National Aeronautics and Space Administration

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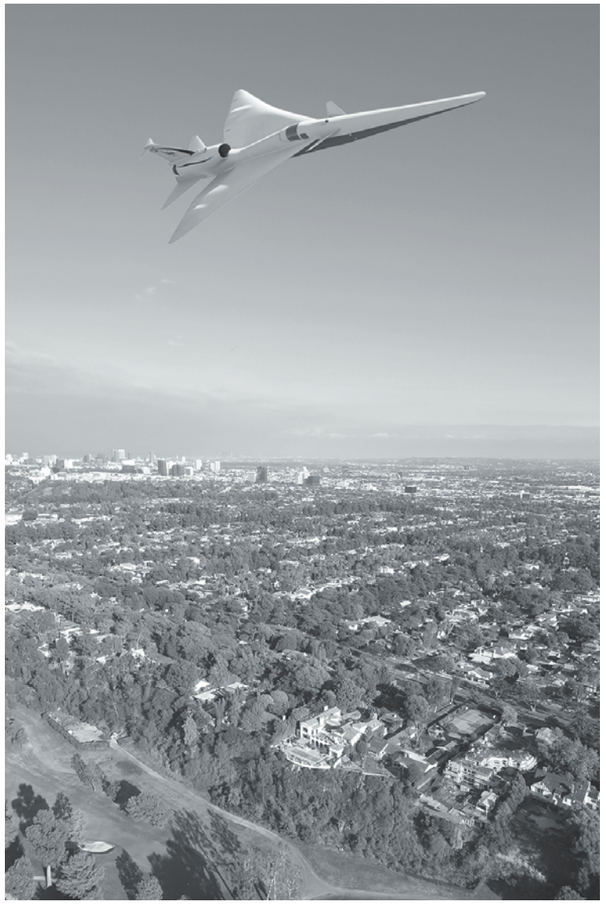
LBFD advances



NASA

NASA awards a contract for the design, building and testing of a supersonic aircraft to Lockheed Martin Aeronautics Company of Palmdale.

Jim Banke
Aeronautics Research Mission Directorate

NASA's aeronautical innovators are ready to take things supersonic, but with a quiet twist.

For the first time in decades, NASA aeronautics is moving forward with the construction of a piloted X-plane, designed from scratch to fly faster than sound with the latest in quiet supersonic technologies.

The new X-plane's mission: provide crucial data that could enable commercial supersonic passenger air travel over land.

To that end, NASA on April 2 awarded a $247.5 million contract to Lockheed Martin Aeronautics Company of Palmdale to build the X-plane and deliver it to Armstrong by the end of 2021.

"It is super exciting to be back designing and flying X-planes at this scale," said Jaiwon Shin, NASA's associate administrator for the Aeronautics Research Mission Directorate. "Our long tradition of solving the technical barriers of supersonic flight to benefit everyone continues."

The key to success for this mission – known as the Low-Boom Flight Demonstrator – will be to demonstrate the ability to fly supersonic, yet generate sonic booms so quiet, people on the ground will hardly notice them, if they hear them at all.

Current regulations, which are based on aircraft speed, ban supersonic flight over land. With the low-boom flights, NASA intends to gather data on how effective the quiet supersonic technology is in terms of public acceptance by flying over a handful of U.S. cities, which have yet to be selected.

The complete set of community response data is targeted for delivery in 2025 to the Federal Aviation Administration (FAA) and the International Civil Aviation Organization (ICAO) from which they can develop and adopt new rules based on perceived sound levels to allow commercial supersonic flight over land.

