AEROSPACE

★ ★ ★ AMERICA ★ ★ ★

NASA'S BOOM BUSTER

X-59 will soon target noise pollution as the first step toward supersonic travel PAGE 22

PAGE 16

50 years after Apollo 17

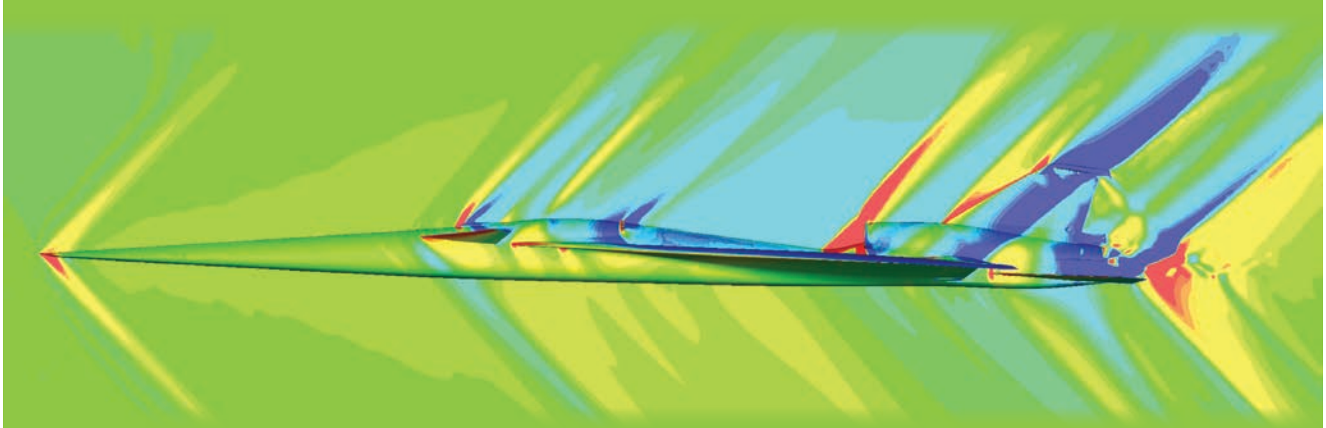
Our future in space in the words of Jack Schmitt and some of those who helped carry out the last moon landing

NOVEMBER 2022 | A publication of the American Institute of Aeronautics and Astronautics | aerospaceamerica.aiaa.org

AIAA
SHAPING THE FUTURE OF AEROSPACE

NASA's X-59 is designed to minimize the shockwaves produced by the nose and tail sections of the aircraft. The highest-pressure shockwaves are shown in red in this computational fluid dynamics simulation.

NASA



On the cover: NASA's X-59 undergoes stress tests at Lockheed Martin's Fort Worth, Texas, facility in early 2022. At 11.5-meters long, the pencil-like nose that makes up one-third of the aircraft's length helps prevent the formation of shockwaves that create the iconic sonic booms during supersonic flight.

Lockheed Martin


UPCOMING ONLINE COURSES
ADVANCE YOUR CAREER
AIAA online short courses help you stay sharp while strengthening your knowledge base. We're committed to assisting in your professional development and maximizing your success year-round. Learn from the industry's leading experts. Member and student member pricing available.
eVTOL Infrastructure Considerations for Advanced Air Mobility
Starts 1 November 2022
Designing Better CubeSats Using System-Level Simulations
Starts 1 November 2022
Practical Design Methods for Aircraft and Rotorcraft Flight Control for Conventional Civil/Military, UAV, and AAM Applications with Hands-on Training using CONDUIT®
Starts 5 December 2022
Space Mission Operations
Starts 30 January 2023
AI for Air Traffic Safety Enhancement
Starts 7 February 2023
Complex Systems Competency
Starts 15 February 2023
Technical Writing Essentials for Engineers
Starts 21 February 2023
Design of Space Launch Vehicles
6 March 2023
Agile Systems Engineering
Starts 13 March 2023
Can't attend the live online lectures?
Most courses are available on demand.
ENROLL TODAY
learning.aiaa.org
AIAA
SHAPING THE FUTURE OF AEROSPACE

AEROSPACE
★ ★ ★ AMERICA ★ ★ ★

NOVEMBER 2022,
VOL. 60, NO. 10

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

ASSOCIATE EDITOR
Cat Hofacker
catherineh@aiaa.org

STAFF REPORTER
Paul Brinkmann
paulb@aiaa.org

EDITOR, AIAA BULLETIN
Christine Williams
christinew@aiaa.org

CONTRIBUTING WRITERS
Moriba Jah, Jon Kelvey, Paul Marks, Andrea Valentino, Robert van der Linden, Debra Werner, Frank H. Winter

Laura McGill **AIAA PRESIDENT**
Daniel L. Dumbacher **PUBLISHER**
Rodger Williams **DEPUTY PUBLISHER**

ADVERTISING
advertising@aiaa.org

ART DIRECTION AND DESIGN
THOR Design Studio | thor.design

MANUFACTURING AND DISTRIBUTION
Association Vision | associationvision.com

LETTERS
letters@aerospaceamerica.org

CORRESPONDENCE
Ben Iannotta, beni@aiaa.org

Aerospace America (ISSN 0740-722X) is published monthly except in August by the American Institute of Aeronautics and Astronautics Inc., at 12700 Sunrise Valley Drive, Suite 200 Reston, VA 20191-5807 [703-264-7500]. Subscription rate is 50% of dues for AIAA members (and is not deductible therefrom). Nonmember subscription price: U.S., $200; foreign, $220. Single copies $20 each. Postmaster: Send address changes and subscription orders to Aerospace America, American Institute of Aeronautics and Astronautics, at 12700 Sunrise Valley Drive, Reston, VA, 20191-5807, Attn: A.I.A.A. Customer Service. Periodical postage paid at Reston, Virginia, and at additional mailing offices.

IN THIS ISSUE

Moriba Jah

Moriba is an associate professor at the University of Texas at Austin and chief scientist at Privateer. He helped navigate spacecraft at NASA's Jet Propulsion Lab and researched space situational awareness issues at the U.S. Air Force Research Laboratory. PAGE 64

Jon Kelvey

Jon covers space for The Independent in the U.K. His work has appeared in Air and Space Magazine, Slate, Smithsonian and the Washington Post. PAGE 9

Paul Marks

Paul is an award-winning journalist focused on technology, cybersecurity, aviation and spaceflight. A regular contributor to the BBC, New Scientist and The Economist, his current interests include eVTOL aircraft, new space and the history of notable inventors — especially the Wright brothers. PAGE 22

Andrea Valentino

Andrea is a New York-based reporter and editor who has written about topics ranging from endangered alphabets to the future of drones. His work has appeared on the BBC and in the Economist, among other publications. PAGE 34

Debra Werner

A longtime contributor to Aerospace America, Debra is also a West Coast correspondent for Space News. PAGE 16

DEPARTMENTS

It's time to replace those hurricane cone graphics

National Hurricane Center

◀ An astronaut aboard the International Space Station took this photo of Hurricane Ian on Sept. 26 as the storm approached Cuba's west coast. The storm reached Florida on Sept. 28. NASA

Each hurricane season, terabytes of temperature, humidity and pressure collections from satellites and hurricane hunter aircraft are fed into forecasting models and ultimately boiled down into the famous hurricane forecasting cones published online by the National Hurricane Center and adapted by local television forecasters.

The collective experience with those cones this hurricane season should prove once and for all that the cones are a dangerous failure as a communications tool. When Hurricane Ian plowed into the west coast of Florida in September, too many residents either ignored warnings to evacuate or decided that local authorities issued them too late to do so.

The decision about whether to leave is a complicated one. Evacuating is expensive. False alarms are common. Getting back home after a storm can be hard. So, every bad decision should not be attributed to the hurricane cones alone. But no one wants to evacuate, and the cones sometimes provide false justification for staying.

Here's how: The spread of the cone depicts the uncertainty about where the center of the storm will go as forecasters look to the future. So far, so good, but then the Hurricane Center puts a string of black dots in the middle of the cone to represent the center, or eye, of the storm and its probable track. That's part of the communications mistake. Here at Aerospace America we make a lot of graphics, and those dots are exactly the tactic I would recommend if the goal were to draw the viewer's attention to the center of the cone, rather than the entirety of it. The implication is that if the track isn't aiming for you, there's no need to leave.

For public safety, the goal should be to draw the viewer's attention to the uncertainties. Forecasters are never certain of the path days ahead, or even that the path will stay in the cone. About a third of the time, it doesn't, and Ian was almost one of those cases.

"The landfall location of Hurricane Ian's center ultimately stayed within or on the edge of the cone throughout the forecast cycle," said Jamie Rhome, acting director of the National Hurricane Center, in an in-house writeup. The center's media shop directed me to this page when I asked to speak to a cone expert, explaining that there is "high demand" for interviews about the cone after Ian.

The cones also feed our fixation with the impressive winds around the center of a storm. As Ian shows, we ought to be focusing at least as much, if not more, on the frightening bulge of water that a hurricane drives toward a coastline. This storm surge proved to be the most deadly aspect of Ian. Warnings of the surge were given, but not on the cone graphics that are so iconic for those living in the danger zones.

There must be a better approach, and hopefully the center is working on one. My idea would be to shift to four arrows that would cover the same span as the old cones. Each arrow's shape would gradually spread to reflect growing track uncertainty ahead in time. Why four arrows? Because then there's no center line to fixate on. Those arrows could be laid on top of a representation of the surge potential. This way, the surge and potential paths of the storm would be shown on one graphic. For those who have to know where forecasters think the eye is most likely to go, that information should be released as text on the center's website.

That's just one idea, and there are probably better ones. Whatever happens, the Hurricane Center needs to move away from highlighting the center track on television screens in every tiki bar in a storm's potential path. ★

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

CLARIFICATION

The introduction to our September Q&A with Ryan Hartman should have been clearer about World View's role in Alan Eustace's 2014 skydive. World View was a member of the team whose stratospheric balloon hoisted Eustace for his skydive, and World View is relying on the same technology for its balloon, shown here. The Q&A has been updated online.

Investing in the Future: AIAA Foundation Day of Giving

It is my honor to serve as the chair of the AIAA Foundation. For over 35 years, AIAA has made a huge impact on my life and professional development. From getting involved in the AIAA Student Branch at North Carolina State University to leading the Institute as its president, and all that came in between, my career has been enabled by AIAA. Today as I continue my involvement, my goal is to ensure we invest in the future through the Foundation.

The Foundation was created over 25 years ago to inspire the next generation of aerospace professionals. We are working every day to impact students and educators where their aspirations begin. We know the significant influence classroom teachers can have on students, making them aware of the possibilities and igniting a spark to consider a career in a STEM field. It's through the Foundation that we make funding available for programs to reach students through educators, providing valuable experiences that rouse their curiosity about space, nurture their passions around STEM topics, and move them along a classroom journey that could lead to an exciting career.

> "Being part of this fantastic opportunity gives hope to my dreams. Receiving the Diversity Scholarship will bring so much knowledge and experience that will help me dive more into a world that young women are deterred from pursuing in my home country."
>
> – Andrea Galvan, student, University of Texas at El Paso, 2022 AIAA AVIATION Forum Diversity Scholar

This year we have a special opportunity to make an investment in the next generation by contributing to the AIAA Foundation Day of Giving on 17 December, as we honor the past on the anniversary of the Wright Brothers' first flight while looking toward the future.

It's important to know more about how the Foundation is impacting young people. The Foundation provides support to university students in many ways: Student Conferences, Diversity Scholars Program, Design Competitions, Design/Build/Fly, and scholarships and grants. The Foundation gives $100,000 annually in scholarships and graduate awards. These scholarships are incredibly meaningful to me, having worked with my late father to establish a graduate award in the aerospace program he helped start at North Carolina State University, the Dr. Hassan A. Hassan Graduate Award in Aerospace Engineering. After his death, I doubled the impact of his scholarship by donating to add an extra recipient annually.

We also have formed some exciting new partnerships that we believe are going to enhance our efforts to reach students even earlier at the K-12 level.

The ExGen program is the product of a partnership with AIAA Corporate Member Estes Rockets and the National Science Teaching Association (NSTA) and provides K-12 educators with free, engaging, classroom-ready lessons and curriculum storylines to help immerse students in real-life applications of STEM while exploring various concepts in aerospace, engineering, and rocketry. The first full unit was launched in October. Learn more at **nsta.org/exploration-generation**.

Students To Launch (S2L) is a new program, created in partnership with First Light, Griffin Communications Group, and Oregon State University, that inspires middle and high school students with the wonders of space. With a focus on those in underrepresented and underserved communities, S2L invites students from across the country to engage in NASA mission-inspired events – from hands-on afterschool activities to attending rocket launches at NASA Kennedy Space Center. Our goal is to give these students the chance to see themselves in exciting STEM-focused careers.

I invite you to read more about the impact of the AIAA Foundation on the website at **aiaa.org/foundation**.

2022 AIAA Foundation Day of Giving

The Foundation will honor the anniversary of the Wright Brothers' first flight on 17 December with its first-ever Day of Giving. We are using the inspiration from this incredible accomplishment in the past to inspire the future. Please consider how you might make your mark on our profession. I hope each of you will join me in contributing toward our goal of raising $75,000 to develop the next generation of aerospace leaders.

As I said when my term ended as AIAA President and I became AIAA Foundation Chair, I believe that AIAA's future is bright! With your generosity, the Foundation can continue supporting students and teachers, thereby inspiring more young people to pursue aerospace careers. Enjoy reading the testimonials on AIAA social media channels leading up to the Day of Giving to feel the impact the Foundation has had on so many students. ★

Basil Hassan
AIAA Foundation Chair

AERO PUZZLER

Email us at
aeropuzzler@aerospaceamerica.org

A Christmas surprise

Q: It's the future. Mr. Grinch has a cousin in the United Kingdom whose heart is still several sizes too small. This Mr. Grinch prefers flying, and he has decided to upgrade to a jet. Being a Grinch, he sets out from his lair to find the loudest, dirtiest engine he can. Sneaking into a warehouse, he finds a huge engine that says "Ultra . . ." on it, but he can't quite make out the rest in the darkness. He shrugs, assuming "ultra" must mean big, and big must mean loud and dirty. What engine has he found, and is this another stroke of evil genius?

SEND A RESPONSE OF UP TO 250 WORDS that someone in any field could understand to aeropuzzler@aerospaceamerica.org by noon Eastern Nov. 14 for a chance to have it published in the next issue.

Get a head start on the December AeroPuzzler: Scan this QR code or follow us @AeroAmMag

FROM THE OCTOBER ISSUE

ROVER MYSTERY:

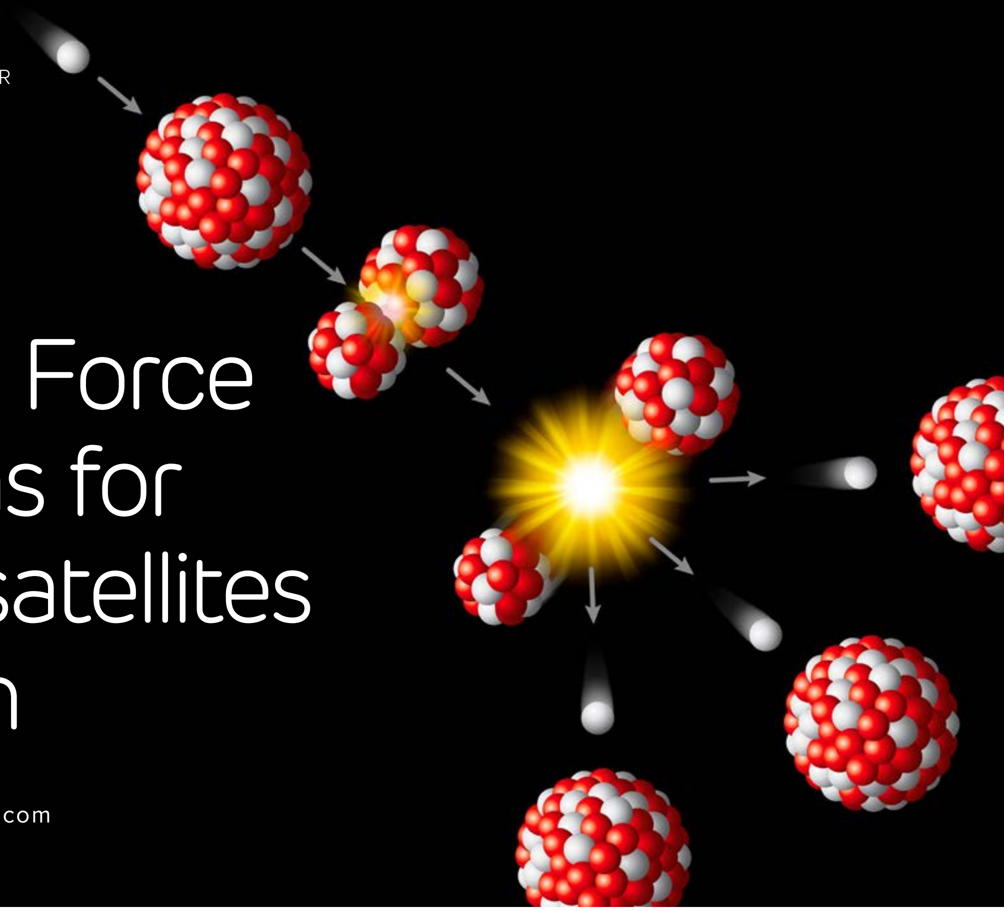
We asked you to explain why a rover's tracks are raised rather than sunken in the sands of a watery exoplanet.

WINNER The sand is probably moist with sea water and behaves like a non-newtonian dilatant fluid and thus, "Unlike most other solid materials, the tendency of a compacted dense granular material is to dilate (expand in volume) as it is sheared," as explained on Wikipedia [https://en.wikipedia.org/wiki/Dilatancy_(granular_material)]. As the rover moves, the sand expands, and thus the tracks are elevated.

George Kyriakou, AIAA Young Professional member
New York, New York
george.kyriakou@botfactory.co

Kyriakou is chief operating officer at BotFactory, a New York startup that additively manufactures circuits.

More about sand: Here is a expanded explanation I crafted after corresponding with civil engineer Stein Sture, principal investigator for the Mechanics of Granular Material experiments flown on two space shuttle missions in the 1990s and the ill-fated Columbia mission in 2003. In between the grains of sand are water molecules. When compressed, the sand in the structure of the imprint comes into tighter contact with those molecules. The result is a capillary effect in which the water molecules adhere to the sandy walls around them and align with each other to create surface tension. The combined effect supports and dilates the structure of the print. Meanwhile, the surrounding moist sand is not compressed, so those water molecules evaporate and drain away, and the sand sinks. Now you have a raised track instead of a sunken one. — *Editor-in-chief Ben Iannotta*



U.S. Space Force wants ideas for powering satellites with fission

BY JON KELVEY | jonkelvey@gmail.com

When it comes to the U.S. Space Force's technology wish list, one element comes up on top: "We want higher power in space," says Space Force Lt. Col. Thomas Nix, an engineer with the Air Force Research Laboratory in New Mexico.

But not just any kind of power.

Nix is the program manager for JETSON, short for Joint Energy Technology Supplying On-Orbit Nuclear Power, within AFRL's Space Vehicles Directorate. The goal, Nix says, is to survey existing nuclear technologies and then contract with industry toward building a prototype of "a spacecraft that has a fission power source" for flight testing.

