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THE *BUZZ* OVER BATTERIES

Researchers are undaunted by doubts over electricity as a quick solution to aviation emissions

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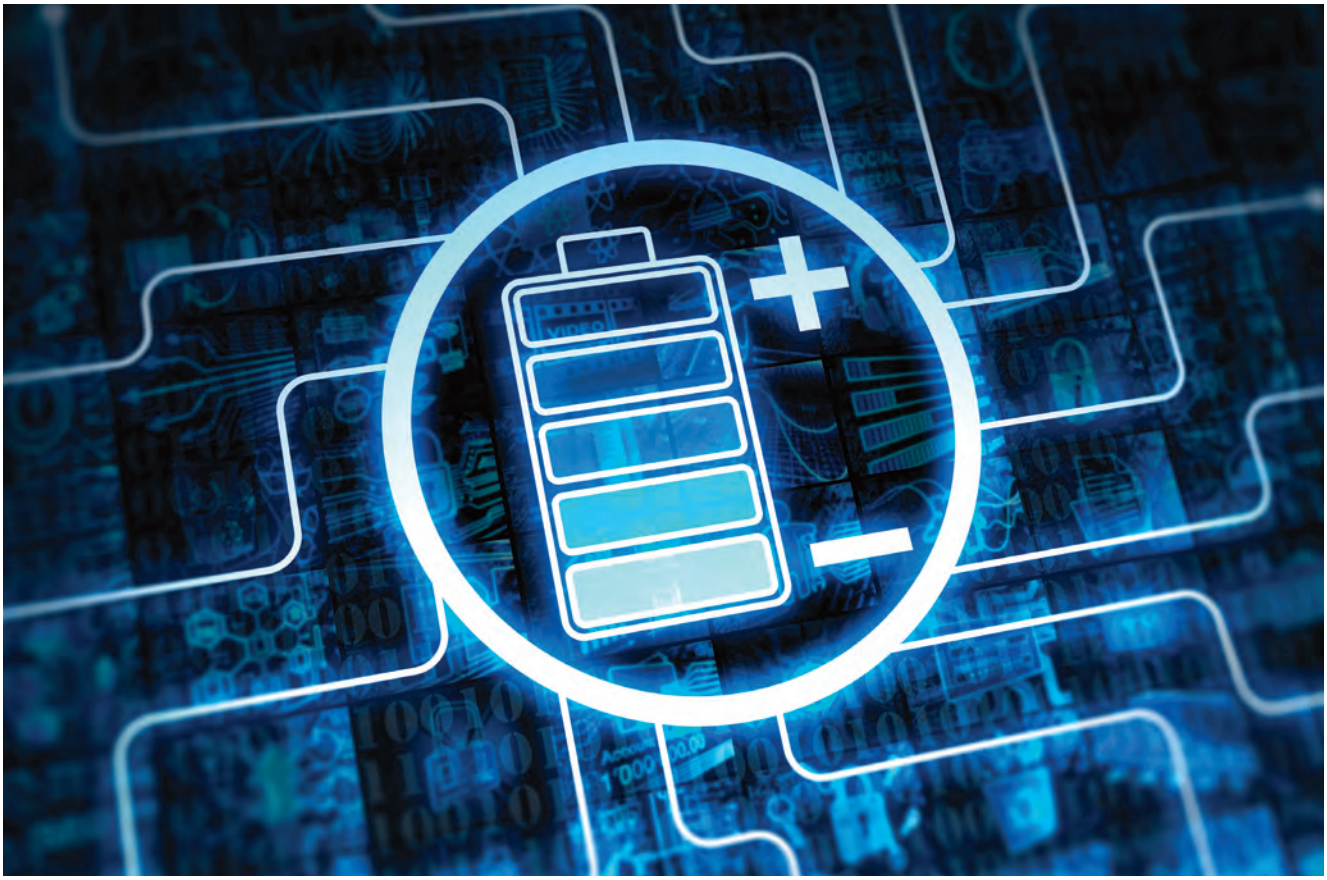

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The buzz over batteries

The hype over the future of battery-powered jetliners is officially over. Nonetheless, technologists are aiming for breakthroughs that could lead to a new class of super-charged batteries.

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Mission: Fission

NASA is hoping to break space fission's long history of stops and starts with a new program with deliberately modest power goals.

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Wanted: An ISR showdown

With its U-2 headed for an apparently inevitable retirement, Lockheed Martin is hoping to persuade the U.S. Air Force to give its concept spy plane a chance to duke it out with competing concepts.

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Doing no harm

Jetliners and cargo planes have many critical sensors that must be protected from inadvertent damage by ground personnel. Here are specific suggestions for ensuring safety.

By Vahid Norouzalibeik


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EDITOR-IN-CHIEF
Ben Iannotta
beni@aiaa.org

ASSOCIATE EDITOR
Kyung M. Song
kyungs@aiaa.org

PRODUCTION EDITOR
Greg Wilson
gregw@aiaa.org

EDITOR, AIAA BULLETIN
Christine Williams
christinew@aiaa.org

EDITOR EMERITUS
Jerry Grey

CONTRIBUTING WRITERS
Keith Button, Adam Hadhazy, Vahid Norouzalibeik, Michael Peck, Robert van der Linden, Debra Werner, Frank H. Winter

James "Jim" Maser **AIAA PRESIDENT**
Sandra H. Magnus **PUBLISHER**
Rodger S. Williams **DEPUTY PUBLISHER**
Craig Byl **MANUFACTURING AND DISTRIBUTION**

ADVERTISING
Joan Daly, 703-938-5907
joan@dalyllc.com
Pat Walker, 415-387-7593
walkercom111@gmail.com

ADVERTISING MATERIALS
Craig Byl, craigb@aiaa.org

ART DIRECTION AND DESIGN
THOR Design Studio | thor.design

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has written for C4ISR Journal and Hedge Fund Alert, where he broke news of the 2007 Bear Stearns hedge fund blowup that kicked off the global credit crisis.
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writes about astrophysics and technology. His work has appeared in Discover and New Scientist magazines.
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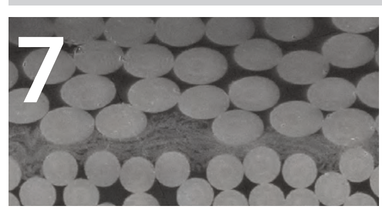
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Cost control

Our story on high altitude intelligence, surveillance and reconnaissance ["Wanted: An ISR showdown," page 30] shows how important it will be for the defense industry and the Pentagon to improve the accuracy of their cost estimating.

Lockheed Martin Skunk Works says it can build 30 unmanned aircraft for $3.8 billion to replace today's U-2s and Global Hawks. Skunk Works is confident that it could win a competition to build a new ISR plane if one were held. The company's TR-X proposal marks the start of a long, uncertain journey toward convincing Congress, the White House and the Pentagon to add a fleet of new ISR planes to the country's long-term spending plan.

The industry's track record of missing cost targets for major programs could make it hard for potential supporters to have faith that whoever wins the competition would get the job done at something close to the promised price.

Possibly sensing this, Lockheed Martin is pledging to wrap in existing technologies as much as possible. For this strategy to work, the government also will have to do its part. The Pentagon and Air Force could invite companies to compete to build the fleet under a firm, fixed-price contract. Requirements leaders could resist the temptation to add new performance requirements during development. In short, they could apply the "KISS" maxim favored by the late Skunk Works guru Clarence "Kelly" Johnson. KISS is short for Keep It Simple Stupid.

To be fair, it's hard to say "no" to additional requirements, because they often arise from commanders who want their troops to benefit from commercial and consumer technologies that enter the market after the design has been set. Incorporating standard electrical and mechanical interfaces and software from the start can give some flexibility, but the rewards of trying to stay abreast of every technology trend are likely to be outweighed by the unpredictability they would inject into cost estimating. ★

Ben Iannotta, editor-in-chief, beni@aiaa.org

Corrections

The *Out of the Past* column in the July/August issue contained an error about the Apollo-Saturn AS-203 mission on July 5, 1966. An orbital restart of the second stage was not attempted and was never intended.

The September cover story on photographing exoplanets incorrectly described the laser test at Princeton's Frick Chemistry Lab. A 21-milliwatt helium-neon laser represents a star.

Aerospace Challenge Prizes Might Inspire Innovation

Standing on a dock close to where the Choptank River flows into the Chesapeake Bay, a friend regaled Tom with his knowledge of the British government's creation of a £20,000 prize in 1714, for solving the problem of accurate determination of longitude, which at the time was the major challenge to maritime navigation. Nearly 60 years later, the prize was awarded to John Harrison, who was rewarded for a nearly lifelong effort to create a chronometer that was accurate at sea.

This exchange got us thinking about the list of innovators and pioneers in our industry. Names like Wilbur and Orville Wright, Glenn Curtiss, Glenn L. Martin, William Boeing, Igor Sikorsky, Robert Goddard, Amelia Earhart, Wernher von Braun, and, more recently, Abe Karem and Elon Musk came to mind. It also made us think about the role of a professional society, such as AIAA, in furthering the accomplishments of such pioneers and founders of what has become the U.S. aerospace industry. This is especially so for the team of people that they surround themselves with to perfect their inventions or create their companies.

One way for AIAA to contribute is to ensure that we stay attune to emerging trends and technologies that are changing the very nature of aerospace and, as a consequence, both the employment opportunities for aerospace professionals and the way in which we work. Several emerging technologies have been featured in previous "Corner Office" articles. One is small Unmanned Aerial Systems, with their myriad and seemingly limitless applications. Another is advanced manufacturing, through which the aerospace industry is realizing the benefits and advantages of being able to design and manufacture using strong, lightweight materials that our industry has long desired.

A key to either the development of the underlying technology or to the many brilliant aerospace applications is innovation. And while innovation defies any kind of individual or organizational construct or prescription to being so achieved, the establishment of aerospace prizes can be a catalyst that accelerates our imaginations, our drive to invent, the speed at which innovations occur, the willingness to invest in aerospace technologies, and ultimately, the impact that such innovation has on not only our profession and industry, but on society. And while the British Government may have incentivized the invention of a device that enabled mariners to accurately determine their location, it would ultimately take the work of many others, and nearly a century, to make chronometers practical and affordable.

Thankfully, the history of the impact of prizes in the aerospace industry has a shorter time frame. The Orteig Prize was established in 1919 and was claimed by Charles Lindburgh in 1927, when the famed aviator completed his nonstop flight from New York to Paris in his Ryan NYP "Spirit of St. Louis." Key technology advances that contributed to Lindburgh's success and to future aeronautics applications included advances in aerodynamics and aircraft design, reliable, high-power-to-weight piston engines, and the development of all-metal airplanes that could carry enough revenue-generating passengers to be profitable. The Kremer Prize for Human Powered Spaceflight was established in 1959 and claimed in 1977 by Dr. Paul MacCready when cyclist Bryan Allen successfully flew MacCready's Gossamer Condor aircraft over a 1.6-mile "figure-8" course as designated by the Royal Aeronautical Society. This team would capture the second Kremer prize in 1979 when Allen successfully flew the Gossamer Albatross across the English Channel. Key enabling technologies that were successfully demonstrated include high strength-to-weight composite structures, low-Reynolds-number aerodynamics at low Mach number, and integrated system design of high-aspect-ratio winged vehicles. The Ansari X-Prize was established in 1996 and claimed in 2004 by the Scaled Composites' Tier One project led by Burt Rutan and financed by Microsoft co-founder Paul Allen. The Ansari X-Prize can be credited with jump-starting the commercial space industry that today is credited with approximately $60 billion in U.S. economic activity.

Might now be the time to establish and develop a set of aerospace-related grand challenge prizes, similar to the Google Lunar X-Prize, that could inspire innovation and entrepreneurship and grow existing, or even foster, new industries? Possible prizes could include an Asteroid X-Prize Challenge centered around either detection and early warning systems for near-Earth asteroids or the exploitation of the natural resources that could be mined from asteroids, a Hypersonic UAS X-Prize challenge that could accelerate rapid and safe access to space, and a personal air vehicle X-Prize that would demonstrate safe and reliable transportation that could operate in the existing airspace. In all of these examples, the potential for technology development and advancement would justify the pursuit of such challenges and prizes. As always, AIAA is the right organization and AIAA events are the right venues for discussing innovations and the merits of grand challenges and for developing and advocating for such ideas, if they prove worth pursuing. ★

THOMAS B. IRVINE, AIAA Managing Director of Content Development and **DARRYLL J. PINES,** Dean and Farvardin Professor of Aerospace Engineering, A. James Clark School of Engineering, University of Maryland

Time to build Orion's jettison motors

By Debra Werner | werner.debra@gmail.com

Aerojet Rocketdyne

▲ **An Orion jettison motor** performed as planned when Aerojet Rocketdyne fired it for 1.5 seconds at its facility in Sacramento, California.

Now that an Orion jettison motor has performed as planned in the third ground test of the motors, Aerojet Rocketdyne plans to start work on six more, including one NASA intends to install atop a Space Launch System rocket for Orion's first astronaut flight.

Each jettison motor will be a critical component of the Launch Abort System, a stack of motors and an aeroshell that would whisk a crew away from an exploding or fizzing SLS launch vehicle. In an emergency, the abort motor would jolt the Orion crew capsule and its aeroshell off the failing SLS. An attitude control motor would then steer the assembly toward a gentle parachute landing once the jettison motor separates the crew capsule from the aeroshell.

On a nominal launch, the jettison motor will ignite in space to pull the entire abort system away from Orion. That step is necessary to clear the way for the parachutes, which are stored directly under the Launch Abort System, to be deployed when Orion splashes down in the ocean on its return.

Engineers faced an interesting challenge because of the motor's position above Orion.

"We had to get the exhaust out and around the capsule because this motor fires just above the crew module," said Don Mahr, Aerojet Rocketdyne's jettison motor program manager. This was done by channeling the exhaust through multiple nozzles.

"The exhaust plumes go in four different directions to help us avoid impinging our hot gas on the crew module."

One of the four jettison motor exhaust plumes is slightly smaller than the other three. That design is intended to push the entire Launch Abort System to the side and move it out of the way of the crew capsule in flight.

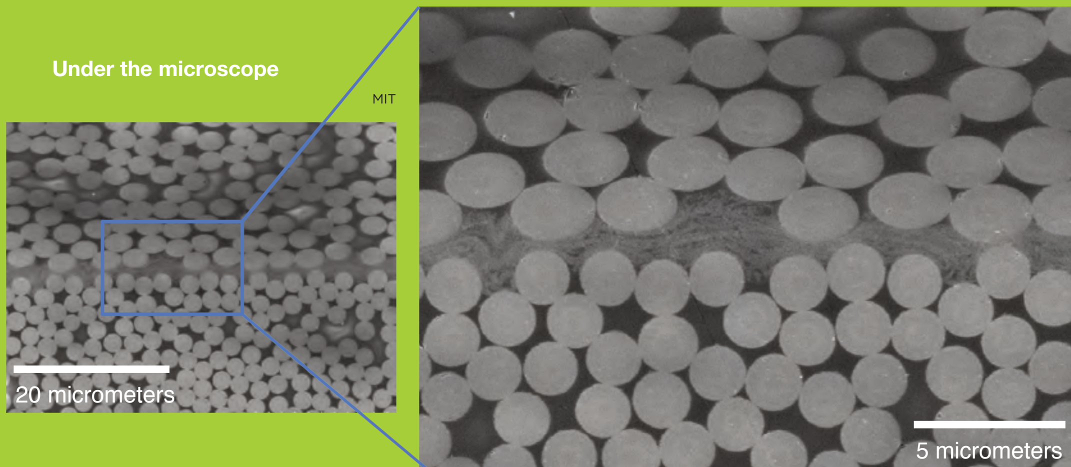
For the Aug. 31 static test, Aerojet Rocketdyne engineers mounted the jettison motor upside down on the test stand to make it easier to gather extensive data on the jettison motor's performance.

The motor was the first of seven the firm is building for NASA and Orion prime contractor, Lockheed Martin, under its current contract. Two of Aerojet Rocketdyne's jettison motors flew on Orion's Pad Abort test in 2010 and Orion's uncrewed test flight in 2014.

Next year, Aerojet Rocketdyne plans to build the first flight versions of jettison motors. One will ride on the first Space Launch System launch with an Orion module, a crewless flight called Exploration Mission-1. Others will ignite in NASA's Ascent Abort test, in which the Launch Abort System will attempt to demonstrate it can hurtle an Orion mockup vehicle away from a Peacekeeper missile standing in for an SLS rocket.

In addition, Aerojet Rocketdyne intends to build three jettison motors for tests to qualify the motor design for flight, before building the jettison motor for Exploration Mission-2, NASA's planned launch in the early 2020s to send astronauts into orbit on an Orion and SLS for the first time. ★

Under the microscope



MIT

Reinforcement: Adding aligned carbon nanotubes (the light gray material in the center of this scanning electron micrograph) to a polymer strengthens the bond between laminates of composite fibers, shown here in a cross section.

Nanotubes for stronger composites

By Debra Werner | werner.debra@gmail.com

Aerospace engineers at the Massachusetts Institute of Technology have shown that carbon nanotubes can act like nanoscopic stitches to bind layers of composite materials and prevent delamination.

The goal of the research is to address an Achilles heel of today's aerospace composites.

"Nothing holds the composite layers together except polymer glue and there is no good technological fix," explains Brian Wardle, an entrepreneur and an aeronautics and astronautics professor at MIT and director of its Nano-Engineered Composite aerospace Structures Consortium, a research group focused on creating new materials.

Conventional methods of stitching or weaving together layers of composite material can damage the fibers and reduce their ability to withstand impact. To find a better way, Wardle worked with MIT postdoctorate researcher Roberto de Guzman de Villoria and engineers from Sweden's Saab AB to embed more than 10 billion carbon nanotubes in vertical alignment in each square centimeter of a glue-like polymer between composite layers. The carbon nanotubes, which are 1,000 times smaller than the composite fibers, poked into microscopic regions between carbon fibers in adjacent composite layers and acted like stitches to bind the layers.

To test the concept, the team grew a forest of carbon nanotubes and embedded them in a polymer contained in 16-layers of a composite laminate. When the researchers heated the flexible composite laminate, the polymer flowed from the pre-impregnated plies into the carbon nanotube forest. The researchers tested the material's strength under a variety of conditions.

In one test, researchers drove a bolt through the composite material and ripped out the bolt to intentionally damage the fibers. Even with the damage, the material withstood 30 percent more force before breaking than composites without nanotube stitches. In another test, researchers forced the bolt hole closed, and the material withstood 14 percent more force than conventional composites. The results were to be published in the Sept. 14 issue of the journal Composites Science and Technology.

"We were surprised by how much the nanoscale stitches improved the strength of the composites," Wardle says. "In more recent tests, the improvement is even larger" than those to be reported in the journal article.

Because these research results were achieved during static tests conducted in ambient conditions, MIT researchers are continuing to evaluate how well the polymer withstands the fluctuating forces known as cyclic stress as well as their durability in the face of environmental extremes, including hot and wet conditions.

Industrial challenges also lie ahead.

"Companies around the world are getting better at making large quantities of these sorts of materials," says Wardle, who founded N12 Technologies Inc. of Cambridge, Massachusetts, to address the problem. "But more work is needed."

When these materials can be produced in bulk, they will help make airplanes lighter and stronger, says Guzman de Villoria, the postdoctoral researcher who now works at the Madrid Institute for Advanced Studies of Materials. Composites make up more than 50 percent of the weight of new planes. If the bond between composite layers is stronger, aircraft designers will be able to rely even more heavily on composites, which could lead to lighter weight aircraft that use less fuel and emit less pollution, Guzman de Villoria says.

Initially, the nanotube stitches may fly in unmanned aircraft.

"In much the same way composites made their way into aircraft, carbon nanoscale stitches will make their way into commercial and military aircraft in secondary and tertiary structures, such as cargo bay doors, hatches and flaps," Wardle says. ★

Fly by Voice

Voice-controlled cockpits promise many advantages, including shorter task times for pilots and enhanced situational awareness. The challenge is to develop software sophisticated and accurate enough to cope with noisy flight decks, varying accents and speech patterns, or muffled voices behind emergency masks. Michael Peck reports on how researchers at Rockwell Collins are refining their algorithms.

By Michael Peck | michael.peck1@gmail.com | @Mipeck1

You can tell Siri to draft a text message or dial a phone number, so shouldn't the pilot of a Cessna or a Boeing 777 be able to command his or her plane in a similar manner? That was the question a research team from the Rockwell Collins Advanced Technology Center in Cedar Rapids, Iowa, set out to address nearly a decade ago.

If the technology can be proven and brought to market, it could be useful for both commercial and general aviation. Rockwell Collins has flight-tested speech recognition to verify that it works with cockpit avionics. Next, it must show that the software recognizes the myriad tones, cadences and accents of human speech, and do that more accurately than Siri or similar software in a noisy cockpit and in emergencies. Saying, "the cow jumped over the moon" and having it appear on the screen as "the corn lumped the room" won't fly for aviation applications.

Geoffrey Shapiro, a senior engineering manager at Rockwell, estimates that voice recognition can shave up to 75 percent off the time required to complete such cockpit tasks as changing altitude, speed and heading, as well as tuning a radio or displaying charts.

"Anything we can do to reduce the amount of time needed to complete a task will benefit flight crew," Shapiro says.

Another benefit of a voice-controlled cockpit is better situational awareness. Speech recognition can function as a sort of verbal head-up display so that a pilot can keep his or her eyes on what's going on outside the cockpit and focus on tasks such as avoiding another aircraft, rather than diverting his or her eyes to the instrument panel to activate the controls.

