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X-57 progresses

Future wing, cruise motors advance

Engineers at Empirical Systems Aerospace, or ESAero, perform fit checks on the future wing to be used on the final configurations of NASA's all-electric X-57 Maxwell, at their facility in San Luis Obispo, California. Using a "fit check" fuselage, seen here, the team is able to determine the safest and most efficient method of integrating the wing to be used in Mods III and IV of X-57, while the primary fuselage prepares for ground, taxi and flight tests at NASA Armstrong. *See related article on page 2.*

Photo courtesy of Empirical Systems Aerospace

Ground tests next

Progress on cruise motors and future wing sets the stage for the next phase

By Matt Kamlet
NASA Armstrong Public Affairs

Significant progress is being made in preparation for NASA's first all-electric X-plane, the X-57 Maxwell.

As NASA completes tasks for X-57's functional ground testing at Armstrong working toward taxi testing and first flight, assembly and qualification tests are underway on two critical components of the X-57 vehicle at NASA's prime contractor for the project, Empirical Systems Aerospace, or ESAero, of San Luis Obispo, California.

These components include the electric cruise motors, which will power X-57 in flight, and the future high-aspect ratio wing that will fly on the aircraft in X-57's final configuration.

The X-57, which was modified from a Tecnam P2006T airplane, is currently in its first of three configurations as an all-electric aircraft called Modification II, or Mod II. While this configuration features the replacement of the vehicle's standard combustion, 100-horsepower Rotax 912S engines with 60-kilowatt electric cruise motors, X-57's test flights in this phase will be flown using the vehicle's standard wing.

The following phase, Mod III, will see this wing replaced with the high-aspect ratio wing, greatly reducing overall vehicle area and relocating the cruise motors out to the wingtips. The aircraft will fly in its final Mod IV configuration with the addition of 12 smaller high-lift motors along the wing's leading edge to be used during takeoff and landing.