Fission-powered satellites would free military planners from constantly worrying about the position of a spacecraft's solar arrays relative to the sun, Nix says. Also, solar arrays deliver constant but limited wattage, and this electricity must be stored in heavy batteries. Fission reactors can vary their output to potentially deliver additional electrical power when needed to drive more powerful sensors and instruments without the need for batteries.

"Today, if we need a higher power, you have to either scope the higher power into the solar panel design," Nix says, "or you have to carry batteries to store that power and then push it to the electrical system."

Nuclear fission could also provide long-term stability for surveillance satellites that would otherwise lose power over time as their solar panels degrade, he adds.

JETSON is expressly not a nuclear propulsion program, however. NASA is exploring nuclear electric propulsion, in which electricity is generated to drive an ion thruster, while DARPA's Demonstration Rocket for Agile Cislunar Operations program, or DRACO, is focused on nuclear thermal propulsion, in which a fission reactor heats and expels propellant from a spacecraft. "We got a briefing from them on that," Nix says, "and we didn't feel that we needed to duplicate any of their efforts."

But DRACO and NASA might benefit from JETSON's work on fission, while the Space Force could make use of nuclear electric ion thrusters from NASA.

JETSON is not starting entirely from scratch; compact fission reactors have been a part of U.S. naval vessels for decades. But a seagoing reactor can't simply be repurposed, say, for a geostationary satellite. "The reactor physics aren't different," Nix says, but the Navy doesn't have to worry as much about "the weight of the reactor itself or the space it takes up."

The first step under JETSON will be a full review of compact nuclear reactors and their attendant technologies like radiation shielding and thermal couplings, Nix says. Then, later this year, Nix's team will issue an "advanced research announcement" soliciting industry white papers for ideas about how to integrate reactors, radiators and "all the things to build an actual satellite, minus the payload."

JETSON is currently funded at $70 million, and Nix hopes that will be enough to proceed through at least preliminary design review — and possibly critical design review — of a satellite powered by a compact nuclear reactor. Additional funds could then be sought for flight testing, or the technology could be handed off to a new Space Force program. ★

Volocopter

Cosmopolitan leader

Dirk Hoke has worked in Africa, China and Europe, and once ran one of the largest business sectors in the world, Airbus Defence and Space, which has 40,000 employees and $10 billion in annual revenue. Now, he runs Volocopter, a 700-employee company with no revenue yet from operating its planned fleet of an unspecified number of air taxis. Hoke's cosmopolitan world view might be just the match for Volocopter, which aims to draw the eyes of the world by flying its VoloCity aircraft during the Summer Olympics in Paris in 2024. Here is our conversation, lightly edited for readability. — *Paul Brinkmann*

DIRK HOKE

POSITIONS: Since September, CEO of Volocopter. Since September 2021, consultant with his own company, D&D Invest Consult of Germany. 2016-2021, CEO of Airbus Defence and Space and member of Airbus Group Executive Council. 2014-2015, CEO of Siemens Large Drives. 2011-2014, CEO of Siemens Customer Services Division. 2009-2011, CEO of Siemens Africa. 2008-2009, CEO of Siemens Northwestern Africa. 2005-2008, CEO of Siemens Transportation Systems Northeast Asia.

NOTABLE: At Siemens in China, Hoke grew the business to become the largest foreign railway supplier in that country. He was the first CEO of Siemens' Africa operations. He also led an effort at Siemens to set up a digital platform business for the company's Industrial Solutions Division. He was part of the World Economic Forum's Young Global Leader Class of 2010 and participated in the Baden-Baden Entrepreneur Talks, a three-week conference that brings together executives from many industries, in 2013.

AGE: 53

RESIDENCE: Karlsruhe, Germany

EDUCATION: Bachelor of Science degree in mechanical engineering, Technische Universität Braunschweig, 1994

Q: Tell us about Volocopter's timeline for achieving certification and offering flights during the 2024 Olympics. Is it achievable?

A: I can tell you everyone at Volocopter stands up in the morning fully energized and motivated to drive toward that goal. I have to finish all my analytics to tell you how reliably this can be achieved, so this is too early to give you my five cents on it, but this is the target, and we will drive for it. I still believe that Volocopter is ahead of the crowd in this certification process, so it's definitely a target to achieve type certification in 2024 and to fly during the French Olympics. But, I believe that we [in the industry] must all work together toward the same goal, that we are not really competitors because it's about opening a totally new market, adding a new modality to the way we all can go from point A to B. This is, I think, what keeps us up at night, what the people are energized and motivated to work for, and I'm totally excited to be part of the team now.

Q: Are we talking about a few demonstration flights, or are you able to offer regular passenger flights? Will you be transporting athletes?

A: This is a partnership with our French partners, so they have predefined routes that will be part of that service. But of course, the exact operational mode will depend on Volocopter's type certificate and license to operate. This will be finalized in due time before the Olympics.

Q: You've said demonstrating safety and ensuring public acceptance are keys to success. What is your plan to make that happen?

A: Aerospace has been built on trust, and that requires creating clear certification processes and safety rules to develop vehicles that can fly over houses and people with full confidence. This has been demonstrated over more than 100 years, and the trust of the people was created by ensuring that any kind of vehicle flying has been certified against these rules. To build on that trust, we need to ensure that we follow the same rules. So it's not a question of whether we have the coolest design or coolest technology on board, but that we also certify against the same rules. This is, I think, one of the strong points of Volocopter. When I looked at the company, I was convinced that this is the base of future success because Volocopter has worked, from very early days, very closely with certification parties in Europe and elsewhere to ensure that the design is something that can be certified afterward.

"Aerospace has been built on trust, and that requires creating clear certification processes and safety rules to develop vehicles that can fly over houses and people with full confidence. ... So it's not a question of whether we have the coolest design or coolest technology on board but that we also certify against the same rules."

Q: What is especially safe or reliable about Volocopter's multicopter design?

A: I just spoke yesterday with one of the founders, Stephan Wolf, about this. They started with the very simple idea that we saw when toy drones were introduced in the market: the multicopter design.

Volocopter is one of a small number of electric passenger aircraft developers pursuing a multicopter, a design that relies on multiple variable speed rotors — 18 in Volocopter's case — to lift and maneuver. Others using this basic approach are China-based EHang and Jetson Aero of Sweden. Multicopters are an alternative to lift-plus-cruise designs that have separate rotors for lift and for forward motion, and to tiltrotors that pivot their rotors or engines to provide forward motion. — PB

They thought that this design has a lot of advantages, and why should that not work for larger drones, either for cargo or personal transportation? So this was the original idea, that the multicopter is easier to pilot than a helicopter on a smaller scale. If you've ever flown a toy helicopter, that's quite a challenge, not something you just pick up and do it right. You need practice and training. But with a multicopter, you can pick it up and you can fly it; little kids can fly it. Over

▲ As preparation for planned passenger flights during the 2024 Summer Olympics, Volocopter in March conducted piloted test flights with its 2X prototype at Pontoise airfield near Paris to measure the aircraft's noise levels.

Volocopter

the past few years, it's been an evolution and learning through different phases of the development, building additional knowledge and then letting that flow into design and development phases. But I think the advantage is using the simplification of the multicopter principle — having more stability, being easier to fly and providing that map toward autonomous transportation eventually. Of course, at first, we are flying with a pilot, because this is the faster way to get to certification and revenues.

Q: What are the biggest challenges the company faces in providing a scalable, safe electric aircraft?

A: We have a timeline that is very challenging to certify and get ready for flight. The Olympics in 2024 is a challenge in itself. It's a challenge on competencies. It's a challenge on resources. We're currently working on what we call our B model, which is what we use for the certification process before we start, let's say, the production of the C model, which will be the serial product. So we have a step-by-step approach to make sure that we can achieve those things in a short time frame. We are growing very fast. We have hired a lot of people in the last 12 months, increasing our flight test teams and of course the engineering team, and getting prepared for the new production, building our first reference factory. We have a very diverse team from 59 nations. We have highly qualified people coming from all different backgrounds and companies. That diversity leads

Volocopter conducted its first flight with a full-size VoloCity prototype in December 2021 after 10 years of test flights with subscale test aircraft. The company is targeting 2024 for beginning passenger service, and 2026 for service of a larger VoloRegion design.

Volocopter

"We have highly qualified people coming from all different backgrounds and companies. That diversity leads to a more successful solution because you have to engage to see the different opinions and learnings and the different backgrounds."

to a more successful solution because you have to engage to see the different opinions and learnings and the different backgrounds. Such diversity may require a few more discussions to make decisions than some teams would take, but you also make sure you aren't taking the easy solution because you look from different angles and backgrounds at the topic.

Q: What concerns do you have about the concurrent validations Volocopter is pursuing? Are you hoping to get more clarity soon from FAA about its certification process for vertical-lift aircraft?

A: We are actually focused on our partnerships in Europe and Asia first, where we have partnerships with 40 cities, but none in North America yet. We are also involved, of course, in the certification process with FAA, and we still expect that there will be more clarification coming. I think it will not be the final status, and we will follow that discussion very closely. But as I said, we follow right now the certification process primarily with EASA [European Union Aviation Safety Agency] and keep it closely linked toward the FAA certification process.

Q: How is Volocopter handling the critical battery technology required for a successful electric passenger aircraft?

A: We have a partner for the cells, but we do the packaging and battery management system ourselves. And we use our own core intellectual property to

▲ In addition to the two-seat VoloCity design, Volocopter is developing the four-passenger VoloRegion, previously named the VoloConnect, for regional flights up to 100 kilometers. A prototype made its first flight in May.

Volocopter

integrate the battery system into the vehicle. Everything you've read so far on targets regarding range and distances and speeds has been based on the current battery technologies. The good news is all future battery technology will be an upside on the existing limits. We see a strong push for sustainability, especially in the automotive industry for electric cars, which will definitely lead to new innovations — replacing rare earth materials, for example. However, battery weight is much more critical for aircraft, and that is why design of batteries is more challenging in aviation. And that's why only a few companies in the world are specialized to produce the battery cells for the aerospace industry.

Q: Regarding supply chain issues, is Volocopter actively engaged and trying to build up a supply chain in Europe, Singapore or elsewhere?

A: Right now, we do the design and development in Europe, which also means that mostly we concentrate on European suppliers, but not exclusively. When we expand in the future toward Asia and then to the U.S., we will definitely look at local production and the local supply chain. We will have our first factory, our reference factory here in southwest Germany in this manufacturing hub.

The Baden-Württemberg region around Stuttgart is home to Mercedes-Benz Group and Porsche. – PB

Q: You've had a career spanning continents from China to Morocco and Germany, of course. How has that shaped you as an executive and a person?

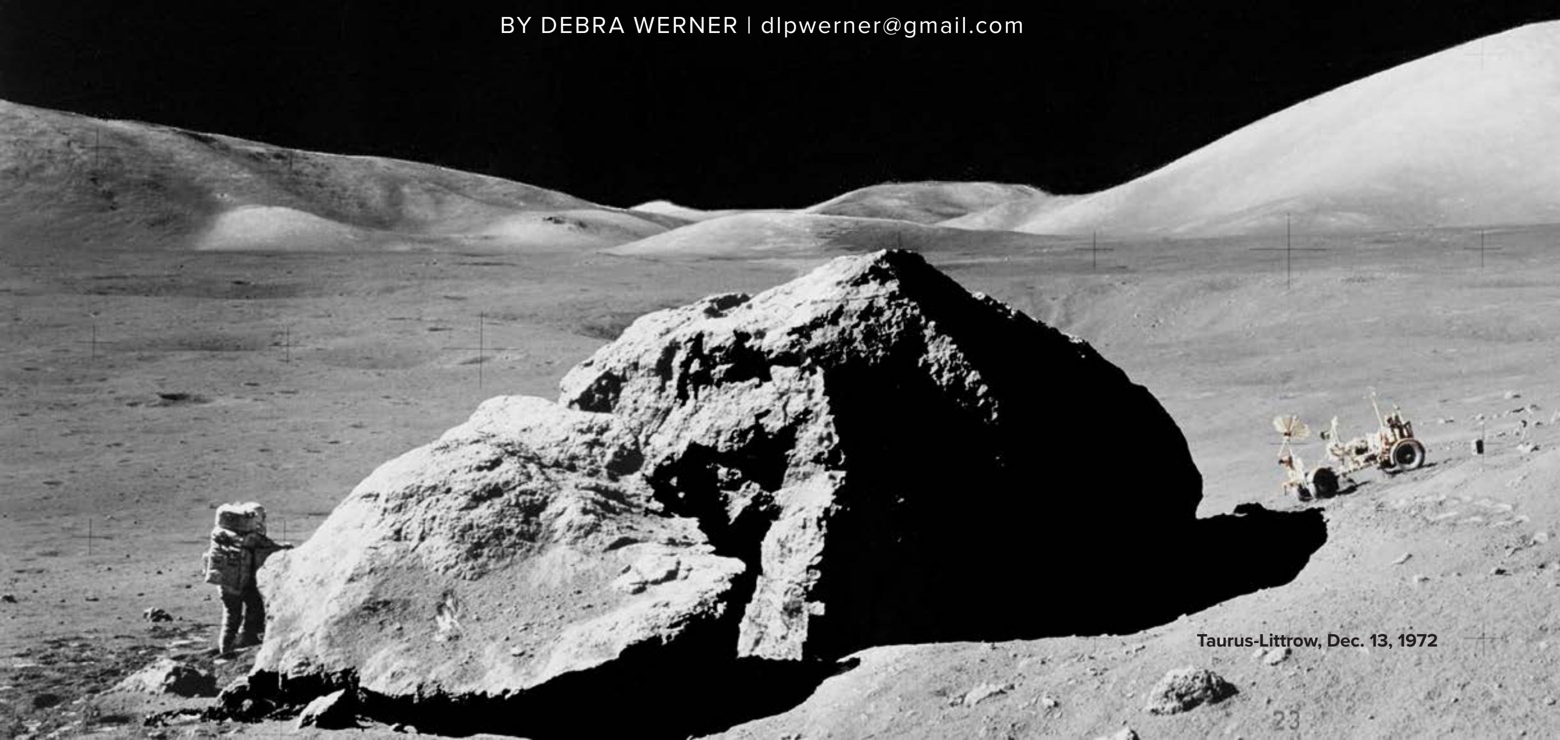
A: As our family was growing, our kids grew up in Beijing and Casablanca. I was also the first-ever CEO for all Siemens African operations and created a new Africa story and strategy. It was quite a complicated setup, as my headquarters were in Johannesburg and my family in Casablanca. In order to travel, I had to first go to Europe and then you can travel to South Africa. So it was a complicated time and challenging, but also very rewarding and a good learning experience.★

In their words: Veterans of the last moon landing share their views

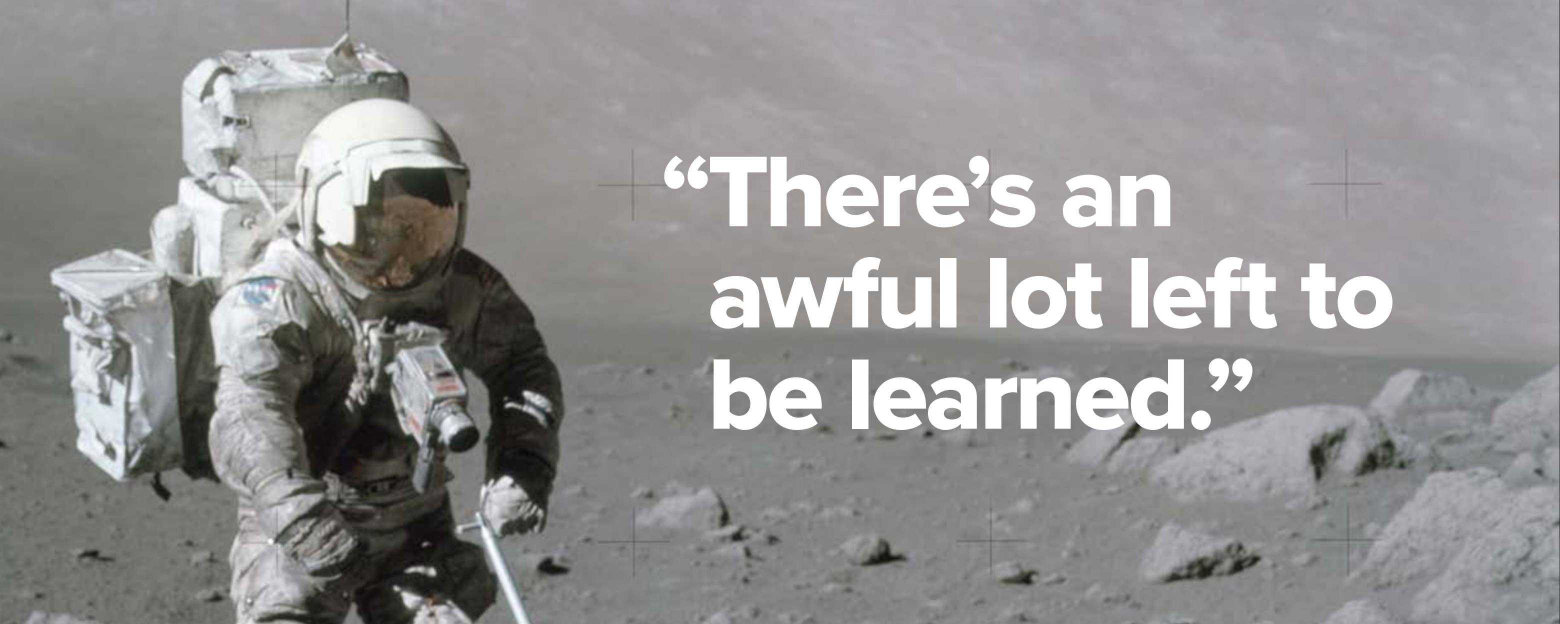
When Gene Cernan and Jack Schmitt rode their rover back to the Lunar Module on Dec. 14, 1972, they knew they would be the last humans on the moon for a while. The Nixon administration had removed the final three missions from the Apollo plan. Now, after what has grown into a half-century hiatus, the moon is back in play under the Artemis program. As the 50th anniversary of Apollo 17 approaches, **Debra Werner** posed this question to four of those involved:

"It's been 50 years since Apollo 17, and no one has been back to the moon. Are you disappointed?"

BY DEBRA WERNER | dlpwerner@gmail.com



Taurus-Littrow, Dec. 13, 1972



“There’s an awful lot left to be learned.”

Astronaut Harrison “Jack” Schmitt | APOLLO 17 LUNAR MODULE PILOT

On the surface of the moon, Schmitt, a geologist with a Ph.D. from Harvard, spent 22 hours over three days traveling in a rover driven by Apollo 17 Commander Eugene Cernan, stopping to take photographs and, together with Cernan, filling sample bags with rocks and regolith. When Schmitt was done, he famously threw their geology hammer into the distance and climbed into the Lunar Module, followed by Cernan. After leaving NASA, Schmitt served a term as a Republican senator from New Mexico before his defeat in 1982.

▲ Astronaut Harrison Schmitt scoops lunar regolith during his second moonwalk with Apollo 17 Commander Eugene Cernan. During their three moonwalks, the astronauts collected about 740 rock and soil samples, a total of 110.5 kilograms.

