National Aeronautics and Space Administration

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Collier Trophy

Armstrong part of team that won aviation's biggest prize

By Elvia Valenzuela
Armstrong Public Affairs

The life-saving Automatic Ground Collision Avoidance System (Auto GCAS) was awarded the 2018 Robert J. Collier Trophy by the National Aeronautic Association June 13.

This prestigious award is presented annually for the greatest achievement in aeronautics or astronautics in America. The 8-foot-high Collier Trophy arrived from the Smithsonian National Air and Space Museum to honor the Auto GCAS team for this historic win.

The Auto GCAS Team is a partnership among the U.S. Air Force led by the Air Force Research Laboratory and the F-35 program; the Office of the Secretary of Defense, guided by the Defense Safety Oversight Council; Lockheed Martin led by the Advanced Development Programs; and NASA led by Armstrong.

A committee comprised of 30 aviation and aerospace professionals selected the team as the recipient for the development, integration and test of the proven life-saving Auto GCAS technology.

The technology behind the Auto GCAS allows the software system to take over the controls of an aircraft upon determining ground collision is imminent. The system warns the pilot, and if no action is taken, it locks the controls and performs an automatic recovery maneuver, returning full control back to the pilot once the aircraft has cleared the near terrain. The F-16 aircraft were the first to have the system installed, which has saved eight pilots in the 4.5 years since it was fielded.

ED09-0290-32 NASA/Carla Thomas

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

The team decided to include the software system on the F-35 fleet, a worldwide implementation of more than 3,200 aircraft. It only took 10 months for the winning team to design, develop, integrate and flight test the system.

"Our team has dedicated countless hours of programming, research and flight testing to build this life saving system," said Mark Skoog, principal investigator for Autonomy at NASA Armstrong. "It's an incredible honor to be part of the team being recognized by such a prestigious award for developing this new milestone in the history of flight."

NASA's involvement began in the mid-80s with the development of this technology under its Aeronautics Research Mission Directorate. Various NASA projects including the migration of the Auto GCAS onto general aviation aircraft such as Langley Research Center's Lancair led to its success.

Further development of the technology continues at NASA Armstrong as part of the Resilient Autonomy effort, a joint collaboration with the Federal Aviation Administration (FAA) and Office of the Secretary of Defense with numerous Department of Defense Services and Commands.

Skoog, who led NASA's Auto GCAS effort, currently has a leading

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AA-2 set for launch

By Jay Levine
X-Press editor

When the Ascent Abort-2 (AA-2) Flight Test Vehicle launches July 2 from Cape Canaveral Air Force Station in Florida, it will do so with contributions from more than 50 people from Armstrong.

The AA-2 tests the launch abort system (LAS) that will be mounted on the top of the Orion crew module, combining for the safest spacecraft NASA has ever built, to send astronauts to the Moon and to Mars. This crew escape system would use the LAS to separate from the rocket and pull the module with the astronauts to safety in the event of a problem either on the launch pad or during the ascent to orbit.

AFRC2018-0128-029 NASA/Lauren Hughes

April Torres and Kyle Dauk set up for a thermal test of components in the Environmental Laboratory at Armstrong.

"Armstrong team members have made critical contributions to the Orion Ascent Abort 2 (AA-2) developmental flight instrumentation (DFI) subsystem," said Gary Martin, Armstrong's AA-2 project manager. "This crucial subsystem was designed, developed, built and tested here before being sent out for installation on the various modules of the AA-2 Flight Test Vehicle by integration teams at four separate major locations."

Martin described the DFI as the nervous system of the AA-2 Flight Test Vehicle. Armstrong DFI team members will lend engineering and control room support on the day of the mission.

"It includes nearly 1,000 sensors scattered over the entire vehicle from the base of the Abort Test Booster (ATB) to the highest tip of the LAS tower," he said. "The DFI system also includes miles of wire connecting those sensors to two major signal processing nodes (the brains of the system). The signal processing nodes forward all of that information to two separate telemetry transmitters and a video transmitter that in turn will relay it to the AA-2 test team."