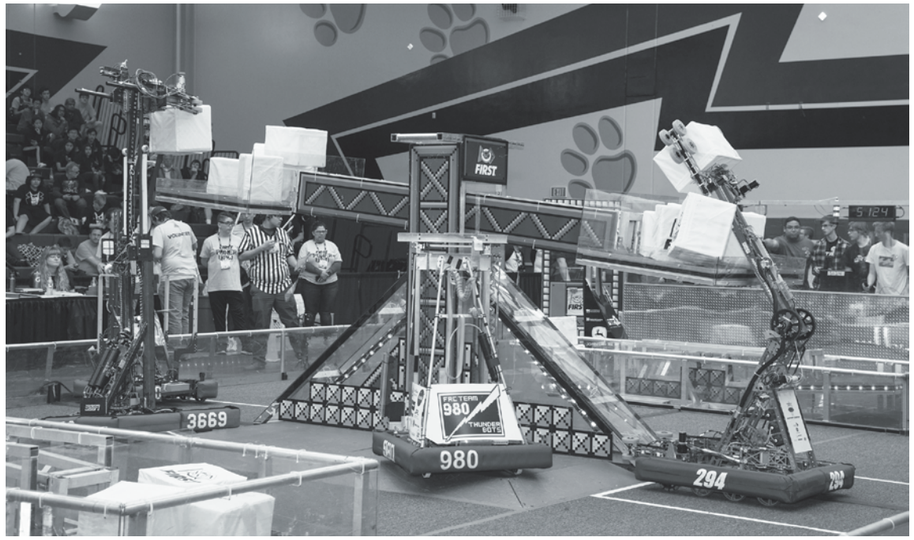
Years of sonic boom research, beginning with the X-1 first breaking the sound barrier in 1947 – when NASA was the National Advisory Committee for Aeronautics – paved the way for the Low-Boom Flight Demonstrator X-plane's nearly silent treatment of supersonic flight.

The answer to how the X-plane's design makes a quiet sonic boom is in the way its uniquely-shaped hull generates supersonic shockwaves. Shockwaves from a conventional aircraft design coalesce as they expand away from the

LBFD, page 7

Robotics inspires students

By Jay Levine
X-Press editor
and Rebecca Richardson
Armstrong Public Affairs



AFRC2018-0068-67 **NASA/Lauren Hughes**

High school teams from around the world participated in the Antelope Valley Regional robotics competition.

Contestants from the U.S. and Ethiopia competed at the Antelope Valley Regional robotics competition at Eastside High School in Lancaster April 6-7.

Called the For Inspiration and Recognition of Science and Technology (FIRST) Robotics Competition, which is a world championship-qualifying event, the focus was to encourage study and careers in science, engineering, technology and mathematics, or STEM.

The event included as many as 700 high school students representing 34 teams in the annual challenge. In January, each team received the description of the game and had six weeks to design, build and test a robot with the help of adult mentors. The FIRST Power Up game featured two alliances of three robots, which represented video game characters trapped in a game, working to defeat the other alliance and to escape.

The NASA Robotics Alliance Working Group at NASA Headquarters is a major sponsor of the Lancaster robotics event. It provided funds to NASA centers for sponsoring mentors and local teams to support and encourage STEM study and career paths. Armstrong sponsored four teams and NASA's Jet Propulsion Laboratory supported six teams at the event.

David Voracek, Armstrong's chief technologist and a longtime robotics supporter, said the project has a lot of benefits for students. He had a key role in helping develop this regional event, but first became involved in the robotics program at Lancaster High School about a decade ago to support his kids and because he enjoyed the project. His son Brad, who worked on the technical side of robotics, is looking to begin teaching computer science in the fall. His daughter Caitlin, who participated in media activities, has a career with a social media company.

AFRC2018-0068-15 **NASA/Lauren Hughes**

Armstrong Center Director David McBride, right, judges a robotics team.

"I think the robotics team challenge gives students a good sense of what it takes to run an organization, the technical tasks, media outreach and the overall business aspects of a corporation," Voracek said. "The biggest opportunity for all of the teams is the chance to work with adult industry mentors. It's fun to see students develop from shy freshmen to team leaders in four years."

Lancaster High School's robotics team was the first one that Armstrong supported. That tradition continues this robotics season as Armstrong engineer Matthew Reaves mentors the team.