NASA/Eugene A. Cernan

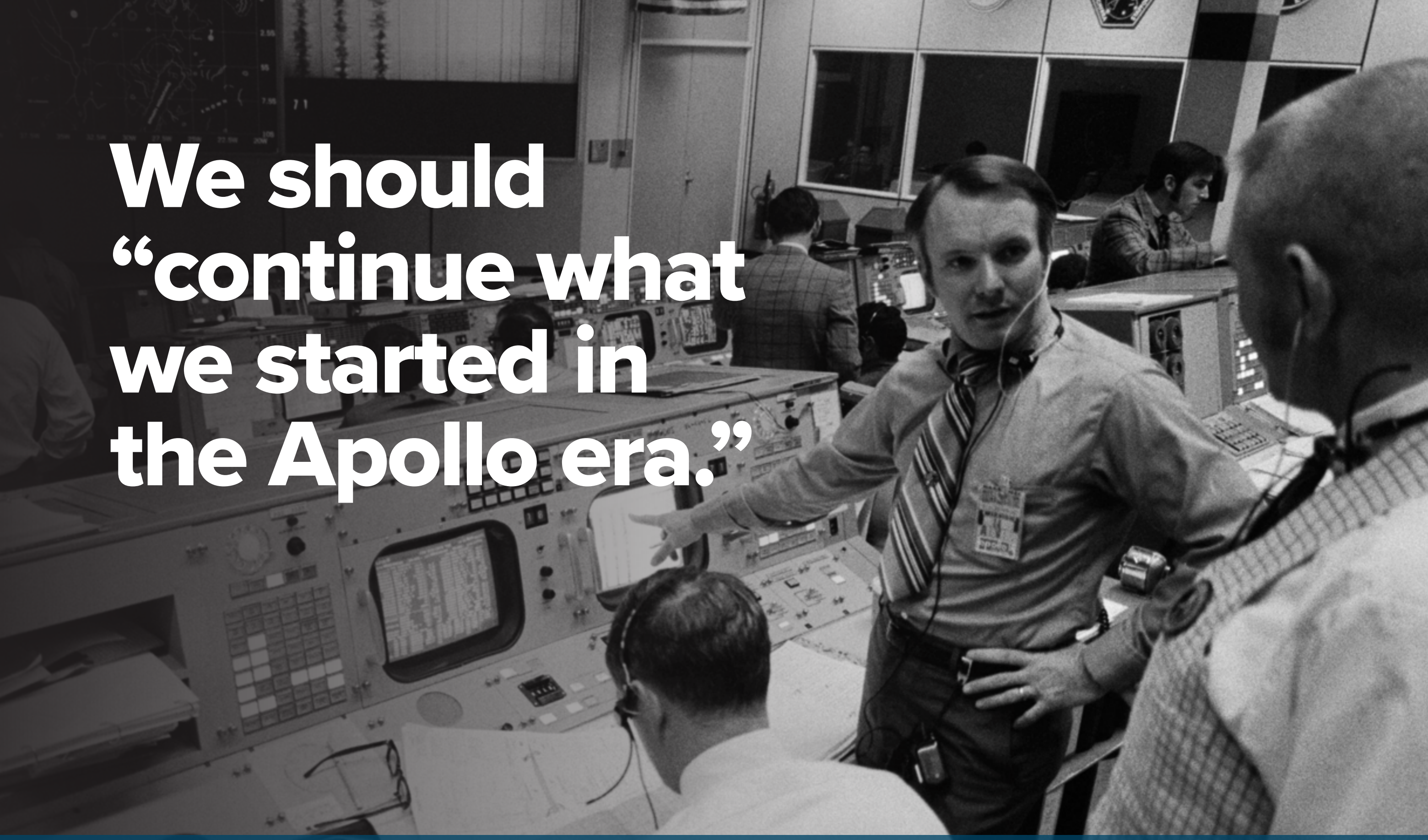
ON THE OPENING SPREAD
A mosaic of Apollo 17 Lunar Module Pilot Harrison Schmitt was taken by Commander Eugene Cernan during their third and final moonwalk. Cernan and Schmitt spent a total of 22 hours exploring the lunar surface during their 75-hour stay, traveling from their lunar module in the Lunar Roving Vehicle, at right.

NASA/Eugene A. Cernan

The answer is yes, particularly that Americans have not been back. It’s a geopolitical priority to be dominant in lunar exploration as well as space exploration in general. The Chinese clearly are very interested in dominating the world here on Earth, and part of that plan is to dominate space. We are basically in another Cold War with China. That is the bottom line again, as it was for Apollo. Apollo was a geopolitical effort, initially. Fortunately, we also had the capability to gather a great deal of exploration information from the surface of the moon based on the six Apollo landings.

From a scientific point of view, there’s an awful lot left to be learned. We know very little about the far side of the moon, which is significantly different than the near side, probably because of the effect of two very large basin formations. On the far side, there’s the South Pole-Aitken basin, which is about 2,500 kilometers in diameter. My lunar science colleagues and I believe that is a very large impact basin. On the near side, there’s the Procellarum basin, which is much larger, about 3,200 kilometers in diameter. The Procellarum basin is the location of the thinnest crust of the moon. We know that from the GRAIL [Gravity Recovery and Interior Laboratory] orbital mission. There are many indications that the Procellarum basin was formed early in lunar history, probably about 4.35 billion years ago. That was a time when the interior of the moon was still quite warm, relatively solid but warm, and the release of pressure from that impact did cause some significant overturn of that warm upper mantle, at least the upper 500 kilometers, and also probably some partial melting, which produced a suite of rocks that we like to call the Mg-suite. [Mg stands for magnesium and refers to rocks produced during the earliest periods of lunar magmatic activity.]

Scientifically, understanding the moon gives us an understanding of what the early solar system was like and, in particular, what was happening here on Earth in about the first 800 million years of Earth’s history. That is the part of Earth’s history that we know the least about. Because the Earth is such a dynamic geological body, that part of Earth’s history has been largely erased. The moon, though, ceased to evolve as a small planet at the end of that 800 million years. So, it tells us what the environment of the solar system was like, particularly the impact environment, during that period of time in which life was getting started here on this planet. The oldest fossils that we have identified here on Earth, that there’s general agreement are indeed fossils, are about 3.5 billion years old. We have no information about that early history except what we have learned from the moon, and again, that is the environment in which life began. It was extremely violent, and here on Earth, it was also wet. In that kind of environment, life somehow or other got its start.



We should "continue what we started in the Apollo era."

Gerald D. Griffin | APOLLO 17 LEAD FLIGHT DIRECTOR

Griffin's role on this mission, as on Apollo 12 and 15, was to imagine every possible problem and envision potential solutions. This is how he ensured that the astronauts and the ground crew were ready. An aeronautical engineer and former U.S. Air Force officer, Griffin began working at NASA's Mission Control Center in Houston in 1964 and led Johnson Space Center from 1982 to 1986. Being flight director was "the best job I ever had," he says.

I'm not so disappointed as I am surprised and somewhat frustrated. We had a great situation in Apollo. We had three presidents: Kennedy, Johnson and Nixon. Two Democrats, one Republican. They supported us through the whole thing. We had a fire. [Virgil "Gus" Grissom, Edward White and Roger Chaffee died during a 1967 Apollo 1 ground test. The capsule was pressurized and filled with oxygen when a fire swept through the cockpit.] We had Apollo 13. We had other kinds of setbacks. Congress, on both sides of the aisle, Democrat and Republican, supported us through the hard times and the good times. The American public was behind us too. There was a Cold War raging at the time with the Soviet Union, and the whole idea of technological dominance was very important, particularly after Sputnik and Yuri Gagarin were launched into orbit. And the U.S. responded. Neil Armstrong talked about that with me after the program had ended. Neil's point was that the nation had always responded well to a threat, particularly from another nation. However, since Apollo ended, the U.S. has never really come back together to consistently support deep space exploration by humans. My frustration is that I wish the country, especially its leaders, could understand and embrace the importance of continuing what we started in the Apollo era. Perhaps 1,000, 5,000 or 10,000 years or more from now, we may have reason to get off this planet if the human species is to survive. I'm not talking about global warming. I'm talking about humans simply using up the resources on Earth. Then, we would need another place to inhabit very much like this planet. What we accomplished in Apollo was a teeny step in human space exploration. What we're going to do in Artemis is a small next step. Even when we get to Mars, that's still a small-to-moderate step in deep space travel and its exploration by humans. Humans need to learn how to move around in really deep space and, ultimately, go to places much farther away than Mars.

CONTINUES ON NEXT PAGE

▲ Gerald Griffin (center) worked in mission control as a flight director for all the crewed Apollo missions.

NASA

“You rarely establish a foothold and then take the next logical steps.”

James W. Head | APOLLO LUNAR EXPLORATION MISSIONS PROGRAM GEOLOGIST

Head, a geologist with a Ph.D. from Brown University, analyzed potential Apollo 17 landing sites, planned mission operations, trained astronauts to collect samples, debriefed astronauts after flights and analyzed samples. After Apollo, Head served as the Lunar Science Institute interim director before returning to Brown’s Department of Geological Sciences. He continues to study planetary evolution and serve as an investigator on NASA and European Space Agency planetary missions, including ESA’s Mars Express and NASA’s Lunar Orbiter Laser Altimeter.

The solar system is a big place with a lot of destinations to go to. The moon is a critically important one because it has such close relationships to the Earth, both in terms of distance as well as, of course, origins. It is literally a sibling of the Earth, or some kind of progeny. We continue to study it. We have the Lunar Reconnaissance Orbiter in orbit around the moon. We’re learning a huge amount from the orbital remote sensing and utilizing all the data from Apollo to connect the dots. We’re still exploring.

My sense of history is that you rarely establish a foothold and then take the next logical steps. There are voyages of discovery and scientific expeditions, but then it takes awhile. Yes, I’m disappointed. I would love to see humans, particularly NASA astronauts that I work with to this day, exploring the moon. But there are lots of destinations. We’re learning a lot about the moon. We’re formulating even better questions for when we go back.

We collected a huge amount of information through the Apollo missions. When Apollo 17 ended, I was thinking about what we would do with all these data to enhance our knowledge, because that knowledge is the legacy of Apollo. Each Apollo mission, we worked shoulder to shoulder with the engineers to engage in what we call science and engineering synergism. Engineers make our scientific dreams a reality. Once we knew we could land humans safely on the moon and return them safely, we focused on the science. We need more samples. We need to go to a specific place. Apollo 12 accomplished that. There was a big problem with Apollo 13. We rebounded from that for Apollo 14. We went to a very rough place in the highlands. Then, we need to get around more. We need a car on the moon. We can do that. Apollo 15, 16 and 17 had rovers that went 30 kilometers or so. We need to bring back more samples. We got more samples. We need to stay longer. We did all that. The whole idea of science and engineering synergism was really important because it showed how the combination of the two — not just scientists going up, you know, scratching their head about problems, or not just engineers going up and building the next bridge — working together enhanced the scientific legacy.

FACT

HEAD IS AMONG THE MANY SCIENTISTS who believe that “moon” should be treated as the proper name for Earth’s natural satellite. Aerospace America does not capitalize moon.

▲ Geologist James Head continued to work with NASA after Apollo 17 but also kept up his Earthly research. He’s pictured here at Mount St. Helens after the May 18, 1980, eruption in which the volcano’s northern face broke apart and created the largest landslide yet recorded.

Lionel Wilson

“NASA only has so much money.”

Sheila Thibeault | RENDEZVOUS DOCKING SIMULATOR TECHNOLOGIST

As a researcher in the Guidance and Control Branch at NASA’s Langley Research Center in Virginia, Thibeault helped improve the resolution of the small black and white displays the astronauts watched as they lined up the Lunar Module ascent stage with the Command and Service Module for docking. “You really needed to get this right the first time around because if not, you could hit it and bounce off,” says Thibeault. She still works at Langley, now developing protective clothing for astronauts.

▲ Sheila Thibeault at NASA’s Langley Research Center circa 1967, plugging numbers into a computer.

NASA

In a way, I am. I knew Apollo 17 was the last Apollo mission. I was young. I was a researcher, not in Washington making decisions. I thought, “There will be another program.” We had the Mercury program, and we had the Gemini program, and we had the Apollo program. These things all had a beginning and a middle and an end. I thought there’d be another program with another name. And there is. It’s called Artemis. I just thought the Artemis program would be earlier.

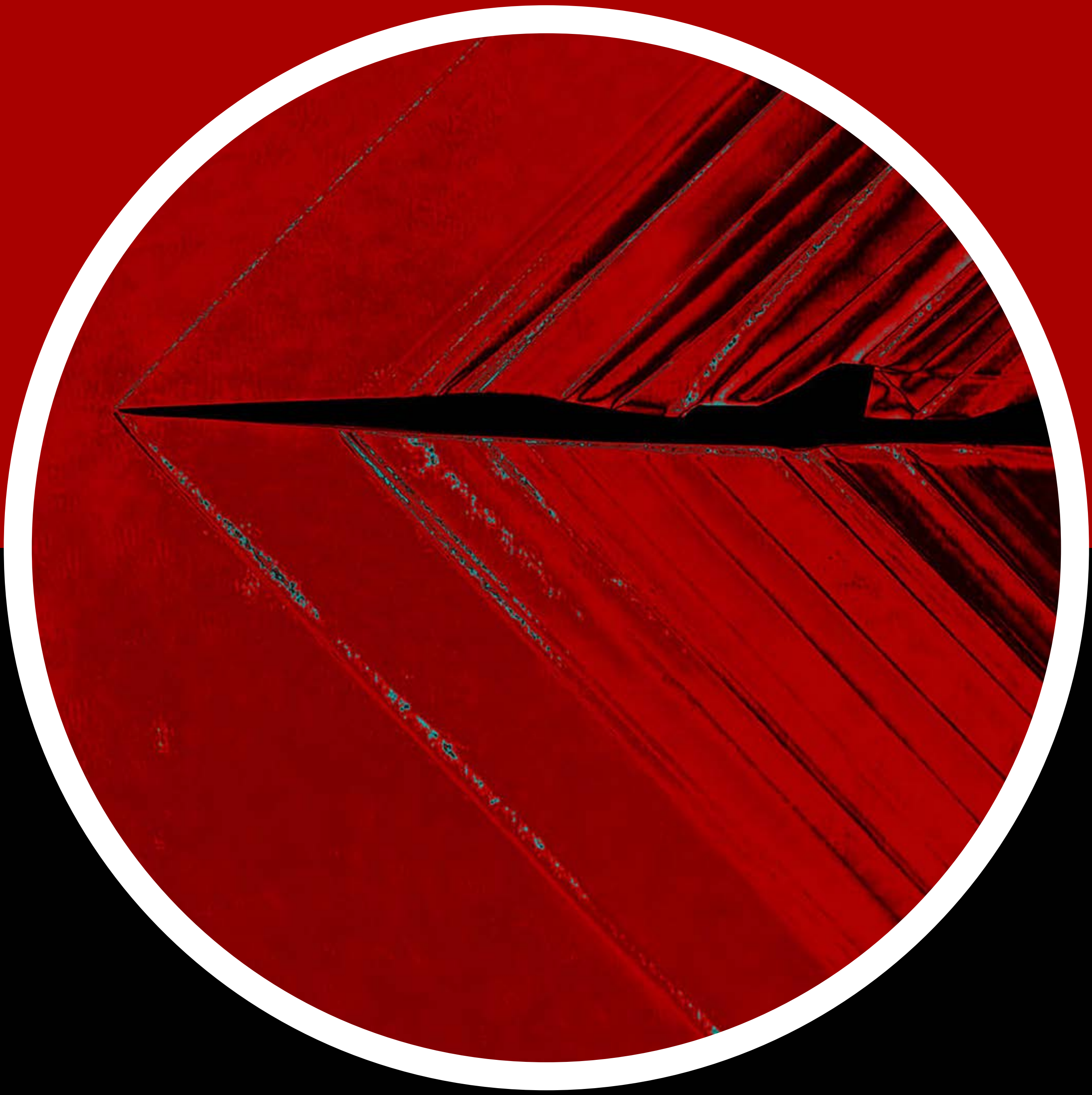
I understand why we haven’t been back. NASA is a small agency with a limited budget. In order to have done more, we would have either needed to have more money, or we would have had to give up something else. One thing we have been doing is looking at Mars. The problems with Mars are so challenging that you have to start early working on them. It’s so far away. It takes a long time to get there and a long time to get back. In order to line up the trajectories to minimize the time spent getting there and coming back, you need to stay awhile. It is a long mission, which means if anything goes wrong, it’s hard to rescue people. There is a radiation problem. The longer the mission, the more you’re exposed to the radiation, and the radiation dose is cumulative.

There’s so much basic research that needs to be done to solve these problems in order to eventually have a mission. All these things take money. And then, of course, there’s the International Space Station. We have been sending astronauts up there to live for long periods of time in microgravity and studying the effects on their bodies and trying to figure out how to overcome the effects. You need to do that if you’re going to be living in space for a long period of time, which is what you’d be doing if you went to Mars.

When we did Apollo, mission success was bringing the astronauts back alive. They knew that, and they had to volunteer for the mission. Well, now that’s not good enough. Mission success is now bringing them back healthy. That is harder to do. We’ve obviously learned from ISS, and we’ve learned a lot from Mars. All of this feeds back to make Artemis a bigger, better mission.

With Apollo, there was this feeling of “Let’s hurry up and do this,” because of Sputnik. Now it’s more, “Let’s take our time and make sure we do everything as safely as possible.” The equipment has to be the latest technology, and it has to last longer.

I look through all of this and understand it. NASA only has so much money. We’ve always wanted to go back to the moon. Finally, we’re getting to do this, and we’re going to do it better. In the meanwhile, we still have ISS, we get the lunar Gateway, and we have vehicles on Mars. I am disappointed, but I’m also not disappointed, because I look at all the things we’ve done. ★



NASA engineers took this colorized schlieren image of an X-59 small-scale model inside the Supersonic Wind Tunnel at NASA's Glenn Research Center to visualize the shockwaves the full-size aircraft would produce, shown here as dark lines.

NASA

NASA'S BOOM BUSTER

Society has changed in the years since NASA announced it would commission construction of an experimental plane to target sonic booms. Environmental sustainability is now the mantra among commercial aircraft designers and operators, and the industry's zest for supersonic flight has cooled. With the X-59's first flight approaching, Paul Marks tells the story of the plane's remarkable engineering and why NASA still believes it can catalyze supersonic flight for all.

BY PAUL MARKS | paulmarksnews@protonmail.com

Sometime in the next few months, Lockheed Martin chief test pilot Dan "Dog" Canin will advance the throttle on a curious-looking paper dart of an airplane and, all being well, take off from a dusty runway at the U.S. Air Force Plant 42 Airport in Palmdale, California. But it will be a very different kind of takeoff roll: With the aircraft's elongated, super-skinny nose, Canin will have no forward windshield to see the view ahead of him. Instead, he'll only see images fed by external cameras to a high-definition computer screen in the cockpit. This is just one of many novel features of this bizarre airplane.

The aircraft is, of course, NASA's X-59, which is being built at Lockheed Martin Skunk Works beside that Palmdale airport. This synthetic vision system is but one tactic for achieving the project's overarching purpose: to demonstrate that a clever fuselage design can guarantee that someone barbecuing in their backyard or putting their baby down for a nap will hear at most a soft thump, rather than a loud sonic boom, as the plane soars overhead at 55,000 feet, thereby winning community acceptance of overland supersonic passenger flight.

When I finished reporting this story in October, the X-59's first flight had just been pushed back from December to "early 2023." After loading and stress tests in Fort Worth, Texas, the engineless and noseless fuselage was back at Skunk Works, awaiting the empennage's removal so its single engine could be installed and the nose reattached. The result will be a sleekly sculpted, $247.5 million airframe. And everything from the hyper-stretched nose to the T-shaped tail, stubby delta wings, movable control surfaces, horizontal stabilators, swept-back canards and even its engine inlet and exhaust structure are designed to reduce the power of the shockwaves that cause the iconic sonic booms of supersonic jets.

