/Ken Ulbrich

A Prandtl-M prototype is air launched from the Carbon Cub aircraft March 13, 2020, at NASA Armstrong.

AFRC2020-0054-144 NASA/Ken Ulbrich

A Prandtl-M aircraft flies following release from a Carbon Cub aircraft.

Sam... from page 7

analysis on the Prandtl-M 6.0 version we flew and that really helped me with the transition as I have never done anything like it and I am learning a lot," Sam said. "Coming into the project I didn't get much say into the design of Prandtl-M, but now doing analysis on the vehicle I am able to be a part of the process. I knew I wanted to work in the aerospace industry once I graduate and performing these type of tasks really confirmed to me what I want to do."

The three Prandtl-M aircraft are of varying sizes and are first air launched from a Carbon Cub to verify their flight characteristics. Next the aircraft is attachment to an Aerostat blimp and air launched from an altitude of more than 500 feet. Once each of the three aircraft are verified, it is intended that they will be air launched at the same time from a weather balloon from about 100,000 feet altitude to simulate the atmospheric conditions that the aircraft would fly on Mars.

AFRC2019-0195-14 NASA/Lauren Hughes

The first of three Prandtl-M prototype aircraft was air launched Aug. 16, 2019, from an Aerostat blimp at NASA Armstrong.

A Prandtl-M could be the first aircraft to fly on Mars and several could be used in a swarm to collect atmospheric and visual information to guide decisions regarding future manned missions to the nearest planet to Earth.

Sam will be challenged again when his summer internship begins and he will be the leader of the intern Prandtl-M team refining the 6.0 aircraft he advanced that is the second of the three potential Mars airplane versions. He and his team will begin work on the third 18-inch wingspan prototype 7.0 Prandtl-M. The first of the series had a 24-inch wingspan and was called the 5.0 Prandtl-M.

Like the other challenges Sam has faced so far, he plans to embrace it.

"I am excited to continue to have first-hand experience, getting back to flight testing the Mars airplane and building skills that will give me a boost in seeking the kind of work I want to do after college," he said.

Wen Painter, former engineer, dies at 84

Weneth "Wen" Painter, a former center controls engineer, died April 21. He was 84.

During his 28-year career at the center, he was known for his work on flight control systems on NASA lifting body aircraft. The research vehicles featured unconventional aerodynamic shapes and designed to validate the concept of flying a vehicle back to Earth from space and landing it like an aircraft at a predetermined site as the space shuttles would do decades later.

Painter was instrumental on the M2-F2, HL-10 and X-24A research vehicles. In fact, his technical support was essential to the first test flight of the HL-10, where in the control room he offered suggestions to the pilot on how to stabilize the aircraft and safely land it. Painter, despite objections, refused to allow the HL-10 to fly until a fix was found. It later flew successfully and is currently mounted on a pedestal near the center's main gate.

Painter also was instrumental as the project engineer for the F-8 Supercritical Wing. The results of that work can be seen in the wing design of most current airliners. This research, involving a new tailoring of an airfoil design to delay the formation and reduce the strength of the shock wave over the wing of an aircraft breaking the sound barrier, have improved the cruising speed, fuel efficiency and flight range of subsonic commercial aircraft.

In a related effort, he also was key in bringing the F-111 Transonic Aircraft Technology program up to flight status. A bulk of the work on the aircraft was a 20-year effort to fit a maneuverable military jet with the supercritical wings proven by the F-8 work, which was successfully accomplished in a joint effort of the center and the U.S. Air Force.

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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