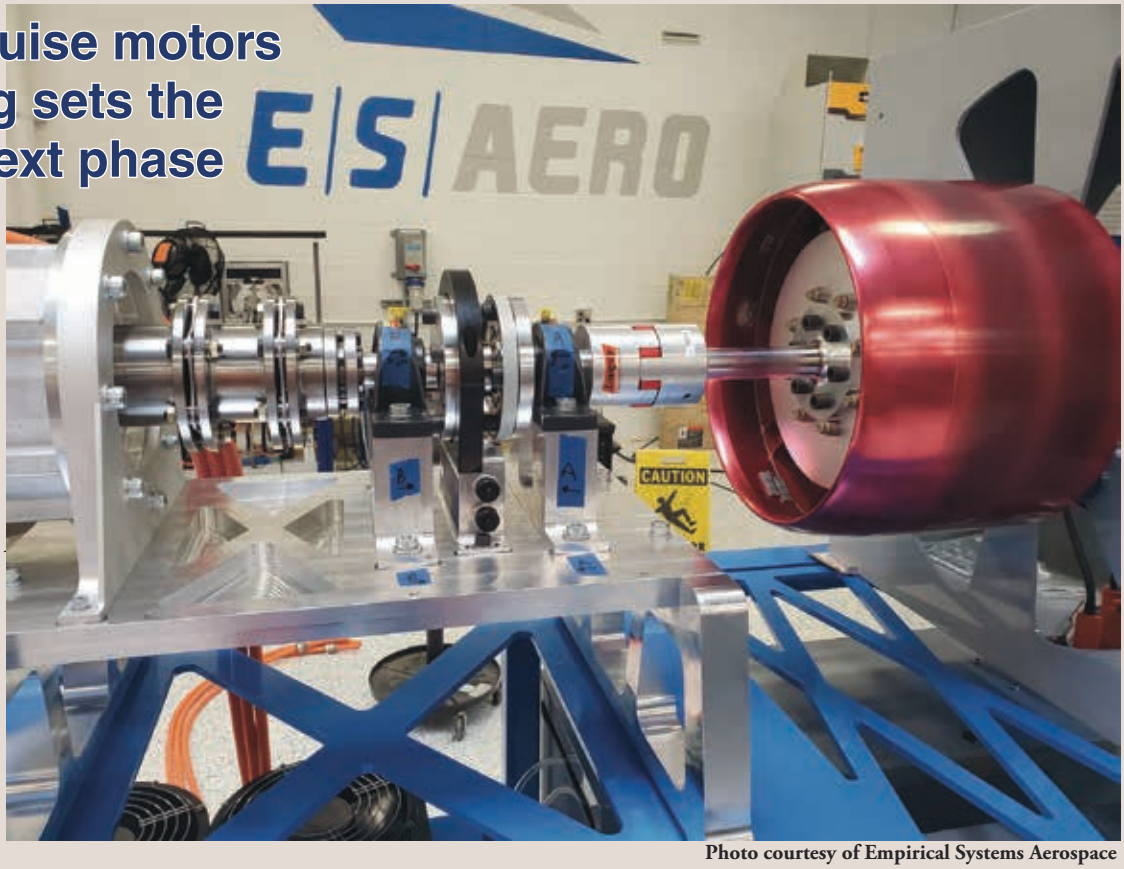

Photo courtesy of Empirical Systems Aerospace

As part of the verification and validation process, the all-electric cruise motors to be used on NASA's X-57 Maxwell began several rounds of tests, high power, and endurance testing at Empirical Systems Aerospace, or ESAero, of San Luis Obispo, California. The lessons learned from cruise motor tests will help in the effort to set airworthiness standards for electric aircraft.

NASA Langley/Advanced Concepts Lab, AMA Inc.

This artist's concept image shows NASA's first all-electric X-plane, the X-57 Maxwell, in its final configuration, flying in cruise mode over Armstrong.

The constant throughout these configurations are the electric cruise motors, which have begun tests at ESAero to verify that they are ready before they are installed in the X-57 vehicle itself.

"We've taken those cruise motors and we're putting them through functionality tests, acceptance tests, and qualification tests to ensure their airworthiness for the X-57 vehicle," said Trevor Foster, ESAero Vice President of Operations. "As part of the NASA airworthiness process, these are the verification and validation steps to reduce risks and increase the safety and reliability of the components on the vehicle."

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Preparing for future missions

AFRC2020-0063-15 NASA/Lauren Hughes

Pilots Troy Asher and Stu Broce walk out of a NASA Armstrong hangar in Palmdale toward the flight line. In addition to aeronautics research, Flight Operations personnel support such missions as the Mars Perseverance Rover, slated to launch in July 2020. Specialized science platform aircraft, such as the DC-8 flying laboratory, high-altitude research aircraft ER-2s, C-20A, Gulfstream III and the Stratospheric Observatory for Infrared Astronomy, are based at the facility.

Armstrong provides Mars Rover Support

By Jessica Arreola
NASA Armstrong Public Affairs

A great example of commitment to the agency mission is the critical work of personnel in the NASA Armstrong Flight Operations Office. The agency approved use of its C-20 and G-III aircraft at Armstrong for transport of mission-critical JPL staff from California to NASA's Kennedy Space Center in Florida.

Trips would begin at sunrise with Armstrong's flight surgeon Dr. Dwight Peake performing health screenings and protective equipment fittings. By sundown in Southern California, the aircraft crew would return home with team members whose work at the Cape was complete.

"One of the best demonstrations of One NASA I've seen in a while is playing out right now with our Perseverance rover. Together we are persevering." said Thomas Zurbuchen, associate administrator of the Science Mission Directorate.

In addition to NASA, personnel from across the U.S. aerospace industry and the Department of Energy have performed critical activities in preparing Perseverance for launch.

AFRC2020-0063-06 NASA/Lauren Hughes

Armstrong flight surgeon Dr. Dwight Peake performs a health check.

News at NASA

Mars rover launch set for July 20

NASA's Perseverance Mars rover is targeted for a July 20 launch. The rover's astrobiology mission will seek signs of past microscopic life on Mars, explore the geology of the Jezero Crater landing site, and demonstrate key technologies to help prepare for future robotic and human exploration. The rover also will collect the first samples of Martian rock and regolith (broken rock and dust) for return to Earth by a set of future missions.