"With speech recognition, you don't necessarily need to look down at the avionics to control them," Shapiro says. "You can be looking out the windscreen for traffic, and push the button to recognize your voice and turn left heading

▲ **Tim Wittkop, a senior software engineer** at the Rockwell Collins Advanced Technology Center, speaks to an avionics simulator to show how pilots might someday control their planes by voice.

Rockwell Collins

258. And you hear the voice in your ear repeating, 'heading 258.'"

Shapiro describes the process as essentially working like this: The pilot says, "Turn left heading 340." The speech is picked up by a microphone. Algorithms in the avionics computers compare the words against a preprogrammed list of commands, and choose the command that best matches the pilot's words. Those are then converted into a machine language that the avionics can recognize. In turn, that command is sent to a central routing application that routes it to the correct avionics subsystem, in this case the primary flight display application. The aircraft then turns to the desired heading.

As with their automobile-based counterparts, aviation voice recognition systems also keep the pilot's hands on the controls instead of pushing buttons. Shapiro notes that this is particularly useful for helicopter pilots who need to fly with their hands on the stick.

As smartphone users can attest, voice recognition can also assist with navigation. Rather than drilling down through a series of touchscreen menus or leafing through papers to find a chart of a specific area, a pilot can call up that exact chart needed by issuing a specific command like, "Display Cedar Rapids Iowa ILS 9 chart."

Noise hurdles

The biggest hurdle by far for cockpit voice recognition is noise.

"For an aircraft, the engines can be turboprops, which are loud," Shapiro says. "Or if you are going fast, you can have a lot of windscreen noise."

The issue isn't so much decibel level as the sound frequency of the background noise. "It's not just that one aircraft is louder," Shapiro explains. "It's the frequency that reaches the mic. The closer this is to the frequency that humans speak on, the more conflict there is."

So, Shapiro's team is using individualized speech recognition algorithms tailored to the noise characteristics of specific aircraft. Users of word processing software such as Dragon Naturally Speaking already do something similar when installing the product on their computers: The software asks them to read a few paragraphs into the microphone, while the software adjusts to the user's voice and microphone quality. Also like Siri or word processors, cockpit voice recognition must be linguistically flexible to recognize commands spoken in multiple languages. Not surprisingly, given that English is the *lingua franca* of aviation, Shapiro is focusing on English spoken in a variety of accents, though the technology can work with other languages.

Among the unique challenges for aviation is that a pilot would need the ability to communicate with his or her plane in an emergency, such as depressurization. Testing in cockpit simulators revealed other issues. Shapiro had to adjust the software to recognize the tonal qualities of a voice muffled by an emergency oxygen mask. With speech recognition, pilots can focus on responding to an emergency, say by looking out the window to see what's going on, rather than having to look down at their instrument panels to change course or speed. On the other hand, human voices change under stress, and speech recognition software needs to understand commands uttered under hectic circumstances. Shapiro says that even if a pilot were to become incapacitated, the system will respond to crew members speaking the proper commands.

Software controlling an aircraft would need to be much more reliable than software controlling an iPhone.

"If Siri gets it wrong, you can take a moment to fix it," Shapiro says. In aviation, no. It has to work in all noise conditions, with all accents."

So, Shapiro needed to add a confirmation function for safety-critical actions such as changes in speed or course.

"We found early that this is an essential element," he says. "Speech recognition is very good, but not 100 percent."

How pilots want to receive that confirmation varies with the type of aircraft. Shapiro says air transport pilots have told him they are accustomed to flying with a sterile cockpit with no small talk. Rather than the speech recognition software repeating voice commands, they would rather the confirmation signal be an aural tone. On the other hand, helicopter pilots prefer voice confirmation.

"They said, 'I am a single pilot. I have my head out looking around. I don't want to look at my displays. I just want to hear the command and execute,'" Shapiro says.

Software coding

When it comes to writing the code for the software, it's critical to create software flexible enough to interpret the language and commands based on context, says Timothy Wittkop, a Rockwell senior software engineer who works with Shapiro on voice recognition. Software coders also need to talk with a variety of avionics experts who can guide them on ensuring that the various avionic subsystems respond to voice command.

"It is not possible for one person to know the intricate details of every subsystem in the avionics," Wittkop says.

Shapiro also cautions that voice recognition isn't practical for all cockpit tasks, such as centering on the correct region of a map.

"For panning a map, touchscreens just work better," he explains. "I can just flick my finger. With speech recognition, it's 'pan left, pan left, more pan left.'"

"We don't think speech recognition will be the only tool pilots will use," Shapiro adds.

As exciting as the technology is, at this point, Rockwell Collins doesn't know when the voice-command technology might be brought to the market. What will likely be the most persistent hurdle is old-fashioned resistance to change.

"Some folks aren't comfortable with speech recognition," Shapiro says. "It's more of a personal preference than a logical limitation." ★

Taming NextGen

In April, Jim Eck became the FAA's assistant administrator for the Next Generation Air Transportation System, which is without a doubt one of the country's most challenging infrastructure modernization efforts. NextGen is a panoply of programs that over time are intended to revamp the U.S. air traffic system into one based on modern networking technologies and GPS. Eck is responsible for rolling all this out efficiently. His predecessor, retired Air Force Maj. Gen. Ed Bolton, was brought in from the outside to inject fresh management rigor over the sprawling initiative. In contrast, Eck is FAA through and through. He joined the agency in 1996 and most recently was vice president for program management in the FAA's Air Traffic Organization unit.

I spoke with him in his Washington, D.C., office and in a follow-up telephone call. – *Ben Iannotta*

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See the full transcript for discussions about cybersecurity, drones and more.

JIM ECK

AGE: 59

EDUCATION:
Bachelor of science degree in electrical engineering from Penn State and a master's in systems engineering from the University of Pennsylvania.

NOTABLE:
Spent the first 18 years of his career as a civilian engineer working for the U.S. Navy on aircraft programs such as the F-14 and the E-2 Hawkeye, with a special focus on command, control and communications. Joined FAA in 1996.

RESIDES: Vienna, Virginia

Evangelizing about NextGen

We've come a long way in the last couple years at getting the message out, but it's pretty much a continual process. We've got a Hill Day coming up with both House and Senate. NextGen's been on a pretty good path from its inception. I think we haven't advertised quite well enough that NextGen had pretty strong roots in the aviation community for a long time. I'm trying to make sure that the path that we're on is robust and it stays on target.

Capitalizing on tech trends

When you talk about things like big data and analytics, we're looking at how can we take advantage of that in the cockpit, in the operations centers at the airlines, and in the FAA itself in a data sharing arrangement where it's not just controllers getting information and making decisions anymore. It's controllers, pilots, airline operations, our command center and our traffic-management units all collectively working off the same common data set and the same common operational picture. And then making collective decisions about: "Okay, this route of flight is affected by this weather pattern or this other event in the systems."

Air crews would like opportunities to be part of that decision-making process, so a lot of research is going into getting more information to them for data visualization. How can you get it to them in a format that they can easily understand, digest and do something about? So there's a lot of display technology going into that as well.

DataComm — explained

DataComm is going into 56 towers by the end of the year. We've got 39 of them installed already. I believe we're going to make the end of the year.

[DataComm] is truly a microcosm of the bigger NextGen initiative. It's a transformational technology in the sense that, prior to Data Comm, the entire system [was] based on a controller talking to pilots, and then independently talking to the airline operating centers, and independently working with the en-route facilities trying to coordinate the departure of a particular aircraft. With DataComm, everybody gets the same information at the same time about when that aircraft is preparing to depart. And then if there is a weather change, that aircraft can immediately get a predeparture re-route, which in voice communications can take several minutes, and therefore slow down the ability of that aircraft to leave, and therefore reduce the opportunity for it to leave if that weather front's moving too quickly. With data communications that can happen instantly.

Turbulence prediction

There are lots of different mechanisms for turbulence: convective weather, movement of air over mountain ranges, the jet stream itself. So we're trying to look at data collection mechanisms. Right now, it's primarily pilots talking to air traffic reporting the situation in a particular piece of sky at a particular time. If you get a preponderance of those kinds of things you could develop a notion of what's going on in that area, and then controllers can move people in altitude. But what we're looking for is a mechanism by which you could have a sensor capability on the aircraft itself and [collect data on] winds aloft and other parameters. So there is research going on right now looking at how to aggregate that kind of information and then disseminate it from an automated perspective.

Staying on top of NextGen

It's a challenge, but we have a variety of ways in which we gather data to make decisions, and then to gather data to ensure that what we're working on is actually not only the right stuff, but is being well managed. We have program reviews that happen every other week, multiple hours at a time. Not all programs are reviewed every other week, but the major efforts are reviewed several times a year by all the stakeholders in the process. So, you've got our folks from NextGen; folks from finance; the Program Management Organization that hosts the meetings; our safety organizations; and our Technical Operations and Air Traffic Organizations; the operations people who are all at the director level get represented.

Drones

We have a strategic partnership with NASA that's rather important in aviation research and specifically to the UAS traffic management system. We'll use that to help the UAS community evolve. Remember, we are talking about low altitude operations, so under 400 feet. We're, talking about the small UAS world in uncontrolled airspace. It's uncontrolled today because we deemed that it's okay to do so, given the level of activity in that airspace now. As the community matures and they want to start conducting beyond line-of-sight operations, or extended operations over people and integrate into airspace where manned aircraft are flying, now the [UAS system] cannot operate in a vacuum. It needs to operate in concert with the systems that we use to control commercial airliners and GA traffic flying in and out of our larger airports.

Surprising lesson

One thing I hadn't anticipated in college, and they don't teach you is, how often you spend explaining to people what you're doing and why you're doing it. Much of those kinds of skills come into play in trying to be a successful engineer, and being a successful program manager, and then ultimately how to be a successful leader. ★

Honoring Achievement: An AIAA Tradition

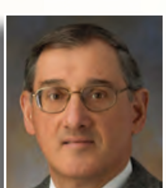
AIAA is proud to recognize the very best in our industry: those individuals and teams who have taken aerospace technology to the next level … who have advanced the quality and depth of the aerospace profession … who have leveraged their aerospace knowledge for the benefit of society. Their achievements have inspired us to dream and to explore new frontiers.

We celebrate our industry's discoveries and achievements from the small but brilliantly simple innovations that affect everyday lives to the major discoveries and missions that fuel our collective human drive to explore and accomplish amazing things. For over 75 years, AIAA has been a champion to make sure that aerospace professionals are recognized for their contributions.

AIAA congratulates the following individuals and teams who were recognized from July 2016 to September 2016.

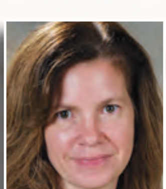
Aerospace Communications Award
Christopher Hoeber
Satellite Industry Consultant
SSL (retired)
Los Altos, California

Aerospace Power Systems Award
Henry Brandhorst
Managing Director
Aliquippa Holdings, LLC and CHZ Tech, LLC
Auburn, Alabama



Air Breathing Propulsion Award
Wesley Lord
Technical Fellow, System Architecture Functional Design
Pratt & Whitney
East Hartford, Connecticut

Energy Systems Award
Ronald K. Hanson
Clarence J. and Patricia R. Woodard Professor of Mechanical Engineering
Stanford University
Stanford, California



Engineer of the Year Award
Robin J. Osborne
Senior Mechanical Engineer
ERC, Inc./Jacobs-ESSSA Group
Combustion Devices Design and Development Branch
NASA Marshall Space Flight Center
Huntsville, Alabama

F. E. Newbold V/STOL Award
Paul Shumpert
Engineering Consultant (retired)
Lockheed Martin Advanced Development Projects
Marietta, Georgia

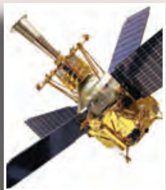
George M. Low Space Transportation Award
Blue Origin New Shepard Team
Kent, Washington

Haley Space Flight Award
James S. Voss
Scholar In Residence
Aerospace Engineering Sciences Department
University of Colorado Boulder
Boulder, Colorado

Jeffries Aerospace Medicine and Life Sciences Research Award
Robert J. Ferl
Director, Interdisciplinary Center for Biotechnology Research
University of Florida
Gainesville, Florida

Propellants and Combustion Award
Ahmed F. Ghoniem
Ronald C. Crane (1972) Professor, Mechanical Engineering
Massachusetts Institute of Technology
Cambridge, Massachusetts

If you need further information about the AIAA Honors and Awards Program, please visit www.aiaa.org or contact Carol Stewart, 703.264.7538 or carols@aiaa.org



Space Science Award
Gravity Probe B Team
Stanford, California
Award to be accepted by C. W. Francis Everitt, Principal Investigator

Space Systems Award
Cygnus Program
Orbital ATK Space Systems Group
Dulles, Virginia
Award Accepted By Frank DeMauro, Vice President and General Manager of the Advanced Programs Division

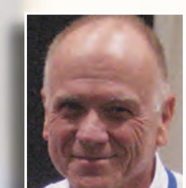
Sustained Service Award
Sanjay Garg
Chief, Intelligent Control and Autonomy Branch
NASA Glenn Research Center
Cleveland, Ohio

Sustained Service Award
Joseph C. (Joe) Majdalani
Auburn Alumni Engineering Council Endowed Professor and Chair, Department of Aerospace Engineering, Auburn University
Auburn, Alabama

von Braun Award for Excellence in Space Program Management
Todd A. May
Director
NASA Marshall Space Flight Center
Huntsville, Alabama

von Kármán Lectureship in Astronautics
Vigor Yang
Chair, Daniel Guggenheim School of Aerospace Engineering and William R. T. Oakes Professor
Georgia Institute of Technology
Atlanta, Georgia

Yvonne C. Brill Lectureship in Aerospace Engineering
Wanda M. Austin
President and CEO
The Aerospace Corporation
El Segundo, California



Wyld Propulsion Award
Gary A. Flandro
Boling Chair of Excellence in Mechanical and Aerospace, Engineering (emeritus), University of Tennessee Space Institute
Chief Engineer, Gloyer-Taylor Laboratories
Tullahoma, Tennessee

Thank You, Nominators!
AIAA appreciates your time and effort in preparing the nomination package!

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THE **BUZZ** OVER BATTERI

Despite ultimate limitations, battery technology still has much to yield for increasingly efficient aircraft. Keith Button reports on advanced battery types that could double or even treble the energy storage of today's counterparts, or enable more efficient airplane designs.

The idea of reconceiving the modern airliner to incorporate battery propulsion was all the rage just a few years ago. Boeing in 2010 released conceptual drawings for a 154-passenger hybrid airliner, dubbed SUGAR-Volt, for Subsonic Ultra-Green Aircraft Research, that by 2035 would be powered partly by batteries. Airbus and Rolls Royce followed two years later with the drawing of the 2050 version of E-Thrust — a hybrid electric 70- to 100-passenger regional airliner to be propelled by six electric engines. The concepts were premised on hoped-for revolutionary advances in battery technology that would help airplanes move down the path to reduced carbon emissions.

Then came a NASA advisory committee of aerospace experts, which in May declared that battery-powered regional passenger aircraft are unlikely to fly within 30 years. Even before release of the report, "Commercial Aircraft Propulsion and Energy Systems NASA Research," battery technologists and aerospace engineers agreed that fundamental science imposes an ultimate ceiling on the energy capacity of batteries, and that powering large jets (defined as 300 passengers) solely with batteries would not be in the cards.

Even so, researchers say they have yet to reach the full potential of batteries for airplanes, and they predict a doubling or even tripling of energy storage compared to today's versions. If they are right, batteries could still replace jet fuel for some applications and certainly supplement it. New design opportunities would be opened for improved energy efficiency.

One line of research would create a new class of batteries — rechargeable lithium metal batteries — capable of storing much more electrical power for their weight than current batteries, and also of discharging that power quickly. Future advances in battery technology will likely come from research that is focused on more financially lucrative potential applications outside of airplane propulsion, such as automobiles and consumer products. In the meantime, airplane designers will have to prove the reliability and performance of hybrid-electric propulsion — jet-fuel-fired generators powering electric motor propulsion to replace or augment traditionally fueled airplane turbine propulsion — applied to larger and larger aircraft.

The 123-page report says that battery-aided and battery-only propulsion shouldn't be a high priority for researchers aiming to curb airplane emissions. One reason, according to the committee: Battery technology won't be developed enough over the next 30 years to meet FAA certification criteria for regional passenger planes. Another reason: Reduction in emissions from using the batteries could be offset by an increase in emissions by the power plants that generate electricity for the batteries.

Batteries also lag conventional jet fuels in terms of energy density, a measure of potential energy per mass. Jet A, the standard kerosene fuel for commercial and military aircraft, has an energy density of 12,000 watt-hours per kilogram. The most advanced aviation batteries such as those powering small drones, have an energy density of 500 watt-hours per kilogram. Even after accounting for the fact that about two-thirds of jet fuel is lost as heat, fossil fuel still is six to eight times more energy dense than the most advanced batteries currently available.

The report findings didn't quash any existing airplane battery research, but actually helped clarify the place batteries have in the development of electric propulsion for airplanes, says James Felder, an aerospace engineer at the NASA Glenn Research Center in Cleveland who develops next-generation electric propulsion concept aircraft for NASA.

"It went over, actually, very well. We've struggled to make clear that batteries have to advance far beyond what they can do today to play even a support role in larger aircraft," Felder says. "I don't think it was in any way a 'You're going in the wrong direction; you need to go in another direction.'"

The focus of electric airplane research should be on turbo-electrical propulsion — or onboard electric power generated by jet-fuel-fired generators, which could be feasible within 30 years for single-aisle passenger aircraft, according to the report. Turbo-electric propulsion combined with distributed propulsion — placing propellers at various locations on an airplane — and boundary layer ingestion, or moving the air currents that travel along the surface of an airplane, could cut fuel consumption by more than 20 percent for large commercial planes.

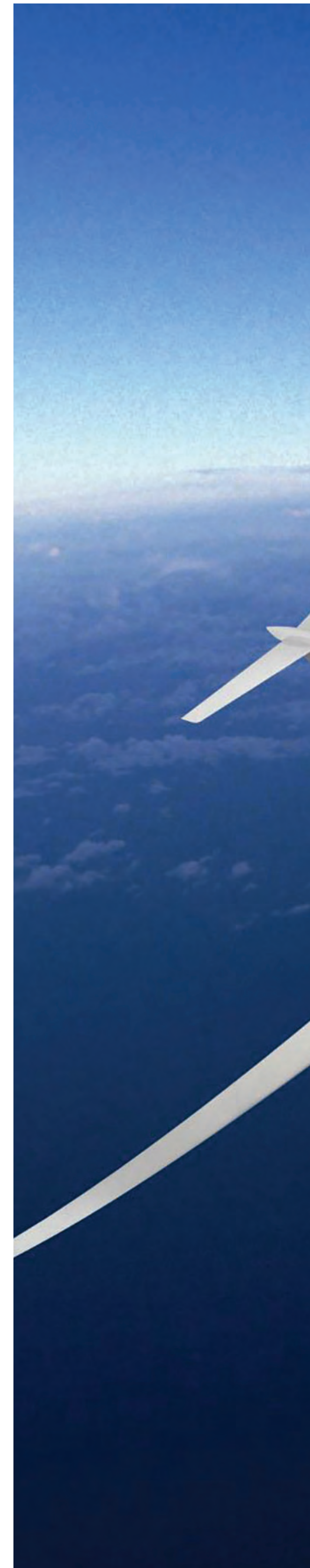
"The batteries, we de-emphasized quite a long time ago," Felder says. "We've never really had it in our plan to develop those batteries ourselves. The intent was always to leverage off of advancements that were being made for other applications, such as cars."

If advanced battery technology under development comes to fruition, then it can be easily slotted into electric systems under development with turbo-electric research, including research into lightweight motors and generators, Felder says.

Most batteries supplying power to electric airplanes under development currently provide about 200 watt-hours per kilogram, Felder says. Jumping to battery energy densities of 1,500 or 2,000 watt-hours per kilogram, their theoretical limits, likely would require radical new concepts for battery materials. Much of the weight of a battery comes from its electrodes, so one idea envisioned by battery developers would be to make the air from the atmosphere serve as the positive electrode, or cathode.

▼ **Lithium batteries already** can power a one-or two-seat aircraft for an hour-long flight. The two-seat trainer Alpha Electro, built by Pipistrel of Slovenia, is one such example.

Pipistrel



NASA/The Boeing Company

The Subsonic Ultra Green Aircraft Research airplane: Boeing unveiled the concept for a partly battery-powered 154-seat airliner dubbed SUGAR Volt in 2010, when battery propulsion for aviation seemed full of potential. In May, a report from a NASA advisory group concluded that battery-powered regional jets are unlikely to fly within 30 years.

Batteries can have low carbon footprints, but only if they are recharged with electricity generated by environmentally friendly sources, Felder says. As with turbo-electrical propulsion, advanced batteries in the future could allow aircraft designers to create more fuel-efficient aerodynamic shapes or propulsion systems. For instance, battery-powered electric motors can turn any sized propellers or fans located on the wings or fuselage to minimize drag and maximize lift, called distributed propulsion. Likewise, supplemental battery power means conventional jet engines don't have to be designed for maximum thrust, saving weight and boosting fuel efficiency.

By contrast, battery-powered electric motors and propellers can be small and light enough that they could be positioned at multiple locations, and their power source can be at another location in the airplane, connected by wires. Designers could choose wing shapes and propeller locations that minimize drag and maximize lift.

Even if it's not possible to propel a plane entirely by battery, supplemental battery power could alleviate the need to design jet engines for maximum thrust. This would save weight and boost fuel efficiency.