In addition, as a backup to recover the information from this Orion Ascent Abort Flight Test, the crew module and LAS information will be forwarded to and recorded by 12 miniature ejectable data recorders (EDRs). The EDRs will be dispersed from the crew module before it hits the surface of the ocean and sinks to its final resting place. Armstrong DFI team personnel also will help oversee the search for and collection of those devices from the surface of the Atlantic by three recovery boats after the test.

"The critical data that the Armstrong-developed DFI subsystem will collect and return is needed to certify the Orion LAS as safe for use on human space flights," Martin explained. "Hopefully, in part due to the essential contributions of the Armstrong AA-2 DFI team, the Orion LAS will ensure no future astronauts' families have to endure a horrific loss."

Martin praised the team.

"I am proud to have had the honor of being a part of the Armstrong AA-2 DFI team, they are some of NASA's finest and are deserving of far more recognition than I can give for their unselfish efforts and their truly superior work," he said.

X-57 progresses

By Matt Kamlet
Armstrong Public Affairs

NASA's X-57 project has marked two critical milestones, taking two major steps toward demonstrating the benefits of electric propulsion for aviation.

More general aviation aircraft are in the air every year, which means that the challenge to address aircraft efficiency, noise and emissions becomes greater. NASA's X-57 Maxwell, the agency's first all-electric X-plane, will seek to meet that challenge by demonstrating innovative technology through electric-powered experimental flight.

The X-57 project is achieving this through several successive phases, in which the aircraft, a Tecnam P2006T, will undergo different modifications, or Mods, which NASA is tackling simultaneously to progress from one phase to the next safely and efficiently.

One of these milestones was achieved as part of X-57's Mod II activity – the configuration in which the X-57 project will flight test the research propulsion system and will eventually fly as a fully electric aircraft. Mod II includes the replacement of the baseline aircraft's two inboard combustion engines with electric cruise motors.

NASA/Armstrong TV/Steve Parcel

The electric motors for X-57's Mod II vehicle and its propellers were powered up and spun together for the first time as part of an integrated spin test.

Having integrated much of the initial electric system into the Mod II aircraft, engineers for the first time tested the motors and propellers integrated onto the vehicle in an initial spin test.

"This is the first time we've had the electric motors installed with

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Walk-up tech helps fast

By Jay Levine
X-Press editor

Sometimes people just want help with a computer problem without having to call or file a trouble ticket.

NASA Armstrong's Information Technology (IT) staff understands that and on Tuesdays at 9 a.m. offers help in the Ken Iliff Knowledge Center in Building 4800.

The walk-up service was fashioned after a similar idea started at NASA's Ames Research Center, said Haig Arakelian, an Armstrong IT manager. At that California center, a streamlined process was developed to help a lot of customers with simple IT challenges that could be solved quickly.

About a year ago, Armstrong premiered the service at several locations, with the Iliff center having the best turnout, he said. That location continues to be available on Tuesdays.

The IT staff has also been aware of key events, such as the migration to Office 365 this past spring. For that effort, Building 4838 on main campus and the DC-8 breakroom at Building 703 in Palmdale were used to help customers with quirks of the new system, he said.

"We have received positive feedback," Arakelian said. "A lot of people during the 365 upgrade had email that didn't work and many saw the benefit of having the walk-up tech available."

Nancy Ayala, the walk-up technician, said her customers face varied challenges.

"It could be email, or a smart card reader, but more common are customer's problems with cell phones and the new mobile desktop (MaaS 360)," she said. "Customers were happy that they received assistance right away and don't have to wait on the phone."

AFRC2019-0104-02 **NASA/Ken Ulbrich**

Nancy Ayala, the walk-up technician, helps customers with a number of different computer challenges.

Milky Way black hole is 'quiet'

By Kassandra Bell and Joan Schmelz
USRA Public Affairs and USRA SOFIA associate director

Supermassive black holes exist at the center of most galaxies, and the Milky Way is no exception. But many other galaxies have highly active black holes, meaning a lot of material is falling into them, emitting high-energy radiation in this "feeding" process. The Milky Way's central black hole, on the other hand, is relatively quiet. New observations from NASA's Stratospheric Observatory for Infrared Astronomy, SOFIA, are helping scientists understand the differences between active and quiet black holes.