"I began mentoring team 399 five seasons ago, while my daughter was in choir rehearsal," he recalled. "While I was a bit lost at first, the experience I had at the first competition convinced me this was a fun way to give back to the community. I have about 20 years of systems and electrical engineering experience students can tap. Since then, my family is becoming involved, with my wife acting in a mentor role and my daughter looking forward to joining the team when she enters high school in a few years."

The best part?

"The most rewarding part of mentoring robotics students is when their design or idea doesn't quite work the first time," Reaves said. "I enjoy watching how a student approaches the troubleshooting aspect of the systems process. I feel that troubleshooting skills are what separates good engineers from great engineers. Experiencing success after initial difficulties is amazingly satisfying and one of the best ways to measure the aptitude of an engineer."

Robotics, page 8

Becklin wins AAS lectureship

By Kassandra Bell
SOFIA Public Affairs

The American Astronomical Society, AAS, awarded the Henry Norris Russell Lectureship to Eric Becklin, senior science advisor for SOFIA, the Stratospheric Observatory for Infrared Astronomy. The lectureship is awarded annually based on "a lifetime of eminence in astronomical research, and for his leadership role in turning infrared astronomy into a fundamental tool for understanding astronomy and astrophysics."

Becklin presented the lecture, "Fifty-four Years of Adventures in Infrared Astronomy," at the AAS winter meeting on Jan. 11. As SOFIA's senior science advisor, Becklin works to ensure that telescope and instrument design and operation are meeting the observatory's goals." Eric Becklin has been at the forefront of infrared astronomy since the mid-1960s," said USRA President and CEO Jeffrey Isaacson. "His leadership within the infrared community has been a guiding force in the proposal and development of SOFIA and in establishing the USRA-operated SOFIA Science Center at NASA's Ames Research Center in California's Silicon Valley."

His adventures began in 1965 as a graduate student at the California Institute of Technology, when he discovered a massive star forming in the Orion Molecular Cloud, a group of bright nebulas and young stars in the Orion Constellation. This forming star can only be seen with infrared light and is now called the Becklin-Neugebauer Object.

In 1966 Becklin made the first measurements of infrared radiation from the center of our Milky Way galaxy. The radiation was later recognized as a cluster of massive stars at the center of the galaxy. He then became the first director of NASA's Infrared Telescope Facility, at Mauna Kea, Hawaii. There he led a team focused on obtaining infrared images of Jupiter to support NASA's Voyager mission. His team captured images that revealed holes in the clouds in Jupiter's atmosphere just two months before the spacecraft's second flyby of the planet in July 1979.

ED15-0187-382 NASA/Carla Thomas

Eric Becklin (back left) celebrates with researchers Sarah Logsdon and Maureen Savage as they observe Pluto aboard SOFIA in 2015.

While at the Infrared Telescope Facility in 1988, he discovered the first L-class star, the first new stellar classification in over 80 years, which is now believed to be the first imaged brown dwarf, called GD165B. Brown dwarfs are small, cool objects that are about the same size as Jupiter, but because they generate very little energy, they do not shine with starlight. Instead they emit most of their radiation at infrared wavelengths – making them very difficult to find.

Becklin was part of an observing team that flew onboard the Kuiper Airborne Observatory, a C-141 aircraft with a 36-inch telescope, to study the circumnuclear disk at the center of the galaxy. He was also part of a team that used the mobility of that observatory to study the Sun during two solar eclipses in the 1980s. While flying inside the path of totality, they measured the height and temperature of the chromosphere, the layer 250 to 1,300 miles from the Sun's surface that gets hotter as the distance from the surface increases.

Later, Becklin became a faculty member in the department of physics and astronomy at the University of California, Los Angeles, where he helped start an infrared lab in 1989. Since then, infrared telescopes and detectors have become significantly more advanced, enabling researchers to obtain high-resolution images of objects that were previously too faint, or shrouded inside too much celestial gas and dust, to be detected.