"The electricity is always a means to an end. It's never an end to itself," Felder says. Electric propulsion "has fundamentally opened the design space. We don't really know where it's actually going to go. We just know that we have more options than we've ever had before."

Next-generation batteries

For battery companies, such as SolidEnergy Systems in Waltham, Massachusetts, the initial goal is incremental improvement rather than a revolutionary breakthrough. SolidEnergy is developing a new class of batteries for drones that would combine the advantages of each of the two current types of aviation batteries.

Non-rechargeable lithium batteries must be discarded after they lose their charge. Often made of lithium thionyl chloride, their advantage is that they have high energy densities, says Qichao Hu, SolidEnergy's chief executive. Other planes fly with rechargeable lithium ion batteries. These are heavier and lower energy density, but are attractive nonetheless. For one, they don't have to be replaced after a single use, but even more importantly, they score high on another critical metric: Power density. That's the term for how quickly a battery releases energy, something an airplane battery has to do fast for takeoffs and other high-speed applications.

New batteries developed by Hu's company have both high energy density and power density. They can provide 500 watt-hours per kilogram, compared to 100 to 150 for rechargeable aviation batteries, Hu says. Lab tests show that the "new lithium metal batteries," as the company calls them, can discharge their full power in 10 to 15 minutes, blisteringly quick compared to the 10 hours typical of primary batteries.

The difference is in the electrodes and the separator, or electrolyte, between the electrodes Hu explains. Inside a primary lithium battery, the anode or negative electrode consists of lithium, the lightest metal on the periodic table, which makes them lightweight and energy dense. In contrast, the anode in lithium ion batteries consists of a substitute for the lithium metal, typically a graphite or a graphite-silicon composite.

SolidEnergy's new batteries are designed to have a thin layer of lithium metal as the negative electrode, and typically sulfur for the cathode, or positive side. The batteries can be recharged 100 to 300 times; Hu says they could triple the flight time of battery-powered drones.

Then there is the battery's electrolyte, the material between the positive and negative electrodes. Lithium metal is very reactive, so designers need an electrolyte that is stable on lithium metal and also safe, which typically means it would have to be a solid material. But to maximize energy density, the electrolyte should be liquid. Making an electrolyte with solid and liquid properties was very challenging, says Hu, who declined to reveal how his company solved that problem, or what the electrolyte ingredients are in his new batteries.

Fundamental science dictates the ultimate limits for battery density. In theory, a battery could be created that used lithium, the lightest metal and therefore most energy-dense material that would work as an anode, and lithium oxygen — also called lithium air — from the atmosphere as the cathode, Hu says. Such a design would make the battery like a fuel cell or internal combustion engine. But the battery could never have the same energy density of a hydrocarbon fuel that is burned to release its energy, because a battery by definition leaves something behind for the next cycle.

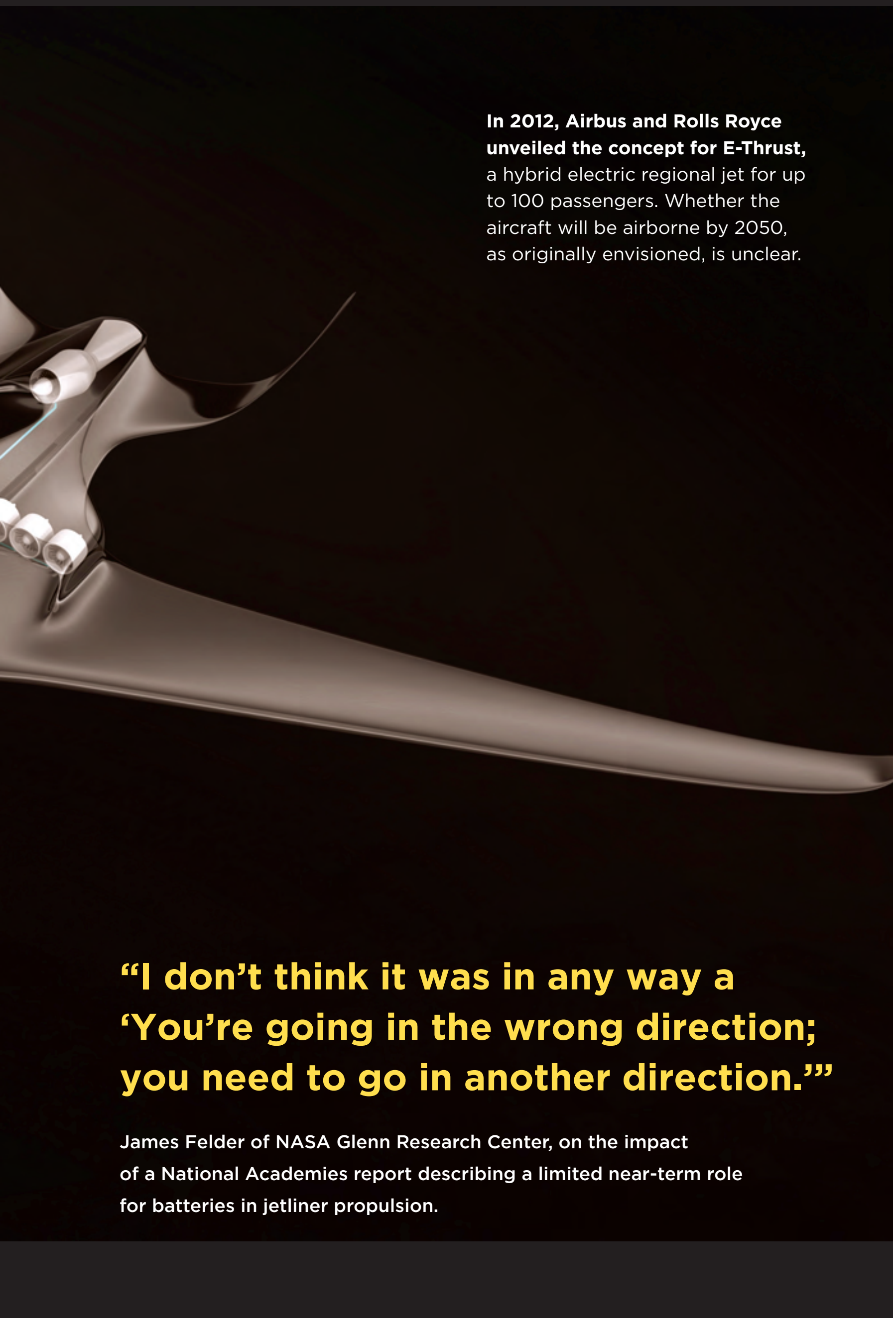
One problem for a lithium oxygen battery is that moisture, carbon dioxide, nitrogen and other gases in the air would have to be separated from the oxygen. Another factor complicating the theoretical battery would be its solid conductive framework working with a liquid electrolyte and with a gas on the cathode side.

"If you want to have lithium metal, which is a very delicate, sensitive material, in contact with all of the junk in the air, then it's just really hard to make that work," Hu says. "Practically, there are a lot of technical challenges and even fundamental science limitations that are preventing this."

Battery-aided design

Engineers anticipate batteries making a propulsion contribution along a continuum, from providing all or most of the power for small planes

NASA



Airbus

In 2012, Airbus and Rolls Royce unveiled the concept for E-Thrust, a hybrid electric regional jet for up to 100 passengers. Whether the aircraft will be airborne by 2050, as originally envisioned, is unclear.

"I don't think it was in any way a 'You're going in the wrong direction; you need to go in another direction.'"

James Felder of NASA Glenn Research Center, on the impact of a National Academies report describing a limited near-term role for batteries in jetliner propulsion.

◀ **NASA's N3-X concept:** Batteries aren't the only way to supply electricity for propulsion. Gas-turbine generators on the wingtips of NASA's envisioned hybrid airliner would supply power to superconducting electric motors that would drive fans.

to contributing power in a hybrid arrangement for large planes.

Even today, currently available lithium batteries could power one-to-two-seat aircraft from 160 to 240 kilometers, which equates to about an hour of flight time, says NASA's Felder. As an example, he cites the two-seat Alpha Electro, a trainer made by Pipistrel of Slovenia.

In the near future, battery powered airplanes will be popular in the one or two-seat recreational airplane market, particularly in Europe, where airports typically have to comply with community noise restrictions, predicts Stefan Gehrmann, managing director and founder of Air Energy of Aachen, Germany, a maker of lithium ion batteries for small planes and solar aircraft.

Felder calculates that in the near future batteries with improved energy densities of 300 to 400 watt-hours per kilogram could propel a nine-seat airplane for a flight of 280 to 370 kilometers.

For airplanes of all sizes, batteries could augment conventionally fueled generators that would supply electricity to motors that spin propellers. The batteries and a generator or generators could run simultaneously in a "range extender" setup. In this design, the generator would run constantly during flight, while the batteries would supply a small amount of power during cruise conditions and a larger amount during periods of flight that demand extra power, such as during takeoffs and landings.

In 2010, Boeing had batteries apply electric power to a turbine jet engine to help the engine spin the shaft attached to the fan that propelled the aircraft. The tests were conducted in the NASA-funded SUGAR Volt program. With this battery assistance, turbine designers can explore the possibility of shaving off the peak thrust requirements so the engine can be sized for cruise, where it spends most of its time, Felder says. Engines without battery assistance must be designed to deliver maximum thrust for takeoffs.

As the second year of follow-up studies to the SUGAR Volt study wrap up, researchers from UTRC, Pratt and Whitney, and Rolls Royce are finding that currently available batteries — at 200 watt hours per kilogram — can augment typical propulsion and save overall energy consumption for the aircraft, Felder says. Researchers are also running scenarios for peak-shaving, or using battery power to augment jet-fuel-fired engines at takeoff, with batteries that currently don't exist — at 750 and 1000 watt-hours per kilogram.

But batteries show a diminishing return as airplanes get larger, with the limit for pure-electric battery powered aircraft at 9 to 19 seats with a 370-kilometer range. For airplanes in the 100- to 150-seat size range, batteries could augment traditionally fueled aircraft.

Airbus and Rolls Royce drew up the E-Airbus in 2013. E-Thrust would be powered by a single turbine engine driving an electric generator supplying electric power to six fans embedded in the wings. A large battery pack would act as the back-up power supply — for flying the plane to safety if the turbine breaks down — as well as providing extra power needed for takeoff. As NASA's Felder puts it: "If everything fails, you're not a glider."

For electric and hybrid-electric airplanes larger than the E-Thrust — in the Boeing 737-and-larger categories — batteries would play a support role, supplying up to 10 percent of the total energy required to power the airplane. Doing more would require a radical breakthrough in battery technology — a lithium air battery that immediately delivers the maximum energy and power densities possible with batteries, for example. But even for an electric airplane in which conventionally fueled turbine generators supplied the lion's share of the propulsive power, batteries would have an important role. They would stabilize the power level in the electrical grid between generator and propeller motor power, like the function of a spring in a mechanical system. Without batteries and an electric controller, the grid would be rigid, which can lead to oversupply or undersupply of electric power and the harmful effects of brownouts or surges.

Batteries would play such a role in the N3-X, a 300-passenger, 80-megawatt, distributed propulsion, hybrid-electric airplane envisioned by Felder and other NASA aerospace engineers. They came up with the concept in 2012 by anticipating the technologies that would be available 15 years into the future, such as motors and generators with superconductor materials with virtually no electrical resistance. The N3-X would have a range, speed and capacity comparable to the Boeing 777-200LR.

If scientists were to achieve a radical breakthrough in battery technology — designing batteries with energy densities of 1,500 or 2,000 watt-hours per kilogram, for example — that would be high enough for aircraft designers to create new designs specifically to take advantage of the batteries, Felder says. Even though that energy density level still wouldn't match jet fuel, battery-only airplanes could fly shorter flights — New York to St. Louis instead of New York to Los Angeles, for example. But at the 600 to 700 watt-hours per kilogram projections, the batteries aren't capable of taking larger passenger aircraft very far on their own.

"As these technologies in batteries and motors and power electronics improve, they can play a role," Felder says. "They may not be good enough for the N3-X 300-seat plane, but they might be good enough for a 50-seat regional. A little bit further on, and they might play a significant role in reducing fuel consumption in the 150-seat 737-class aircraft, which consume most of the aircraft fuel. If we can reduce fuel consumption there, then we take a bite out of the biggest segment of fuel use by all aircraft."

NASA's latest evolution of the N3-X concept — the STARC-ABL, for single-aisle turboelectric aircraft with aft boundary layer propulsion — has shown that with a single-aisle Class 800 737, with 150- to 180 passengers, a concept plane with partial turbo-electric propulsion can produce 7 percent to 12 percent fuel savings versus the same airplane with highly efficient typically fueled turbofans, Felder says. Even with advances in battery technology in the future, there is a barrier that technology advancements probably won't be able to cross because energy density cannot increase beyond a certain ceiling.

"As you go bigger, I think batteries are going to become less of a central player and more of an adjunct, or support player," Felder says.

Battery density has an ultimate density. In theory, a battery could be created that used lithium, the lightest metal and therefore most energy-dense material that would work as an anode, and lithium oxygen — also called lithium air — from the atmosphere as the cathode, Hu says. Such a design would make the battery like a fuel cell or internal combustion engine. But the battery could never have the same energy density as a hydrocarbon fuel that is burned to release its energy, because a battery by definition leaves something behind for the next cycle.

A factor complicating the theoretical battery would be its solid conductive framework working with a liquid electrolyte and with a gas on the cathode side.

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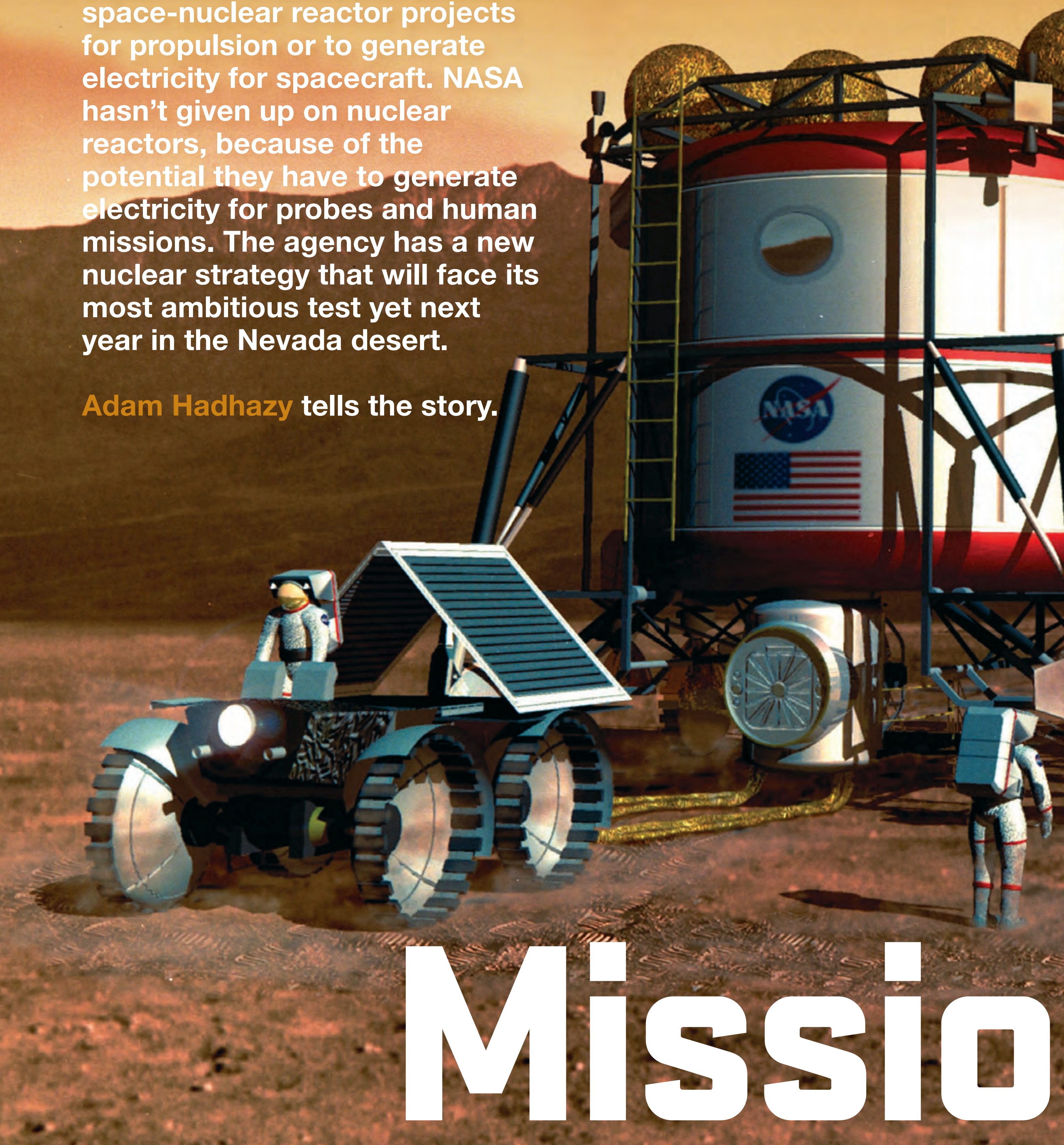
▼ **NASA's electric research plane**, christened X-57 "Maxwell" in June, is meant to be powered solely by batteries, and emit no carbon.

NASA Langley/Advanced Concepts Lab/Analytical Mechanics Associates

Since the 1960s, the U.S. has repeatedly started and folded space-nuclear reactor projects for propulsion or to generate electricity for spacecraft. NASA hasn't given up on nuclear reactors, because of the potential they have to generate electricity for probes and human missions. The agency has a new nuclear strategy that will face its most ambitious test yet next year in the Nevada desert.

Adam Hadhazy tells the story.



Missio

NASA

Sustained human presence on Mars could be enabled by the thousands of watts of electricity made available by nuclear fission reactors. NASA plans to test one in 2017.

n: Fission

Department of Energy

▲ **The 1965 flight of SNAP 10A**, the Systems Nuclear Auxiliary Power spacecraft, turned out to be the only time the U.S. orbited a fission reactor.

The future of human robotic space exploration might depend on a technology from the past: The nuclear fission reactor. Fueled by the element uranium, these reactors have produced energy commercially on terra firma since the 1950s, and currently supply a fifth of United States' electricity. Nevertheless, despite decades of on-and-off development across a litany of canceled NASA programs, fission has failed to break into the final frontier.

Its promise has long tantalized. For missions to deep space, fission could offer magnitudes more power than NASA's current workhorses: Solar cells and radioisotope thermoelectric generators. RTGs typically contain plutonium-238 pellets that passively emit enough heat to generate a few hundred watts of electricity — about as much as a kitchen blender requires. RTGs are handy when spacecraft are far from the sun, but mission planners must ration power for scientific payloads and limit data transmission rates, while relying on limited chemical fuel for spacecraft maneuvering.

Fission has been repeatedly doomed by prohibitive development costs and questions over the demand for power beyond tried-and-true solar and RTGs. Bucking this history, researchers now have high hopes for a new fission project, called Kilopower. Designers of the Kilopower reactor are testing components and finalizing plans for a kilowatt-level test in 2017, after demonstrating a small-scale version at the Nevada National Security Site, a Department of Energy facility near Las Vegas, in 2012. That lab experiment marked the first production of electricity from a space nuclear reactor by the U.S. since 1965's first, and only, flight of a reactor. The Soviet Union went on to use fission reactors in more than 30 reconnaissance satellites into the late 1980s, but the technology has otherwise remained grounded.

If Kilopower can break fission's losing streak, a robotic probe could someday land on Jupiter's moon Europa and have enough juice to drill into its icy crust to potential pocket pools of liquid near the surface. Another possibility: Human explorers could set up a fission-powered outpost on Mars to turn Martian air and dirt into rocket propellant for the return trip to Earth. NASA thinks it knows how to succeed this time, and the strategy has as much to do about management as technology.

"With Kilopower, we're starting small and keeping it simple and affordable," says NASA's Lee Mason, the principal technologist for power and energy storage at Glenn Research Center in Ohio. "Every time we've tried to deliver fission before we've started at a very aggressive, optimistic endpoint where we're trying to develop a pretty advanced, high-tech system."

This time, NASA has set modest power goals and is applying existing, regulatory-approved testing hardware and reactor architecture.

Should the 2017 test go well, Kilopower and its descendant reactors will still have hurdles to overcome before taking to space. Safety and nuclear proliferation concerns must be assuaged, funding lined up and, most importantly, NASA will need to greenlight costly, ambitious missions in dire need of kilowatt-levels of power.

Fission on the backburner

Fission for space began with a flourish. After NASA's inception in 1958, the agency worked with other federal entities on nuclear reactors for

NASA

▲ **Workers at NASA's Kennedy Space Center** install the radioisotope thermoelectric generator onto the New Horizons probe for its journey past Pluto. A fission reactor on a probe would be much more powerful than such RTGs.