These results give unprecedented information about the strong magnetic field at the center of the Milky Way galaxy. Scientists used SOFIA's newest instrument, the High-resolution Airborne Wideband Camera-Plus, HAWC+, to make these measurements.

Magnetic fields are invisible forces that influence the paths of charged particles, and have significant effects

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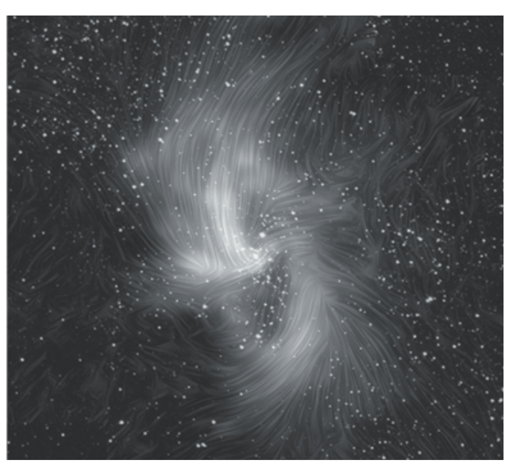

Dust and magnetic fields: NASA/SOFIA; Star field image: NASA/Hubble Space Telescope

Streamlines show magnetic fields layered over an 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.

News at NASA

Bumble first to fly on its own

A robot named Bumble became the first Astrobee robot to fly under its own power in space June 14. Astrobee is a free-flying robot system that will help researchers test new technologies in zero gravity and perform routine work alongside astronauts aboard the International Space Station. Robots that can operate on their own in space, such as Astrobee, can be caretakers for the NASA lunar gateway and will play a significant part in future NASA missions to explore the Moon and Mars.

Before Bumble's first solo flight, the Astrobee team at NASA's Ames Research Center in Silicon Valley verified that Bumble can find its position and was ready to navigate within the space station. Canadian Space Agency astronaut David Saint-Jacques provided hands-on help for the pre-flight tests, manually moving Bumble around the Kibo laboratory to allow Astrobee's navigation system to calibrate to its new surroundings. The navigation system uses a camera to observe the robot's surroundings and compares what the camera sees to a map of the space station's interior.

Bumble's first flights tested basic motions, such as "fly 11.8 inches forward" or "rotate 45 degrees to the right." NASA will continue to test Bumble's movement capability through a series of increasingly complex maneuvers to determine how well the robot performs in zero gravity.

 X-Press May 2019

X-56A control room

View from the ground provides insight into research

By Jay Levine
X-Press editor

It was a brisk morning as the final checks on the lakebed and in the control room were nearly complete for the X-56A to take flight at NASA Armstrong.

The flight crew worked with the ground crew to check that the control surfaces on the remotely piloted aircraft were responsive to commands. The center's Dryden Aeronautical Test Range, the range safety officer and the Edwards Air Force Base tower were added in the communication loop and ready.

Test conductor Jake Schaefer directed the team as a symphony conductor manages a performance. He also is the dedicated flight crew communicator and a test information filter to help the pilots manage their work load.

Schaefer checked for final confirmation that the aircraft was ready for flight. "Controls," he called out. "Go" was the response. Similarly, representatives from the launch team on the lakebed, structures, systems and Cheng Moua, the X-56A project manager, signaled that the vehicle was ready to fly.

Reports from a weather balloon and from a T-34 aircraft circling overhead were evaluated as the final checks were completed. The X-56A aircraft moved down the runway faster and faster until the wheels no longer touched the ground and co-pilot Dana Purifoy called, "NASA five-six is airborne."

AFRC2019-0113-08 NASA/Jim Ross

The X-56A remotely piloted aircraft, which has flexible wings and has suppressed flutter, begins a research mission in the skies above Edwards Air Force Base June 11.

As the aircraft approached a test point, the flight was monitored by experts in different disciplines, who were seated in rows behind the pilots. The experts reviewed information displayed on the screens in front of them. "Mark" was called out to begin a test point. When the needed data had been collected from a maneuver, "complete" was called. If more data were needed, "repeat" was called.