In the 1990s he built on that advancement, leading the proposal to develop and operate SOFIA, a Boeing 747SP aircraft carrying a 100-inch (2.5-meter) telescope. Researchers have used the observatory to make the highest resolution image of the circumnuclear ring of gas and dust orbiting the black hole at the center of the Milky Way galaxy, to study celestial magnetic fields in star-forming regions, to make advance observations of the New Horizons

Becklin, page 8

News at NASA

Roots and shoots get their space

The Advanced Plant Habitat (APH), a recent addition to the International Space Station, is the largest growth chamber aboard the orbiting laboratory. Roughly the size of a mini-fridge, the habitat is designed to test which growth conditions plants prefer in space and provides specimens a larger root and shoot area. This space in turn will allow a wider variety of crops to grow aboard the station. Arabidopsis, small flowering plants related to cabbage and mustard, and Dwarf Wheat have been grown and studied in the habitat so far.

The habitat's monitoring and environmental control systems regulate temperature, oxygen, and carbon dioxide levels and the system settings can be adjusted for growing different types of plants. Although the system is largely autonomous, the crew adds water to the chamber and changes atmospheric elements such as an ethylene scrubber, carbon dioxide scrubber and bottles and filters. All systems can be monitored and controlled from a computer on the ground that interfaces directly with the habitat to relay instructions and detailed adjustments to ensure investigation integrity.

Because gravity is a constant downward force on Earth, researchers take advantage of the microgravity environment to gain a clearer perspective of plant growth habits.

Gravity is one of the major cues plants use to guide their growth, but microgravity can act as a kind of mute button that suppresses the role of gravity, enabling researchers to see what other cues take charge.

X-Press March 2018

AFRC2018-0056-100 NASA/Ken Ulbrich

***Above**, Al Bowers explains the Prandtl experimental aircraft and how its wing twist could redefine the efficiency of aircraft. **Below**, Armstrong pilots Paul Newton and Tim Williams stand by the center's research F/A-18 aircraft.*

AFRC2018-0056-49 NASA/Ken Ulbrich

L.A. County Air Show

Event draws as many as 100,000 people

AFRC2018-0056-112 NASA/Ken Ulbrich

AFRC2018-0056-15 NASA/Ken Ulbrich

***Above,** Amberly Guerra, left, tries on life support equipment while Ali Zendejas, Betty Mojica and Julian Guerra, her dad, watch.*

AFRC2018-0056-135 NASA/Ken Ulbrich

A young woman tries her hand at "piloting" a high-performance jet. The representation of a jet cockpit is a popular display at Armstrong-supported air shows and festivals across the nation.

AFRC2018-0056-35 NASA/Ken Ulbrich

AFRC2018-0056-16 NASA/Ken Ulbrich

***Above**, new meets old as the the F-22 and a P-38 share the sky.*

***At left,** Zack Roberts from NASA's Ames Research Center explains elements of the Unmanned Aircraft Systems Integration into the National Airspace System.*

AFRC2018-0056-62 NASA/Ken Ulbrich

Above, *Dana Purifoy, Armstrong director of Flight Operations, talking, and John McKay, former Armstrong SR-71 crew chief, left, participate on a panel discussion about the triple supersonic aircraft.*

***At left,** Armstrong pilots Stu Broce, Greg Nelson and Tim Williams sign autographs for people at the Los Angeles County Air Show at Fox Field.*

NASA helps test new engine oils

By Jay Levine
X-Press editor

NASA is assisting with performance testing and validation of three new bio-based engine oils that developers said could lead to better gas mileage, longer oil change intervals and reduced emissions.

Four vehicles and soon five at Armstrong are using the new engine lubricant. The U.S. Department of Defense (DOD) Bio-based Motor Oil Demonstration Program focuses on these new oils that are a blend of conventional synthetic oils with 25-40 percent bio-based material, such as domestically produced soybean and canola oils and animal fat.