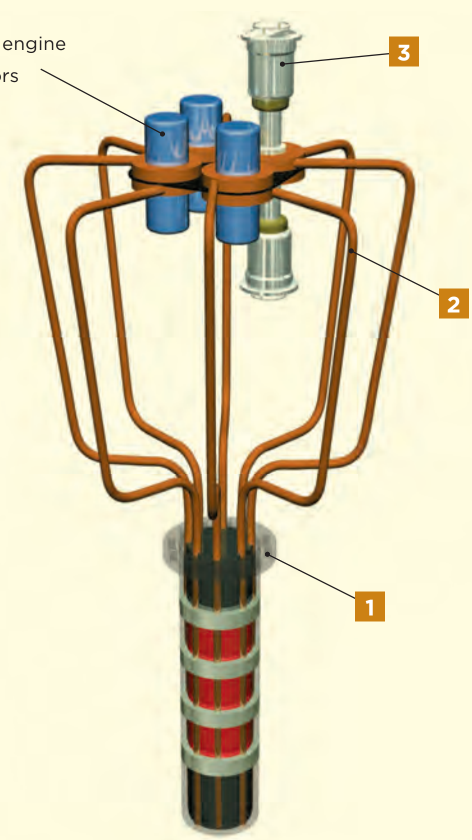
launch vehicles and space propulsion under the Nuclear Engine for Rocket Vehicle Applications, or NERVA, project. On the electricity front, the Systems Nuclear Auxiliary Power, or SNAP, effort culminated in the flight of the SNAP 10A spacecraft in 1965, the only fission reactor the U.S. has ever orbited. The satellite cranked out 590 watts, but stopped working 43 days after launch due to a non-reactor, voltage regulator issue. NASA abandoned SNAP in favor of well-understood chemical rockets for NASA's astronaut flights. RTGs, also developed in the SNAP program, offered sufficient electricity at lower cost than fission.

"Missions have typically required less than 500 watts electric, and at that power level, RTGs weigh less, and you're always trying to keep your mass down at launch," to cut down on costs, says John Casani, who retired in 2012 from NASA's Jet Propulsion Laboratory in Pasadena, California.

During his career, Casani served as project manager for the Voyager 1 and 2, Galileo and Cassini spacecraft, all of which relied on RTGs to take them to planets of the outer solar system (and in Voyager 1's case, all the way into interstellar space). RTGs have performed well on dozens of missions because they have no moving

Reactor setup

In the Kilopower test that NASA and the Energy Department plan to run in mid-2017, a uranium-fueled fission reactor **1** will produce heat carried by eight sodium heat pipes **2** to Stirling engines **3** which convert heat into electricity.



parts but an ability to provide heat and steady power even in the extreme cold and dark of space, or on the dim, dusty surface of Mars.

A renewed case for fission

The overall nuclear landscape has changed considerably since RTG's dominance was established. Availability of the isotope plutonium-238, once a byproduct of nuclear weapons production, plummeted after the element's domestic manufacture by the Department of Energy ended in 1988 with the Cold War's decline. In the 1990s, the U.S. government had to purchase plutonium for NASA's Cassini mission from Russia, at around $3 million a kilogram, according to Casani, though that pipeline has now also closed.

Supplies have therefore continued dwindling. Just 35 kilograms of plutonium are now on hand, and only about half meet the power specifications for slated missions, like the Mars 2020 rover. In a bind, NASA in 2012 started paying the Energy Department to restart plutonium production. The first 50 milligrams from the effort at the Oak Ridge National Laboratory in Tennessee were announced in November 2015, with the goal to ramp up to 1.5 to 2 kilograms per year by 2018. The cost to NASA is about $100 million annually, though, because the extraction, irradiation, and fabrication of the material that becomes plutonium-238 fuel pellets occur at three sites. Ultimately, NASA, which is the sole end user of the dangerous material, could end up paying perhaps $50 million per kilogram of plutonium for major missions launching in the 2030s, or $240 million for a standard, 4.8-kilogram plutonium, multi-mission RTG like the one in the Curiosity rover.

Given NASA's big bet on RTGs, the technology will likely remain a pillar for conventional, low-power space exploration for another couple decades. But Casani and others think that fission's time has finally come.

"Plutonium has outlived its usefulness for space," Casani said to an audience at the AIAA Propulsion and Energy Forum in Salt Lake City in July. "That's why I am so much in favor of fission-powered missions ... we need to get on to uranium."

Nuclear engineer Susan Voss put it like this: "We have a real driver in a way we never have had before, which is that the cost of plutonium has gone up too much."

Voss is president of the Global Nuclear Network Analysis, a consulting firm in Corvallis, Oregon. In the 1980s and the '90s, she worked on the American SP-100 fission project, mostly at Los Alamos, and served as project leader for the TOPAZ fission reactor projects with the Russians. She thinks that NASA will have to make the jump to fission, assuming a viable pathway is demonstrated at last. For every decade or so, another NASA fission project has sprung up, sputtered, and gotten the ax. The last such effort, a proposed 200-kilowatt propulsion concept called Prometheus, which Casani managed, succumbed in 2005.

▲ **Fusion test:** A researcher adjusts a heat pipe as it's inserted into the reactor core reflector (the dark hemisphere) in preparation for a 2012 ground experiment called DUFF, for the Demonstration Using Flattop Fissions. DUFF marked the first U.S. production of electricity by a fission reactor for space since the 1965 SNAP 10A mission.

Onward, Kilopower

This time around, Kilopower is not swinging for the fences. The project passed its initial test in 2012 in an experiment called DUFF, for Demonstration Using Flattop Fissions. (Flattop is one of the critical assembly machines at the Nevada National Security Site long used for testing nuclear material.) For the first time ever, a heat pipe (filled with water) transferred thermal energy from a uranium source to a Stirling engine for conversion to electricity. Inside a Stirling engine, a heat source of some kind warms gas inside a loop. The gas expands and pushes a piston as it flows by, then cools in a perpetuating, power-generating cycle. When the Stirling cycle was conceived in the 19th century, coal was the preferred heat source. DUFF split uranium atoms to yield a mere 24 watts, but it functioned smoothly and was cheap, with a tab of less than a million dollars.

The mid-2017 test will expand on DUFF, and has its own amusingly contrived acronym, KRUSTY, for Kilopower Reactor Using Stirling TechnologY. At the heart of KRUSTY will be a 30-kilogram, coffee cylinder-sized chunk of highly enriched uranium, about 93 percent uranium-235 and 7 percent molybdenum, made by the Y-12 plant in Oak Ridge, Tennessee. Instead of the horizontal Flattop, the core will be placed in a vertically oriented critical assembly stand, called Comet, to better accommodate additional components, such as eight heat pipes. These will be placed at the core's periphery and filled with sodium, which will vaporize and transport heat to two Stirling engines. Criticality will be induced in the uranium core by raising a beryllium reflector over the core to bounce back some neutrons into it, spurring a heat-producing, fission chain reaction.

For both DUFF and KRUSTY, NASA has so far budgeted around $10 million over three years — peanuts when compared to the $464 million NASA sunk into Prometheus over three years.

"One of the reasons [space fission projects] have died is because they have lasted too long and cost too much money," says Patrick McClure, the project lead for Kilopower at Los Alamos National Laboratory in New Mexico.

Fuel costs-wise, the highly enriched uranium would be nearly free, being just a sliver of the couple hundred metric tons in the existing government stockpile from dismantled nuclear warheads. Fashioning the uranium metal into a solid cast core costs only a few million dollars, McClure says. This kind of core is ideal for relatively low-energy reactors like Kilopower's because of trivial fuel burnup or volume swelling issues overthe core's intended lifespan. So, while it looks like a Kilopower-style power system will be inexpensive, McClure is quick to note that at this early stage, a price point for future reactors cannot be set.

Continued development and funding for Kilopower will hinge, at least in part, on a successful outcome in the Nevada desert next year. KRUSTY is set up to closely mimic the architecture of a potential flight system.

"If we get KRUSTY done, we're confident we can build a flight version," says David Poston, the lead reactor designer for Kilopower at Los Alamos National Laboratory.

The road ahead

The flight version would likely be geared for Mars, but scalable for a range of environments.

"We would like the Kilopower unit we develop for Mars to be versatile enough to use on the moon, if we decide to go that way, or deep space," says NASA's Mason.

Solar power can only do so much on the Red Planet. Many regions of astrobiological or resource interest, where subsurface ice can be found, are at higher, dimmer latitudes. The ballpark goal for a Mars surface reactor would be 10 kilowatts, about twice what the average American home uses. To obtain that output in a Kilopower-style device, more thermal energy must be pulled from the reactor, so heat pipes would plunge into its core and be bonded to the uranium itself, requiring further development work.

As for safety, the Kilopower reactors' uranium is inherently far less radioactive than the plutonium routinely shot into space.

"On the launch pad, it has very minimal radioactivity," says McClure. A fission reaction would not start, and radioactivity soar, until the mechanical removal of a boron carbide control rod from the core. "The reactor is not going to get turned on until it gets where we want it to, either deep space or Mars," says McClure.

Should the rod's removal somehow happen during a botched launch operation, the reflector necessary to maintain fission would surely be damaged as well; even a millimeter crack would let out enough neutrons to stop the chain reaction.

"If there is a launch pad accident, the reactor is not going to go critical," says Poston.

A greater concern is the fact that the highly enriched uranium in the reactor is nuclear weapons-grade material. In light of the rarity of such specialized missions launching perhaps once a decade for the foreseeable future, Voss — who worked in non-proliferation — grants that the advantages to space science with fission justifies uranium-235 as a fuel choice.

Perhaps fission's biggest obstacle, though, will be getting NASA and its Congressional budget-setters to commit to the grander sorts of missions kilowatt power enables. In Salt Lake City, Leonard Dudzinski, a veteran of Prometheus and now NASA's radioisotope power systems program manager, offered a bold prediction: "Space fission power is going to cause a revolution," he said. "It supports, by its nature, larger, more capable missions." The trouble is missions of that scope would be "unaffordable in our current budget environment." For now, NASA is seriously considering only "small, cheap" missions falling under 500 watts. Until budgets increase and space fission proves itself, "we're going to have to pay the bill for plutonium-238," he added.

For his part, Casani would rather see the money for plutonium production "plowed into the Kilopower system."

Expect to hear plenty more debate in the years ahead should Kilopower indeed establish a toehold for fission in the great beyond. ★

Thermoelectric workhorses

Twenty seven NASA spacecraft have gotten their power from 46 radioisotope thermoelectric generators. Among these spacecraft, the Cassini Saturn probe set the power-level record with three RTGs combining to deliver a shade under 900 watts. Other iconic missions fueled by RTGs include New Horizons, which cruised past Pluto in July 2015; the Viking Mars landers in the 1970s; and the Curiosity rover, still treading on the Red Planet.

Wanted: An ISR showdown

The U.S. pours billions of dollars into flying and sustaining two high-altitude intelligence, surveillance and reconnaissance fleets, the U-2s and Global Hawks. The Air Force knows that's not financially viable, so it plans to retire the U-2s in 2019 and keep the Global Hawks. Lockheed Martin has another idea. Keith Button looks at Lockheed Martin's bid to force change with a proposed aircraft called TR-X.

Lockheed Martin

▲ **Lockheed Martin** is asking the Air Force to consider replacing the U-2 and Global Hawk spy planes with the company's TR-X as a single successor high-altitude reconnaissance aircraft.

Sometimes when a stalemate lingers, one of the frustrated combatants demands closure with a head-to-head competition. And so it is when it comes to U.S. high-altitude ISR, short for intelligence, surveillance and reconnaissance. In hopes of ending the questions over the futures of the conventionally piloted U-2s and unmanned RQ-4 Global Hawks, Lockheed Martin earlier this year released a rendering of a proposed unmanned spy plane called the TR-X, which it has been working on at its Skunk Works unit in California since 2015.

Lockheed doesn't expect the Pentagon and Air Force to simply sign onto the TR-X proposal. The intent is to jar the U.S. acquisition system into squeezing development of a new high-altitude ISR plane into a crowded spending program of new bombers, air tankers and fighter planes, not immediately but within several years.

Specifically, Lockheed Martin wants the government to hold a competition to choose a successor to the Global Hawks and the U-2s. Lockheed Martin says it could build 30 TR-Xs for $3.8 billion by 2030 and it says this expenditure would make more sense than spending billions to maintain and improve the Global Hawks and improve their sensors to match the U-2s, which is the Air Force's current plan. Lockheed Martin has tailored its pitch to address the weaknesses it perceives in the Global Hawks, built by rival Northrop Grumman. By going unmanned like the Global Hawks, Lockheed Martin also plans to beat its own U-2s on endurance.

"It's a coherent path to get beyond the U-2 Global Hawk fight into a future platform," Lockheed Martin's J. Scott Winstead told reporters earlier this year. "We think we've got the best design because we're Skunks," he said, using a nickname for workers at the company's Skunk Works unit in Palmdale.

At stake is the ISR future of two aerospace giants, not to mention an answer to the long standing question of whether conventionally piloted planes or drone aircraft are best for delivering high-altitude eavesdropping data and imagery to commanders and intelligence analysts.

The Global Hawks got off to a difficult start when the Pentagon decided to transition the effort from a demonstration project into a manufacturing program without going through the normal requirements vetting and establishment process. Deliveries were late and budgets escalated. Intelligence professionals bemoaned the quality of the Global Hawk sensors compared to U-2s, and the Air Force barred them from flying in icing conditions.

Even so, it's unclear whether Lockheed Martin's pitch to apply Global Hawk funds toward a new aircraft will gain traction. The Air Force lauds the ability of the Global Hawks to stay up for longer than a day and appears committed to the upgrade plan.

Lockheed Martin provided a briefing on the TR-X proposal on the Hill, but a Senate staffer was unaware of any discussions or presentations of the idea by the Air Force or the Department of Defense.

"It sounds very interesting, but usually there needs to be some sort of interest in the [Department of Defense]. We're not that good at creating programs here," the staffer says.

The Air Force is remaining publicly neutral about the idea of an ISR competition and whether the TR-X has merit.

"The Air Force is always studying emerging technologies in concert with our industry partners and assessing what capabilities and operational effects will be required for future ops," the Air Force said in a statement in response to my questions about high altitude ISR.

As for the RQ-4 Global Hawks, the Air Force said it is "committed" to maintaining them as "the High-Altitude ISR Program of Record" through a modification program called the High-Altitude ISR Transition Plan, which it says will "ensure the viability of the program for the future."

The Air Force has made clear that it had to make a choice between continuing to fly the U-2s beyond 2019 or flying the RQ-4 Global Hawks.

"While both the U-2 and RQ-4 provide valuable high-altitude intelligence," the statement said, "fiscal constraints have necessitated the AF to dedicate resources to the sustainment of one program of record."

Northrop Grumman declined to discuss the potential for a new ISR plane.

The standoff

The U-2 fleet has a rich history, from monitoring Soviet missile sites during the Cold War to watching North Korea and mapping Afghanistan during the U.S. and allied occupation. Those and other operations have earned the U-2s many admirers among the Air Force brass and the intelligence community. Congress weighed in by passing a law in 2006 forbidding the Air Force from retiring any U-2s unless the secretary of defense certifies that the spy plane's ISR capabilities are no longer needed.

Winstead, a former U-2 pilot, said that when he started flying the airplane as an Air Force officer in 1995, he was informed that the spy plane was a "sunset" aircraft destined for retirement. The U-2 retirement date has been set re-

The U.S. Air Force says it plans to continue upgrading its Global Hawk fleet even as deliveries of the unmanned reconnaissance plane will end next year.

U.S. Air Force

Lockheed Martin

After 60 years, the U-2S Dragon Lady spy plane still has admirers in the intelligence community who oppose its retirement.

Gauging costs

Lockheed Martin says 30 TR-X spy planes would cost $3.8 billion. Here are other examples of what the U.S. spends on aerospace products:

- $379 billion for 2,457 variants of the F-35 for the Air Force, Marines and Navy
- $10 billion for 45 Global Hawks, 33 of which remain in the fleet
- $8.8 billion for the James Webb Space Telescope

Source: U.S. Government Accountability Office

peatedly and pushed back. The U-2s retirement date remains 2019, but some Pentagon watchers predict that the date will be extended yet again.

"Quite honestly, what's keeping us around is the capability and the fact that our [combatant commanders] are enjoying a higher capacity of ISR than they've ever received before, and that's resonating with Congress," Winstead said in the briefing to reporters.

The Global Hawk's edge is that it can stay aloft for about 36 hours; the U-2 can stay up for about 16 hours, but in practice about 10 hours, limited by the human pilot's endurance. The U-2 is also notoriously difficult to fly — its pilots need assistance from a pilot on the ground when landing because of visibility restrictions, and its glider-like design makes it difficult to set down. Also, pilots have to wear space suits, and pressurization malfunctions can lead to serious health problems from the bends, or decompression sickness.

Nevertheless, in the ISR community, the U-2 is revered for its adaptability, says retired Maj. Gen. James Poss, a former Air Force assistant deputy chief of staff for ISR.

"We always used to joke and call the U-2 Mr. Potato Head, and that's kind of what it was. You could rip the nose off and stick a completely different sensor in; you could transfer pods on both sides and put just about whatever you wanted into it," Poss explains.

Meanwhile, Northrop Grumman has been chipping away at the U-2 advantages by equipping Global Hawks with brackets so a variety of sensors can be swapped in or out, including two that previously were flown exclusively on U-2s. One is the Senior Year Electro-optical Reconnaissance System-2, a multispectral long-range camera. The other is the Optical Bar Camera, a film-camera famous for mapping Afghanistan for the U.S. and its allies during the war against the Taliban and the hunt for Osama bin Laden.

SYERS-2, made by UTC Aerospace Systems, is described by its maker as a "folding telescope" that creates high-resolution infrared images so that it can pierce the night and hazy or foggy conditions. A Global Hawk carried a SYERS-2 on an ISR mission earlier this year.

The film in the Optical Bar Camera, also built by UTC, is processed after landing. The camera has been flown on U-2s for nearly 50 years and has been highly valued for its ability to take pictures with extremely fine resolution and broad areas of coverage. An Optical Bar Camera may fly on a Global Hawk before the end of the year.

Not everyone sees the logic in the Pentagon's current path.

"Right now, they're spending literally billions of dollars shrinking all of the stuff on the U-2 to fit on the Global Hawk, to then can" — meaning retire — "the U-2," says Keven Gambold, chief executive of the Americas operations for Unmanned Experts, which advises companies on drone use.

Conceptualizing the TR-X

Lockheed Martin decided to start work toward a new spy plane after learning of the Air Force's plan to spend billions upgrading the Global Hawks to make them more like U-2s.

"Our engineers said: 'Gosh, for that kind of money, we could build a whole new fleet,'" Winstead said.

In 2015, Rob Weiss, general manager of Skunk Works, put his engineers to work on coming up with the concept for a new aircraft. After about five months, they produced the TR-X plan. Because the operational TR-X would rely heavily on existing technology, copying many features from the U-2, it could be developed, tested and fielded relatively quickly — in 10 years. As U-2s are taken out of service, many of their components could be reused in new TR-Xs.

Unlike the U-2s and Global Hawks, the TR-Xs would be refuelable and their shapes would be designed for stealth. Enemy radars would find it difficult to detect them, or at the very least they would be forced to expend more energy in the attempt. Each TR-X would carry any payload that U-2s and Global Hawks carry, and because of their open-mission system design, they could carry any sensors built to a non-proprietary software standard.

If maximum radar evasion were a priority, then for an additional cost, the TR-X could be modified to hide U-2 and Global Hawk antennas that would otherwise attach to the fuselage and create a radar signature. Designers could hide the nose sensors that TR-X would adopt from the U-2 or Global Hawk. Electronic radar evasion measures also could be added at a cost for wartime missions. The additional radar stealth measures could be fitted onto only some of the airplanes in the fleet to hold down costs.

About 90 percent of the payload systems from the U-2 and Global Hawk would be repurposed, and 80 percent of the TR-X's hardware would come from existing aircraft, Winstead says.

The TR-X would fly at 70,000 feet, allowing it to scan 480-kilometer segments of the ground; carry U-2-sized payloads of up to about 2,300 kilograms; carry a U-2-sized generator or bigger — U-2's is larger than Global Hawk's; and the data links carried by both aircraft. Like the U-2, it could carry both a multi-spectral imager and radar at the same time, which it could switch between if bad weather obstructed the multi-spectral imager.

The TR-X would also save money by having pilots control the planes from a common mission control center where other kinds of planes would also be flown.

Proposing a timeline

Lockheed Martin wants the Air Force to spend the first money on TR-X in fiscal 2020, and continue for 10 years until 30 of the new aircraft are fielded. It argues that building a new fleet would eliminate the need to someday improve and refurbish the Global Hawks, which it calculates would be required in about 2035.

"Do you want to look at extending the wings on the Global Hawk and a life extension there, or do you want to look at a next-generation platform? And that's what we think will resonate within the Air Force," Winstead told reporters.

A new spy plane with U-2-or-better capabilities would also make a definitive wind-down plan for the U-2, rather than keeping the costly plane flying and having to forgo relatively inexpensive upgrades because the plane is designated as a sunset system. The year-to-year U-2-vs.-Global-Hawk battle is hurting both programs, Winstead said.

Also, if and when the U-2s are finally retired, currently the only way the Air Force can get similar high-altitude ISR into the field is to produce more Global Hawks.

"Is that what you want to do for a platform that's a '90s design, that's only going to carry you into the 2030 timeframe?" Winstead asked. "Or do you go with something new?"

According to Poss, the retired Air Force major general, the company will have a tough time convincing the Air Force to spend money on a new project.

The Air Force has been clear that its spending priorities are the new B-21 stealth bombers that Northrop Grumman was chosen to build, as well as the Boeing KC-46 air tankers and the F-35As.

Whenever a new airplane is under development, even if it's based on existing technology, there's always risk with the technology, he says. Lockheed would have to prove that risk was pretty low, and prove that the new plane could take over seamlessly without losing ISR coverage ability in the transition.

The U-2 and Global Hawk aircraft play such an important role today that the Air Force cannot take any of them off line to free up money for their replacements, Poss says.

"The problem you're always going to come back to is: 'OK, it might be the best platform in America, but can you fit that with the existing program,'" he says. "If we're struggling to afford the existing program, how do you recapitalize and get a new program out of that money?"