The Mars 2020 mission has been slated to liftoff this summer ever since the agency announced the project in December 2012. Owing to the relative positions of Earth and Mars to each other, launch opportunities come up only every 26 months. If Perseverance didn't head to Mars this summer, the project would have to wait until September 2022 to try again, seriously impacting the long-term objectives of NASA's Mars Exploration Program and increasing overall mission risk.

Significant challenges come with the territory when planning a Mars mission. In the case of Perseverance – the heaviest payload yet to go to the Red Planet – those included implementing a test project to confirm the soundness of their parachute design. In addition, an extensive effort honed the performance of the rover's Sample Caching System, the most complex and the cleanest mechanism ever sent into space, and challenges of working in a new work environment as a result of the coronavirus.

AFRC2017-0093-045 NASA/Ken Ulbrich

With a NASA F/A-18 in background, aviation maintenance crew chief Walt Kondracki guides a NASA F-15. These are two of 33 research and support aircraft maintained by a team of 300 people at NASA Armstrong.

Appreciating AMTs

Coleman details AMTs role in aircraft flight safety

By Jim Banke
Aeronautics Research Mission Directorate

To mark Aviation Maintenance Technician Day May 24, James "J.C." Coleman III of NASA Armstrong worked with his son on changing the transmission of their 1990 Nissan 300ZX.

The plan couldn't have been more perfect.

Since 2008, on May 24 everyone in the United States is asked to take a moment and give thanks to the more than 250,000 men and women who keep airplanes in the air by working on them on the ground.

James "J.C." Coleman III

The date was chosen because that's the birthday of Charles Edward Taylor, the man credited with building the engine the Wright Brothers used to make their first historic flights in 1903.

So, if you're looking for an aviation maintenance technician – AMT for short – to appreciate, Coleman is certainly a worthy candidate. He'll be the one with tools in hand and dirty fingernails.

For about 25 years as an AMT Coleman has inspected, repaired, upgraded and otherwise maintained some of the nation's most sophisticated aircraft for the United States Air Force and NASA.

Today he is a division chief at NASA Armstrong and oversees a team of some 300 people who are responsible for keeping 33 research and support aircraft in flightworthy condition.

Coleman and his colleagues take their charge seriously, even to the point of demonstrating a haughty boast that they have come to honestly and that has been shared by many proud AMTs throughout the history of flight.

"It may be the pilot who gets all the glory, but it's the AMTs on the ground that should get all the credit," Coleman said. "We're responsible for that airplane, from nose to tail. If it flies well, or if it flies poorly, that's a reflection on its ground crew."

Put another way, it's the AMTs who own the airplanes, while pilots just borrow them for a bit and hope to bring them back in the same condition or risk the – good-natured? – wrath of the ground crew.

It's not arrogance. It reflects the respect and seriousness to which AMTs approach their work because it can literally mean the difference between life and death.

"That really is a mentality that is bred into the culture of AMTs. That aircraft on the ground is ours. If the pilot has a successful mission, it is in no small part due to the maintainer," Coleman said.

AFRC2018-0287-158 NASA/Josh Valcarcel

NASA Armstrong technician James Ford works on the nose wheel of a NASA F/A-18 research/support jet on the ramp at Ellington Field in Houston, Texas.

A Familiar Story

If there is such a thing as a stereotypical AMT, it's probably someone who tends to work on their own cars, has a tool for every job, and loves to create and build things, Coleman said.

So, it's probably no surprise that Coleman's personal tale echoes the origin story of many AMTs.

Originally from Raleigh, North Carolina, Coleman was bit by the bug at an early age. Not so much an aviation bug – although he had an interest in airplanes – but more of a mechanical one.

"Even as a kid I would take apart my toys to see how they worked and try to improve them as I put them back together," Coleman said.

To save money, his father did all the maintenance on the family car and young Coleman helped, gaining practical training and confidence in knowing that he was indeed mechanically inclined. (He wouldn't buy his first new car until 2017.)

Coleman's interest in figuring out how things worked initially prompted him to pursue a degree in electrical engineering. He began his studies at North Carolina State University and continued at North Carolina A&T State University until money ran out.

His father insisted that if Coleman wanted to finish school, he had to pay his own way. The Air Force turned out to be the solution, even if it meant an unsure future as a certified AMT rather than holding an engineering degree.