During the flight the X-56A suppressed potentially destructive vibration called flutter, which permitted research of the aircraft's lightweight, flexible wings. The results of the research could enable future airliners to use similar wing designs to conserve fuel. The X-56A team also is facilitating the development of tools and technologies and acquiring data to validate modeling techniques.

It's not just the aircraft readiness that determines if the mission will fly. Weather, turbulence at test altitudes, lakebed conditions, pilot availability, and experiment or aircraft challenges can make or break flight plans.

"They are not just going out to fly, they are doing experiments," Moua explained. "The conditions have to be right to successfully conduct the mission."

The team understands that flight research is complicated, so they focus on what they can do. Cross training team members and selecting backups where possible enable the team to be ready when something inevitably happens.

For example, before former test conductor Chris Miller transitioned to a detail assignment, he helped Schaefer, who was the controls lead, train for the certification required for that role. Matt Boucher then became

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AFRC2019-0107-02 NASA/Ken Ulbrich

The X-56A control room is busy as the remotely piloted aircraft prepares for takeoff to fly a mission to gather more information on its flexible wings and flutter suppression system.

AFRC2019-0107-09 NASA/Ken Ulbrich

Scott Howe, X-56A chief pilot, and Troy Asher, co-pilot, fly the aircraft from a ground cockpit in the control room. It was odd at first flying the aircraft with a group of people behind him, Howe said. However, practices build confidence in the team and he knows they support him and the mission well.

Control room... from page 5

the new controls lead. It's a busy control room, with as many as 10 people during a flight – if one is out, the show must still go on. Jason Lechniak, who is capable of monitoring data for controls, structures or systems, is an example of how the team can manage an absence.

It is stressful before takeoff to make sure the aircraft is ready and when a new test condition is reached, Miller explained.

"The way X-56A is structured, we can practice everything, which allows us to know what the test point is supposed to look like and what it feels like," he said. "It gets stressful when things do not go as planned and that's why we rehearse."

Schaefer was surprised at how he felt during his first experiences as the mission controller on a different flight.

"Being mission controller felt far less stressful than the flights where I was a discipline engineer in the control room," he said. "As an engineer, there is a large amount of data you are constantly looking at, trying to pick out anything that looks different from what was expected based on simulations or past flights. You want to spot a problem before it gets bad and pass that information to the pilots."

The X-56A control room is similar to many others, except the pilots are seated in gaming chairs in the front of the control room – they are not flying the aircraft across the sky from its cockpit.

"Initially I thought it would be a distraction, having so many people behind me, but I realized everyone behind me is extremely focused on monitoring their particular vehicle parameters during the flight," said chief X-56A pilot Scott "Jelly" Howe. "They are ready in an instant to call out an abort or a flutter warning call that the crew will instinctively react to thanks to repeated test rehearsals."

Practice adds familiarity and confidence.

"Full team control room rehearsals remove any notion of distraction or being 'watched' and replaces that with the confidence that the folks behind me are keeping the aircraft safe," Howe said. "That is especially important when the test points are near uncharted, higher speeds for the aircraft that may be hazardous. I'm a huge proponent of thorough, realistic test rehearsals before every flight."

The X-56A pilots don't have some of the physical cues of flying in an airborne cockpit, but they do have video from Armstrong videographers and a camera on the nose of the aircraft, plus cockpit displays and maps.

X-56A flights last about 30 minutes, depending on how fast the aircraft is flying. At the end of the flight, the aircraft is piloted to lower altitudes until it lands and taxis to the ground crew, who will make sure the parking brake is set, the engines are shut down and the aircraft is powered down. The X-56A is then secured to a trailer for transport back to its hangar.

The good, the bad and the unexpected from each flight are discussed in a debrief about an hour after each flight. Following the debrief, it is determined whether there will be a practice for the next flight later in the day. If the data and the weather are good, the team might be able to come in the next day and do it all again. Regardless of the situation, it's certain the team will be ready.

AFRC2019-0107-13 NASA/Ken Ulbrich

Test conductor Jake Schaefer, standing, orchestrates an X-56A test mission.