If Lockheed can't have the TR-X funded through an existing program and can't ensure that the coverage of the currently fielded Global Hawks and U-2s continues uninterrupted, then it won't convince the Air Force to adopt the new concept, Poss predicts.

Lockheed Martin's Winstead said that a new spy plane, regardless of who builds it, will be the best way for the Air Force to solve its U-2-Global-Hawk dilemma, and it makes the most fiscal sense.

"Let's just establish a time frame," he said. "Let's establish a way ahead, and let us compete with Northrop Grumman. Let us compete with General Atomics, or Raytheon, or whoever else wants to grow the platform out." ★

Spying standoff

The Pentagon relies on two competing spy planes for high-altitude reconnaissance missions — and appears to be in no hurry to ditch either one.

The U-2, a single-pilot aircraft that first flew during the Cold War, can see farther and carry bigger payloads than the smaller RQ-4 Global Hawk. On the other hand, the Global Hawk, which is operated by pilots in ground stations, can stay aloft two or three times longer than the U-2.

U-2S Dragon Lady

Manufacturer:
Lockheed Martin
Wingspan:
31.4 meters
Maximum weight:
18,144 kilograms
Cruise speed:
764 kph
Payload:
2,268 kilograms
Ceiling: 70,000 feet
Range:
9,600 kilometers
Endurance:
16 hours (in practice, human pilots can fly about 10 hours at a stretch)

RQ-4 Global Hawk

Manufacturer:
Northrop Grumman
Wingspan:
39.9 meters
Maximum weight:
14,628 kilograms
Cruise speed:
574 kph
Payload:
1,360 kilograms
Ceiling: 60,000 feet
Range:
22,780 kilometers
Endurance: 36 hours

Doing no

An Airbus A320 operated by British low-cost carrier easyJet at Berlin's Schönefeld Airport. In the U.S., some low-fare airlines turn their planes around in as little as 15 minutes between flights. Such time pressure can make it more difficult to assure that ground-operations crew avoid accidents that could damage sensitive aircraft components.

harm

Airbus

As airlines and freight operators reduce the turnover time between flights, more must be done to ensure that ground personnel do not unwittingly damage aircraft. This will be especially true as some Airbus A320s are converted into freighters. Airport-operations expert Vahid Norouzalibeik examines the problem and suggests specific solutions.

Any plane at a passenger or freight terminal has delicate sensors and aerodynamic structures around which ground personnel must take care when operating equipment such as loaders. These areas include wings, flap track fairings, landing gear, engine cowlings, antennas and sensors. Among the most important features are the aircraft's angle of attack sensors, also called alpha probes. They calculate the angle between the direction in which a wing is pointed and the direction of the air flowing over it. If damage to an AOA sensor were to go undetected, the consequences could be fatal. In 2008, a leased XL Airways Germany A320 that was being prepared to be turned over to Air New Zealand crashed into the Mediterranean Sea, because the aircraft had been repainted and rinsed off by high-pressure water that entered the AOA sensors and froze at a high altitude. All seven aboard were killed.

Of course, steps are taken to detect sensor or other damage to an aircraft before takeoff. Most importantly, there is the walkaround. A pilot circles the aircraft slowly clockwise, eying the various components and systems. Some faults can only be revealed by visual inspection. It will be especially important with the converted A320 passenger aircraft to conduct visual inspections of sensors before and after ground handling operations. In addition, with one engine running, AOAs and other sensors, including temperature probes and static ports that measure altitude, are electrically heated to prevent ice formation. It would be impossible to expunge all risk of human error by ground handlers, any more than errors by flight crews can be eliminated. But risks must be mitigated on the ground because the safety of a flight starts from there. The airlines should update manuals, standard operating procedures and training curricula to communicate the locations of AOAs and other critical sensors to ground personnel. This is especially important as airlines incorporate more Airbus jets into their fleets alongside the Boeing planes that some ground workers might be more familiar with.

Also, prototype work is underway at the company where I work toward converting A320 passenger planes to freighters, which means that all parties in ground operations will need to become familiar with the new A320Fs. On a Boeing cargo plane, the cargo operations areas are clear of sensors, but on a newly converted A320F, there will be sensors in the area where cargo will be loaded and unloaded. Ground handlers who have not worked with Airbus planes have to learn about the new safety hazards and precautions.

When an A320 is converted to a freighter, pains are taken to ensure that any sensors that must be removed temporarily are returned to their original locations. This removal is necessary because the fuselage must be cut and a cargo door installed that's large enough to accommodate unit load devices. These ULDs are used for grouping, transferring and restraining cargo for transit, as well as overhanging cargo. ULDs may consist of a pallet with a net or may be a container. An aluminum frame shell also must be added to the exterior fuselage to reinforce the opening before the cargo door goes in. Because two AOA sensors are located on the area of the fuselage where a hole must be cut, these sensors will be removed and refastened. One is on the door and the other is on the shell.

During loading and unloading, cautions will need to be taken, because the reinstalled AOA sensors will protrude farther into the surrounding workspace. Off-the-shelf AOA covers should be placed over the AOAs during cargo handling operations to give some protection in the event of a collision. To reduce the risks of that, a guidance marshaller should be present to constantly guide the loader operator. Door-sill rollers, which provide a surface for moving ULDs into or out of the plane, can be of significant help to mitigate risks.

Notably, altering the design of an aircraft like the A320 in a passenger-to-freighter conversion, or PtoF, requires going through a rigorous process to earn a Supplemental Type Certificate, the document showing that the plane remains airworthy and in full compliance without the need for an entirely new type certification, as would be required for a new aircraft. The FAA and the European Aviation Safety Agency, EASA, will only sign off on the A320 Freighter if it meets their Continued Airworthiness requirements. Training the ground personnel is the airline or aircraft operator's task. Operators need to update their standard operating procedures and their matching training courses, including textbooks and curricula, to address and highlight the AOA sensor safety hazard. Airlines and other operators of this type of aircraft will have to supervise operations and also monitor their personnel strictly for some time to assure compliance.

These updates and changes are currently being documented by the subject-matter experts involved in the PtoF conversion. A320F operators will then update the documentation used by ground handlers.

Performing any kind of operation on the ramp or airside is inherently risky, and achieving 100 percent safety would be wishful thinking. A significant responsibility for preventing runway incursions rests on the shoulders of the airport operations staff as well as other vehicle and ground support equipment operators who drive on the airfield.

For low-cost service by a Boeing 737 or Airbus 320 in the U.S., the turnaround time can be as short as 15 to 20 minutes. When performing full service for a Boeing 747 on an international route, the turnaround time can be 1.5 to two hours. Some airlines have their own ground handling agents who carry out both airside and landside services at their base or hub airports.

Airbus

An angle of attack probe for Airbus aircraft. Damage to this critical sensor could result in fatal consequences.

Others outsource their ground handling services to independent service agents or to different airlines to keep costs down, especially at non-hub airports. With outsourcing, it's much harder to assure conformity and the level of safety can diminish.

My experience shows that situational awareness, judgment and decision-making skills can be improved through structured training, consisting of initial and refresher courses at the theoretical and practical levels. This is being done by the airlines and airport operations authorities today, and its importance should not be overlooked.

Let's look at some specific examples: Among the safety precautions in the Ground Operations Manual published by the International Air Transport Association are the following, which are helpful, but not sufficient if not adhered to:

"The rubber bumpers on a loader must NEVER make contact with the aircraft. The minimum distance to be maintained at all times is 1 in/2.5 cm from the fuselage."

"Do not drive GSE" — ground support equipment — "with lifting devices in the raised position, except for final positioning of the GSE onto the aircraft."

"Do not drive GSE faster than walking speed."

"In general, when operating loaders, the bridge needs to be moved slowly until it touches the aircraft — avoiding any aircraft sensors until either the protective bumpers touch the aircraft or the equipment's proximity sensors stop the movement."

There's nothing wrong with these. The A320F characteristics need to be highlighted in this IATA manual in the future when the Supplemental Type Certificate for the PtoF conversion is granted by the FAA and the EASA.

In the IATA Airport Handling Manual, there is a chapter called Airport Handling Ground Support Equipment Specifications that addresses different aircraft, including the A320. Freighter versions will surely be added by IATA when this freighter receives a supplmental certificate and is ready to enter the fleets.

Unfortunately, human complacency being what it is, there is a risk that operations personnel will deviate from their training and tend to neglect what they learned. All A320F operators should be given a heads up with regards to the locations of AOA sensors in the cargo operations area, and this can be done via revised or updated training textbooks and refresher courses for all personnel.

Specifically, I would suggest adding something like the following to the affected textbooks, manuals, documents and other materials for the Airbus A320F:

"UTMOST CARE SHALL BE TAKEN WHEN OPERATING AIRBUS A320 CARGO AIRCRAFT. OUT OF THE THREE AOA SENSORS, TWO ARE LOCATED ON THE LEFT HAND SIDE OF THE FORWARD FUSELAGE: ONE IS LOCATED ON THE MAIN DECK CARGO DOOR AND ONE IS LOCATED RIGHT UNDERNEATH THE MAIN DECK CARGO DOOR IN THE VICINITY OF LOADER OPERATIONS. HITTING/SLAMMING INTO THESE SENSORS SHALL RESULT IN SEVERE CONSEQUENCES AND AOG ["aircraft on ground,"meaning the plane cannot takeoff] WILL FOLLOW! THE RULES OF 'RAISE THEN APPROACH' FOR THE LOADER OPERATORS AS WELL AS "DETACH THEN LOWER" MUST BE OBSERVED DURING UN/LOADING OPERATIONS.'"

The good news is that the human element is the most flexible, adaptable and valuable part of the aviation system. But we are all vulnerable to influences that can adversely affect performance. As long as airplanes are serviced and operated by humans, fatigue, distraction and other inherent weaknesses can only be managed, never erased. Without controlling and monitoring measures, safety won't be assured because day-to-day operations can become habitual and routine. When that happens, a formalized plan for change is necessary because individuals sometimes resist change and they become accustomed to performing a particular process that becomes the preferred way. One of the solutions that comes from my own experience is an honest communication with respectful feedback. This increases the chances of success and helps eliminate the severe penalty in time, effort, and damage to the organization's reputation.

Implementation of a non-punitive reporting system towards eradication of the name-blame-shame game must not be taken for granted. Voluntary reporting always helps in the wake of incidents or accidents. To support a reporting culture, the organization must cultivate the willingness of its members to contribute to the organization's understanding of its operation. Since some of the most valuable reports involve self-disclosure of mistakes, the organization must make the commitment to act in a non-punitive manner when those mistakes are not the result of careless or reckless behavior.

With these approaches, we can convert A320s to freighters, or integrate new planes into fleets, without surprising the personnel and increasing safety risks. ★

Vahid Norouzalibeik

is a safety management system specialist and instructor, specializing in human factors and commercial aircraft operations. He leads the Human Factors Subcommittee of AIAA's Product Support Technical Committee and works for Pacific Aviation and Lease Management in San Diego. He is part of a team that is performing a passenger-to-freighter prototype conversion for Airbus A320s and A321s. Norouzalibeik grew up in Tehran, Iran, where his father was a loadmaster at Mehrabad International Airport, where the younger Norouzalibeik began his career.

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DIRECTORY

AIAA Headquarters / 12700 Sunrise Valley Drive, Suite 200 / Reston, VA 20191-5807 / **www.aiaa.org**

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We are frequently asked how to submit articles about section events, member awards, and other special interest items in the AIAA Bulletin. Please contact the staff liaison listed above with Section, Committee, Honors and Awards, Event, or Education information. They will review and forward the information to the AIAA Bulletin Editor.

Calendar

Notes About the Calendar

For more information on meetings listed below, visit our website at www.aiaa.org/events or call 800.639.AIAA or 703.264.7500 (outside U.S.).

DATE	MEETING	LOCATION	ABSTRACT DEADLINE
2016			
12–13 Oct†	12th Annual International Symposium for Personal and Commercial Spaceflight (ISPCS 2016)	Las Cruces, NM (Contact: http://ispcs.com/)	
17–20 Oct†	22nd KA and Broadband Communications Conference and the 34th AIAA International Communications Satellite Systems Conference	Cleveland, OH (Contact: Chuck Cynamon, 301.820.0002, www.kaconf.org)	
7–10 Nov†	International Telemetering Conference	Glendale, AZ (Contact: www.telemetry.org)	
8–10 Nov†	Aircraft Survivability Symposium 2016	Monterey, CA (Contact: http://www.ndia.org/meetings/7940)	
15–16 Nov†	Drone World Expo (DWE)	San Jose, CA (http://www.droneworldexpo.com/)	
2017			
7 January	Space Standards and Architecture Workshop	Grapevine, TX	
7–8 Jan	Introduction to Shock-Wave/Boundary-Layer Interactions Course	Grapevine, TX	
7–8 Jan	Liquid Atomization, Spray, and Fuel Injection in Aircraft Gas Turbine Engines Course	Grapevine, TX	
7–8 Jan	Six-Degrees-of-Freedom Modeling of Missile and Aircraft Simulations Course	Grapevine, TX	
7–8 Jan	2nd AIAA Sonic Boom Prediction Workshop	Grapevine, TX	
8 Jan	Hypersonics Test Course	Grapevine, TX	
9 Jan	2017 Associate Fellows Recognition Ceremony and Dinner	Grapevine TX	
9–13 Jan	AIAA SciTech 2017 (AIAA Science and Technology Forum and Exposition) Featuring: – 25th AIAA/AHS Adaptive Structures Conference – 55th AIAA Aerospace Sciences Meeting – AIAA Atmospheric Flight Mechanics Conference – AIAA Information Systems — Infotech@Aerospace Conference – AIAA Guidance, Navigation, and Control Conference – AIAA Modeling and Simulation Technologies Conference – 19th AIAA Non-Deterministic Approaches Conference – 58th AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference – 10th Symposium on Space Resource Utilization – 4th AIAA Spacecraft Structures Conference – 35th Wind Energy Symposium	Grapevine, TX	6 Jun 16
22–26 Jan†	97th American Meteorological Society Annual Meeting	Seattle, WA (Contact: https://annual.ametsoc.org/2017/)	
23–26 Jan†	63rd Annual Reliabiltiy & Maintainability Symposium (RAMS 2017)	Orlando, FL (http://rams.org/)	
5–9 Feb†	27th AAS/AIAA Space Flight Mechanics Meeting	San Antonio, TX (Contact: www.space-flight.org/docs/2017_winter/2017_winter.html)	7 Oct 16
4–11 Mar†	IEEE Aerospace Conference	Big Sky, MT (Contact: www.aeroconf.org)	
6–9 Mar†	21st AIAA International Space Planes and Hypersonic Systems and Technology Conference (Hypersonics 2017)	Xiamen, China	22 Sep 16
18–20 Apr†	17th Integrated Communications and Surveillance (ICNS) Conference	Herndon, VA (Contact: Denise Ponchak, 216.433.3465, denise.s.ponchak@nasa.gov, http://i-cns.org)	

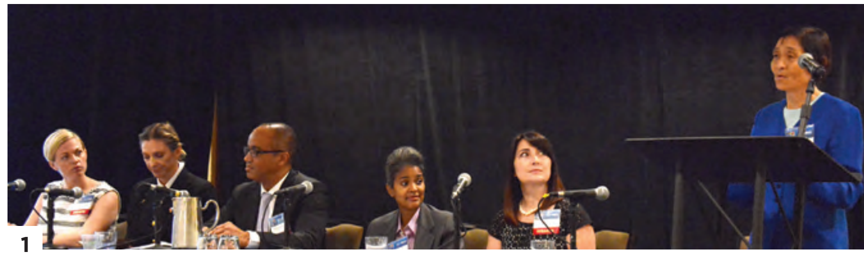
†Meetings cosponsored by AIAA. Cosponsorship forms can be found at https://www.aiaa.org/Co-SponsorshipOpportunities/.

AIAA Continuing Education offerings

DATE	MEETING	LOCATION	ABSTRACT DEADLINE
25–27 Apr	AIAA DEFENSE 2017 (AIAA Defense and Security Forum) Featuring: – AIAA Missile Sciences Conference – AIAA National Forum on Weapon System Effectivenss – AIAA Strategic and Tactical Missile Systems Conference	Laurel, MD	4 Oct 16
25–27 Apr†	EuroGNC 2017, 4th CEAS Specialist Conference on Guidance, Navigation, and Control	Warsaw, Poland (Contact: robert.glebocki@mel.pw.edu.pl; http://www.ceas-gnc.eu/)	
2 May	2017 Fellows Dinner	Crystal City, VA	
3 May	Aerospace Spotlight Awards Gala	Washington, DC	
8–11 May†	AUVSI/AIAA Workshop on Civilian Applications of Unmanned Aircraft Systems	Dallas, TX (www.xponential.org/auvsi2016/public/enter.aspx)	
15–19 May†	2017 IAA Planetary Defense Conference	Tokyo, Japan (Contact: http://pdc.iaaweb.org)	
25–29 May†	International Space Development Conference	St. Louis, MO (Contact: ISDC.nss.org/2017)	
29–31 May†	24th Saint Petersburg International Conference on Integrated Navigation Systems	Saint Petersburg, Russia (Contact: Ms. M. V. Grishina, icins@eprib.ru, www.elektropribor.spb.ru)	
3–4 Jun	3rd AIAA CFD High Lift Prediction Workshop	Denver, CO	
3–4 Jun	1st AIAA Geometry and Mesh Generation Workshop	Denver, CO	
5–9 Jun	AIAA AVIATION 2017 (AIAA Aviation and Aeronautics Forum and Exposition) Featuring: – 24th AIAA Aerodynamic Decelerator Systems Technology Conference – 33rd AIAA Aerodynamic Measurement Technology and Ground Testing Conference – 35th AIAA Applied Aerodynamics Conference – AIAA Atmospheric Flight Mechanics Conference – 9th AIAA Atmospheric and Space Environments Conference – 17th AIAA Aviation Technology, Integration, and Operations Conference – AIAA Flight Testing Conference – 47th AIAA Fluid Dynamics Conference – 18th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference – AIAA Modeling and Simulation Technologies Conference – 48th Plasmadynamics and Lasers Conference – AIAA Balloon Systems Conference – 23rd AIAA Lighter-Than-Air Systems Technology Conference – 23rd AIAA/CEAS Aeroacoustics Conference – 8th AIAA Theoretical Fluid Mechanics Conference – AIAA Complex Aerospace Systems Exchange – 23rd AIAA Computational Fluid Dynamics Conference – 47th Thermophysics Conference	Denver, CO	27 Oct 16
6–9 Jun†	8th International Conference on Recent Advances in Space Technologies (RAST 2017)	Istanbul, Turkey (Contact: www.rast.org.tr)	
10–12 Jul	AIAA Propulsion and Energy 2017 (AIAA Propulsion and Energy Forum and Exposition) Featuring: – 53rd AIAA/SAE/ASEE Joint Propulsion Conference – 15th International Energy Conversion Engineering Conference	Atlanta, GA	4 Jan 2017
12–14 Sep	AIAA SPACE 2017 (AIAA Space and Astronautics Forum and Exposition)	Orlando, FL	23 Feb 17
25–29 Sep†	68th International Astronautical Congress	Adelaide, Australia	

News

AIAA and AIA Host National A&D Workforce Summit



Dan Stohr

Dan Stohr

1 Hsiao-hua Burke, MIT Lincoln Lab and AIAA Diversity Working Group (right), moderated a panel on Expanding Diversity and Inclusion in the A&D Workforce with panelists (left to right): Erin Hogeboom, National Girls Collaborative; Leedjia Svec, NASA Ames Research Center; Achille Messac, Howard University; Stephanie Turner, Lockheed Martin; and Angela Lamb, Harris Corporation.

2 Senator Tim Scott (R-SC) (left) and Congressman Mike Honda (D-CA) (right) spoke about legislative priorities in STEM education and workforce development for Congress.

As our members know, the adequacy and size of the nation's STEM workforce continues to be an ongoing concern for the aerospace and defense (A&D) community. The sector faces impending retirements and a shortage of trained technical graduates while work and skills requirements become increasingly advanced. More and more companies are attempting to improve quality and boost productivity by automating their facilities. Furthermore, because of a stringent visa process, many highly skilled, foreign-born students who have been educated at U.S. colleges and universities must return to their home countries to work. This removes a lucrative workforce who could otherwise help drive U.S. entrepreneurship and economic growth.

Recognizing the importance and urgency of these issues, AIAA teamed with the Aerospace Industries Association (AIA) to organize and host the 2016 National A&D Workforce Summit: Collaborating to Inspire and Build the Aerospace Workforce of Tomorrow in Washington, DC. The two-day forum, which took place last month, convened nearly 150 leaders from academia, government, industry, and nongovernment organizations. It was by design that this summit took place during a presidential and congressional election year an ideal time to assess the current state of the A&D workforce and consider what needs to be done in the future to sustain and advance this critical national asset. Both organizations last partnered in 2008, hosting a similar summit in another election year.

The event kicked off with opening remarks by AIAA Executive Director Sandy Magnus, who said that summits like this allow us to "take stock of where we are as an industry, examine the issues, and identify actions that could be taken to reach solutions." She continued by reminding participants that, "our voices can effect powerful change both legislatively and more practically in classrooms, design rooms, human resource offices, and production facilities around the nation."

Dr. Reginald Brothers, Under Secretary for Science and Technology Directorate, Department of Homeland Security, delivered a poignant luncheon keynote speech. He articulated that the A&D workforce should not "just be fluent in a single technical area, but many." He added that we need "folks who can work in a team across areas with different synergies."

Other first day highlights included a panel on how companies like Boeing and Northrop Grumman are partnering with colleges and universities on regional projects to develop an in-demand workforce, and explore skills gaps in manufacturing and technical labor as experienced in particular geographic regions. Another panel discussed how to engage more female and underrepresented minority students in STEM subjects and attract them into the workforce, and opportunities to hear from both current and past participants about how their experiences in STEM programs influences their academic and career choices.