"I had no idea what an aircraft maintainer was when I joined the Air Force, or even really how an aircraft flew other than you put a whole lot of power behind it and hopefully it takes off," Coleman said.

During the next 24 years Coleman would ascend through the enlisted ranks to the top, retiring in 2019 as a Chief Master Sergeant stationed at Edwards Air Force Base. He and his wife of 21 years, Carmen, also raised a son, Jalen.

Along the way he would work on many different types of aircraft – trainers, fighter jets, spy planes – and earn two degrees: a Bachelor of Science in Aeronautics Technology and a Master of Science in Aerospace Operations Management, both from Embry Riddle Aeronautical University.

A is for Aeronautics

When Coleman retired from the Air Force in 2019, he didn't travel far for his next job at NASA, as he only moved a couple of miles down the edge of massive Rogers Dry Lakebed from Edwards to Armstrong.

In starting his civilian career at the nation's space agency, Coleman said some of his Air Force colleagues wondered what he would be doing "up there" and needed to be reminded that the first A in NASA stands for Aeronautics.

"We do fly aircraft and we do it exceptionally well!" Coleman said he told his friends.

Armstrong's aircraft fleet includes 33 airplanes, of which there are 12 different major types. These aircraft range from the big DC-8 airliner-turned-research-platform, to small electric-powered drones.

"The beauty of working at NASA is the variety of aircraft we fly," Coleman said.

Armstrong's fleet also includes F/A-18 and F-15 fighter jets long since retired from the military. The F-15 was the first type of airplane Coleman worked on in the Air Force and it remains his favorite.

But it's also a kind of love-hate relationship as the F-15 represents for Coleman and his team the kind of challenge they face in maintaining aging aircraft NASA has obtained from the military and industry.

"The older and more high performance they are, the more love and attention they need," Coleman said. "They are beautiful when they fly but when they break it gets increasingly more challenging and expensive to find spare parts or to make our own."

The hunt for spare parts might

AMTs page 6

More X-59 pieces are coming together

The wing and cockpit sections of NASA's X-59 Quiet SuperSonic Technology (QueSST) are coming together at Lockheed Martin's Skunk Works® factory in Palmdale. Major structural components still to be added include the long, forward nose and rear section – known as the empennage – that includes the tail and single jet engine. Nearby, although not seen in this picture, Lockheed Martin technicians and engineers are completing other assembly tasks, with fabricating the composite wing skins with the help of a sophisticated robot already done. When it is complete, Lockheed Martin and NASA will put the X-59 through a series of ground and test flights to ensure not only its air worthiness, but also its ability to create a sonic boom that can barely be heard – if at all – by people on the ground while it flies supersonic at a cruise altitude overhead.

Photo courtesy of Lockheed Martin

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require Coleman's team to look through old, grounded aircraft stored at Armstrong or Edwards; travel to other desert airfields where large numbers of retired aircraft are sent; or seek out help from NASA research centers having aircraft operations.

"We really have excellent relationships with the Air Force here at Edwards and elsewhere, as well as with the other NASA centers. If you're in aircraft maintenance you're part of a kind of club and we all try to help each other out," Coleman said.

AFRC2018-0134-19 **NASA/Lauren Hughes**

NASA Armstrong technician David Johnson works on rewiring the cockpit and nose area of NASA's high-altitude ER-2 research aircraft.

AMT Work Ahead

At the same time the Armstrong AMT team is working to keep their current aircraft flying, its members have their eyes on the future.

"We just took delivery of the all-electric X-57 and we're working with our program managers to prepare for the supersonic X-59 – those are just two examples – so we're definitely keeping busy and continuing to train and learn new things," Coleman said.

The future also is bright for anyone thinking about joining the AMT ranks.

"Being an aircraft maintainer is one of the most rewarding careers. It is a labor of love. It is a skill set that will be needed because air travel in one form or another – and NASA is working on a lot of different ideas – is not going to disappear," Coleman said.

His advice for anyone thinking about such a career: If you have a passion for working with your hands and with tools, and if you have a knack for problem solving and troubleshooting, then you probably have what it takes to succeed as an AMT.

And just because Coleman wound up working on high-performance fighter jets, among other advanced aircraft, being certified as an AMT means you can work on anything from the smallest single-engine general aviation airplane to the largest jumbo jet airliners.