"We are basically tailoring the shockwaves around the entire configuration so that by the time noise reaches the ground, it's 30 to 40 decibels quieter than any conventional supersonic airplanes you might think of, like Concorde," explains Mike Buonanno, lead engineer for X-59 at the storied Skunk Works. Hence the program's official name: QuessT, short for Quiet Supersonic Technology.

If, as hoped, the X-59 produces only a gentle thump in community flight tests over a wide variety of rural and urban locations across the continental United States — which have yet to be selected — that could prompt the United Nations' International Civil Aviation Organization, and the national regulators who follow ICAO's lead, to embrace supersonic flight over land later this decade. The first chance to make the

▲ Because the X-59's tapered nose doesn't leave room for a front window, the test pilot will rely on the eXternal Vision System. A 4K-resolution monitor in the cockpit (above) will display video from cameras on the aircraft's belly and on top of the fuselage, shown in the photo at right.

NASA

case with X-59's community acceptance results will be in 2028 at the earliest, according to Peter Coen, QuessT mission integration manager at NASA, who leads the agency's interactions with FAA, and through them with ICAO's Committee on Aviation Environmental Protection, CAEP.

CAEP, Coen says, has been working for "a number of years" on drafting standards and recommended practices, or SARPs, for supersonic en route noise. "Community response data from NASA's QuessT mission is key to helping define the noise limits that will be part of that SARP," he says.

NASA has made a "commitment" to FAA and ICAO to supply the results from the test flights in time for the new SARP to be proposed at the 2028 meeting, he adds.

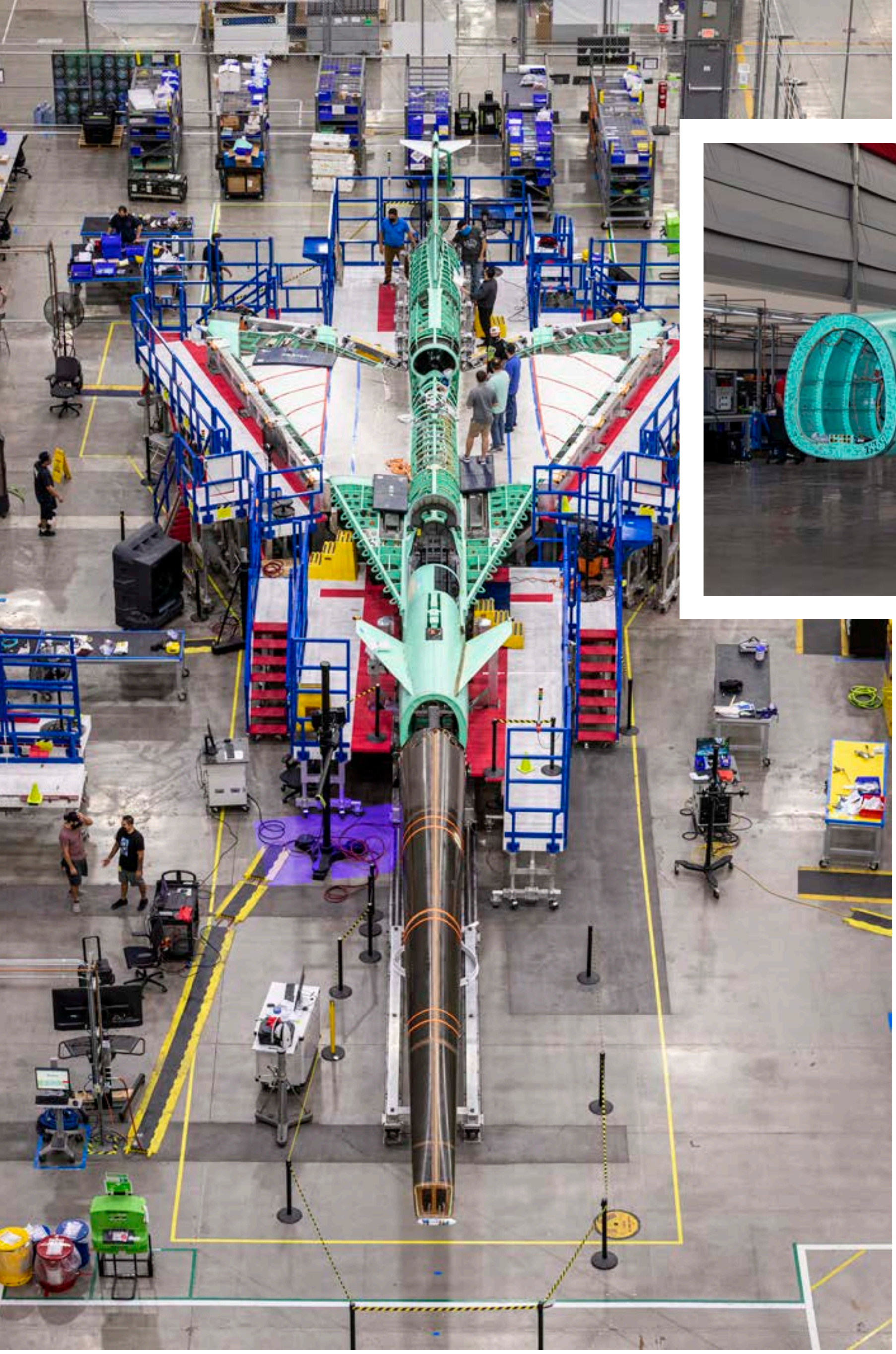
If booms can indeed be hushed, and ICAO goes for it — and you can afford it, of course — overland trips at Mach 1.4 could seriously cut flight times, with a trip from Los Angeles to New York, for instance, taking just two and a half hours, against the five hours it takes on today's subsonic airliners.

But, tantalizing as that might sound, the world has changed in at least two relevant ways since June 2016, when NASA announced its intention to commission construction of a series of X-planes, including one dedicated to quietening supersonic technology — X-59.

FACT

SONIC BOOMS were not the main reason the Concordes were retired in 2003, but they were a persistent limitation throughout the fleet's 27 years of commercial service. Three years before passenger flights began in 1976, FAA banned civilian supersonic flights over land in the United States due to the noise of sonic booms. Also, the exorbitant amounts of fuel required to achieve the Mach 2 cruising speed required Air France and British Airways to charge nearly $12,000 in today's dollars for a round trip across the Atlantic Ocean.

The biggest blow came in 2000, when an Air France Concorde crashed shortly after takeoff from Charles de Gaulle Airport, killing all 109 aboard and four employees at the hotel struck by the doomed jet. Investigators concluded that as the plane rolled down the runway, it struck a piece of metal left earlier by a departing DC-10, shredding one of the Concorde's tires. Debris from the tire punctured a fuel tank, igniting a fire. The pilot took the plane airborne, but the engines lost power and the plane crashed. Concordes returned to the air in 2003 with Kevlar-reinforced fuel tanks. Reduced ticket sales and Airbus' decision to stop providing maintenance prompted Air France and British Airways to retire their fleets months apart.



▲ NASA's X-59 aircraft has been under construction at Lockheed Martin Skunk Works since 2018. This photo from August 2021 shows the nose and tail being installed. The nose was later removed for transport to Lockheed Martin's Fort Worth, Texas, facility for stress tests. Lockheed Martin returned the noseless fuselage (inset) to Skunk Works in April.

Lockheed Martin, NASA/Lauren Hughes

The first is climate change. The issue was thrust into public consciousness when 15-year-old Swedish schoolgirl Greta Thunberg began a solo sit-in outside the parliament in Stockholm in 2018, demanding action on climate change. As her campaign gathered steam, environmental activists soon began *flygskam*-ing — "flight shaming" — frequent fliers, and in 2021 the International Air Transport Association ended up calling for net-zero carbon emissions for air travel by 2050. The second blow also came in 2021, when a fierce competition to build supersonic jets fizzled to one active company.

NASA officials are aware of all this, and they and Lockheed Martin Skunk Works have forged ahead with their low-boom innovations.

"There's a lot of challenges to supersonic transport, and one of the key enablers is suppressing sonic boom noise," says Jay Brandon, chief engineer for X-59 at NASA's Langley Research Center in Virginia. "We're taking one barrier at a time — and we'll see where it goes."

Along with being a veteran test pilot, Brandon, not surprisingly, is a student of sonic booms and the long efforts of scientists and engineers to design them away. The U.S. Air Force received some 40,000 noise damage claims in the 1950s and 1960s from Americans regularly harassed by sonic booms from military jets. In 1973, with the British and French Concordes undergoing test flights, FAA banned overland supersonic commercial flights.

"Since the 1960s, this stumbling block for supersonic transportation became a subject of continuous interest and a focus area for NASA, just trying to figure it out. And it took many years of research to come up with this approach that we're trying to demonstrate here," Brandon says.

That approach? Although a tech-savvy observer might imagine it would involve the X-59 being peppered with adaptive, boom-killing devices on a fuselage made from a raft of supersmart shape-shifting materials, that's absolutely not the case.

"It has nothing to do with the materials technology," says Buonanno of Skunk Works. "On X-59, we're actually using very, very conventional materials — ones that are very similar to those used on other airplanes, even subsonic airplanes.

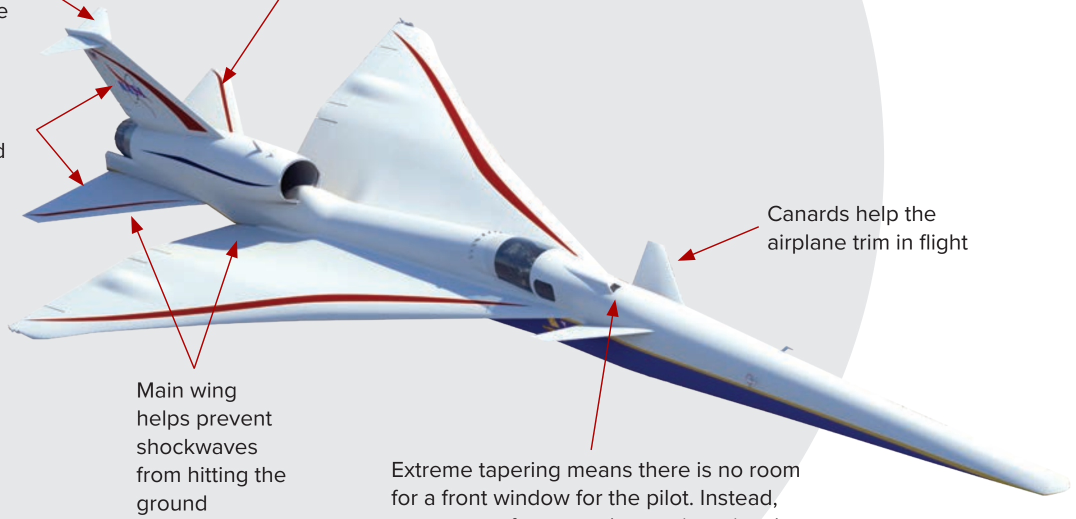
"There's nothing magic about it. It really comes down to the way that we design the airplane's shape: The way the wings are shaped, the long nose, the canards that help balance the lift that we need to carry on the tail, the way that we integrate the engine inlet and the nozzle," he says. "The devil's in the detail — and every single detail matters."

Shockwave whack-a-mole

Those aerostructural details have to combine to do one crucial aeroacoustic job, says David Richwine, X-59 deputy project manager for technology at NASA

QUIETER SUPERSONIC FLIGHT

For the X-59, NASA and contractor Lockheed Martin Skunk Works are relying on clever engineering to prevent the shockwaves that will roll off its airframe from coalescing into sonic booms. Here's a closer look at the aircraft.



Graphic by THOR Design

Sources: Staff research, NASA

Langley: They must kill the N-wave.

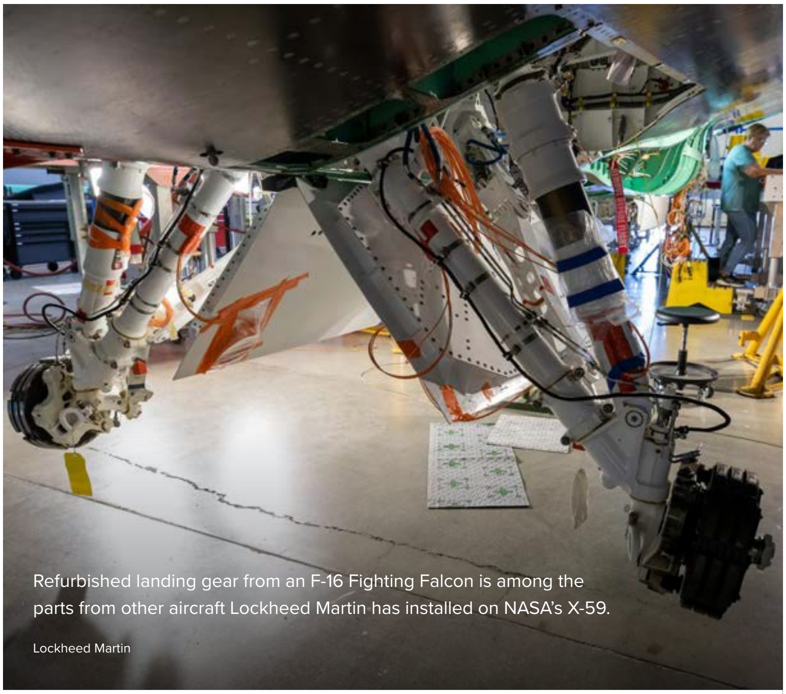
Picture a supersonic aircraft such as the Concorde or a warplane side on. In cruise mode, above the speed of sound, shockwaves are generated along the fuselage, but by far the most dominant are the two shockwaves generated by the nose and the tail structures, known as the forward and aft shocks.

Richwine says the message is clear from decades of aeroacoustic analysis, supercomputer-powered computational fluid dynamics simulations and schlieren photography in supersonic wind tunnels equipped with backlighting: The loud sonic booms that so upset people on the ground are caused by the forward and aft shocks merging to create one large boom as the aircraft flies over.

On the ground, this additive process creates a single, loud, disturbing sound pulse, lasting about half a second, and when plotted as pressure against time has a capital N shape — hence the wave's name. When flying at Mach 2, Concorde created an N-wave sonic boom of 105 decibels — about the same noise level somebody sitting in a car would hear when the vehicle's door is slammed.

Shockwaves must coalesce beneath the plane to reach that volume, and so the trick is to prevent them from ever coming together. The different aerodynamic shaping of the space shuttle orbiters compared to airplanes, for instance, prevented the aft and forward shocks from coalescing, and people on the ground would hear two distinct sonic booms on their Mach 1.5 landing approach. These booms were loud, but neither was as loud as if they had coalesced into one.

"So what we have done with the X-59 is create an airplane that, because of its volume distribution and lift distribution, smooths out the shocks so that, in general, they are of smaller amplitude and are also of



Refurbished landing gear from an F-16 Fighting Falcon is among the parts from other aircraft Lockheed Martin has installed on NASA's X-59.

Lockheed Martin

Borrowing reliable technologies

To control costs and stay focused on the aircraft's shape that would enable quiet flight, Lockheed Martin Skunk Works built the experimental X-59 using parts from other aircraft — some brand new components and others that were taken off in-service airplanes and refurbished.

NEW COMPONENTS:

- One F414-GE-100 engine and the throttle lever/control system, a design similar to those that power F/A-18E Super Hornets that GE had previously modified for Sweden's Saab JAS 39E Gripen fighter
- Components from F-35, F-15, F/A-18 and F-16 aircraft
- Hydraulics systems from F-16 and F-15 aircraft
- Environmental control system from a T-50 supersonic trainer

REFURBISHED PARTS:

- Landing gear from an F-16
- Rear-seat canopy and crew escape system from a T-38 trainer
- Pilot's control stick from an F-117

similar strength," says Richwine. "And so they don't coalesce and form that N-wave."

Instead, all their predictions suggest the X-59's sonically sculpted architecture will produce a "thump" of about 75 decibels — equivalent to hearing a car door shut from about 6 meters away.

A packed pick 'n' mix plane

By "volume distribution," Richwine is referring to how broad and tall the aircraft cross section can be along its length. And because it needs its long, slender nose to avoid creating high-pressure-generating frontal airflow obstructions that might generate a large forward shockwave, that has presented problems in the build process.

"It's a long, skinny airplane, and so we don't have a lot of normal fuselage cross section to put all the systems in," says Brandon. "So it's a real packing and integration challenge to get everything in that we need to fly a supersonic piloted airplane."

And because the innovation with X-59 is its sonically sculpted shape and not the systems within it, Brandon says they decided "not to invent a whole bunch of new things. So we tried to use all the parts that we could from other airplanes."

And they have done that, as you can see in the box at left.

Turning to off-the-shelf components saved the program cash, but that's not the whole story.

"It's an opportunity, but one that also presents challenges: The opportunity is that we don't need to fund development of bespoke systems for this aircraft, so that's good, because it allows us to minimize investment while delivering the product," says Buonanno.

"The challenge comes in the integration, because now we're taking systems from different aircraft, which haven't necessarily worked together before. So making sure we have good interface control, both in terms of hardware and software, is a large amount of work. It's not inventing new technology, but it requires a lot of diligence and attention to detail."

Synthetic vision

Where the X-59 team has most definitely invented new technology is in that artificial vision system that test pilot Dan Canin will be using in the cockpit. Aviation fans may immediately find this part reminiscent of the Spirit of St. Louis, the single prop Ryan monoplane that Charles Lindbergh flew from New York to Paris in 1927. Because Lindbergh chose to have a capacious fuel tank forward of his cockpit, he had no vision straight ahead — and so had to use a periscope to see where he was going.

Similarly, the X-59 will have no optical forward vision because the cockpit sits so low in the slim, dart-like fuselage, there is nowhere on the elongated nose to site a forward cockpit windshield with any useful amount of a view. So NASA developed a synthetic imaging system, which it calls the eXternal Vision System, XVS. Two cameras — one topside in a small raised bump on the nose between the aluminum canards and another beneath the fuselage — feed video of the external world to a 4K widescreen monitor right in front of the pilot.

The camera on top is a higher-resolution imager, designed for “see-to-avoid” type tasking, says Richwine, while the one beneath the plane is largely used for “see-to-land.”

“The beauty of this computer imagery is that you can merge the camera with ADS-B technology and your head-up display and fuse an image that gives you a lot more information than even a pilot would have regularly,” he says, referring in part to Automatic Dependent Surveillance-Broadcast, the GPS and identity broadcasts that are transmitted and received by commercial aircraft and received by air traffic control antennas.

“For example, we box cooperative traffic that the pilot can’t even see yet. We can tell them that it’s there.” That said, like the Spirit of St. Louis had side windows, the X-59 also has small “eyebrow” windows at the pilot’s sides, so the pilot has some peripheral vision should the XVS fail.

Nozzles on deck

Although X-59 is not replete with multitudes of novel gadgets like XVS and the aircraft is made from conventional aviation-grade aluminum and carbon fiber composites, there is still much innovation in the choices the team made about its structure. For instance, right at the back, there is a small flat area behind the engine outlet nozzle called the aft deck that works alongside adaptive elements of the engine to limit boom magnitude.

“We have a variable nozzle on our engine,” says Buonanno, “so as the pilot changes the throttle setting, the nozzle changes both the amount of thrust it makes and also its external shape. And so we had to carefully integrate that nozzle with the aft deck to attenuate the impact of the nozzle on the sonic boom.”

Another boom-limiting decision was to mount the engine atop the delta wing jet, rather than sling it underneath it in a nacelled pod.

“The airflow that goes into the inlet is hard to model. So if the engine were below the wing, it would be a big modeling problem. But since it’s above the wing, the shocks from it are going to go upwards, not downwards,” says Brandon.