Robert Durbin, AIA's chief operating officer, opened the second day of the summit. Representatives from various state STEM networks spoke about stakeholder collaboration at the state and local levels. Next, Senator Tim Scott (R-SC) and Congressman Mike Honda (D-CA) provided perspectives on some of the education and workforce accomplishments in the 114th Congress, as well as what they hope the 115th Congress can tackle in these areas. Senator Scott offered, "Exposing our kids [to STEM] at an early age allows for anything to be possible; however, they ultimately choose their future career path." Congressman Honda added that many of our schools "are not equipped to properly educate each and every child." He continued, "We must understand what each and every child needs in order to have equity in our education system."

Another panel included officials from the Department of Defense, the FAA, the National Oceanic and Atmospheric Administration, and the White House Office of Science and Technology Policy, who reviewed their agency STEM initiatives and workforce issues impacting the executive branch. The event concluded with a special panel, including representatives from the United Kingdom and French aerospace industry associations, designed to help identify how international stakeholders might collaborate to develop the aerospace workforce around the globe.

Scientists and engineers are essential to U.S. innovation and economic growth, and much more must be done to encourage generations of Americans to study science, technology, engineering, and math. The summit produced many ideas and recommendations that will inform our work going forward. AIAA and AIA will publish a proceedings report of the summit, for release in January 2017, which will both shape our own strategies on STEM education and workforce development and include recommendations to the new administration and 115th Congress.

The event was sponsored by 180 Skills LLC, The Boeing Company, Connecticut Center for Advanced Technology, Lockheed Martin Corporation, and Rolls-Royce.

AIAA K–12 STEM Activities

The K–12 STEM Outreach Committee would like to recognize outstanding STEM events in each section. If your section would like to be featured, please contact Supriya Banerjee (1Supriya.Banerjee@gmail.com) and Angela Diggs (Angela.Spence@gmail.com).

The Winchester STARBASE Academy (http://starbasewinchester.webs.com/) provides inspiring and exciting STEM education activities to 4th- and 5th-grade public and private schools students in northwestern Virginia. Winchester STARBASE is part of the Department of Defense STARBASE program, and is managed by the Virginia Department of Military Affairs.

Students and their teacher attend the program for 5 days providing 25 hours of instruction. The STARBASE curriculum emphasizes Engineering, Chemistry, Physics, Math, and Technology. Programs have an inquiry-based curriculum containing "hands-on, mind-on" experiential activities that highlight the real-world applications of each area. Examples include:

- Using PTC's CAD software sketching and modeling to create a physical product on a Stratasys 3-D printer.
- Egg drop tests using the Engineering Design Process
- Investigations with molecule building kits, chemical & physical changes, and atmospheric properties
- Newton's laws of motion using inertia toys, straw rockets, Newton's cradles, and solid fuel rockets
- Navigational concepts using Tyvek maps and handheld GPS units
- Programming robots to traverse an obstacle course / perform required maneuvers

Math is embedded throughout all activities as well as metric measurement lessons, circuit board geometry, and data analysis of an Alka-Seltzer rocket.

Students learn about different STEM careers during presentations from military, government, and private sector volunteers, including Air Force pilots, medical professionals, and civil and structural engineers. AIAA members have participated, presenting information on

Congresswoman Barbara Comstock observing robotics programming.

the Space Shuttle, Space Station, and Mars programs.

Over 2,700 students in the Winchester STARBASE region have attended the five-day program. The program is being expanded for the upcoming school year, doubling participation from 750 students per year to an anticipated 1,500.

For information on how AIAA members can help support Winchester STARBASE, please contact Program Director Susan Corrigan at starbasewinchester@gmail.com or AIAA Associate Fellow and K–12 STEM Committee Member Jeff Jones at j.d.jones@applewoodengineering.com.

AIAA Foundation Presents Graduate and Undergraduate Awards

The AIAA Foundation annually awards financial aid to graduate and undergraduate students in science or engineering programs related to aerospace. Its graduate scholarship program presents awards to graduate students doing excellent research in the air and space sciences. The Foundation also offers scholarships to college sophomores, juniors, and seniors each year, and recipients can apply to renew their scholarships annually until they graduate.

Graduate Awards for the 2016–2017 Academic Year

Each year the AIAA Foundation presents the Orville and Wilbur Wright Graduate Awards. These $5,000 awards, given in memory of the Wright brothers' contributions to the evolution of flight, honor full-time graduate students. The winners are:

- **Robert Jacobi**, University of Arizona, Prescott, Arizona
- **Trevor Bennett**, University of Colorado, Boulder, Colorado

In addition, **Connie Liu**, Georgia Institute of Technology, Atlanta, Georgia, received the **Neil Armstrong Graduate** Award. This $5,000 award honors the character and achievements of the late astronaut, military pilot and educator, Neil A. Armstrong.

The AIAA Foundation also presented the **John Leland Atwood Graduate Award** to **Markus Geiss**, University of Colorado, Boulder, Colorado. Established in 1999, the $1,250 award, sponsored by endowments from Rockwell and what is now The Boeing Company and named in memory of John Leland "Lee" Atwood, former chief executive officer of Rockwell, North America, recognizes a student actively engaged in research in the areas covered by the technical committees (TC) of AIAA.

Three AIAA TCs also presented graduate awards:

- **Evan Harrison**, Georgia Institute of Technology, Atlanta, Georgia, received the General Aviation Systems TC's $1,000 **William T. Piper Sr. General Aviation Systems Graduate Award**.
- **Patrick Kenneally**, University of Colorado, Boulder, Colorado, received the Guidance, Navigation, and Control (GNC) TC's $2,500 **GNC Graduate Award**.
- **Vaibhav Kumar**, Georgia Institute of Technology, Atlanta, Georgia, received the Modeling and Simulation TC's $3,500 **Luis de Florez Graduate Award**.

Undergraduate Scholarships for the 2016–2017 Academic Year

The AIAA Foundation have awarded ten AIAA Foundation undergraduate scholarships for the 2016–2017 academic year.

The $5,000 **David and Catherine Thompson Space Technology Scholarship,** named for and endowed by former AIAA President David Thompson, chairman, chief executive officer, and president of Orbital ATK, Dulles, Virginia, and his wife Catherine, was presented to **Erin Tesny**, Cleveland State University, Cleveland, Ohio.

The $5,000 **Vicki and George Muellner Scholarship for Aerospace Engineering**, named for and endowed by former AIAA President Lt. Gen. George Muellner, U.S. Air Force (retired) and president of advanced systems for Boeing Integrated Defense Systems (retired), and his wife Vicki, was presented to **Andrew Orme**, Brigham Young University, Provo, Utah.

The $5,000 **Wernher von Braun Scholarship**, named in honor of German rocketeer and founder of the U.S. space program, Wernher von Braun, was presented to **Young Wu**, United States Air Force Academy, Colorado Springs, Colorado.

The $1,500 **Leatrice Gregory Pendray Scholarship**, awarded to the Foundation's top female scholarship applicant, was presented to **Tammy Witzens**, Arizona State University, Tempe, Arizona.

Six AIAA Foundation scholarships were presented by AIAA Technical Committees (TC) to students performing research in the TC's area:

- The **Liquid Propulsion TC** presented a $2,500 scholarship to **Aadil Pappa**, University of Texas at Austin, Texas.
- The **Space Transportation TC** presented a $1,500 scholarship to **Oseas Hudy-Velasco**, Western Michigan University, Kalamazoo, Michigan.

The Digital Avionics TC presented four scholarships of $2,000 each:

- The **Dr. James Rankin Digital Avionics Scholarship** was presented to **Eylul Bilgin**, University of California, San Diego, California.
- The **Dr. Amy R. Pritchett Digital Avionics Scholarship** was presented to **McKenzie Kinzbach**, University of Cincinnati, Ohio.
- The **Ellis F. Hitt Digital Avionics Scholarship** was presented to **Andreas Martinez**, Embry-Riddle Aeronautical University, Daytona Beach, Florida.
- The **Cary Spitzer Digital Avionics Scholarship** was presented to **Diane Nguyen,** University of Virginia, Charlottesville, Virginia.

For more information on the AIAA Foundation Graduate Awards and Undergraduate Scholarship Program, please contact Felicia Livingston at felicial@aiaa.org or 703.264.7502.

Join us as we continue to inspire teachers and students. For more information and to donate, please visit www.aiaafoundation.org.

AIAA Scholarships and Graduate Awards site is now accepting applications for the 2017–2018 academic year. The application deadline is **31 January 2017**. For more information visit us online: www.aiaa.org/Scholarships.

AIAA Jeffries Aerospace Medicine and Life Sciences Research Award Presented

Dr. Robert Ferl (left), 2016 awardee and director, University of Florida Interdisciplinary Center for Biotechnology Research, with Dr. Anna-Lisa Paul (center), University of Florida, and nominator Dr. Matthew Bamsey (right) of DLR. (Photo credit: Dr. Anna-Lisa Paul)

New England Honors and Awards speakers and organizers (left–right): Peter Ricupero, Douglas Joyce, Will Schaefer, Richard Hallion, and Sheila Widnall.

AIAA New England Honors and Awards Banquet Held in June

The AIAA New England Section held its Honors and Awards Banquet on 28 June. Members and guests were treated to AIAA Distinguished Lecturer Dr. Richard Hallion speaking on "A Century of Military Aviation," which traced the development of military aviation around the world, cautioned on evaluating testing, and made recommendations for future development. The evening also included presentations of Special Service Citations to four AIAA council members by Dr. Sheila Widnall, former Secretary of the Air Force and former AIAA President; the 63 section members whose membership spanned more than 50 years were noted.

The banquet included a special exhibition of U.S. Air Force flight clothing since Korea, curated by Will Schaefer, MITRE Corporation, and a description of former section chair and Air Force Test Pilot Col. Douglas Joyce's book *Flying Beyond the Stall, the X-31 and the Advent of Supermaneuverability*.

CALL FOR NOMINATIONS
AIAA Foundation Award for Excellence

Honoring Excellence within the Aerospace Community

The AIAA Foundation Award for Excellence is the highest award presented by the AIAA Foundation Board of Trustees, recognizing excellence within the aerospace community. Eligible nominees will offer a unique achievement or extraordinary lifetime contributions inspiring the global aerospace community.

Nomination Deadline:
15 November 2016.

For more information, please go to: www.aiaa.org/FoundationAwardForExcellence.

Student Paper Competitions

AIAA is pleased to announce the winners of the student paper competitions held during AIAA AVIATION 2016. Congratulations!

Atmospheric and Space Environments
Gustavo E. C. Fujiwara, Michael Bragg, Stephanie Camello, and Christopher Lum, University of Washington, AIAA 2016-3734, "Computational and Experimental Ice Accretions of Large Swept Wings in the Icing Research Tunnel."

Multidisciplinary Optimization Design
Koorosh Gobal, Ramana Grandhi, and Christopher Koehler, Wright State University, AIAA 2016-3992, "A Robust Analytical Sensitivity Analysis for Coupled Aero-Structural Systems."

Call For Papers for Journal Of Guidance, Control, and Dynamics

Special Issue on "The Kalman Filter and Its Aerospace Applications"

On 2 July 2016 the guidance, navigation, and control (GN&C) community lost its eminent ambassador, with the passing of Rudolf Emil Kálmán. Although Kálmán made significant advances to general control and estimation theory, his greatest legacy is the invention of the legendary "Kalman filter," first published in 1960. For his pioneering work he was given many prestigious awards.

In honor of Rudolf Kálmán, the Journal of Guidance, Control, and Dynamics (JGCD) will dedicate a special issue on "The Kalman Filter and Its Aerospace Applications." The focus of the special issue is specifically targeted to novel aerospace GN&C applications involving the Kalman filter. The applied research paper must address original and/or unique uses of the Kalman filter.

More information about this special issue as well as guidelines for preparing your manuscript can be found in the full Call for Papers on the journal website in Aerospace Research Central http://arc.aiaa.org/loi/jgcd.

Deadline: Submissions are due by 1 December 2016 with prior approval of the Guest Editor

Contact Email: John L. Crassidis, Guest Editor (johnc@buffalo.edu) Ping Lu, Editor-in-Chief of JGCD (plu@mail.sdsu.edu).

Obituaries

AIAA Associate Fellow Leeper Died in May

Charles K. Leeper died on 12 May 2016. He was 92.

Mr. Leeper earned a B.S. in mechanical engineering from the University of Texas at Austin in 1944. He then worked as a junior engineer at the American Manufacturing Company of Texas, and the Johns Hopkins University Applied Physics Laboratory. He earned his M.S. in 1948 and his Sc.D. in 1954, both in mechanical engineering from MIT.

His professional career focused on nuclear energy and rocket propulsion. In 1954, he worked at Nuclear Development Associates, before moving to Atlantic Research Corporation, where he served as a division director. From 1963 to 1969, Mr. Leeper was manager of engineering at Aerojet Liquid Rocket, contributing to rocket engine designs that were integral to the space program. He also patented six designs in the field of fuel technology.

Throughout the 1970s and early 1980s, Mr. Leeper held leadership positions at various aerospace and energy companies, including Aerojet Nuclear Systems, where he directed engineering for NERVA.

AIAA Associate Fellow Reisz Died in July

Aloysius I. "Al" Reisz passed away on 21 July. He was 78 years old.

Reisz began his career as a Boeing propulsion engineer during development and flight of the Apollo Saturn V. He worked with Marshall Space Flight Center propulsion engineers, and helped develop the propellant management system for the F-1 engines and the second stage J-2 liquid hydrogen engines. He also developed the post flight performance predictions for the Saturn V flights. Later, he worked on two Skylab missions.

Reisz started Reisz Engineers in 1974, providing and managing engineering services to aerospace and other industries. One of his projects was selected as one of the ten outstanding engineering projects of 1976 by the National Society of Professional Engineers.

Reisz was a long-time AIAA Greater Huntsville Section member and the section's 2011 Oberth Award Winner. He was involved in ASME and was a past president of the Von Braun Astronomical Society.

AIAA Fellow Kuo Died in July

Kenneth Kuan-Yun Kuo, 76, died on 31 July 2016. He was 76 years old.

Dr. Kuo graduated from the National Taiwan University with a B.S. in 1961 and received a M.S. in Mechanical Engineering from the University of California, Berkeley in 1964 and a Ph.D. in Aerospace and Mechanical Sciences from Princeton University in 1971.

Dr. Kuo retired as Distinguished Professor Emeritus after serving as Distinguished Professor of Mechanical Engineering and Director of the High Pressure Combustion Laboratory for 39 years at The Pennsylvania State University. An internationally recognized authority on chemical propulsion and propellant combustion, he greatly impacted his field with the founding of the High Pressure Combustion Laboratory at Penn State, leadership on more than 100 scientific research projects, and authorship of several textbooks and over 420 articles on propulsion, combustion, and energetic materials. He conducted fundamental research on hybrid rocket propulsion and developed energetic solid fuels with various nano-sized energetic additives through detailed combustion characterization and diagnostics.

A Fellow of AIAA and ASME, Dr. Kuo received numerous awards throughout his career, including the 2014 Ballistics Science Fellow of the International Ballistics Society and the 2011 AIAA Wyld Propulsion Award.

AIAA Senior Member Pearce Died in August

Earl H. Pearce, Commander, U.S. Navy (retired), died on 5 August 2016, at the age of 85.

CDR Pearce graduated with a Mechanical Engineering degree in 1952 from Auburn University, and joined the U.S. Navy serving as a fighter pilot, completing 550 carrier landings on 11 different aircraft carriers. He earned an Aeronautical Engineering degree from the Naval Postgraduate School in 1962.

CDR Pearce retired from the Navy in 1972. In 1975, he earned an MBA degree at the University of Alabama in Birmingham (UAB). He was Assistant Professor in the UAB Mechanical Engineering department from 1980 to 1990. CDR Pearce was a longtime member of the AIAA Greater Huntsville Section. In 2011, the section renamed its Professional of the Year Award after him. The Earl Pearce Professional of the Year Award is given annually to a section member in recognition of extraordinary dedication, creativity and leadership while engaged in a professional work or activity in within the aerospace community.

AIAA Associate Fellow Rendleman Died in August

Retired U.S. Air Force Reserve Colonel **James "Jim" D. Rendleman** died on 26 August 2016. He was 59 years old.

At age 20, he received a Bachelor's of Science in Chemistry at the University of North Carolina, Chapel Hill. He also obtained a Master's of Business Administration, a Master's of Public Administration, Juris Doctorate, and a Master's of Laws, LLM, in Tax.

Rendleman began his Air Force career as a rocket propellant chemist, and then served as executive officer for the Space Shuttle program; chief, Space Policy Office for the Secretary of the Air Force; and an aerospace attorney. He most recently served as supervising attorney for Joint Functional Component Command for Space (JFCC SPACE).

He was a leader in space law and policy, authoring several seminal papers on the subject. Rendleman served as Chair of the AIAA Rocky Mountain Section (2012–2013). He was also involved with AIAA's Engineering and Technology Management Group and the Legal Aspects of Aeronautics and Astronautics Technical Committee. He attended AIAA's Congressional Visits Day and inspired his fellow members to become more politically involved.

AIAA Recognizes 2016 Section Award Winners

By Chris Jessee, *AIAA Section Program Manager*

WHAT ARE SECTION AWARDS?

The AIAA Section Awards honor particularly notable performances made by an Institute section working as a unit, and are intended to formally underscore the AIAA conviction that intellectually stimulating section activity is fundamental to the health of the Institute. All awards are given annually in five section member categories, based on the number of members in the Section: Very Small, Small, Medium, Large, and Very Large. A certificate and cash award ($500 for first place, $200 for second, and $100 for third) are presented to the winning sections in all size categories. The award period covered is 1 June 2015–31 May 2016.

The **Outstanding Section Award** is presented to sections based upon their overall activities and contributions through the year. The winners are:

Very Small: First Place: Delaware, Breanne Sutton, section chair; **Second Place: Adelaide,** Mark Ramsey, section chair; **Third Place: China Lake,** Jeff Scott, section chair

Small: First Place: Sydney, Evan Smith, section chair; **Second Place: Savannah,** Jason Riopelle, section chair; **Third Place (tie): Twin Cities,** Kristen Gerzina, section chair; **Third Place (tie): Vandenberg,** Keegan McCoy, section chair

Medium: First Place, Tucson, Brian Biswell, section chair; **Second Place: Long Island,** David Paris, section chair; **Third Place: Southwest Texas,** Joan Labay-Marquez, section chair; **Honorable Mention: Wichita,** Mike Brennison, section chair

Large: First Place: San Diego, Katherine Kucharski, section chair; **Second Place: Northern Ohio,** James Gilland, section chair; **Third Place: Orange County,** Amir S. Gohardani, section chair

Very Large: First Place: Greater Huntsville, Kurt Polzin, section chair; **Second Place: Hampton Roads,** Craig Hutchinson, section chair; **Third Place: Los Angeles/Las Vegas,** Jeff Puschell, section chair; **Honorable Mention:** Dayton/Cincinnati, Michael List, section chair

The **Career and Professional Development Award** is presented for section activities that focus on career development, such as time management workshops, career transition workshops, job benefits workshops, and technical versus management career path workshops. The winners are:

Very Small: First Place: Delaware, Timothy McCardell, career and professional development officer

Small: First Place: Sydney, Andrew Gong, career and professional development officer; **Second Place: Savannah,** Jason Riopelle, section chair

1 **The China Lake Section** (3rd Place, Outstanding Section) hosted an Aerospace Toy Train Christmas Display for kids and their parents.

2 **The Orange County Section** (3rd Place, Outstanding Section) hosted its 13th Southern California Aerospace Systems and Technology Conference (ASAT) and Awards Banquet in April. This was a joint program, with sponsorship from The Boeing Company. The AIAA Orange County Section is building a significant working relationship with professionals, academia, students, and their community and families while also emphasizing STEM education.

Medium: First Place (tie): Tucson, Jeff Jepson, Regional Activities Committee representative; **First Place (tie): Southwest Texas,** Joan Labay-Marquez, section chair

Large: Second Place: Northern Ohio, James Gilland, section chair; **Third Place: San Diego,** Ioana Broome, section vice chair

Very Large: Second Place: Greater Huntsville, Jesse Jones, continuing education and career and professional development officer and Kurt Polzin, section chair

The **Communications Award** is presented to sections that have developed and implemented an outstanding communications outreach program. Winning criteria include level of complexity, timeliness, and variety of methods of communications, as well as frequency, format, and content of the communication outreach. The winners are:

Very Small: First Place; Delaware, Joseph Scroggins, communications chair; **Second Place: China Lake,** Jeff Scott, communications chair

Small: First Place: Sydney, Evan Smith, section chair; **Second Place: Savannah,** Chris Kabureck, communications officer; **Third Place: Twin Cities,** Andrew Carlson, webmaster and Chris Sanden, secretary and membership officer

Medium: First Place: Tucson, Elishka Jepson, STEM outreach officer and Michelle Rouch, aerospace and societies officer; **Second Place: Long Island**, Dave Paris, chair and newsletter editor; **Third Place: Central Florida,** Josh Giffin, secretary

Large: First Place: Northern Ohio, Edmond Wong, communications officer; **Second Place: Albuquerque,** Sally Smith, newsletter editor; **Third Place: San Diego,** Stevie Jacobson, secretary

Very Large: First Place: Greater Huntsville, Kurt Polzin, section chair; Arloe Mayne, webmaster and Gabe Xu, newsletter editor. **Second Place: Hampton Roads,** John Lin, newsletter editor

The **Membership Award** is presented to sections that have increased their membership by planning and implementing effective recruitment and retention campaigns. The winners are:

Very Small: First Place: Delaware, Di Ena Davis, membership officer; **Second Place: China Lake,** Jeff Scott, membership officer

Small: First Place: Twin Cities, Kristen Gerzina, section chair; **Second Place: Savannah,** Chris Kabureck, membership and communications officer

Medium: First Place: Tucson, Rajka Corder, membership officer; **Second Place: Central Florida,** Josh Giffin, membership officer

Large: First Place: Orange County, Bob Welge, vice chair membership; **Second Place (tie): San Diego,** Brian Quan, membership officer; **Second Place (tie): Cape Canaveral,** Tristan Clouse, membership officer

Very Large: First Place: Greater Huntsville, Roger Herdy, membership officer and Kurt Polzin, section chair; **Second Place: Hampton Roads,** Troy Lake and Marlyn Andino, membership co-chairs; **Third Place: Los Angeles/Las Vegas,** Rick Garcia, membership officer

3 **The Central Florida Section** (2nd Place, Membership) hosted Sandy Magnus, AIAA executive director, who spoke about the future of AIAA at one of their networking socials. Jerry Lutz, former section chair, is shown presenting the Graduation Certificate from Orlando Youth Aviation Center's 8-week course.