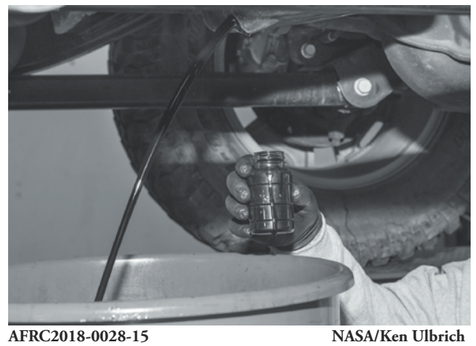
All three bio-based motor oils used in the demonstration have American Petroleum Institute certification for use in gasoline engines, said Andy Shaban of the U.S. Defense Logistics Agency (DLA) and a coordinator for the lubricant oil tests. Using the oil does not require engine modifications and is expected to be comparable in cost to fully synthetic petroleum engine oil, he said.

"The bio-based synthetic oils demonstration is to validate performance and to determine when, based on vehicle miles driven or idle time, the lubricant needs to be changed, Shaban explained. "The new oils will be compared to the laboratory test results of the previous oil."

Vehicles at NASA's Kennedy Space Center in Florida, Langley Research Center in Virginia, Johnson Space Center's White Sands Test Facility in New Mexico and other government agencies across the country also are part of the pilot project expected to conclude in 2019, he said. Project participants were chosen to represent the diversity of climate regions and are for use in non-tactical federal vehicles.

AFRC2018-0028-09 NASA/Ken Ulbrich

Scott Rogers pours a new bio-based synthetic engine oil into one of the four vehicles that Armstrong is using to assist in the performance testing of the new product.



AFRC2018-0028-15 NASA/Ken Ulbrich

Before new bio-based synthetic oils were added to four Armstrong vehicles, the old oil was drained and sent to a lab for analysis to compare to the new oil.

The demonstration vehicles' use of the engine lubricants and laboratory analysis will provide information that will help evaluate current oil performance and determine oil change intervals. Of the three participating oil companies, one has its oil commercially available. The other two bio-based lubricants are in pilot production and expect to have their products commercially available soon, Shaban said.

At Armstrong, as at other federal facilities, the engine oil was drained in test vehicles and analyzed at a lab to develop a baseline of comparison to the synthetic lubricant, said Jason Denman, auto shop lead at Armstrong for Kay and Associates Inc. The new oil, which has a clear, gold tint like traditional engine oils, was poured into the engines.

Every six months samples will be collected using a tube inserted in the dipstick opening to obtain a sample of about half a pint, Denman said. The oil will be analyzed for metal flakes and particulates, carbon content and breakdown of the additives that will give researchers the clues as to how long the oil will last in actual use and engine wear.

Denman is enjoying helping on the research side of the center.

"I like being part of something that could be the new standard," he said. "Anything that can help the environment and what we leave behind is a benefit."

The DOD uses 1.1 million gallons of four-cycle engine oil annually in 180,000 vehicles, Shaban said. The entire federal government, including the military services, civilian agencies and the U.S. Postal Service, maintains 633,000 vehicles.

The DLA also is coordinating on the project with the Office of the Assistant Secretary of Defense for Energy, Installations and Environment in Washington, D.C., and the Air Force Research Laboratory, Advanced Power Technology Office in Ohio.

Warren, crew chief, and Doss, specialist, die

Donald A. Warren, an aircraft mechanic at NASA for 33 years, died March 8. He was 66.

Warren was crew chief of the F/A-18 Active Aeroelastic Wing and worked on projects such as the NB-52B, the Convair CV- 990 space shuttle tire testing, the F/A-18 System Research Aircraft, the F-106 tow testing and the Boeing 720 crash testing.

People who knew him said he was always calm, consistent, was conscientious, had a great attitude and was a practical joker.

Leslie Doss, who had worked in Armstrong's Human Resources Office for more than a decade, died March 20. She was 39.

She was a training and development specialist in Armstrong's Human Resources Office where she designed and managed Armstrong's mentoring program, which her co-workers said was her passion. Additionally, she was responsible for leadership development with a focus on early- and mid-career employees and bringing training classes and instructors to the center.