The result: They don’t have to be so precise in their computer modeling of the engine.

While that helped the QuessT team, how useful might it be to would-be commercial supersonic operators? The answer is not much immediately, but perhaps a lot later in the decade.

Designers of the Concordes and NASA’s X-59 needed their aircraft to have elongated noses, but this raised the question of how the pilots would see what’s ahead during takeoff and landings. Concorde’s designers came up with a nose that drooped when necessary, shown here, while X-59 solves the problem with cameras and an augmented reality display.

British Airways

“THERE’S A LOT OF CHALLENGES TO SUPERSONIC TRANSPORT, AND ONE OF THE KEY ENABLERS IS **SUPPRESSING SONIC BOOM NOISE**.”

— Jay Brandon, NASA’s Langley Research Center

Boom Supersonic in July released this updated rendering of its supersonic airliner, saying the plane will carry 65-80 passengers. Boom is targeting 2029 for Overture to begin passenger flights and has secured purchase agreements from American and United Airlines.

Boom Supersonic

Boom Supersonic, the Denver startup borne out of the same Silicon Valley business incubator Y Combinator that spawned Airbnb and Reddit, is targeting 2025 for the rollout of the first prototype of its Overture supersonic airliner, a design that would fly at Mach 1.7 over water and Mach 0.94 over land to comply with FAA's prohibition.

With four podded engines slung beneath a delta wing, Overture won't have much resemblance to X-59 — visually or audibly.

"Because Overture will only fly supersonic over water, it does not include low-boom design features," Troy Follak, senior vice president in Boom's Engineering and Program Office, told me by email. "In future generations of Overture, we may explore different engine placements and configurations."

Also, Spike Aerospace of Boston tweeted in August that it is "getting ready to reveal its plans for supersonic flight," which center around a mooted, 18-seat business jet. Founder and CEO Max Kachoria said in response to emailed questions that its S-512 design "already incorporates advanced

FACT

ENGINE TROUBLE

Fifty years after supplying the engines for the famous Concordes, Rolls-Royce appeared poised to take on the role for the next-generation supersonic airliner: Boom Supersonic announced in mid-2020 an agreement with Rolls-Royce "to identify a propulsion system that would complement" the airframe for its Overtures.

But no more: The engine maker said in September it wouldn't continue with the project, having "determined that the commercial aviation supersonic market is not currently a priority for us."

For its part, Boom said in a statement that "Rolls' proposed engine design and legacy business model is not the best option for Overture's future airline operators or passengers." The company added that an announcement about "our selected engine partner" would come "later this year." The Overture design calls for four engines behind the aft pressure bulkhead, which Boom says would reduce noise during takeoff and landing, plus prevent a cabin depressurization if a turbine blade were to separate during an uncontained engine failure.

— Cat Hofacker and Paul Marks

aerodynamics that will reduce the sonic boom tremendously," but the company is "looking forward to the data [X-59] will provide regarding supersonic aircraft design and overland noise tolerance."

It's in these future generations of aircraft that the X-59 team might see the results of the forthcoming test flights. Also, work will continue on the analytical tools (which NASA will open source) that led to the flights. For now, they seem supremely confident that the results from their community flights will presage a new era of faster flight.

So it's eyes on the skies for the new year: Five to 10 checkout flights will be made from Palmdale, says Richwine, followed by envelope expansion to subsonic and then supersonic flight over the next seven to nine months. After that, there are nine months of atmospheric tests above Edwards Air Force Base, with an instrumented F-15 following X-59 to probe its near field shockwaves.

After that, it's down to that most serious of tests. The air data can say what they like; it's the ears of the American public that will have the final say. ★

AIAA
SHAPING THE FUTURE OF AEROSPACE

TECHNICAL PROGRAM

More than 3,400 technical papers will be presented, giving you access to the latest research and development across 60 disciplines, including:

- Aerodynamic Measurement Technology
- Applied Aerodynamics
- Fluid Dynamics
- Guidance, Navigation, and Control
- Intelligent Systems
- Multidisciplinary Design Optimization
- Propellants and Combustion
- Structural Dynamics
- Structures
- Thermophysics

WHAT'S INCLUDED IN FULL CONFERENCE REGISTRATION?

	In Person	Online
Plenary Sessions	✓	✓
Forum 360s	✓	✓
Conference Proceedings	✓	✓
In-Person Technical Sessions	✓	–
Virtual Technical Sessions	✓	✓
Technical Presentation Summary Videos	✓	✓
Exposition Hall	✓	–
In-Person Technical Lectures, Workshops, and Panels	✓	–
Virtual Technical Lectures, Workshops, and Panels	✓	✓
Networking Events	✓	–

REGISTER NOW

aiaa.org/SciTech

SPONSORS

as of 20 October 2022

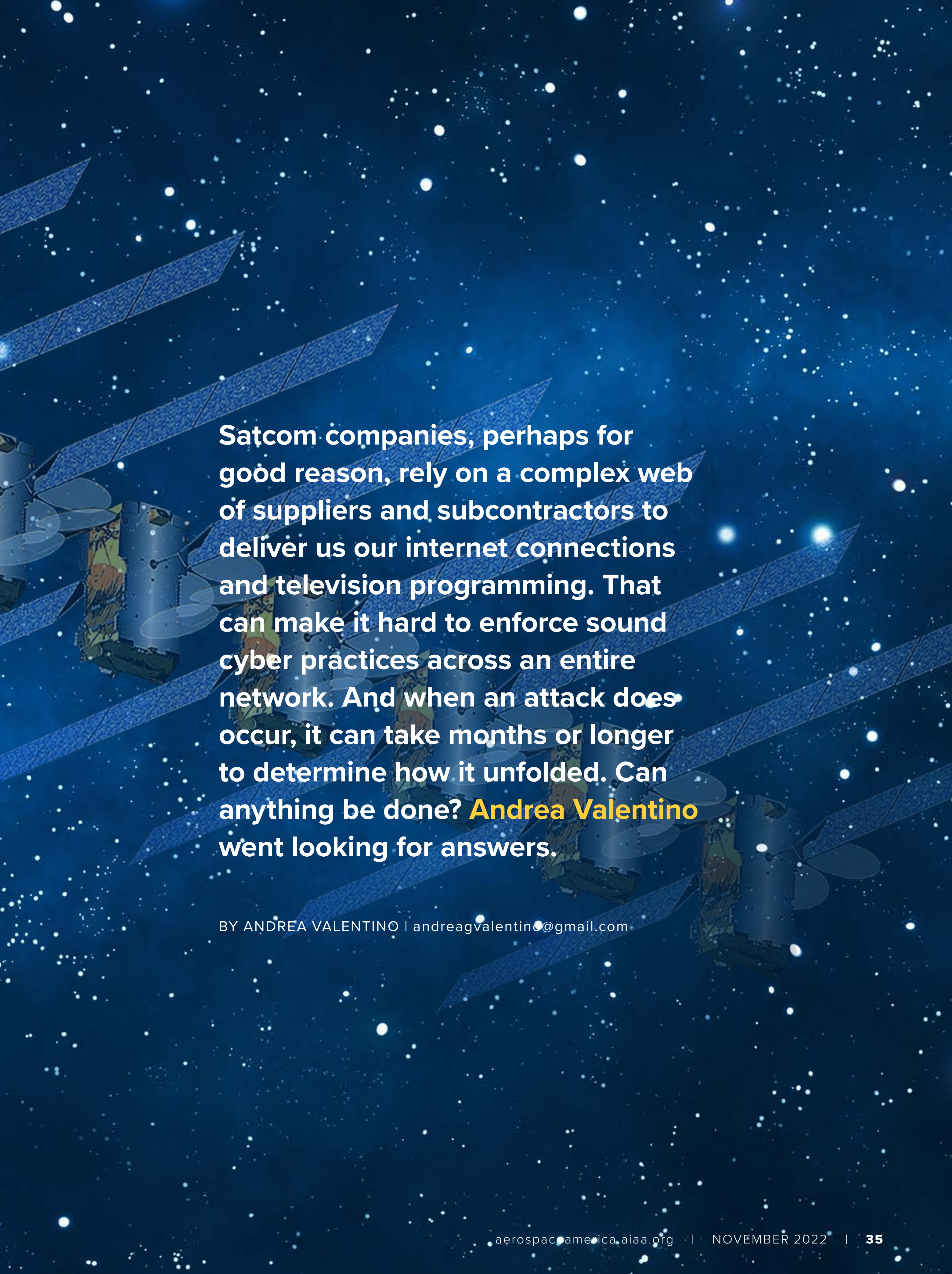
LOCKHEED MARTIN

BOEING

HEXAGON

BASTION TECHNOLOGIES

Why the Viasat attack still echoes



Satcom companies, perhaps for good reason, rely on a complex web of suppliers and subcontractors to deliver us our internet connections and television programming. That can make it hard to enforce sound cyber practices across an entire network. And when an attack does occur, it can take months or longer to determine how it unfolded. Can anything be done? Andrea Valentino went looking for answers.

BY ANDREA VALENTINO | andreagvalentino@gmail.com

In the early hours of Feb. 24, Ukraine faced two assaults. One, all tanks and airstrikes, was plain to see. The other came at about 6 a.m. local time, when internet modems began to go offline in homes and military sites across Ukraine and at locations in Europe. Depending on whose account you believe, wiper malware or a flood of malicious traffic or some combination of those rained down on thousands of satellite dishes affixed to civilian homes and military installations. The signals came from a van-sized geostationary satellite positioned high over the western coast of Africa at the equator. In normal times, the broadband KA-SAT, operated by California-based Viasat, was a godsend for rural customers lacking the option of connecting to the internet via fiber optics. Now, customers were waking up to crashing modems and a loss of connectivity during a national emergency.

While the disruption proved to be relatively short-lived — according to Viasat, most connectivity was restored in "several days" by shipping out some 30,000 fresh modems — nine months on, it continues to reverberate in the satcom industry. For one, there remains no definitive, agreed-upon and publicly shared account of exactly how the attack unfolded. But enough is known to worry that the attacker exploited a vulnerability tied to the business practices of the satcom industry, practices so deeply rooted that the vulnerability could prove difficult, though perhaps not impossible, to fix.

Much of what is known, or theorized, about the attack comes from three sources: a "cyber attack overview" released by Viasat in March; an open-source intelligence study released in October by the Aerospace ADVERSARY Lab at Johns Hopkins University in Baltimore; and forensics performed independently on one of the attacked modems by Ruben Santamarta, a cybersecurity researcher based in Spain.

All agree that the attacker entered through a virtual private network, VPN, appliance, which is software that's supposed to only allow authorized users to enter a company's internal network remotely from the wilds of the internet. From there, the attacker "moved laterally" into one of Viasat's crown jewels, "the trusted management segment of the KA-SAT network," as Viasat's overview document puts it. Ultimately, the attacker sent commands to the modems via the satellite's spot beams. In what might have been an unintended spillover effect, "one fifth" of the wind turbines operated by Enercon in Germany were rendered "inaccessible" for command and control, according to the Johns Hopkins paper.

That's where the accounts diverge. The overview document describes a denial-of-service attack in which "malicious traffic" was detected "emanating from several" modems. Personnel from Skylogic, the Italy-based subcontractor in charge of key parts of the KA-SAT network, "worked to force the malicious modems offline." Nevertheless, the "traffic-based attack" kept "legitimate modems" from entering the network or staying online.

Gregory Falco, one of the authors of the Johns Hopkins paper, says there is "absolutely no empirical evidence" for that account. Citing forensics by Santamarta, he says that "wiper malware" was sent to the modems and that they were incapable of emanating anything once that was done.

What is the evidence for that? Santamarta tells us by email that he received two Viasat SurfBeam2 modems that he will only say came from a "remote place in a Nordic country." One was in working condition, and the other was one of those attacked on Feb. 24. He took the attacked modem apart and downloaded its main, or flash, memory.

"The attacked modem was effectively bricked due to the wiper malware that was deployed during the attack. As a result, its main memory only contained 'garbage,'" he wrote. "I repeated the same process for the working modem, but this time I analyzed the software that runs into it, by using reverse engineering. This allowed me to understand the attack vectors and vulnerabilities that could have been used by the attackers to remotely install the wiper malware in the modems."

Santamarta speculates that the malicious traffic described in the Viasat overview was "intended just to divert the attention of the Skylogic engineers from the main attack, which was focused on remotely installing the wiper malware into the modems."

A security conundrum

Details aside, cybersecurity analysts see plenty of lessons. The VPN appliance implicated in the attack was controlled not by Viasat, but by Skylogic, the Eutelsat subsidiary based in Italy, Santamarta and others say. Eutelsat said the compromised VPN was in Turin, Italy, which is where Skylogic's headquarters are located. Viasat, for its part, did not answer our questions about the VPN.

Such outsourcing lies at the heart of the broader vulnerability that cybersecurity analysts see. For sure, such arrangements are not unique to Viasat. Other satcom operators have similarly complex webs of partnerships and contractors, and those webs are dynamic, changing with the addition of a new contractor or the sale or merger of a contractor. Viasat, in fact, acquired KA-SAT in 2020 — as well as an associated wholesale broadband business — from Eutelsat, a French company. As part of this agreement, Skylogic, a Eutelsat subsidiary, was to continue operating parts of the KA-SAT network temporarily. Such additions and shifts add to the challenge of promoting a unified cybersecurity policy. In fact, Falco and others wonder if the attacker deliberately chose

▲ In February, Viasat's newly purchased KA-SAT became an unwitting conduit for an attack on thousands of internet modems.

Viasat

Viasat because of the ownership transition.

"I think this is a wakeup call for every industry but is clearly a wakeup call for the satellite industry because of the numbers of vendors out there," says James Turgal, a former chief information officer at the FBI and now a vice president at the Optiv cybersecurity firm in Colorado.

In reality, however, a company like Viasat might always need a company like Skylogic, with specific skillsets, to serve its customers. Reflecting this, satcom is a strikingly decentralized industry. Without the strict security requirements of U.S. government satellite networks, and constrained by staffing and financial pressures, most companies instead focus on specific parts of the process and outsource the rest. From building satellites to maintaining ground-based satellite dishes and installing modem boxes in businesses and homes, firms like Viasat rely on a "very diffuse ecosystem" of providers and vendors, as Falco puts it.

This reality is reflected in the statistics. According to one July survey, there are 44 companies specializing in satcom antenna systems alone. It's the same story for satellite operators. Canada's Telesat company, for example, in February announced it was working with an external partner to boost services in Africa. Viasat, judging by its public announcements, works in a similar fashion. Since 2021, it has reached deals with a TV operator in Brazil and a telecommunications company in Australia. Those are just two examples.

A dual-use network like KA-SAT, which serves not only civilians but also the Ukrainian military, becomes a tempting target. But if arrangements of varying complexity are inevitable, can anything be done? The experts we interviewed have some ideas.

FACT

WHAT'S IN A NAME?

The Aerospace ADVERSARY Lab at Johns Hopkins University in Baltimore presents ADVERSARY in uppercase because it is an acronym for Autonomy, Defense and Vulnerability Exploitation for Resilient and Secure Aerospace Risk/Yield.

Security commitments

As matters stand today, a satcom company will typically specify the security arrangements a third party is expected to make. But Falco suggests that these agreements are not always taken seriously by any party. "Sometimes they're doing it, sometimes they're not," he says, adding that it can be hard for firms like Viasat to know exactly what their external partners are up to.

Turgal, the former FBI official, argues that the answer to these troubles, at least in part, is to

strengthen those contracts. A "recovering attorney" himself, he says that giving partners detailed and specific security checklists — and then being willing to follow them up with legal action — can be a good way of forcing compliance. What if there's a breach like this one again, despite a commitment to follow a checklist? "That's when Viasat lawyers are going back to Skylogic and the lawsuits ensue."

Not that stopping a repeat of the Viasat hack would merely involve lawyering up. After compromising the VPN, after all, Viasat's report says the attacker "moved laterally" across the network to gain access to the modems through KA-SAT. To cybersecurity experts, "moved laterally" is an especially telling choice of words, implying that the attacker easily moved about inside the network. Santamarta says that ease speaks to another possible flaw in Viasat's cybersecurity setup: Ideally, he says, you shouldn't be able to compromise an entire network from a single point of access.

Those in the cybersecurity field borrow an analogy from the physical world to show how things should work. If a VPN acts like an outer wall protecting a company's network from intruders, the network should have inner walls or "defense in depth," in cyber parlance. These secondary barriers, for instance in the form of passwords, are designed to prevent an attacker who jumps that first fence from wandering through a network until reaching what AIAA's Steve Lee describes as the "holy grail" — in Viasat's case, the customer modems.

Viasat, in response to our questions, noted that it has "different network segments and partitions designed to help manage traffic and protect different user groups for security reasons."

If Viasat really did fall prey to wobbly internal defenses, it wouldn't be the first time a company has suffered a similar fate. In 2013, criminals stole the credit or debit card information of around 40 million Target customers. Investigators determined that the hackers compromised a private area of the retailer's network by first hacking a heating and refrigeration contractor.

Defense in depth requires the related concept of "zero trust" in which everyone is treated as a prospective attacker. Those inside a network are viewed no less suspiciously than those outside. How could this approach have helped Viasat in February? Falco puts it bluntly: Once the attacker entered the network via the Skylogic VPN, "it wouldn't have mattered." Zero trust would have required Viasat to ensure that every command sent, even ones coming from inside the network, were genuine before letting them go ahead.

In a world in which all your colleagues are treated as potential enemies, departments are encouraged to promote a "need to know" mentality in the vein of government agencies. Lee of AIAA borrows the Target example, arguing that "the person who has access to the air conditioning system shouldn't also have access to customer credit card numbers." Swap "credit card numbers" for "satellite modems," and you begin to see how these principles could usefully be applied to Viasat.

Take things in-house?

In theory, zero trust could revolutionize cyber protection. Certainly, that's reflected in the numbers, with a June report by MarketsandMarkets claiming that the global zero trust security market could reach $60.7 billion by 2027, up from just $27.4 billion this year. Satellite companies seem to be following this

▲ This Maxar satellite image from Feb. 28 captured the progression of Russian ground forces as they moved toward Ukraine's capital, Kyiv. The invasion began Feb. 24, hours after the cyberattack that cut Viasat modems across Ukraine off from the internet.

Maxar Technologies

Steps of the attack

Researchers from the Aerospace ADVERSARY Lab at Johns Hopkins University gathered open-source intelligence to hypothesize about the steps the attacker likely took to knock thousands of satellite internet modems in Ukraine offline during February's attack on Viasat's KA-SAT network. The researchers surmise that a contractor did not patch a vulnerability detected after a 2021 attack on the same kind of virtual private network appliance, the security software that acts as a gatekeeper to allow authorized users to access the network remotely from the wilds of the internet.

1 Conducted reconnaissance to obtain IP addresses and credentials, including passwords, for Viasat's Earth Gateway Centers, servers for controlling KA-SAT's spot beams 2 Via the internet, accessed the IP address of one or more of the Earth Gateway Centers 3 Exploited unpatched vulnerability in FortiGate, a virtual private network appliance firewall, to breach one or more Gateway 4 Selected spot beams 5 Established contact with modems through KA-SAT 6 Accessed modems' management interface 7 Uploaded wiper malware to modems

Graphic by THOR Design | Source: Johns Hopkins University Aerospace ADVERSARY Lab

trend too. In late March, barely a month after the Viasat attack, Lockheed Martin Space said it was promoting zero-trust principles.

All the same, actually putting zero trust into practice across satcom would be far from simple. Fundamentally, this can again be understood in terms of the sector's complexity. Blocking colleagues or vendors from sensitive parts of your network sounds great in theory. But in satcom, an industry built on speed, too many checks risk being counterproductive.