4 **The Tucson Section** (1st Place, STEM K–12) held a Kids Club event for 4th–6th graders. The students learned about principles of systems engineering and the engineering design process through the creation of aviation art. Students worked as a team on their art project to satisfy customer requirements, a good model for how engineers operate in the real world.

The **STEM K–12 Award** is presented to sections that have developed and implemented an outstanding STEM K–12 outreach program that provides quality education resources for K–12 teachers in the STEM subject areas. The winners are:

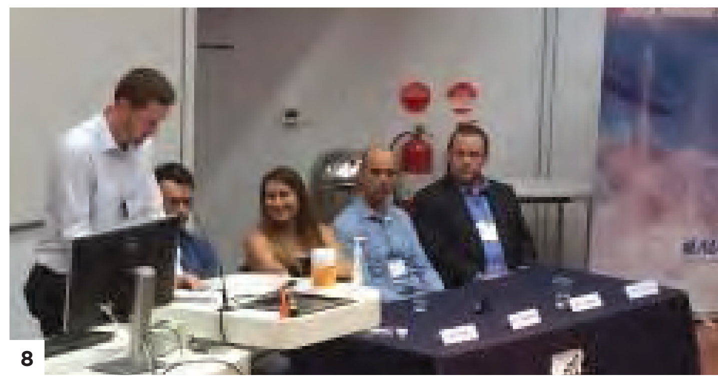
Very Small: First Place: Delaware, Elishabet Lato, STEM K–12 outreach officer

Small: First Place: Northwest Florida,


5

7


6


8

Angela Diggs, vice chair; **Second Place: Vandenberg,** Tom Stevens, STEM K–12 outreach officer; **Third Place: Savannah,** Alex Rummel, STEM K–12 outreach officer

Medium: First place: Tucson, Elishka Jepson, STEM K–12 outreach officer and Michelle Rouch, aerospace and societies officer; **Second Place: Southwest Texas,** Joan Labay-Marquez, STEM K–12 outreach officer

Large: First Place: Orange County, Jann Koepke, vice chair, education; **Second Place: San Diego**, Chris McEachin, student activities coordinator; **Third Place (tie): Cape Canaveral,** Brian Kaplinger, STEM K–12 outreach officer; **Third Place (tie): Northern Ohio,** Julie Kleinhenz, STEM K–12 outreach officer

Very Large: First Place: Hampton Roads, Karen Berger and Shann Rufer, education/pre-college committee co-chairs; **Second Place: Los Angeles/Las Vegas,** Dana Puschell, programs chair; **Third Place (tie): Greater Huntsville,** Megan Beattie, pre-college outreach officer and Kurt Polzin, section chair; **Third Place (tie): Houston,** Alan Sisson, chair

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The **Public Policy Award** is presented for stimulating public awareness of the needs of aerospace research and development, particularly on the part of government representatives, and for educating section members about the value of public policy activities. The winners are:

Very Small: First Place: Delaware, Tim Dominick, public policy officer; **Second Place: Adelaide,** Mark Ramsey, section chair

Small: First Place (tie): Twin Cities, Josh Borchardt, public policy officer; **First Place (tie): Savannah, Ted Meyer,** public policy officer

Medium: First Place: Tucson, Matthew Anguilo, public policy officer; **Second Place: Central Florida,** Jason Hopkins, public policy officer

Large: First Place: Atlanta, Steven Justice, public policy officer; **Second**

5 **The Cape Canaveral Section** (3rd Place, STEM K–12) participated in the NASA Kennedy Space Center Community Day in September 2015. The open house event targeted students up to 6th grade, and included experiments, demonstrations, astronauts, and hands-on family fun, with special educational displays provided by a number of organizations. AIAA Cape Canaveral Section, with help from the Florida Institute of Technology and Embry-Riddle Aeronautical University student branches, staffed an exhibition table where kids built an airplane from a Styrofoam plate while learning some basic principles of aeronautics, such as weight and balance.

6 **The Savannah Section** (3rd Place, STEM K–12) had eight AIAA volunteers assist surf instructors in the water, as well as with on-land activities at the Surfers for Autism, a not-for-profit group dedicated to using the sport of surfing to provide therapeutic benefits to children and young adults within the autism spectrum. This group held their Annual Coastal Empire Beach Festival on Tybee Island.

7 **The Greater Huntsville Section** (1st place, Young Professional) held a Young Professional event for approximately 150 people at a local brewery. "The Martian: Science Fact vs Science Fiction" included a viewing of an extended trailer before the movie's release and a discussion with NASA Marshall Space Flight Center subject-matter experts on the technologies of the film.

8 **The Adelaide Section** (1st Place, Outstanding Activity), teamed up with the International Space University and University of South Australia, to co-host a major public event titled "Space Entrepreneurs: The Rewards and Risks." The event included five Australian entrepreneurs who have been involved in space startups in the last few years to help showcase local industry entrepreneurship, including two AIAA Adelaide Section members. Each of the five speakers gave a presentation about how they came to entrepreneurship in space. Mark Ramsey, chair of the Adelaide section, moderated the event.

Place: Northern Ohio, Amber Abbott-Hearn, public policy officer; **Third Place: Cape Canaveral,** Jarvis Hudson, public policy officer

Very Large: **First Place: Greater Huntsville,** Robert LaBranche, public policy officer; **Second Place: Hampton Roads,** Steven Dunn, public policy officer; **Third Place: Los Angeles/Las Vegas,** Michael Todaro, public policy officer

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The **Young Professional Activity Award** is presented for excellence in planning and executing events that encourage the participation of the Institute's young professional members, and provide opportunities for leadership at the section, regional, or national level. The winners are:

Very Small: **First Place: Delaware section,** Daniel Nice, young professional officer

Small: **First Place: Sydney,** Mathew Vella, vice chair – technical

Large: **First Place (tie): Northern Ohio,** Roger Tokars, young professional officer; **First Place (tie): San Diego,** Marjorie Rima, young professional officer

Very Large: **First Place: Greater Huntsville,** Tamara Cottam, young professional officer

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The **Outstanding Activity Award** allows the Institute to acknowledge sections that held an outstanding activity deserving of additional recognition. The winners are:

Very Small: **Adelaide,** Mark Ramsey, section chair. "**Space Entrepreneurs: The Rewards and the Risks."** The AIAA Adelaide Section teamed up with the International Space University and University of South Australia to co-host a major public event titled "Space Entrepreneurs: The Rewards and Risks." The event included five Australian entrepreneurs who have been involved in space startups in the last few years to help showcase local industry entrepreneurship, including two AIAA Adelaide Section members. Each of the five speakers gave a presentation about how they came to entrepreneurship in space, followed by a panel discussion with many questions from the audience. As the event was also streamed live over the Internet, questions were taken from Twitter across the globe. The event was introduced by Dr. John Connolly, who is the director of the Space Studies Program at the International Space University, and former chief exploration scientist at NASA. Dr. Connolly introduced Mark Ramsey, AIAA Adelaide Section chair, who was the moderator for the event. The event was enjoyed by a crowd of over 150 people.

Small: **Niagara Frontier,** Walter Gordon, section chair. **New Horizons Interplanetary Mission to Pluto.** The AIAA Niagara Frontier Section hosted a dinner meeting and lecture in conjunction with the Aero Club of Buffalo and Buffalo Astronomical Association. There were over 150 in attendance including teachers and students from dozens of local schools in Erie and Niagara counties, all participants in the Student Spaceflight Experiment Program (SSEP). Alice Bowman, missile operation manager at the Johns Hopkins University Applied Physics Laboratory for the new mission to Pluto, was the speaker. Ms. Bowman discussed the challenges of the mission, including the nine years it took the spacecraft to reach Pluto and its next potential goal of reaching a small Kuiper Belt object (KBO) known as 2014 MU69 that orbits nearly a billion miles beyond Pluto.

Medium: **Tennessee**, Joe Sheeley, section chair. **Rocketday!** This event celebrated rocketry and the aerospace science profession. It was held at the Hands-On Science Center in Tullahoma and included activities and competitions for the students, displays, and speakers. The activities for K–5th graders were straw rocket building, rocket coloring, and face painting. The competitions for 3th–8th graders included soda bottle rockets and match head rockets, and for 7th–12th graders "Cool-Two" two-liter rocket Design/Build/Fly. Judging was based on looks, engineering/design, flight radicality, and style.

Large: **Cape Canaveral,** Dave Fleming, section chair. **AIAA Cape Canaveral Section Spring Banquet.** The 2016 Spring Banquet was held at the Valiant Air Command Warbird Museum in Titusville, FL, which has a collection of over 45 historic aircraft (C-47, A-6, F-4J, F-86 to name a few) housed in two large hangars and in exterior display. In addition to being able to tour the museum, one of the three AIAA Cape Canaveral Section Science Fair Award winners displayed her winning science fair project, along with three science fair projects from K–12 students of the Weiss School in Palm Beach Gardens, FL. A large contingent of students and parents (50 total, including 36 students) from the Weiss School traveled to participate in this meeting. These students also made a brief presentation about their activities. The featured speaker was Captain Judy Rice of Think Global Flight who had recently concluded a round-the-world flight stopping in 25 countries to promote STEM education.

Very Large: **Dayton/Cincinnati section,** Michael List, section chair**. Dayton-Cincinnati Aerospace Sciences Symposium (DCASS).** The AIAA Dayton-Cincinnati Aerospace Sciences Symposium has provided a unique venue for technical interchange with members of our regional aerospace community for over four decades. The 41st AIAA DCASS saw 236 registrants and 157 technical presentations. With a large professional attendance, students and Young Professionals received feedback from nationally recognized experts and observed professional briefings prior to major conferences. The student attendance was invaluable to the professionals as well. The keynote session included opening remarks by Allen Arrington, AIAA vice president – standards on the AIAA governance changes. The invited keynote speaker was Lt. Col. Tucker "Cinco" Hamilton, an AIAA distinguished lecturer. His presentation, "Making a Difference at Mach 2.0," addressed his time as a U.S. Air Force Test Pilot and his view on how to live life.

AIAA SCIENCE AND TECHNOLOGY FORUM AND EXPOSITION

9–13 January 2017
Gaylord Texan
Grapevine, Texas

AIAA SciTech 2017 is structured around the topic *Addressing Full Spectrum Disruption Across the Global Aerospace Community*. Plenary and Forum 360 sessions will address the following.

Plenary Program

- *Factors Driving Today's Disruptive Environment* — How is our current environment leading to disruption in the aerospace community?
  - Robie Samanta-Roy, Lockheed Martin Corporation (Moderator)
  - Chuck Beames, Vulcan Aerospace
  - Carissa Christensen, The Tauri Group
  - Dave Whelan, The Boeing Company
  - George Whitesides, Virgin Galactic

- *Disruptive Business Models* — How are new business models changing aerospace science and technology?
  - Dava Newman, Deputy Administrator, NASA

- *Disruptive Policy Issues: Presidential Transitions* — How will the change of administration and public policy issues impact the future research and development landscape?
  - Ann Zulkosky, Lockheed Martin Corporation (Moderator)
  - Michael D. Griffin, Schafer Corporation
  - L. G. Henry "Trey" Obering, Booz Allen Hamilton
  - Dorothy Robyn, Independent Consultant/Writer

- *Disruptive Technology Developments: Breakthroughs That Will Transform Aerospace* — What are the next big technologies that will disrupt the way we design, develop, and operate new aerospace systems?
  - Samantha Brainard, George Washington University (Moderator)
  - Danette Allen, NASA Langley Research Center
  - Neil Gershenfeld, The Center for Bits and Atoms, MIT
  - Rob High, IBM Watson
  - Robert Lutwak, Microsystems Technology Office, DARPA

- *Next-Generation Workforce* — How is disruption changing the way we educate, recruit, develop, and grow the global aerospace workforce of the future?
  - Speakers TBA

Forum 360

- CREATE Modeling & Simulation Environment
- NASA Langley Research Center, Storied Past, Soaring Future—100-Year Anniversary Historical Look at NASA Langley
- Future of the Aerospace Industry and Workforce Needs
- Green Engineering to Mitigate Climate Change
- Space Traffic Management
- Transitioning Your Idea from the Lab to Flight Test
- Managing Change During the Development of Disruptive Technologies
- NASA Innovative Advanced Concepts (NIAC): Enabling Missions from Venus to Alpha Centauri

Technical Program

More than 2,400 technical papers from more than 700 institutions in 40 countries will be presented. Technical conferences meeting as part of AIAA SciTech 2017 include:

- 25th AIAA/AHS Adaptive Structures Conference
- 55th AIAA Aerospace Sciences Meeting
- AIAA Atmospheric Flight Mechanics Conference
- AIAA Information Systems—AIAA Infotech @ Aerospace
- AIAA Guidance, Navigation, and Control Conference
- AIAA Modeling and Simulation Technologies Conference
- 19th AIAA Non-Deterministic Approaches Conference
- 58th AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference
- 10th Symposium on Space Resource Utilization
- 4th AIAA Spacecraft Structures Conference
- 35th Wind Energy Symposium

Courses and Workshops

Attend one of our continuing education courses or workshops, taking place 7–8 January, and leave with invaluable solutions that you can put to immediate use.

- 2nd AIAA Sonic Boom Prediction Workshop
- Hypersonics Test (NEW!)
- Introduction to Shock-Wave/Boundary-Layer Interactions (NEW!)
- Liquid Atomization, Spray, and Fuel Injection in Aircraft Gas Turbine Engines
- Six-Degrees-of-Freedom Modeling of Missile and Aircraft Simulations

Registration Register today! aiaa-scitech.org/register

OPTIONS	CONFERENCE RATE	EARLY MEMBER RATE	STANDARD MEMBER RATE
	AVAILABLE 12 Sep – 13 Jan	AVAILABLE 12 Sep – 19 Dec	AVAILABLE 20 Dec – 13 Jan
OPTION 1: Full Conference	$1,300	$800	$1,150
OPTION 2: Full-Time Undergraduate Students	$125	$65	$95
OPTION 3: Full-Time Graduate or PhD Students	$230	$170	$200
OPTION 4: Full-Time Retired Members	N/A	$65	$95
OPTION 5: One Day Rate	$350	$350	$350

Recognition

Join with AIAA as we celebrate our community's discoveries and achievements.

- Durand Lecture for Public Service and Luncheon
- AIAA Associate Fellows Recognition Ceremony and Dinner
- Recognition Luncheon Celebrating Achievements in Aerospace Sciences and Information Systems
- Dryden Lecture in Research
- Spacecraft Structures Lecture
- Adaptive Structures Lecture
- Structures, Structural Dynamics, and Materials Lecture
- Recognition Luncheon Celebrating Achievements in Aerospace Design/ Structures and Aerospace Literature

Women at SciTech Social Hour and Keynote

This event celebrates women's accomplishments in aerospace and aeronautics. The event is open to everyone.

Keynote: Mary "Missy" Cummings, Professor, Department of Mechanical Engineering and Materials Science, Duke University

Student Activities

Last year more than 2,000 students participated at AIAA SciTech 2016. With special events geared toward students, AIAA SciTech 2017 is the perfect place for students to meet peers, establish professional relationships, and research future employment opportunities.

Generation STEM: Discovering Aerospace through Experience

Generation STEM will be a day filled with fun and interactive educational STEM experiences for middle school students.

Rising Leaders in Aerospace

This popular multidimensional program provides multiple opportunities for networking. Updates: http://www.aiaa-scitech.org/rla.

Exposition

The Exposition Hall will be the site of several networking activities Tuesday–Thursday. Please visit aiaa-scitech.org/exposition for the latest updates.

Accommodations

AIAA has made arrangements for a block of rooms at the:

Gaylord Texan
1501 Gaylord Trail
Grapevine, Texas 76051

- Book your regular attendee hotel room. https://resweb.passkey.com/go/e93c3aaf
- Book your government rate hotel room. https://resweb.passkey.com/go/e92e2a6d

Regular rate is $204/night, plus taxes and fees. Government rate is currently $149/night, plus taxes and fees.. These rates will be available until 15 December 2016 or when the block is full.

Executive Steering Committee

- Robie Samanta Roy, Lockheed Martin Corporation (Forum General Chair
- Darryll Pines, University of Maryland
- Jill Marlowe, NASA Langley Research Center
- Pamela Melroy, DARPA
- Chuck Gustafson, The Aerospace Corporation
- Robbie Robertson, Air Force Research Laboratory (Forum 360 Chair)
- Martiqua Post, U.S. Air Force Academy (Forum 360 Deputy Chair)

Sponsors

CELEBRATE 20 YEARS
WITH A $20 DONATION

IN 2016 the AIAA Foundation is celebrating **20 YEARS** of making a direct impact in K–12 classrooms, **20 YEARS** of our hands-on STEM-focused activities, **20 YEARS** of our college scholarships, **20 YEARS** of our design competitions and **20 YEARS** of our student conferences & awards. Be part of the celebration and join us *with a $20 donation.* **AIAA IS ASKING ALL MEMBERS TO DONATE $20** with the goal of raising $200,000.

YOUR DONATION will provide leadership and resource opportunities for our future aerospace leaders.

DONATE TODAY
www.aiaafoundation.org

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FUNDS RAISED TO DATE

$178,426

GOAL
$200,000

AIAA FOUNDATION
Advancing Aerospace

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Tenured or Tenure-Track Faculty Position
Department of Aerospace Engineering

The Department of Aerospace Engineering at Iowa State University (**www.aere.iastate.edu**) invites applicants for multiple tenure-track faculty positions at the Assistant and Associate Professor level, however, exceptional candidates at the rank of Full Professor may also be considered. We seek outstanding individuals with strong research interest in two broad areas: *(1) Composite and Multifunctional Material Systems*. Research areas of interest include, but are not limited to design; failure prediction; fabrication; damage/defect detection; static/dynamic testing; and/or structural life cycle analysis and (*2) Intelligent Systems and Autonomy*. Research areas of interest include, but are not limited to software challenges in aerospace; remote sensing/intelligent sensor fusion; formal methods; autonomous control; automated crop monitoring; and classical areas of guidance, navigation, and control of both manned and unmanned vehicles in both air and space. Outstanding candidates at the rank of Full Professor whose research interest is outside the two broad areas listed above and candidates who can enhance the diversity of the department may also apply; candidates who can bring leadership and stature to the department and has the potential to greatly expand our research base will be given preference.

The successful applicant will participate in all aspects of the department's mission, including developing a strong externally funded research program, teaching and supervising students at the undergraduate and graduate levels and participation in service to the university. The department strongly emphasizes collaborative research and hence the successful candidates are expected to work in multi-disciplinary teams with other active research programs in the university, both within and outside the college of engineering, while taking advantage of the on-campus research centers and laboratories such as Virtual Reality and Applications Center (VRAC, **www.vrac.iastate.edu**), Center for Nondestructive Evaluation (**www.cnde.iastate.edu**), Ames Laboratory (**www.ameslab.gov**) and Wind Energy Manufacturing Laboratory (**www.ie.imse.iastate.edu/WEML**).

An earned Ph.D. or equivalent terminal degree in Aerospace Engineering or a closely related field is required at the start date of employment. Underrepresented minorities and women are strongly encouraged to apply. Candidates at the level of Associate or Full Professor must demonstrate a strong record as evidenced by a quality research program, publications, professional recognitions, and scholarly impact. Candidates are required to have credentials commensurate with teaching undergraduate and graduate classes in engineering.

Iowa State University is classified as a Carnegie Foundation Doctoral/Research University-Extensive, a member of the Association of American Universities (AAU), and ranked by *U.S. News & World Report* as one of the top public universities in the nation. Over 36,000 students are enrolled, and served by over 6,200 faculty and staff (see **www.iastate.edu**). Ames, Iowa is a progressive community of 60,000, located approximately 30 minutes north of Des Moines, and recently voted the best college town in the nation (see **www.visitames.com**).

The Aerospace Engineering Department currently has 39 faculty and is housed in a $50 million state-of-the-art teaching and research complex. The College of Engineering consists of 8 departments, with 250+ faculty members and annual research expenditures exceeding $88 million.