"When it comes to the general theory of aircraft maintenance and aircraft engine operation, while the complexity level can increase, there's not a lot variance between the different aircraft you might work on," he said.

Being an AMT is a career that certainly has worked out well for the North Carolina native, one that can be celebrated on Aviation Maintenance Technician Day.

"I truly believe I've got the greatest job in the world."

SOFIA New Zealand deployment canceled

By Kassandra Bell
USRA

The leadership of the Stratospheric Observatory for Infrared Astronomy, SOFIA, reached a decision that the observatory's annual deployment to Christchurch, New Zealand, is not feasible this year, given ongoing concerns related to the COVID-19 pandemic. A revised flight schedule is being coordinated to focus on high-priority celestial targets that can be studied from SOFIA's base at NASA Armstrong.

SOFIA observations were temporarily suspended effective March 19, in response to the COVID-19 situation. In the meantime, the SOFIA team has been preparing for a future return to flight through the formulation of new flight plans and will make that information available when it is finalized.

"Though we can't fly to New Zealand this year, we are excited about leveraging new opportunities to observe from our base in California," said Naseem Rangwala, SOFIA's project scientist. "As always, we are thankful to the New Zealand government, U.S. Antarctic Program, Christchurch Airport, German Aerospace Center and other partners for the extensive work and cooperation that went into evaluating options for a deployment this year. We value the scientific data we collect from Christchurch and look forward to returning in the future."

NASA/SOFIA/Wayne Williams

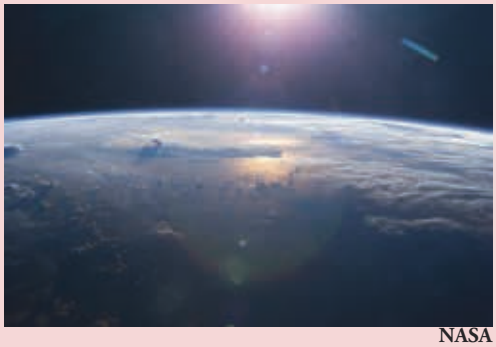
SOFIA taxiing on the ramp at Christchurch International Airport in 2017. The leadership of SOFIA reached a decision that the observatory's annual deployment to Christchurch, New Zealand, is not feasible this year, because of ongoing concerns related to the COVID-19 pandemic.

SOFIA typically deploys to Christchurch, New Zealand, from approximately June to August each year to study celestial objects best viewed from the Southern Hemisphere and to take advantage of optimal observing conditions during the Southern Hemisphere's winter months, including long nights. The observations that were scheduled to take place from New Zealand will be assessed for future deployments to the Southern Hemisphere. The SOFIA Science Center continues to be fully operational, supporting services such as data pipeline operations, helpdesk and user support.

SOFIA, the Stratospheric Observatory for Infrared Astronomy, is a Boeing 747SP jetliner modified to carry a 106-inch diameter telescope. It is a joint project of NASA and the German Aerospace Center, DLR. NASA's Ames Research Center in California manages the SOFIA program, science and mission operations in cooperation with the Universities Space Research Association headquartered in Columbia, Maryland, and the German SOFIA Institute (DSI) at the University of Stuttgart. The aircraft is maintained and operated from Armstrong.

Researchers could fly with future experiments

For the first time in the agency's history, NASA has initiated a new effort to enable NASA personnel to fly on future commercial suborbital spaceflights. NASA's Flight Opportunities program has successfully worked with emerging commercial suborbital transportation systems to fly research payloads to space for short periods of microgravity time. In addition, the Flight Opportunities program recently released a call that allows those non-NASA researchers to propose accompanying their payloads in suborbital space.



NASA

Now the Suborbital Crew (SubC) office within NASA's Commercial Crew Program will lay the groundwork for flying NASA personnel on commercial suborbital space transportation systems. The goal of the SubC office is to perform a system qualification, or safety assessment, to enable NASA astronauts, principal investigators and other NASA personnel to take advantage of these unique capabilities. Following the qualification, NASA plans to purchase seats on commercial suborbital space transportation systems for NASA use.