"The more security controls you add, the less accessibility is associated with it," says Melody Champlin of IronNet Cybersecurity in Washington, D.C. That could mean that staff struggle to keep connectivity up, especially if they constantly have to contend with extra passwords and firewalls.

One alternative could be to take more services in-house — something that's actually been done before. Being owned by a billionaire, SpaceX can operate much more freely of partners and franchisees. And though it lacks an Elon Musk, Viasat may be moving in a similar direction. Even before the Skylogic debacle, the company planned to take over the Italian firm's responsibilities later this year. That's shadowed by other plans, notably a $7.3 billion deal, approved by shareholders in June, to acquire British satcom giant Inmarsat.

But here, too, some experts caution that the industry's sophistication makes genuine vertical integration tough. Without farming out parts of the process, predicts Falco, satellite companies will struggle to drive down costs and grow.

Whatever the solution, time is of the essence. Groups, including the Cyber Peace Institute, have cataloged dozens of other cyberattacks on Ukrainian targets over recent months. Given the importance of satellite communications, warns Santamarta, attackers are bound to try again. Ideally, if another penetration does come to Viasat or another company, zero trust and defense in depth mean that the attacker won't get far. ★

Editor-in-chief Ben Iannotta contributed to this report.

Baking in cybersecurity for air taxis

By now, it should be obvious that no sector of society is immune to cyberattacks. And yet, the legions of companies that are planning the electric air taxi revolution spend far more time showing off their cabin designs and flight ranges than bragging about their cybersecurity plans. Architects of these aircraft and the traffic management system must plan now for cybersecurity, say three authors from the Institute for Public Research, part of the nonprofit CNA Corporation based in Virginia.

BY ADAM MONSALVE, REBEKAH YANG AND ADDAM JORDAN

It's the year 2045. In urban centers, electrically powered air taxis have become commonplace and have drastically eased surface road traffic. A trip across town that had typically been filled with red lights and traffic can now be quickly accomplished by flying above the city in special corridors. Areas where public transportation had been less accessible now have hubs where these advanced vehicles offer access to travel in ways not possible before.

Urban air mobility is arguably the most exciting part of today's advanced air mobility movement. Companies are flying prototypes of their aircraft; FAA is deliberating over the regulations for certification; the basics of a traffic management approach have been established. This progress is driven by the fact that UAM promises to unlock a variety of societal advances. But those benefits cannot be achieved unless this sector immediately takes steps to "bake in" cybersecurity from the start. An attack on UAM infrastructure, such as the communications links or navigation data, could have devastating consequences that endanger UAM passengers and potentially result in the loss of lives. Such an incident in the early stages of UAM would demoralize the public's confidence and could disrupt the sector's viability altogether.

The first iterations of UAM aircraft will retain pilots aboard for purposes of FAA certification, but subsequent versions could well be monitored from the ground with no pilot aboard. Either way, existing aircraft traffic management techniques cannot be scaled up to meet the coming UAM demand, and this is forcing the aviation industry to think innovatively about how to manage UAM traffic. As a starting point, FAA released a Concept of Operations for UAM in June 2020 based on collaboration with NASA and the industry. The proposed management of UAM traffic follows a similar approach to that planned for small uncrewed aircraft: Regulators will set forth operational requirements, and a collection of industry service suppliers will work together to ensure aircraft are safely separated in the skies. Whatever form the final concept takes, communications among aircraft and to the ground infrastructure will be key, and as the industry strives for greater automation, aircraft will become more reliant on software and computers, making the vehicles and traffic management scheme juicy targets.

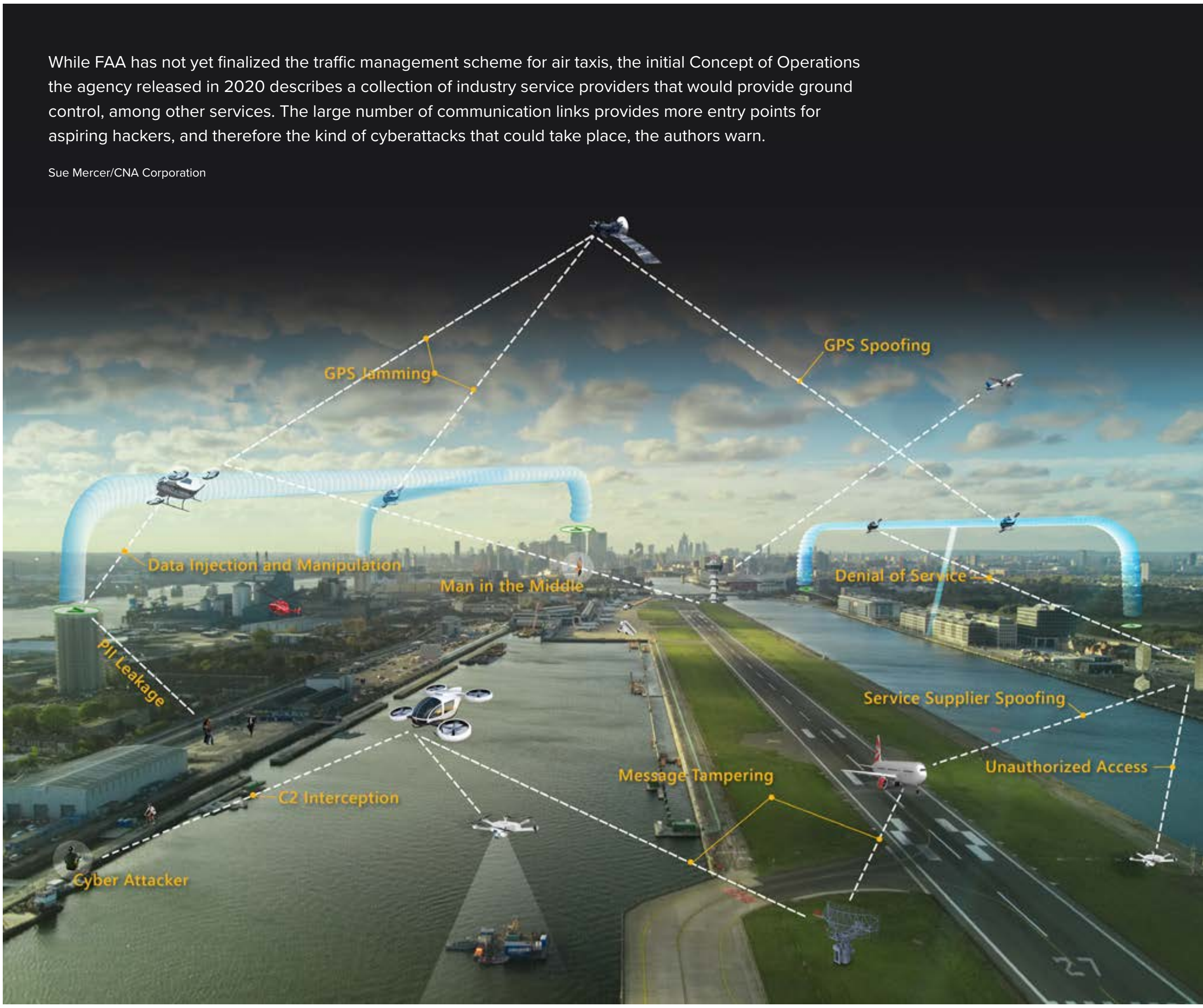
Why would anyone attack this infrastructure or the aircraft within it? Researchers project that the UAM market will continue to grow across the globe and by 2030 will achieve an annual valuation upward of $6.5 billion in the United States. Such a lucrative and transformative component of the transportation infrastructure inherently becomes a highly attractive target. Incidents such as the May 2021 Colonial Oil Pipeline ransomware attack highlight the damaging consequences of being unprepared for an attack on key infrastructure. As society becomes increasingly reliant on digital technologies, the attack surface continues to expand, presenting an increasing threat of cyberattacks.

Due to the increased reliance on industry providers for services typically provided centrally by FAA in its highly secured network, there will be a larger cyberattack surface for UAM than in traditional aviation. That translates to more potential entry points for attackers compared to traditional air traffic managed by a single entity. UAM stakeholders must conduct an in-depth assessment of the entire UAM ecosystem spanning cloud servers, aircraft and software to include navigation algorithms and patches, and other processes or capabilities supporting UAM operations.

We have been alerting the UAM industry to the cyber threat since 2021, when CNA initiated a study with support from NASA that led to the white paper, "Cybersecurity of a Federated Airspace." We leveraged the National Institute for Standards and Technology Cybersecurity Framework, which provides guidance and a common set of terminology and mechanisms to help organizations manage risks to critical infrastructure. The framework defines and provides guidance about five "core functions": **identify** ecosystem needs to manage cybersecurity risk; **protect** against cybersecurity risks to ecosystem resources; and **detect**, **respond** to and **recover** from a cybersecurity event. These functions are relevant to any critical infrastructure, including UAM environments, and provide a comprehensive method of addressing cybersecurity risks that considers the business, implementation and operations levels.

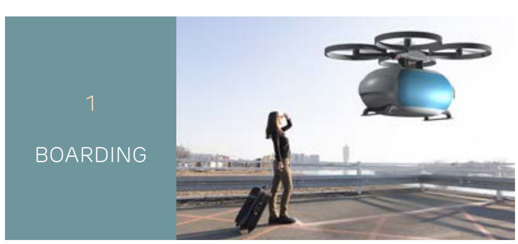
A day in the life

Cybersecurity mechanisms will need to be unmistakably but inconspicuously integrated into the everyday UAM experience. Ahead, we present a typical UAM flight and provide examples of how the NIST core functions should be present throughout the journey to win the confidence of the general public.



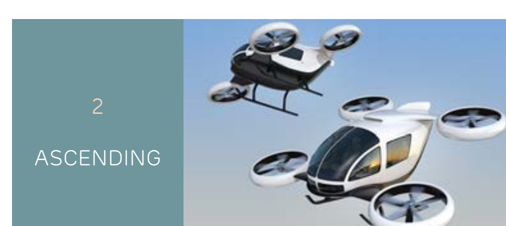
While FAA has not yet finalized the traffic management scheme for air taxis, the initial Concept of Operations the agency released in 2020 describes a collection of industry service providers that would provide ground control, among other services. The large number of communication links provides more entry points for aspiring hackers, and therefore the kind of cyberattacks that could take place, the authors warn.

Sue Mercer/CNA Corporation



It's 8 a.m. You check your mobile app to see that you're next in line at the neighborhood vertiport. You board the next available air taxi and sync your phone to the onboard Wi-Fi so that your route appears on the screen. As the flight takes off, you remark to yourself, "The navigation interface looks different today; I see some new processes that seem to be running in the background. I wonder if there was an upgrade?"

Indeed, in the future, many UAM vehicles will incorporate third-party vendors that rely on upstream libraries requiring periodic updates. The use of third-party components will result in a very complex supply chain that is difficult to secure and can be susceptible to cyberattacks. Future UAM service providers must secure supply chains at all levels in the ecosystem by proactively **identifying** vulnerabilities. As seen in the 2020 SolarWinds cybersecurity breach, malicious code injected into upstream software can have widespread impacts on downstream applications.



After some pondering, you look outside the window and notice a few air taxis nearby that are operated by a competing company. You think, "That air taxi to the west looks like it's coming my way. How do all these different companies communicate with each other to avoid colliding?"

Communication will be a foundational component of the future UAM ecosystem, especially due to its federated nature. To ensure all communication is secure against attacks such as spoofing, future UAM requirements should follow a zero-trust approach. Zero-trust, as its name implies, assumes that an attacker has already compromised your network, and all security decisions are made based on this notion. Therefore, all other parties are not automatically trusted, requiring all communications to be effectively **protected** to ensure that the entity with whom you are communicating is indeed the correct entity.

The neighboring air taxi makes a turn to the north, so you settle in and check the morning news on your phone. While you are relaxing, the taxi continues en route and hums as its systems process information.

In the future UAM ecosystem, vehicles will constantly send, receive and monitor communications to **detect** anything out of the ordinary. For example, a series of unexpected requests coming from an unusual IP address may warrant further inspection. To distinguish between normal and abnormal situations, service providers will need to develop baselines of acceptable and expected behavior that can be used as a comparison to detect for anomalies that may indicate unintended intrusions. Baseline data will define typical characteristics such as frequency, type, format and content of data exchanged between vehicles or service providers. Because UAM will be a novel, nonoperational ecosystem, the development of comprehensive baseline data will be a difficult but critical challenge as the industry advances.

You look up from your phone and realize the air taxi is hovering. Unbeknownst to you, your destination vertiport detected a possible denial-of-service attack and asked operators to consider landing at a nearby vertiport. You wonder, "What's going on?"

To effectively mitigate impacts in this future ecosystem, UAM systems including service providers, vehicles and operators, and infrastructure will need to be programmed to **respond** to detected cybersecurity events by immediately alerting nearby systems, as well as industry and government stakeholders. This communication about cybersecurity incidents will be critical to ensuring all stakeholders maintain awareness of any vulnerabilities or threats. The expected number and diversity of future UAM stakeholders will be vast and will render accurate and timely communication more challenging. They will need to develop incident response plans that detail the necessary communication protocols in the case of attacks.

The attack is quickly resolved, and your air taxi continues toward your destination. You gather your belongings and are ready to alight from the vehicle as soon as the doors open.

UAM stakeholders will need to develop protocol to assess the **recovery** process of any affected system to actively process and learn from cybersecurity events. These protocols should assess how the situation was handled and identify actions that were successful and areas that can be enhanced in future recovery activities. In addition, each stakeholder should track a series of recovery metrics, such as the mean time to recovery, to monitor the ability of the UAM operational environment to recover. These metrics will be important for ensuring that cybersecurity events are addressed in a timely manner and improving future recovery rates.

Looking forward

Thanks to these cybersecurity measures, our passenger's air taxi journey was incident-free, aside from a short pause in operations. The average user of UAM systems is blissfully ignorant of the hard-working personnel and systems behind the scenes who have evaluated, engineered, planned and developed cybersecurity protocols to thwart attempted attacks. Integrating cybersecurity across the UAM ecosystem involves designing protocols for secure information sharing, testing for interoperability beginning from the earliest stages and setting up how to identify the good actors from the bad from the start. Stakeholders must plan now for cybersecurity events, being proactive rather than reactive in applying solutions to prevent the UAM equivalent of the Colonial Pipeline attack from ever occurring. ★

Adam Monsalve is a cybersecurity analyst at CNA Corporation's Institute for Public Research. He has a doctorate in materials science and engineering from the University of Florida.

Rebekah Yang is a systems engineer at CNA Corporation's Institute for Public Research. She has a doctorate in civil engineering from the University of Illinois.

Addam Jordan is chief scientist of the Enterprise Systems and Data Analysis division in CNA Corporation's Institute for Public Research. He has a master's degree in systems engineering and integration from George Washington University and a bachelor's in aviation and air traffic control from Hampton University.

AIAA Bulletin

DIRECTORY

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

To join AIAA; to submit address changes, member inquiries, or renewals; to request journal fulfillment; or to register for an AIAA event. Customer Service: 800.639.AIAA (U.S. only. International callers should use 703.264.7500).

All AIAA staff can be reached by email. Use the formula first name last initial@aiaa.org. Example: christinew@aiaa.org.

Addresses for Technical Committees and Section Chairs can be found on the AIAA website at aiaa.org.

Other Important Numbers: Aerospace America / Catherine Hofacker, ext. 7587 • AIAA Bulletin / Christine Williams, ext. 7575 • AIAA Foundation / Alex D'Imperio, ext. 7536 • Book Sales / 800.682.AIAA or 703.661.1595, Dept. 415 • Communications / Rebecca Gray, 804.397.5270 • Continuing Education / Jason Cole, ext. 7596 • Corporate Programs / Nancy Hilliard, ext. 7509 • Editorial, Books and Journals / Michele Dominiak, ext. 7531 • Exhibits and Sponsorship / Paul doCarmo , ext. 7576 • Honors and Awards / Patricia Carr, ext. 7523 • Integration and Outreach Committees / Angie Lander, ext. 7577 • Journal Subscriptions, Member / 800.639.AIAA • Journal Subscriptions, Institutional / Online Archive Subscriptions / Michele Dominiak, ext. 7531 • K–12 Programs / Jake Williams, ext. 7568 • Media Relations / Rebecca Gray, 804.397.5270 • Engage Online Community / Luci Blodgett, ext. 7537 • Public Policy / Steve Sidorek, ext. 7541 • Section Activities / Lindsay Mitchell, ext. 7502 • Standards, International / Nick Tongson, ext. 7515 • Technical Committees / Angie Lander, ext. 7577 • University and Young Professional Programs / Michael Lagana, ext. 7503

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

DATE	MEETING	LOCATION	ABSTRACT DEADLINE
2022			
1–10 Nov	Designing Better CubeSats Using System-Level Simulations Course	ONLINE (learning.aiaa.org)	
1–10 Nov	eVTOL Infrastructure Considerations for Advanced Air Mobility Course	ONLINE (learning.aiaa.org)	
7–10 Nov	Space Mission Operations Course	ONLINE (learning.aiaa.org)	
17 Nov	AIAA Aerospace Perspectives Series: On-Orbit Mission Enhancement and Logistics	Online (aiaa.org/events-learning/events)	
18–19 Nov	Young Professionals, Students, and Educators (YPSE) Conference	Laurel, MD	
28–29 Nov	AIAA Region VII Student Conference	Adelaide, Australia	31 Aug 22
5–8 Dec	Practical Design Methods for Aircraft and Rotorcraft Flight Control for Unpiloted, UAV, and AAM Applications with Hands-On Training Using CONDUIT ® Course	ONLINE (learning.aiaa.org)	
2023			
15–19 Jan*	33rd AAS/AIAA Space Flight Mechanics Meeting	Austin, TX (space-flight.org)	
21–22 Jan	6th AIAA Propulsion Aerodynamics Workshop (PAW06)	National Harbor, MD	
21–22 Jan	3rd AIAA Aeroelastic Prediction Workshop (AePW-3)	National Harbor, MD	
23–27 Jan	AIAA SciTech Forum	National Harbor, MD	1 Jun 22
7 Feb–2 Mar	AI for Air Traffic Safety Enhancement Course	ONLINE (learning.aiaa.org)	
15–24 Feb	Complex Systems Competency Course	ONLINE (learning.aiaa.org)	
21 Feb–2 Mar	Technical Writing Essentials for Engineers Course	ONLINE (learning.aiaa.org)	
4–11 Mar*	IEEE Aerospace Conference	Big Sky, MT (www.aeroconf.org)	
6 Mar–12 Apr	Design of Space Launch Vehicles Course	ONLINE (learning.aiaa.org)	
13 Mar–5 Apr	Agile Systems Engineering Course	ONLINE (learning.aiaa.org)	
21 Mar–20 Apr	Design of Modern Aircraft Structures Course	ONLINE (learning.aiaa.org)	
24–25 Mar	AIAA Region III Student Conference	Dayton, OH	3 Feb 23
25–26 Mar	AIAA Region VI Student Conference	Davis, CA	5 Feb 23
27–28 Mar	AIAA Region II Student Conference	Knoxville, TN	27 Jan 23
28 Mar–6 Apr	Introduction to Propellant Gauging	ONLINE (learning.aiaa.org)	

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

DATE	MEETING	LOCATION	ABSTRACT DEADLINE
2023			
29–30 Mar	ASCENDxTexas	Houston, TX	
31 Mar–1 Apr	AIAA Region I Student Conference	Buffalo, NY	27 Jan 23
31 Mar–1 Apr	AIAA Region IV Student Conference	Las Cruces, NM	31 Jan 23
11–13 Apr	AIAA DEFENSE Forum	Laurel, MD	18 Aug 22
13–16 Apr	AIAA Design/Build/Fly Competition	Tucson, AZ	
19 Apr–12 May	Electrochemical Energy Systems for Electrified Aircraft Propulsion Course	ONLINE (learning.aiaa.org)	
21–22 Apr	AIAA Region V Student Conference	Kansas City, MO	11 Feb 23
18 May	AIAA Awards Gala	Washington, DC (aiaa.org/gala)	
23 May–6 Jun	Sustainable Aviation Course	ONLINE (learning.aiaa.org)	
12–16 Jun	AIAA AVIATION Forum	San Diego, CA	10 Nov 22
19–23 Jun*	International Conference on Icing of Aircraft, Engines, and Structures 2023	Vienna, Austria (https://www.sae.org/attend/icing)	
27–30 Jun*	ICNPAA 2021: Mathematical Problems in Engineering, Aerospace and Sciences	Prague, Czech Republic (icnpaa.com)	
13–17 Aug*	2023 AAS/AIAA Astrodynamics Specialist Conference	Big Sky, MT (https://space-flight.org)	
2–6 Oct*	74th International Astronautical Congress	Baku, Azerbaijan (iac2023.org)	
23–25 Oct	ASCEND Powered by AIAA	Las Vegas, NV	

Meetings cosponsored by AIAA. Cosponsorship forms can be found at aiaa.org/events-learning/exhibit-sponsorship/co-sponsorship-opportunities.