People who knew her said she was at her best working one-on-one with people, was caring, very dedicated to training and development and she loved learning.

LBFD... from page 1

airplane's nose and tail, resulting in two distinct and thunderous sonic booms.

But the design's shape sends those shockwaves away from the aircraft in a way that prevents them from coming together in two loud booms. Instead, the much weaker shockwaves reach the ground still separated, which will be heard as a quick series of soft thumps – again, if anyone notices them at all.

It's an idea first theorized during the 1960s and tested by NASA and others during the years since, including flying from 2003-2004 an F-5E Tiger fighter jet modified with a uniquely shaped nose, which proved the boom-reducing theory was sound.

NASA's confidence in the Low-Boom Flight Demonstration design is buoyed by its more recent research using results from the latest in wind-tunnel testing, and advanced computer simulation tools, and actual flight testing.

Recent studies have investigated methods to improve the aerodynamic efficiency of supersonic aircraft wings and sought to better understand sonic boom propagation through the atmosphere.

Even a 150-year-old photographic technique has helped unlock the modern mysteries of supersonic shockwave behavior during the past few years.

"We've reached this important milestone only because of the work NASA has led with its many partners from other government agencies, the aerospace industry and forward-thinking academic institutions everywhere," said Peter Coen, NASA's Commercial Supersonic Technology project manager.

So now it's time to cut metal and begin construction.

Lockheed Martin

An artist's concept shows the Low Boom Fight Demonstrator outside the Lockheed Martin Aeronautics Company's Skunk Works hangar in Palmdale. NASA aeronautics is moving forward with the construction of a piloted experimental aircraft for the first time in decades. It was designed from scratch to fly faster than sound with the latest in quiet supersonic technologies.

The X-plane's configuration will be based on a preliminary design developed by Lockheed Martin under a contract awarded in 2016. The proposed aircraft will be 94 feet long with a wingspan of 29.5 feet and have a fully-fueled takeoff weight of 32,300 pounds.

The design research speed of the X-plane at a cruising altitude of 55,000 feet is Mach 1.42, or 940 mph. Its top speed will be Mach 1.5, or 990 mph. The jet will be propelled by a single General Electric F414 engine, the powerplant used by F/A-18E/F fighters.

A single pilot will be in the cockpit, which will be based on the design of the rear cockpit seat of the T-38 training jet famously used for years by NASA's astronauts to stay proficient in high-performance aircraft.

Jim Less is one of the two primary NASA pilots at Armstrong who will fly the X-plane after Lockheed Martin's pilots have completed initial test flights to make sure the design is safe to fly.

"A supersonic manned X-plane!" Less said, already eager to get his hands on the controls. "This is probably going to be a once-in-a-lifetime opportunity for me. We're all pretty excited."

Less is the deputy chief pilot for the Low-Boom Flight Demonstrator. He and his boss, chief pilot Nils Larson, have already provided some input into things like cockpit design and the development of the simulators they will use for flight training while the aircraft is under construction.

"It's pretty rare in a test pilot's career that he can be involved in everything from the design phase to the flight phase, and really the whole life of the program," Less said.

The program is divided into three phases and the tentative schedule looks like this:

• 2019 – NASA conducts a critical design review of the low-boom X-plane configuration, which, if successful, allows final construction and assembly to be completed.

• 2021 – Construction of the aircraft at Lockheed Martin's Skunk Works facility in Palmdale is completed, to be followed by a series of test flights to demonstrate the aircraft is safe to fly and meets all of NASA's performance requirements. The aircraft is then officially delivered to NASA, completing Phase One.

• 2022 – Phase Two will see NASA fly the X-plane in the supersonic test range over Edwards to prove the quiet supersonic technology works as designed, its performance is robust, and it is safe for operations in the National Airspace System.

• 2023 to 2025 – Phase Three begins with the first community response test flights, which will be staged from Armstrong. Further community response activity will take place in four to six cities around the U.S.