One of the initial activities for SubC is to work with the Federal Aviation Administration (FAA) and commercial suborbital space transportation providers to define the approach for system qualification for NASA personnel, as well as identify the specific performance capabilities NASA desires.

NASA created the Commercial Crew Program to transport NASA astronauts to and from the International Space Station in low-Earth orbit and awarded contracts to Boeing and SpaceX to develop human space transportation systems that will launch American astronauts on American rockets from American soil. The first test flight with NASA astronauts, the SpaceX Demo-2 mission, launched May 30.

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These steps include endurance and high power testing of the cruise motors and cruise motor controllers, with a focus on monitoring overall system efficiency. To do this, engineers use a dynamometer to measure current and voltage, taking in data at a rate of two million times per second. From there, the performance of these components can be recorded, analyzed and augmented as necessary to achieve maximum efficiency. The goal of this high power testing is to ensure that the cruise motors and their controllers can perform, with overhead, any of the steps of a flight mission.

Endurance testing involves a wider spectrum of activities, according to ESAero Cruise Motor Acceptance and Qualification Lead, Colin Wilson.

"The endurance testing involves everything from doing small checks and low power checks, making sure that the motor spins and communicates and gives us the information we need, all the way up to running full mission profiles," Wilson said. "We take the testing beyond mission profiles, where you're really pushing the limits of temperature and power."

"So far, the motors and controllers have performed exceedingly well, and we're in the process of getting them to perform even better."

While X-57 will always fly with a pair of cruise motors in each configuration, five motors in total have been built for the project. One was disassembled and used for evaluation of the unit's construction as a safety measure, two will be used as flight motors on the X-57 aircraft, and the other two will be used for envelope expansion testing and will act as spares to the flight motors.

Lessons learned from this testing are helping to pave the way for future Federal Aviation Administration airworthiness standards for electric aircraft, says Foster.

"It's critical for the success of the project that we achieve the efficiency goals that we're looking at, but also as we're going through these steps that we're beginning to develop how anyone else in the industry is going to certify or make airworthy motors," said Foster. "We're taking those first steps."

As this cruise motor testing directly feeds the effort for X-57 Mod II, currently housed at NASA Armstrong, preparation for Mods III and IV are well underway with the team getting the vehicle's future wing ready for integration. An additional P2006T fuselage, off the same assembly line as X-57's fuselage, was acquired and is acting as a "tooling" fuselage to allow engineers to assess the best way to integrate the cutting-edge wing designed by Xperimental LLC to X-57 for Mods III and IV and troubleshoot any challenges with the attachment.

Among the lessons learned from this phase is a better understanding of what physical modifications must be made to the fuselage to allow the wing to be mounted as efficiently and safely as possible. The wing is also undergoing instrumentation development, with engineers working to finalize the positioning of hardware inside the wing to accommodate X-57's complex distributed electric propulsion system.

"We're working to figure out the right positioning for specific instruments, and how to mount them," said Phil Osterkamp, ESAero vehicle instrumentation lead. "It's a small wing and the challenge is to get all these items fitted onto and inside it and trying to understand how to make this as light and as small as possible. It's a lot of layout and routing."

This is being done as a risk reduction for X-57, which will be the first NASA X-plane in two decades to have a test pilot onboard, but also as a schedule reduction effort. With these activities taking place in parallel to Mod II, the transitions from Mod II to Mods III and IV will require less time.

"The work being done now for X-57 is extremely important," said NASA's X-57 Project Manager Tom Rigney. "The team is proving out the key electric components that will very soon set the stage for all the parts to come together and for on-aircraft ground testing to begin. This critical step must be completed successfully before the airplane can take its first flight. Although managing this and the wing development simultaneously is challenging, doing both in parallel is proving to be a huge time savings."

As testing on these critical components continues to advance X-57 toward its historic first flight, an approaching milestone in NASA's effort to help set certification standards for electric aircraft of the future, anticipation for that day grows across the team.

"In the beginning, we were trying to push the envelope for this technology and I think now sharing lessons learned along the way, we're providing more benefits to the aerospace community at this stage than we thought we would," said Foster. "It's really exciting to see how far we've come and really seeing things start to come together here in these final phases as we approach first flight for Mod II. I'm incredibly excited to see this thing fly."

"Words can't express it."

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