AIAA Continuing Education offerings

MAKING AN IMPACT

AIAA Launches New STEM Initiative

AIAA is excited to announce a new STEM education initiative called Students to Launch (S2L), designed to help underserved, underrepresented students develop a deeper understanding of the challenges and goals of spaceflight missions and inspire them about the possibility of a career in aerospace and astronautics.



S2L works with informal education institutions across the country. These S2L Hubs, such as museums, science centers, afterschool programs, and libraries, invite middle school students to participate in NASA-inspired mission activities. Students who complete S2L activities at these hubs are eligible to be selected for the full-scale experience of witnessing a space launch in person, traveling to NASA Kennedy Space Center (KSC) to learn about a wide spectrum of space missions, meeting aerospace professionals including astronauts, and imagining a future for themselves working in the space industry.

S2L employs a multifaceted approach to engage students as they witness and celebrate the triumphs and challenges of spaceflight. Short videos led by explorer and television host Josh Bernstein (known as "Commander Josh") introduce students to real-life subject matter experts working on the frontlines of NASA missions. Hands-on activities allow students to complete their own NASA-inspired projects. Finally, special opportunities to meet astronauts and other industry experts, as well as participate in live launch watch parties, both virtual and in person, involve students in the inspiring atmosphere of space launches.

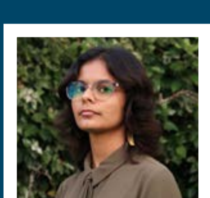
The first S2L in-person launch experience was piloted in August 2022 at NASA Kennedy Space Center (KSC) as 47 students and chaperones from the Panama City, Jacksonville, and Miami areas were hosted to watch the first Artemis I launch attempts. The students engaged in multiple days of hands-on educational activities, learning about space, and hearing from NASA leaders.

Since August, S2L has led S2L Hub experiences with students in Florida, Montana, Texas, and Connecticut. The second in-person launch experience occurred in early October. While the students toured NASA KSC they were able to witness the SpaceX Crew-5 spacecraft docking at the International Space Station, and they viewed the SpaceX launch of the Intelsat G-33/G34 mission.

"The Students To Launch mission has lifted off and we couldn't be more excited," said Dan Dumbacher, AIAA Executive Director. "Students involved in this program are seeing for themselves the diverse opportunities and careers in the aerospace industry. This is confidence inspiring! They will be able to see themselves doing this kind of work soon, being an integral part of something that changes the world."

The S2L program, offered through a unique collaboration between NASA, founding sponsor AIAA, Griffin Communications Group, First Light Ventures, and Oregon State University, will open students' minds to the trajectory their lives could take in STEM careers, particularly in the space industry. More information can be found at **studentstolaunch.org**.

November is National Scholarship Month



AIAA is celebrating National Scholarship Month by reminding student members about the amazing opportunities available through AIAA to fund their education, with over $100,000 available to student members each year. We offer scholarships and graduate awards to deserving student members studying at colleges and universities all over the world. Supported fields include aerospace engineering, structural and mechanical engineering, and electrical engineering for students at the high school level all the way through Ph.D. "Receiving this award and being able to represent AIAA as well as Marillyn Hewson's legacy is a great honor for me," said Penelope Nieves-Colon, rising junior at the University of Puerto Rico-Mayaguez and winner of the inaugural $10,000 2022 AIAA Lockheed Martin Marillyn Hewson Scholarship. "The scholarship will greatly enable me to pursue my dream of becoming an aerospace engineer and help develop the industry. I am profoundly grateful for all the support!" AIAA is proud to offer scholarships that make investments in students like Penelope, who are the future of the aerospace industry. Applications for the 2023 AIAA scholarships and graduate awards are open through 31 January 2023. Apply today: **aiaa.org/scholarships**.

AIAA Announces Candidates for 2023 Election

The Council Nominating Committee has selected candidates for next year's openings on the AIAA Council of Directors.

Elections will be held January/February 2023. Council Nominating Committee Chair John Blanton and AIAA Governance and Executive Operations Administrator Susan Silva confirmed the names of the candidates who will appear on the 2023 ballot.

Integration and Outreach Activities Division

Director–Business and Management Group
Gustavo Ordonez, *Icarus Management Consulting, and University of California*
Abdi Khodadoust, *The Boeing Company*

Director–International Activities Group
Thomas Sebastion, *MIT Lincoln Laboratory*
Robert Winn, *Engineering Systems, Inc.*

Director-Elect–Young Professionals Group
Bryan Kowalczyk, *University of Cincinnati*

Regional Engagement Activities Division

Director–Region I
Timothy Dominick, *Northrop Grumman Defense Systems*
Kyle Zittle, *Johns Hopkins University Applied Physics Laboratory*

Director–Region II
Ryan Sherrill, *Air Force Research Laboratory*

Director–Region VII
Cees Bil, *RMIT University*

Technical Activities Division

Director–Aircraft Technology, Integration, and Operations Group
David Maroney, *The MITRE Corporation*

Director–Space and Missiles Group
Stephen Blanchette, *The Aerospace Corporation*

On 4 October, Robert Braun, Space Exploration Sector Head at Johns Hopkins University Applied Physics Laboratory, gave the 2022 Yvonne C. Brill Lecture in Aerospace Engineering at the National Academy of Engineering, discussing "Are We Alone? Grand Challenges in Solar System Exploration." Al Romig, Executive Officer of the National Academy of Engineering (left), and John Casani, Brill Lectureship Chair (right), presented Braun with a certificate after the lecture.

Russell M. Cummings Appointed AIAA Education Series Editor-in-Chief

In January 2023, Russell M. Cummings, Professor of Aeronautics, U.S. Air Force Academy, will assume responsibility as the new editor-in-chief of the AIAA Education Series. Cummings succeeds Joseph Schetz of Virginia Polytechnic Institute and State University, who has served as editor-in-chief of the book series since 2003.

The AIAA Publications Committee oversees the search and selection effort for new editors-in-chief. This year's search committee was led by Noel Clemens, University of Texas at Austin, Publications Committee member. Cummings was chosen from among a group of highly qualified candidates.

Cummings holds a Ph.D. in Aerospace Engineering from the University of Southern California and Master of Engineering and B.S degrees in Aeronautical Engineering from California Polytechnic State University. He is currently a Professor of Aeronautics and managing director of the DoD HPCMP Hypersonic Vehicle Simulation Institute at the U.S. Air Force Academy. From 2015 to 2018 he was the technical director at AFOSR's European Office of Aerospace Research & Development in London. He has previously worked at Hughes Aircraft Company, NASA Ames Research Center, and California Polytechnic State University.

A Fellow of both AIAA and the Royal Aeronautical Society, Cummings currently serves as deputy editor of AIAA's *Journal of Spacecraft and Rockets* and is an associate editor of AIAA's *Journal of Aircraft*. He has also served as an associate editor for Elsevier's *Aerospace Science & Technology*. He is co-author of the sixth edition of *Aerodynamics for Engineers* and lead author for the *Applied Computational Aerodynamics* textbook.

"My experiences with book publishing, coupled with my education, research, and program management background, have given me significant insight into the Education Series and how we can continue to improve and expand the reach of the series," said Cummings

The AIAA Education Series publishes books that are adopted for classroom use in many of the top undergraduate and graduate engineering programs around the world. These important texts are also referred to on a daily basis by aeronautics and astronautics professionals who want to expand their knowledge and expertise. Books in the series present the subject material tutorially, discussing fundamental principles and concepts.

AIAA Announces University Student Design Competitions Winners

AIAA is pleased to announce the winners of its 2021–2022 Design Competitions. AIAA Design Competitions give undergraduate and graduate students the opportunity to respond to requests for proposals outlining a design problem that requires specialized technical solutions. Several of the competitions allow students to perform theoretical work and gain real-world insight into the design process.

Five competitions were held in the following categories:

- Aircraft: Undergraduate Team, Graduate Team
- Missile Systems: Graduate Team
- Space: Undergraduate Team
- Engine (Trial Basis): Undergraduate Team

The 2021–2022 AIAA Design Competitions winners are:

Undergraduate Team Aircraft Design

First Prize: Nanyang Technological University (Singapore), for their design "Fireflighter." Puay Him Ler, Wenhui Tock, Szecsenyi Tamas, Kenneth Neoh, Cherng En Lee, Wen Yue Tang. Prof. Wai Tuck Chow, faculty advisor. Team Name: Fireflighter.

Second Prize: University of Illinois at Urbana-Champaign (Champaign, Illinois), for their design "AE-443 Njord." Macy Nanda, Ram Dwarakanth, Maverick Emerson, Nicholas Hall, Alan Hong, Nikhil Wagher, Kuan-Ta Wu. Prof. Jason Merret, faculty advisor. Team name: Njord.

Third Prize: University of Illinois at Urbana-Champaign (Champaign, Illinois), for their design "N513-Firehawk." Scott Brindise, Quang Do, Jason McIntyre, Rohan Patel, Andrew Strubhar, Maryna Syb, Shri Tandon, Yiyang Wang. Dr. Jason Merret, faculty advisor. Team name: Albatross.

Graduate Team Aircraft Design

First Prize: Politecnico di Milano (Milan, Lombardi, Italy), for their design "Colibr-e: An Agile Hybrid-Electric STOL Aircraft." Luca Bottà, Alessandro Garatti, Andrea Romani, Carlo Spitale, Marco Tomasoni. Lorenzo Trainelli, faculty advisor, Carlo E. D. Riboldi, project advisor. Team name: Colibr-e

Second Prize: Université de Liège (Liège, Belgium), for their design "HARPON." Hugo Agnello, Emrah Altin, Maxime Borbouse, Julien Caudron, Simon Dehareng, Hasan Sait Erdogan, Bruno Fontaine, Hugo Stegen, Adrien Vandyck. Adrien Crovato, Arnaud Budo, and Thomas Lambert, project advisors. Dr. Ludovic Noels and Dr. Dimitriadis Grigorios, faculty advisors. Team name: Kingfisher Aerospace.

Third Prize: Politecnico di Milano (Milan, Lombardi, Italy), for their design "Hexi: A hybrid-electric STOL air taxi for advanced air mobility." Anna Sofia Passerelli D'Onofrio, Luca Caccetta, Maria Vittoria Rossetti, Nicola Tartari, Matteo Guidotti, Irene Salmoiraghi. Lorenzo Trainelli, project advisor, Carlo E.D. Riboldi, faculty advisor. Team name: Team HExi

Graduate Team Missile System Design

First Prize: Georgia Institute of Technology (Atlanta, Georgia), for their design "Hypersonic UPRISE: Unmanned Platform for Reconnaissance Intelligence and Surveillance Efforts." William Cammack, Baptiste Cramette, Joey Ji, Antonio Macias Salil Sodhi, Gowtham Venkatachalam, Tyler Wills, Karen Yehoshua. Dr. Dimitri Mavris, faculty advisor. Dr. Brad Robertson and Dr. Ken Decker, research advisors. Team name: Hypersonic Uprise.

Second Prize: University of Kansas (Lawrence, Kansas), for their design "Hypersonic Jayhawks Reusable Penetrating Hypersonic ISR Platform." Nathan Wolf, Gerell Miller, Zachary Rhodes, Justin Clough, Garin McKenna, Jack Schneider. Dr. Ron Barrett, faculty advisor. Team name: Hypersonic Jayhawks.

Undergraduate Team Space Design

First Prize: Virginia Polytechnic Institute and State University (Blacksburg, Virginia), for their design "Manned Sample Acquisition Mission to Phobos and Deimos." Juliana Ruiter, Nathan Horner, Carson Peters, Jacob McDaniel, Aidan Messick, Tanushree Manohar Shinde, Connor Poole, Musfique Mazumder, Matthew Smith, Shelly Natoli. Kevin Shinpaugh, faculty advisor Team name: Project Chariot.

Second Prize: University of Texas at Austin (Austin, Texas), for their design "Scientific Phobos And Deimos Explorer (SPADE)."Reece Appel, Teja Gorantla, Shannon Scott, Nicholas Delurgio, Shea Popov, Sir Jherg Jones, Nils Schlautmann, Christian Hinton, Rye Seekins, Pete Lealiiee Jr. Adam Nokes, faculty advisor. Team name: Space Pirates.

Third Prize: University of Maryland, College Park (College Park, Maryland), for their design "Martian Moons Explorer Vehicle." Nicolas Pouliquen, Michael Hanlon, Nico Lagendyk, Ryan Quigley, Thomas Brosh, Nathaniel Wunderly, Rahul Jain, Derek Hounkale, Gracelyn Pham. Jarred Young, faculty advisor. Team name: Project Cupid.

Undergraduate Team Engine Design

For 2022, AIAA conducted this competition on a trial basis using a new format, with teams that elected to participate. Four teams participated in this year's competition. They received no prize funds for their placements.

First Place: Beihang University (Beijing, China), for their design "BH-22." Xilong Fang, Guohe Jiang, Shiying Song, Ziyu Qin, Wenhao Ma. Xingmin Gui, project advisor. Min Chen, faculty advisor. Team name: Flyingbird.

Second Place: Arab Academy for Science, Technology, & Maritime Transport (Alexandria, Egypt), for their design "AAP-100." Abdelmageed Elgammal, Asser Mohamed, Ahmed Mostafa, Ahmed Sharaf. Prof. Dr. Yehia Eldrainy, project advisor. Prof. Dr. Aly Esmail, faculty advisor.

Third Place: Turkish Naval Academy (Istanbul, Turkey), for their design "Future High Bypass Engine." Muhammad Abdullah Kacmaz, Oguzhan Pala, Muzaffer Onalan, Mehmet Ali Keles. Associate Professor Dr. Dogus Ozkan, faculty advisor. Team name: Two Blue Eyes.

Obituaries

AIAA Associate Fellow Martino Died in July

Joseph P. Martino, 91, died on 29 July. Martino received a Bachelor's degree in Physics from Miami University in 1953, and was commissioned in the U.S. Air Force, where he served for 22 years. His duty stations included Air Force research laboratories throughout the United States, and a tour of duty in Thailand during the Vietnam War. He also received a Master's degree in Electrical Engineering from Purdue University and a Ph.D. in Mathematics from Ohio State University.

In 1975 Martino retired from the Air Force as a Colonel. He joined the University of Dayton Research Institute as a Research Scientist and worked there for 18 years until his retirement from the university. He spent two semesters as a visiting professor at Marmara University in Istanbul, Turkey. He was a visiting scholar at the International Institute for Applied Systems Analysis in Vienna, Austria, and also at the Institute for Technological Research at University of Sao Paolo in Brazil.

As well as being an AIAA Associate Fellow, Martino was also a Fellow of the Institute of Electrical and Electronics Engineers and the American Association for the Advancement of Science. He was the author of over a dozen papers in technical journals and two engineering books, and he also wrote a murder mystery and numerous stories in science fiction magazines.

AIAA Fellow Rand Died in August

James L. Rand, age 86, died on 26 August.

After high school Rand enlisted in the U.S. Air Force where he served for four years. He then attended the University of Maryland, receiving his B.S. in Aeronautical Engineering (1961), M.S. in Aerospace Engineering (1963), and a Ph.D. in Mechanical Engineering (1967). While he was working on his graduate degrees, Rand also worked as a research engineer in the Aeroballistics Department at the U.S. Ordnance Laboratory in Maryland.

From 1968 to 1979 Rand was a Professor of Aerospace Engineering at Texas A&M University. He became widely known for his work on the shape and stress analysis of high-altitude scientific balloons. In addition, he managed programs for a variety of sponsors to develop preliminary designs, feasibility studies, failure analysis, thermal studies, and materials testing and characterization of thin film, flexible balloon systems. He consulted with a variety of organizations in the areas of stress analysis, impact effects, and balloon engineering. He also defined the effects of impact by foam insulation on the Space Shuttle Thermal Protection System. Prior to that, Rand was instrumental in the development of the Hypervelocity Impact Laboratory at Texas A&M University to simulate meteorite impact. Rand also taught both undergraduate and graduate courses covering such subjects as aircraft structures, elasticity, and wave propagation in gases, liquids, and solids.

He joined Southwest Research Institute in 1979 where he continued scientific balloon-related research first as a staff engineer in the Department of Energetic Systems and then as manager of the Dynamic Analysis Section. His research included the development of a unique strain gage to measure the strains in balloon films, for which he received a patent.

After becoming president and COO of Winzen International in 1983, he was elected CEO in 1985. In 1989, Dr. Rand patented a new method for manufacturing large scientific balloons that has increased the quality of the seals while reducing balloon costs. In 1994 he formed Winzen Engineering to design, analyze and research inflatable vehicles and materials and obtained numerous patents related to ballooning and remained there until 2001, when he limited his activities to personal consulting.

Rand was recognized as a Fellow of the American Society of Mechanical Engineers and AIAA, and was a member of the American Society for Engineering Education and the National Society of Professional Engineers. He served on advisory engineering committees for Texas A&M, Trinity University, and the University of Texas Austin for over 40 years. In 2002 he was honored with the AIAA Otto C. Winzen Lifetime Achievement Award.

AIAA Fellow Roskam Died in September

Jan Roskam, Distinguished Professor Emeritus of Aerospace Engineering at the University of Kansas, died on 9 September at the age of 92.

He earned his Master's degree in aeronautical engineering from the Technical University of Delft in 1954, and Ph.D. degree in Aeronautics and Astronautics from the University of Washington in 1965. He also obtained his private pilot's license in 1954.

He first was employed as an assistant chief designer for the Aviolanda Aircraft Company working on military airplane projects. He fulfilled his military service in The Netherlands as a Second Lieutenant in the Royal Netherlands Air Force while remaining in his job. Afterward he worked at Cessna Aircraft Company in Wichita, where he assisted in the design of the Cessna T-37 and AT-37 military jets from 1956 to 1958.

From 1958 to 1967 he was employed by The Boeing Company, where he worked on a variety of military and civilian aircraft designs, including the Boeing TFX fighter, the AMSA bomber (that became the B-1) and the 2707 Supersonic Transport.

While working at Cessna and Boeing he taught aeronautical engineering and mathematics courses in the evening at the University of Wichita (now Wichita State University) and later at Seattle University.