All of NASA's aeronautics research centers play a part in the Low-Boom Flight Demonstration mission, which includes construction of the demonstrator and the community overflight campaign. For the low-boom flight demonstrator itself, these are their roles:

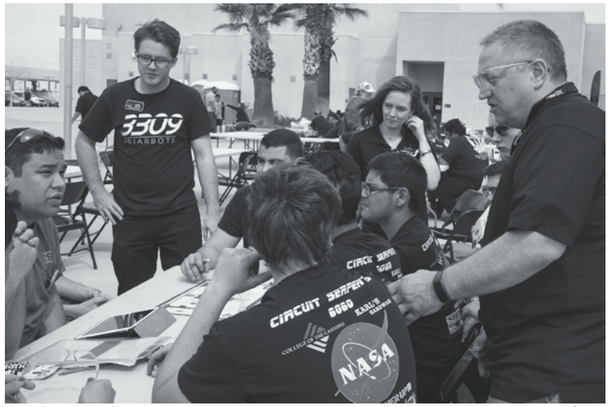
• Ames Research Center, California – configuration assessment and systems engineering.

• Armstrong – airworthiness, systems engineering, safety and mission assurance, flight/ground operations, flight systems, project management and community response testing.

• Glenn Research Center, Cleveland – configuration assessment and propulsion performance.

• Langley Research Center, Virginia – systems engineering, configuration assessment and research data, flight systems, project management and community response testing.

"There are so many people at NASA who have put in their very best efforts to get us to this point," said Shin. "Thanks to their work so far and the work to come, we will be able to use this X-plane to generate the scientifically collected community response data critical to changing the current rules to transforming aviation!"



AFRC2018-0068-50 NASA/Lauren Hughes

David Voracek, Armstrong's chief technologist, talks with members of the Turkish team. He was named FIRST's Volunteer of the Year at the event.

AFRC2018-0068-84 NASA/Lauren Hughes

C.J. Bixby, Armstrong's chief of the Systems Engineering and Integration branch, talks at a Society of Women Engineers event to inspire young women.

Robotics... from page 2

Jacob Dluzak, who is in his fourth year on the Lancaster squad, said his technical and leadership skills have grown.

"Robotics projects inspired me to be a leader and led me to apply and be accepted to the United States Military Academy at West Point," he said. "The most valuable part of my robotics experience has been experiencing high stress situations and managing tight deadlines. Without robotics, I also would not have gained a love for STEM."

Robotics competitions can help students zero in on what they want to do for a career, just ask Armstrong engineer Aamod Samuel.

"I participated with Penn High School in Indiana on Team 135, the Black Knight Robotics," he recalled. "I worked as a (robot) driver, but I also worked in design, prototyping and construction. I was most likely going to choose something engineering, or at least STEM related, as my career choice but participating in robotics definitely solidified my path toward engineering."

Engineering prowess and defeating opponents are valued, but awards are presented for safety and a Chairman's award recognizing outreach efforts during the year.

Armstrong's Office of Education also supports Armstrong-sponsored teams with their outreach efforts and attends robotics events in which the teams compete. The teams reciprocate by support of NASA education STEM goals with summer robotics workshops and hosting robotics-themed education booths at public events, said Miranda Fike, Education program specialist. Fike also managed the more than 160 volunteers that participated in a number of diverse roles needed for the event to succeed.

The FIRST robotics competition is a worldwide program for students in grades 9-12. FIRST also sponsors programs from younger age groups. The district and regional contests are in March and April, followed by the world championship events in Houston and Detroit in mid-April.

Becklin... from page 3

next flyby target, and more.

"It's most important to enjoy the excitement of discovery - I know I have," Becklin said during the lecture. "Thank you to all my collaborators, students, colleagues, supporters and family. The future is bright."

SOFIA is a joint project of NASA and the German Aerospace Center, DLR. NASA's Ames Research Center in California's Silicon Valley 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 based at Armstrong's Hangar 703 in Palmdale.

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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