AFRC2019-0107-14 NASA/Ken Ulbrich

X-56A Project Manager Cheng Moua monitors a flight in the control room.

AFRC2018-0222-15 NASA/Ken Ulbrich

Peter Suh and Jeff Ouellette complete X-56A preflight checks.

"Full team control room rehearsals remove any notion of distraction or being 'watched' and replaces that with the confidence that the folks behind me are keeping the aircraft safe."

Scott "Jelly" Howe
X-56A chief pilot

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propellers and had them spinning," said Sean Clarke, NASA principal investigator for X-57. "This was a big milestone, as it was a big systems test where we were able to run both motors on the airplane at the same time.

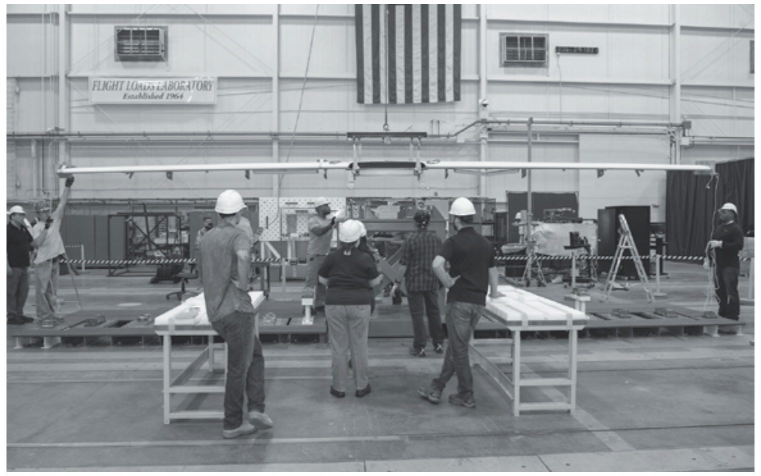
"It's really exciting to actually have all of the systems integrated and to be able to operate the vehicle that we've been designing for our system tests. It's a huge opportunity for us, so we're very excited."

The test took place at the Scaled Composites facility in Mojave and verified that the propellers, which pull energy from the motor to provide thrust and propel the aircraft, operate as expected as the motors were provided with significant power for the first time.

Instead of using batteries, which the vehicle will ultimately use during taxi and flight tests, the spin test was carried out from the ground using a power supply. Following stages of Mod II testing include repeating the test with the use of batteries and delivery of the Mod II aircraft to Armstrong. Once delivered to NASA the Mod II aircraft will undergo verification, followed by taxi tests, and eventually experimental flight tests.

While Mod II proceeds toward testing, efforts are already well underway for X-57's Mod III phase.

Mod III includes the replacement of the aircraft's baseline wing with a new, high-aspect-ratio wing and features the repositioning of the electric cruise motors out to the wingtips – an arrangement that presents the potential to boost aircraft efficiency considerably, but was not feasible with heavier, traditional combustion engines.



AFRC2019-0081-08 NASA/Ken Ulbrich

Engineers and specialists prepare X-57s Mod III wing for testing in the Armstrong Flight Loads Laboratory.

The X-57 Mod III activity also achieved a major milestone, as NASA received delivery of the Mod III wing from the project's prime contractor, Empirical Systems Aerospace Inc. of San Luis Obispo, California, or ESAero.

Upon delivery of the wing, NASA immediately began running tests to verify that its specifications and components are sound, and that the wing matches NASA structure and design models.

NASA testing of the wing, which was built by Xperimental LLC in San Luis Obispo, includes weight and balance measurement, ground vibration testing and wing loading tests. Weight and balance measurement determines the total mass and the center of gravity on the wing and helps NASA verify that the aircraft will perform correctly during taxi and flight tests.

Ground vibration testing, or GVT, considers the engineering challenges of the relatively thin, high-aspect-ratio wing, which could be prone to flutter and other vibration conditions in flight. The GVT lets NASA verify whether the structural properties built into the wing match what is expected for flight.

Finally, the wing will undergo wing loading tests. These tests will confirm whether the wing structure acts as predicted as it carries the approximately 3,000-pound aircraft through flight.