All interested, qualified persons should apply for this position online by visiting **www.iastatejobs.com**. For the Composite and Multifunctional Material Systems position please refer to posting # 600140 and for the Intelligent Systems and Autonomy position please refer to posting # 600141 while clearly stating in the cover letter the specialty research area you are applying for. Please be prepared to enter or attach the following:

1. Cover Letter
2. A detailed Curriculum Vitae
3. Full contact information for at least three references
4. A concise statement of research plans and teaching interests

Interested candidates are encouraged to apply early. To ensure full consideration, applications must be received by November 1, 2016. Review of applications after this date will continue until the position is filled. All offers of employment, oral and written, are contingent upon the university's verification of credentials and other information required by federal and state law, ISU policies/procedures, and may include the completion of a background check.

If you have questions regarding this application process, please email **employment@iastate.edu** or call 515-294-4800 or Toll Free: 1-877-477-7485.

Iowa State University is an Equal Opportunity/Affirmative Action employer. All qualified applicants will receive consideration for employment without regard to race, color, age, religion, sex, sexual orientation, gender identity, genetic information, national origin, marital status, disability, or protected veteran status, and will not be discriminated against. Inquiries can be directed to the Director of Equal Opportunity, 3350 Beardshear Hall, 515 Morrill Road, Ames, Iowa 50011. Tel. (515) 294-7612.

University of Minnesota
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Aerospace Engineering and Mechanics
UNIVERSITY OF MINNESOTA

The Department of Aerospace Engineering and Mechanics seeks to fill one or more faculty positions in aerospace systems. Applications are invited in all areas of aerospace systems, particularly those that complement current research activities in the department. These research activities include but are not limited to control system analysis and design; state estimation; multi-sensor fusion; dynamics; and guidance, navigation and control of aircraft, spacecraft and autonomous aerial vehicles. The department has close ties with other departments and on-campus multidisciplinary centers. In addition, the department has access to excellent experimental and computational facilities. Information about the department is available at http://www.aem.umn.edu/

The successful candidate will participate in all aspects of the Department's mission, including teaching undergraduate and graduate courses in aerospace engineering mechanics and aerospace systems; supervision of undergraduate and graduate students; service responsibilities; and developing an independent, externally funded research program.

Applicants must have an earned doctorate in a related field by the date of appointment. The intent is to hire at the assistant professor rank. However, exceptional applicants may be considered for appointment at the rank of associate professor with or without tenure. It is anticipated that the appointment will begin fall 2017.

To apply for this position, candidates must apply on-line at:

http://humanresources.umn.edu/jobs and search for Job ID No. 312589; or visit: http://z.umn.edu/17ts

If searching for the Job ID number, it may be necessary to broaden the "Jobs Posted Within" range.

Please attach your cover letter, detailed resume, names and contact information of three references, and a statement of teaching and research interests as one PDF.

The initial screening of applications will begin on **December 1, 2016**. Applications will be accepted until the position is filled.

The University of Minnesota is an equal opportunity educator and employer.

San Diego State University
Leadership Starts Here

Aerospace Engineering
San Diego State University
Faculty Position

The Department of Aerospace Engineering invites applications for a tenure-track faculty position at the Assistant Professor level. A preference will be given to applicants in spacecraft systems. The areas of interest include but are not limited to: guidance, navigation, control, autonomy, space robotics, and small satellites. Exceptional candidates in other areas of aerospace engineering including propulsion and structures will also be considered. The faculty member will be expected to develop a vigorous, externally funded research program in his/her area of expertise, while teaching undergraduate and graduate courses in Aerospace Engineering. Applicants must have an earned PhD in Aerospace Engineering or a closely related field. Recent graduates as well as those with industrial or university experience are welcome to apply.

The department offers the BS and MS degrees in Aerospace Engineering and participates in Joint Doctoral programs with the University of California, San Diego, and Claremont Graduate University. Southern California offers exceptional opportunities for research partnerships with its extensive aerospace industry. Additional information about the university and department may be obtained at http://www.sdsu.edu and http://aerospace.sdsu.edu. Initial review of applicants begins November 15, 2016, and will continue until the position is filled. Expected start date is August 2017. Applicants should apply via Interfolio at https://apply.interfolio.com/36836. Inquiries should be directed to Prof. Ping Lu, Department Chair, plu@sdsu.edu.

SDSU is a Title IX, equal opportunity employer.

Embry Riddle Aeronautical University
Department of Aerospace Engineering Faculty Position

The Department of Aerospace Engineering at Embry-Riddle Aeronautical University in Daytona Beach, Florida has an ambitious agenda for the next five years, focused on expanding graduate programs, research capabilities, facilities, and recruiting highly talented faculty. A new state-of-the-art engineering building housing research laboratories including a new wind tunnel and supporting facilities is under construction and will be completed by the spring of 2017 in support of this agenda.

The Department invites applications for a faculty position at the Assistant or Associate Professor rank, although an appointment at the Professor level may be considered. Successful candidates for the Assistant rank should demonstrate a potential to establish and grow a strong research program and to excel at teaching and mentoring. Applicants for the Associate rank should have an exemplary record of teaching and scholarly activities including externally funded research. Appointment at the Professor rank may be considered for individuals with exceptional qualifications and national recognition. The preferred area of expertise is Dynamics and Control, with specialization in Astronautics and Space Applications. However, applicants in all areas of Aerospace Engineering will be considered. The intended start date is August 2017.

Current research thrust areas of the Department include: aeroacoustic modeling, rotorcraft aerodynamics, flow control, air-breathing hypersonic and rocket propulsion, autonomous unmanned air and ground vehicles, aircraft and spacecraft guidance, navigation and control, aeroelasticity, composites, nanomaterials, smart materials, structural health monitoring, computational structural mechanics, and design optimization.

The Department offers bachelors, masters, and Ph.D. degrees. The undergraduate program is the nation's largest, with 1300 full-time students, and has been ranked # 1 in its category by U.S. News and World Report for the past sixteen years. Embry-Riddle Aeronautical University, the world's largest, fully-accredited university specializing in aviation and aerospace, is a nonprofit, independent institution offering more than 70 baccalaureate, master's and Ph.D. degree programs.

An earned Doctorate in Aerospace Engineering or a closely related field is required. Women and underrepresented minorities are especially encouraged to apply. Applicants must submit a cover letter, a curriculum vitae, a detailed research and teaching plan, and the names of at least three references. For more information about the position and application process, please visit our careers site http://careers.erau.edu and view requisition #160296. For assistance, please email: eraujobs@erau.edu.

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Livestream.com/AIAAvideo

Stanford | ENGINEERING

Faculty Opening

STANFORD UNIVERSITY

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

The Department of Aeronautics and Astronautics at Stanford University invites applications for a tenure track faculty position at the Assistant or untenured Associate Professor level. We will also consider senior candidates with outstanding research and teaching track records.

Research advances in the fundamental areas of aerospace engineering are critical for future air and space transportation systems that will provide efficiency, safety, and security, while protecting the environment. We are seeking exceptional applicants who will develop a program of high-impact research, contribute to an innovative undergraduate curriculum, and develop graduate courses at the frontier of areas such as aerospace system design, autonomous vehicle technologies, and breakthroughs in aerospace propulsion concepts. We will place higher priority on the impact, originality, and promise of the candidate's work than on the particular sub-area of specialization within Aeronautics and Astronautics.

Evidence of the ability to pursue a program of innovative research and a strong commitment to graduate and undergraduate teaching is required.

Candidates whose research programs in Aeronautics and Astronautics will involve the development of sophisticated computational and/or mathematical methods may be considered for an appointment with an affiliation with the Institute for Computational and Mathematical Engineering (http://icme.stanford.edu/).

All candidates should apply online at https://aa.stanford.edu/job-openings. Applications should include a brief research and teaching plan, a detailed resume including a publications list, and the names and addresses of at least five references. Applications will be accepted until the position is filled. However, the review process will begin on January 1, 2017.

Stanford University is an equal opportunity employer and is committed to increasing the diversity of its faculty. It welcomes nominations of and applications from women, members of minority groups, protected veterans and individuals with disabilities, as well as from others who would bring additional dimensions to the university's research, teaching and clinical missions.

MICHIGAN AEROSPACE

FACULTY SEARCH

COLLEGE OF ENGINEERING
AEROSPACE ENGINEERING
UNIVERSITY OF MICHIGAN

The Department of Aerospace Engineering at The University of Michigan invites applications for multiple tenure-track/tenured faculty positions in all areas of Aerospace Engineering. We are seeking exceptional candidates who will develop a world-class research program and innovative educational experiences for our students. This is a broad search and, while we will consider all levels, preference will be given to junior-level applicants.

The Aerospace Engineering Department completed its 100th anniversary in 2014 and our undergraduate and graduate programs continue to be among the very best in our nation. Research interests of the faculty cover a broad spectrum of topics including high-performance multiphysics computational sciences, aerostructures, smart structures and materials, flight dynamics and control, avionics and software systems, multidisciplinary design optimization, propulsion, combustion, and sustainable energy with a mix of air and space applications. More information about the department can be found at aerospace.engin.umich.edu. Applicants should have earned a doctoral degree in Aerospace Engineering or a closely related field. The successful candidate will be expected to participate in all aspects of the Department's mission, including the development of a strong and relevant externally funded research program, the teaching of undergraduate and graduate courses, and the supervision of graduate students.

Please prepare a single PDF file to the Faculty Search Committee that contains the curriculum vita, statements of research and teaching interests, three representative publications, and the names and contact information of five references and submit it at: **http://www.engin.umich.edu/aero/about/new-faculty-search**. The evaluation process will start in the Fall of 2016 and will continue until the positions are filled.

The University of Michigan is an equal opportunity/affirmative action employer with an active dual-career assistance program. The college is especially interested in candidates who can contribute, through research, teaching, and/or service, to the diversity and excellence of the academic community.

Princeton University Department of Mechanical & Aerospace Engineering

School of Engineering and Applied Science

Lecturer

PRINCETON
Mechanical and Aerospace Engineering

The Department of Mechanical & Aerospace Engineering (MAE) seeks to appoint a full- time Lecturer for the 2017-18 academic year. The Lecturer will have full-time teaching responsibilities central to the undergraduate program in the Department that will generally involve teaching 4 courses per year:

- planning, coordinating and teaching 2 undergraduate courses and/or laboratories each semester;
- teaching coverage of undergraduate courses for faculty who are on leave;
- mentoring and advising of undergraduate student independent work.

Princeton's MAE department has a long history of leadership in its core technical areas and seeks applicants with the willingness and ability to teach foundational courses as needed. Applicants with interest and experience in, and enthusiasm for, aeronautics and astronautics, design and manufacturing, and robotics are encouraged to apply.

The Lecturer will have the opportunity to interact with faculty, researchers and students, as well as to participate in the various outreach activities of the department, mentoring students on career development and serving on committees for the Department. We seek applicants who will create a climate that embraces excellence and diversity, with a strong commitment to teaching and mentoring, and who will incorporate creative approaches to teaching that enhance the student learning experience.

The successful candidate must have a PhD in Engineering, Materials Science, Physics or related fields, and classroom teaching experience with demonstrated excellence designing and teaching a variety of courses. Candidates should be accomplished educators who have teaching experience with a focus on undergraduate education.

Preferred qualifications are evidence of a successful teaching record, a track record of mentoring undergraduate students in innovative design and/or research assignments and CAD/CAE and/or manufacturing experience. Industrial experience is desired however not required.

Lecturers may be appointed for up to 3 year terms, with possibility of renewal. Part time appointments may be considered.

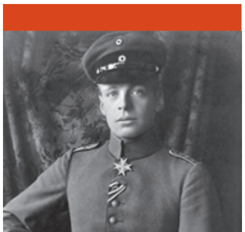
Review of applications will continue until the position is filled. Applicants should submit a curriculum vitae, a 1-2 page teaching and research interest statement, evidence of teaching effectiveness and contact information for at least three references online at http://jobs.princeton.edu, reference number 1600594.

Princeton University is an equal opportunity employer and all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, disability status, protected veteran status, or any other characteristic protected by law. This position is subject to the University's background check policy.

1916

Oct. 1 The German dirigible L. 31 is destroyed over London during a bombing raid. All on board are killed, including its commander, Kapitänleutnant Heinrich Mathy. A. van Hoorebeeck, La Conquete de L'Air, p. 120.

Oct. 12 Royal Naval Air Service pilot Raymond Collishaw downs the first of his eventual 60 German aircraft, mostly while Collishaw flew his Sopwith Triplane over the Western Front. He survives the war as the third leading ace of the British Empire and continues to serve through World War II. David Baker, Flight and Flying, A Chronology, p. 91.



Oct. 28 Famed German ace and pioneering air combat tactician Oswald Boelcke dies after he collides with a fellow pilot while attempting to avoid a British fighter that crossed too closely in front of them. David Baker, Flight and Flying, A Chronology, p. 91.

1941

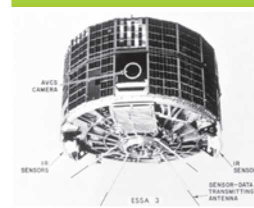
Oct. 1 Hawaii's Inter-Island Airways, established in 1929, changes its name to Hawaiian Airlines. The company has taken delivery of three new Douglas DC-3 transports to supplement its Sikorsky S-43 twin-engined amphibians. R.E.G. Davies, Airlines of the United States Since 1914, p. 316.

Oct. 2 German test pilot Heini Dittmar sets a new absolute speed record for aircraft while piloting the revolutionary Messerschmitt Me 163 rocket-propelled interceptor. Launched from an altitude of 12,000 feet, the Me 163 flies for more than four minutes before exhausting its fuel. Dittmar breaks the 1,000-kph milestone when the aircraft reaches 1,004.5 kph. J.R. Smith and Antony Kay, German Aircraft of the Second World War, p. 511.

Oct. 9-16 The first active test of a permanent air defense system for the entire U.S. takes place. Participants include nearly 40,000 civilian observers of the Aircraft Warning Service along with Army planes and anti-aircraft gunners. These regiments fire 76-millimeter and 37-millimeter anti-aircraft guns and rely on searchlights to spot mock enemy bombers. All parties are linked by an intricate communication network. About 400 planes of all combat types are deployed and travel some 3 million kilometers over 1,800 observation posts. Aviation, Nov. 1941, p. 115.

Oct. 10 The British Admiralty announces that certain escort vessels and merchant ships will be fitted with catapult installations and carry a fighter airplane to defend convoys against enemy bombers. When near British coasts, the aircraft will be launched to escort the ships and land at British airfields at the end of their missions. Interavia, Oct. 13, p. 19.

1966



Oct. 2 The third Environmental Survey Satellite is launched for the U.S. Department of Commerce by a Thor-Delta booster, the first launch of a Thor-Delta from the Western Test Range at Vandenberg Air Force Base in California. The mission of the 147-kilogram satellite is to obtain global cloud-cover photos and to measure the Earth's heat balance. New York Times, Oct. 3, p. 11; Flight International, Oct. 6, p. 610.

Oct. 2 The twin-jet sweptwing corporate transport Grumman Gulfstream 2, with coast-to-coast range, makes its first flight when it takes off from Grumman's plant at Bethpage, New York. The 30-passenger transport has a top speed of 941 kph. The Gulfstream 2 becomes highly popular, with 258 produced up to the late 1970s. Aviation Week, Oct. 10, p. 33.

Oct. 9 Leslie Irvin, developer of the famous Irvin parachutes, dies at 71 in his native Los Angeles. Irvin made his first jump from a balloon at age 14 (other references say 16). In 1914, as a stunt man, he first jumped from an aircraft at 985 feet for a silent film called "Sky High." From 1918, Irvin began developing his own static line parachute and jumped with it several times. In the following year he formed his own firm and over the years developed parachutes credited with saving some 250,000 lives, including 40,000 during World War II. His parachutes had been adopted by both the U.S. air forces and the Royal Air Force. Irvin lived in Britain from 1926 to 1949. Flight International, Oct. 20, p. 661.

Oct. 15 On this final day of the 17th International Astronautical Federation Congress held in Madrid, Spain launches its first sounding rocket, the Carabela 4, from the Arenosillo base, near Huelva, in southern Spain. The British-built rocket carries a 5.5-kg scientific payload up to a 265,000-foot altitude. This is the first of a program of six rockets to gather meteorological data within the 158,000-to-318,00-feet region. New York Times, Oct. 16, p. 78.

Oct. 20 The USSR orbits its fourth Molniya communication satellite, the Molniya 1D, and the first equipped with a television camera. The launch at the Baikonur Cosmodrome in Kazakhstan is witnessed by leaders from eight Communist-bloc nations. The Cosmos 130 scientific satellite is launched on the same day. From Nov. 9, people in the far eastern territories of the country are able to watch television programs as relayed from Moscow via the Molniya. David Baker, Spaceflight and Rocketry, p. 201; Flight International, Oct. 27, p. 733; Aviation Week, Oct. 24, p. 40.

Oct. 22 The USSR launches its Luna 12 spacecraft toward the moon, which enters lunar orbit and then transmits a series of TV images of the lunar surface. These transmissions cease on Jan. 19, 1967, after 602 lunar orbits. Aviation Week, Oct. 31, p. 39 and Nov. 7; David Baker, Spaceflight and Rocketry, p. 201.

Oct. 27 The Intelsat 2-A communication satellite is launched by a three-stage Thrust-Augmented Improved Delta booster from Cape Canaveral, Florida, and is eventually placed in a geostationary orbit. This is the Communication Satellite Corp.'s first satellite designed to provide both transatlantic and transpacific communication satellite coverage. The 87-kilogram satellite also is to help the upcoming Project Apollo in providing capability for live transpacific TV broadcasts of Apollo recovery operations in the Pacific. The satellite is nicknamed Lani, Hawaiian for heavenly bird. David Baker, Spaceflight and Rocketry, p. 201.

Oct. 26 The Atlas-Centaur 9 is launched from Cape Kennedy and successfully demonstrates the restart of its Centaur liquid oxygen/liquid hydrogen second stage while in parking orbit. During this mission, the Centaur first burns for 326 seconds to arrive at the parking orbit, then after a coasting period of 23 minutes the Centaur is re-ignited for an additional 107 seconds and injects a 725-kilogram dummy payload, a model of a Surveyor spacecraft, into a lunar transfer orbit. Flight International, Oct. 27, p. 734 and Nov. 3, p. 773.

Oct. 29 NASA Jet Propulsion Laboratory sends a radio signal to the Lunar Orbiter 1 spacecraft to ignite a velocity control rocket so that the spacecraft will drop out of its lunar orbit and fall onto the moon. Lunar Orbiter 1 has completed its photographic mission around the moon and NASA wants to assure radio signals from the spacecraft will not interfere with Lunar Orbiter 2 that is soon to be launched. Shortly later, Lunar Orbiter 1 impacts upon the far side of the moon. Aviation Week, Nov. 7, p. 69.

1991

Oct. 2 The USSR's Soyuz TM-13 is launched, with Toktar Aubakirov of the Kazak Republic and Franz Viehboeck of Austria onboard. They dock with the Mir space station. This mission turns out to be the last conducted by the former Soviet Union. NASA, Astronautics and Aeronautics, 1991-1995, p. 683.

Oct. 25 Airbus Industries announces the completion of the first flight of its new long-range A340 widebody jetliner. The A340 shares its fuselage with its twin-engine A330. The A340 has four GE/SNECMA CFM56 high-bypass turbofans that are particularly suited for operating long distances over water. The first flight lasts 3 hours and 40 minutes. Launch customer Lufthansa is expecting delivery of its first aircraft in January 1993. David Baker, Flight and Flying, A Chronology, p. 486.

RUBÉN DEL ROSARIO, 49

Manager, Advanced Air Transport Technology Project at NASA Glenn Research Center in Cleveland.

In 2015, 3.44 billion people worldwide traveled by airplanes. Traffic among U.S. carriers rose fivefold from 1970. Yet even today, the vast majority of those flights are powered by petroleum, specifically kerosene-based jet fuel for turbine engines. It's Rubén Del Rosario's job to do something about it. He leads the group at NASA focused on generation-skipping technologies for fixed-wing subsonic commercial aircraft. The challenge: Pursue cleaner, leaner and quieter alternatives to conventional turbofan engines.

How did you become a NASA researcher?

I grew up in Puerto Rico, where I developed a passion for sports, particularly baseball, volleyball and basketball. While others were perfecting their shot or hitting, I kept wondering how a curveball worked or why shooting the ball with a backward spin made for better shots. That led me to my interest in becoming an engineer, always with an interest in airplanes, but I wasn't clear on how to pursue a career in this field. It wasn't until I registered for a workshop on aeropropulsion that a professor first talked to me about NASA Lewis Research Center (now NASA Glenn) and its history in propulsion research and development. My dream started to take shape soon after, when recruiters from NASA Lewis visited the University of Puerto Rico and I was recruited as a test engineer. Since then, I have had the privilege of leading one of NASA's largest research projects, and I'm currently part of NASA's Senior Executive Service Candidate Development Program. I've been rotating through various jobs for the last 18 months and looking forward to future leadership opportunities.

What management advice do you try to follow?

The first was probably from my own parents, who advised me to "always assume that people are trying to do their best and mean well, even if they fail to do it." Recently, I heard a senior NASA leader say, "always assume good intent." This has protected me from falling into wrong first impressions. The same official also talked about the importance of "listening without the intent of talking." I believe that the majority of the time, the primary cause of failed communication is not in transmission, but in receiving.

Imagine it's 2050. How do jetliners differ from those flying today?

There will be aspects of aviation that will be absolutely different than today and others in which the advances will not be quite visible to the naked eye. The airplanes of the future will not be the traditional tube-and-wing configurations, but highly integrated propulsion and airframes systems. These will be hybrid electric propulsion airplanes using less than a third of the fuel and energy of today's airplanes, with negligible pollution and so quiet that they cannot be heard outside of the airport's perimeters. They also will be more autonomous, largely eliminating human-induced accidents. ★