"I think that getting the wing here really brings Mod III to reality for the team," said X-57 Deputy Operations Engineering Lead Kirsten Boogaard. "Having the wing come here and people being able to see the size of it, the look of it, just actually see it in person instead of in models, I think is a really big deal for the project.

"It's a cool thing when ideas go from concept to reality, but that's what NASA does."

After these tests are complete, NASA will then send the wing back to ESAero, where the wing will undergo fit checks onto a second "fit-check" fuselage. Here, the wing will also have 12 nacelles integrated, which will eventually house 12 small electric high-lift motors and propellers, which will be featured on X-57's final phase, Mod IV.

The NASA X-57 project is operated under the agency's Aeronautics Research Mission Directorate.

SOFIA... from page 3

on the motions and evolution of matter throughout the universe. But magnetic fields cannot be imaged directly, so their role is not well understood. The HAWC+ instrument detects polarized far-infrared light, which is invisible to human eyes, emitted by celestial dust grains. These grains align perpendicular to magnetic fields. From the SOFIA results, astronomers can map the shape and infer the strength of the otherwise invisible magnetic field, helping to visualize this fundamental force of nature.

"This is one of the first instances where we can really see how magnetic fields and interstellar matter interact with each other," noted Joan Schmelz, Universities Space Research Center astrophysicist at NASA Ames Research Center in California's Silicon Valley, and a co-author on a paper describing the observations. "HAWC+ is a game-changer."

Previous observations from SOFIA show the tilted ring of gas and dust orbiting the Milky Way's black hole, which is called Sagittarius A* (pronounced "Sagittarius A-star"). But the new HAWC+ data provide a unique view of the magnetic field in this area, which appears to trace the region's history over the past 100,000 years.

Details of these SOFIA magnetic field observations were presented at the June 2019 meeting of the American Astronomical Society and will be submitted to the *Astrophysical Journal*.

The gravity of the black hole dominates the dynamics of the center of the Milky Way, but the role of the magnetic field has been a mystery. The new observations with HAWC+ reveal that the magnetic field is strong enough to constrain the turbulent motions of gas. If the magnetic field channels the gas so it flows into the black hole itself, the black hole is active, because it is eating a lot of gas. However, if the magnetic field channels the gas so it flows into an orbit around the black hole, then the black hole is quiet because it's not ingesting any gas that would otherwise eventually form new stars.

The aircraft is maintained and operated from NASA Armstrong.

The Automatic Ground Collision Avoidance System Team accepted the Collier Trophy on June 13. From left to right: Col. Robert Ungerman, Mark Skoog, Ed Griffin, Mark Wilkins, Jim Albaugh, Greg Principato, Donald Swihart and Lt. Col. Tucker Hamilton.

NASA

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role in Resilient Autonomy at NASA Armstrong. His team is currently developing the Expandable Variable-Autonomy Architecture (EVAA) system. EVAA will determine when safety should take priority over a mission and when human safety should take priority over the vehicle safety by following a set of programmed rules. The goal is to have EVAA serve as a moral compass for unmanned aircraft vehicles as the Auto GCAS performs in piloted planes.

"Our goal is to build a certification approach, based on the framework of our EVAA system, for general aviation aircrafts and full autonomous aircrafts to be equipped with an automatic air and ground collision system," added Skoog.

The Office of the Secretary of Defense joined the collaboration last year by funding the Resilient Autonomy task to expand the EVAA capability and develop a certification guidance that could allow linkless operations in an unpiloted aircraft.

For the next two years, the team will perform the flight tests in a variety of scenarios using EVAA. Flight tests will begin early summer with Langley's Lancair aircraft and continue with the use of two small unmanned aerial vehicles (UAV), the Hybrid Quadrotor HQ-10 and HQ-90.

The HQ-10 is an all-electric UAV that features a two-pound payload with one hour of flight time.

The HQ-90 is larger scale version with an 8-to 22-pound payload capacity with a long endurance flight time of 12 to 22 hours, depending on the payload.

The project team selected both small UAVs and general aviation aircraft to undergo flight tests with the hopes to have all aircraft implement EVAA or a similar software system as our national airspace prepares for urban air mobility.

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