In 1967 Roskam was appointed as Associate Professor of Aerospace Engineering at the University of Kansas in Lawrence, promoted to full professor in 1972, and Distinguished Professor in 1974. He was named chairman from 1972 to 1976 and formed the KU Flight Research Laboratory in 1968, serving as its Director until 1984.

He was the author of more than 155 publications, including his ubiquitous 8-volume set on *Airplane Design*, *Airplane Aerodynamics and Performance* (with C.T.E. Lan), and a two-volume set on *Airplane Flight Dynamics*, *War Stories*. An inspiring and demanding teacher of undergraduate and graduate flight dynamics and aircraft design courses until his retirement in 2003, Roskam taught more than 1,000 college students, including 200 graduate students—his first being Dr. Alan Mulally (Boeing/Ford). From 1980 to 2019 he guided individuals and teams to win 33 awards in the annual AIAA Aircraft Design Competitions. His Aircraft Design, Flight Dynamics and History of Aircraft Design short courses have been attended by more than 8,000 technologists and are still taught by his former students as part of the KU Continuing Education Program.

Roskam worked on more than 36 airplane design and development projects, including the Gates-Learjet Models 25 and 36, SIAI-Marchetti S-211, Beech King Air, Grumman X-29 and Piaggio P.180 Avanti.

In 1991 Roskam cofounded, with Dr. Willem Anemaat, Design, Analysis and Research Corporation (DARcorporation) and functioned as president until 2004. From 2004 until 2019 he served as Project Advisor. He was actively involved on over 400 aircraft design and analysis projects at DARcorporation over 31 years.

He was a Fellow of AIAA, the Society of Automotive Engineers (SAE), and the Royal Aeronautical Society (RAeS) of England. He served on a wide variety of advisory committees for NASA and the U.S. Air Force and received numerous awards including the 2003 KU Chancellors Career Teaching Award and the 1987 J. Leland Atwood Award. He was also recognized by AIAA with the 1986 Piper General Aviation Award and the 2007 Aircraft Design Award.

AIAA Associate Fellow Jaggard Died in September

Catherine (Cathy) Jaggard died on 19 September 2022. She was 67 years old.

Jaggard earned a Bachelor of Business Administration, International Business from Stockton University in 1994, and an MSSE, Engineering from Monmouth University in 1998. In 2022, she received a Master's in Software Engineering and graduated from the NJIT Cyber Security Boot Camp.

In Jaggard's 20+ years of technical experience in the public and private sector, she spent five years as a program manager for Homeland Security projects. She also spent time maintaining technical documents for deployed systems, documented technical processes, and had a working knowledge of the CMMI, iCMM, ISO 9000 Quality standards, and Total Quality Management (TQM). Jaggard chaired Configuration Management Boards and worked with IPT teams from Washington, DC. She also had eight years as a systems engineer with multiple systems.

She worked with the AIAA Student Activities Committee (2002–2012), the STEM K-12 Outreach Committee (2000–2010), the Regional Engagement Activities Division (2004–2006), and the Aerospace Traffic Management Program Committee (2002–2012). Jaggard was Region I Deputy Director, Education (2002–2012) and was an AIAA Southern New Jersey Section officer, including a term as section chair. She was recognized for her dedication with a 2007 Special Service Citation and a 2007 Harry Staubs STEM K-12 Outreach Award. Jaggard also was the Jersey Shore Science Fair coordinator for decades, growing it from six participating schools to over 32 schools and 700 students.

Region and Section Officers, 2022–2023

Daniel Jensen
Regional Engagement
Activities Division Chief

Region I – North East Officers

Steven Bauer
Director

Vanessa Aubuchon
Deputy Director, Career and Workforce Development

Kenneth Visser
Deputy Director, Education

Colin Britcher
Deputy Director, Education

David Paris
Deputy Director, Finance

Linda Bangert
Deputy Director, Honors & Awards

Raymond Trohanowsky
Deputy Director, Membership

Kerri Phillips
Deputy Director, Public Policy

Megan Tucker
Deputy Director, STEM K-12

Joseph Burns
Deputy Director, STEM K-12

Vanessa Aubuchon
Deputy Director, Technical

Jessica Evans
Deputy Director, Young Professionals

Region II – South East Officers

Kurt Polzin
Director

Ashley Scharfenberg
Assistant Deputy Director, Education

Brittani Searcy
Assistant Deputy Director, Education

Cassondra Dellinger
Deputy Director, Education

Matthew Zuk
Deputy Director, Finance

John Dankanich, Co-Deputy Director, Honors & Awards

Terri Tramel
Co-Deputy Director, Honors & Awards

Trevor Moeller
Deputy Director, Membership

Bruce Morris
Deputy Director, Public Policy

John Fay
Deputy Director, STEM K-12

Joseph Majdalani
Deputy Director, Technical

Tamara Statham
Deputy Director, Young Professionals

Region III – Central Officers

Peggy Cornell
Director

Christopher Pestak
Deputy Director, Education

Darius Sanders
Deputy Director, Finance

Sivaram Gogineni
Deputy Director, Honors & Awards

James Gilland
Deputy Director, Membership

Patrick McNally
Deputy Director, Public Policy

TBD
Deputy Director, STEM K-12

Robert Bruckner
Deputy Director, Technical

Janice Gong
Deputy Director, Young Professionals

Region IV – South Central Officers

Ellen Gillespie
Director

Humberto Silva
Deputy Director, Education

Edward Laverdure
Deputy Director, Education

James Walker
Deputy Director, Finance

Alicia Baker
Deputy Director, Honors & Awards

Douglas Yazell
Deputy Director, International

Svetlana Hanson
Deputy Director, Membership

Wayne Rast
Deputy Director, Public Policy

Edgar Bering
Deputy Director, STEM K-12

Isaias Chocron
Deputy Director, Technical

Alexander Foster
Deputy Director, Young Professionals

Region V - Mid West Officers

Jim Guglielomo
Director

Sam Stanton
Deputy Director, Education

Kristen Gerzina
Deputy Director, Finance

Michael Martin
Deputy Director, Honors & Awards

Enanga Fale
Deputy Director, Membership

Colin Campbell
Deputy Director, Public Policy

Karolyn Evans
Deputy Director, STEM K-12

John Schaefer
Deputy Director, Technical

Christopher Stevens
Deputy Director, Young Professionals

Region VI – Western Officers

Oleg Yakimenko
Director

Jeffery Puschell
Deputy Director, Education

L. Jane Hansen
Deputy Director, Finance

TBD
Deputy Director, Honors & Awards

Joel Perez, Deputy Director, Membership

TBD
Deputy Director, Public Policy

Elana Slagle
Deputy Director, STEM K-12

Catherine Beck
Deputy Director, Technical

TBD
Deputy Director, Young Professionals

Region VII – International Officers

Cees Bil
Director

Roelof Vos
Deputy Director, Europe

João Luiz Azevedo
Deputy Director, South America

AIAA Section Chairs

Patrick Neumann
Adelaide

Kyle Lynch
Albuquerque

Jason Lechniak
Antelope Valley

Neil Sutherland
Atlanta

Kevin Johnson
Cape Canaveral

John Blanton
Carolina

Michelle Itzel-Montoya
Central Coast of California

Walter Hammond
Central Florida

Puneet Singla
Central Pennsylvania

Michael Peterson
China Lake

David Hobbs
Connecticut

Troy Hoeger
Dayton/Cincinnati

Daniel Nice
Delaware

Tracie Prater
Greater Huntsville

Glen Guzik
Greater New Orleans

Jonathan Moore
Greater Philadelphia

Soumyo Dutta
Hampton Roads

Jorge Hernandez
Houston

Laura Villafañe Roca
Illinois

Alan Tribble
Iowa

John Gebhard
Indiana

Kenneth Lui
Los Angeles-Las Vegas

David Paris
Long Island

TBD
Michigan

Kyle Zittle
Mid-Atlantic

David Brandt
National Capital

Hiroaki Endo
New England

Walter Gordon
Niagara Frontier

James Sergeant
North Texas

Raymond Trohanowsky
Northern New Jersey

Joseph Connolly
Northern Ohio

Ryan Sherrill
Northwest Florida

Alfred Striz
Oklahoma

Dino Roman
Orange County

Matthieu Masquelet
Pacific Northwest

Randy Parsley
Palm Beach

Scott Fouse
Phoenix

Giovanni Minelli
Point Lobos

Alexandra Dukes
Rocky Mountain

Andre White
Sacramento

Lindsey Sweeney
San Diego

L Dean Miller
San Fernando Pacific

Eric Wahl
San Francisco

Hemali Vyas
San Gabriel Valley

TBD
Savannah

Angela Campbell
Southern New Jersey

Pablo Bueno
Southwest Texas

Charles Svoboda Jr.
St. Louis

Daniel Walsh
Sydney

Taylor Swanson
Tennessee

Teresa Clement
Tucson

Kristen Gerzina
Twin Cities

Michael Stevens
Utah

Stephen McDougle
White Sands

Edward Feltrop
Wichita

Trent Cybela
Wisconsin

Jane Hansen
Student Branch Committee Chair

Jeffrey Marchetta
Student Branch Committee Deputy

2022 Best Professional and Student Papers

AIAA technical committees (TCs) and integration and outreach committees (IOCs) have selected the best professional and student technical papers presented at recent AIAA forums. With a standard award criteria and selection process from the respective committees, the following technical papers were selected as the "best," and the by were presented with a Certificate of Merit. The papers can be found online at the AIAA Aerospace Research Central (arc.aiaa.org), marked as "Best Paper."

BEST PROFESSIONAL PAPERS

2020 AIAA Pressure Gain Combustion Best Paper Award

"MHz Mid-infrared Laser Absorption of CO and CO2 for Pressure, Temperature, and Species in Rotating Detonation Rocket Flows" (AIAA 2020-3867) by Anil P. Nair, Daniel D. Lee, Daniel I. Pineda, and R. Mitchell Spearrin, University of California, Los Angeles; Jason Kriesel, Opto-Knowledge Systems Inc. (OKSI); and William A. Hargus Jr., John W. Bennewitz, and Stephen A. Danczyk, Air Force Research Laboratory

2021 AIAA Atmospheric Flight Mechanics Best Paper Award

"Stall Model Identification of a Cessna Citation II from Flight Test Data Using Orthogonal Model Structure Selection" (AIAA 2021-1725) by Joost B. van Ingen, Coen C. de Visser, and Daan M. Pool, Delft University of Technology

2021 AIAA Design Engineering Best Paper Award

"Small UAS Design Toolkit: Characterization and Development using Optimization and Advanced Manufacturing Modeling" (AIAA 2021-0625) by Brandon E. Sells and Philip Baldwin, Purdue University

2021 AIAA Design Engineering Best Paper Award

"High Fidelity Digital Cabin Mock-Up based on Preliminary Aircraft Design Data for Virtual Reality Applications and Beyond" (AIAA 2021-2775) by Jan-Niclas Walther, Christian Hesse, Jörn Biedermann, and Björn Nagel, German Aerospace Center (DLR)

2021 AIAA Electric Propulsion Best Paper Award

"Performance Measurements of a 5 kW-Class Rotating Magnetic Field Thruster" (AIAA 2021-3384) by Christopher L. Sercel, Tate Gill, Joshua M. Woods, and Benjamin Jorns, University of Michigan, Ann Arbor

2021 AIAA Electrified Aircraft Technology Best Paper Award

"Results for an Electrified Aircraft Propulsion Design Exploration" (AIAA-2021-3280) by Ty V. Marien, Nathaniel J. Blaesser, Zachary J. Frederick, Mark D. Guynn, and Jason T. Kirk, NASA Langley Research Center; Kenneth Fisher, Steven Schneider, and Robert P. Thacker, NASA Glenn Research Center; and Peter Frederic, Tecolote Research Inc.

2021 AIAA Ground Testing Best Paper Award

"Evaluation of CFD Predictions of CobraMRV Control Surface Effectiveness at the NASA Langley Unitary Plan Wind Tunnel" (AIAA-2021-2965) by Marie F. Denison, Joseph A. Garcia, Ben E. Nikaido, Scott M. Murman, and James C. Ross, NASA Ames Research Center; Robert E. Childs, Paul M. Stremel, and Veronika M. Hawk, Science and Technology Corporation; Bil Kleb, Stephen J. Alter, and Thomas K. West, NASA Langley Research Center; and Philip Robinson, NASA Johnson Space Center

2021 AIAA Guidance, Navigation and Control Best Paper Award

"Convex Optimization Guidance for Precision Landing on Titan" (AIAA 2021-1345) by Rayan Mazouz, Marco B. Quadrelli, NASA Jet Propulsion Laboratory; and Erwin Mooij, Delft University of Technology

2021 AIAA High Speed Air Breathing Propulsion Best Paper Award

"Application of Flux-Conserved Modeling to an Unsteady Combustion Driven Pseudo-Shock" (AIAA 2021-1763) by Louis M. Edelman and Mirko Gamba, University of Michigan, Ann Arbor; Robin Hunt and Aaron Auslender, NASA Langley Research Center; and Jeffrey M. Donbar and Mark Hagenmaier, Air Force Research Laboratory

2021 AIAA Intelligent Systems Best Paper Award

"Multi-Class Anomaly Detection in Flight Data Using Semi-Supervised Explainable Deep Learning Model" (AIAA 2021-0774) by Milad Memarzadeh, Bryan Matthews, and Thomas Templin, NASA Ames Research Center

2021 AIAA Liquid Propulsion Best Paper Award

"Chemical Composition of Mixed Oxides of Nitrogen using Raman Spectroscopy" (AIAA 2021-3589) by Alicia Benhidjeb-Carayon, NASA Jet Propulsion Laboratory, California Institute of Technology; and Victoria M. Boulos, Catriona M. L. White, Jason R. Gabl, Robert G. Orth, and Timothée L. Pourpoint, Purdue University

2021 AIAA Modeling and Simulation Best Paper Award

"Deriving an Estimated Time of Arrival Accuracy Requirement for Departure Scheduling Operations" (AIAA 2021-0672) by Lesley A. Weitz, Brock J. Lascara, and Stephanie Priess, The MITRE Corporation

2021 AIAA Modeling and Simulation Best Paper Award

"A Gaussian Process Enhancement to Linear Parameter Varying Models" (AIAA-2021-3006) by Stefan Schuet, Carlos Malpica and Jeremy Aires, NASA Ames Research Center

2021 AIAA Multidisciplinary Design Optimization Best Paper Award

"Active Manifold and Model Reduction for Multidisciplinary Analysis and Optimization" (AIAA 2021-1694) by Gabriele Boncoraglio and Charbel Farhat, Stanford University

2021 AIAA Pressure Gain Combustion Best Paper Award
"Individual Wave Detection and Tracking within a Rotating Detonation Engine through Computer Vision Object Detection applied to High-Speed Images" (AIAA 2021-1382) by Kristyn B. Johnson and Donald H. Ferguson, National Energy Technology Laboratory; and Andrew C. Nix and Zachary Tallman, West Virginia University

2021 AIAA Sensor Systems and Information Fusion Best Paper Award
"A Bayesian Mixture Model Approach to Anomaly Detection with Application to Wind Tunnel Experiments" (AIAA 2021-1268) by Sierra Nicole Merkes, Scotland Leman, Eric Smith, Aaron Defreitas, W. Nathan Alexander, and William Devenport, Virginia Polytechnic Institute and State University

2021 AIAA Small Satellite Best Paper Award
"Adaptive Double-Layer Continuous Super-Twisting Control of a Satellite Formation" (AIAA 2021-0560) by Mason Nixon, Leidos; and Yuri B. Shtessel, University of Alabama in Huntsville

2021 AIAA Small Satellite Best Paper Award
"Formation Flying Orbit and Control Concept for the VISORS Mission" (AIAA 2021-0423) by Adam Koenig and Simone D'Amico, Stanford University; and E. Glenn Lightsey, Georgia Institute of Technology

2021 AIAA Small Satellite Best Paper Award
"Novel Approaches to Environmental Shielding for Small Satellites" (AIAA 2021-0806) by Coen J. Williams, Johnathan W. Ford, Jonathon L. Gabriel, Kaleb D. Overby, and Michael L. Anderson, United States Air Force Academy; and Jason H. Niebuhr, SAFE, Inc.

2021 AIAA Solid Rockets Best Paper Award
"Implicit Large-Eddy Simulation of Solid Rocket Motors using the Immersed Boundary Method" (AIAA 2021-3696) by Matteo Bernardini, M. Cimini, and F. Stella, Sapienza University of Rome; E. Cavallini, Italian Space Agency; A. Di Mascio, University of l'Aquila; F. Salvadore, CINECA; and E. Martelli, Università degli Studi della Campania "L. Vanvitelli"

2021 AIAA Spacecraft Structures Best Paper Award
"Reduced-Order Modeling for Flexible Spacecraft Deployment and Dynamics" (AIAA 2021-1385) by Michael Marshall and Sergio Pellegrino, California Institute of Technology

2021 AIAA Structural Dynamics Best Paper Award
"Fundamental Understanding and Prediction of Loads and Stability of a Full-scale Hingeless Tiltrotor" (AIAA 2021-0090) by Seyhan Gul and Anubhav Datta, University of Maryland, College Park

2021 ASME/Boeing Structures and Materials Award
"Progressive Failure Analysis of 3D Woven Composites via Multiscale Recursive Micromechanics" (AIAA 2021-0702) by Trenton M. Ricks, Evan J. Pineda, Brett A. Bednarcyk, and Steven M. Arnold, NASA Glenn Research Center

2021 Collier Aerospace HyperX/ AIAA Structures Best Paper Award
"Structural Joints and Repairs: Bearing Fatigue Response in Bolted Hybrid Composite Joints" (AIAA 2021-1402) by John Brewer and Anthony Palazotto, Air Force Institute of Technology; and Casey Holycross and Michael Gran, Air Force Research Laboratory

2021 Shahyar Pirzadeh Memorial Award for the Outstanding Paper in Meshing, Visualization and Computational Environments
"Sparse Spatial Sampling: A mesh sampling algorithm for efficient processing of big simulation data" (AIAA 2021-1484) by Daniel Fernex and Andre Weiner, Technische Universität Braunschweig; Bernd Noack, Harbin Institute of Technology; and Richard Semaan, Technische Universität Braunschweig

2022 AIAA Aircraft Design Best Paper Award
"Aerodynamic Performance Benefits of Over-the-Wing Distributed Propulsion for Hybrid-Electric Transport Aircraft" (AIAA-2022-0128) by Reynard de Vries and Roelof Vos, Delft University of Technology

2022 AIAA Applied Aerodynamics Best Paper Award
"Development of a Subsonic-Supersonic, Unstructured Panel Method" (AIAA-2022-0403) by Cory D. Goates and Douglas F. Hunsaker, Utah State University

2022 AIAA Fluid Dynamics Best Paper Award
"Formation of a Nacelle Inlet Ground Vortex in Crosswind" (AIAA-2022-1698) by Derek A. Nichols, Bojan Vukasinovic, and Ari Glezer, Georgia Institute of Technology; and Bradley Rafferty, The Boeing Company

2022 AIAA Plasmadynamics and Lasers Best Paper Award
"Experimental study of electron transpiration cooling with a 2-kW laser heating system" (AIAA-2022-0983) by Junhwi Bak, Anuj Rekhy, Christopher Limbach, Richard Miles, and James Creel, Texas A&M University

2022 AIAA Solid Rockets Best Paper Award
"Solid Rocket Motor Internal Ballistics with a Surface-Vorticity Solver" (AIAA-2022-1898) by Griffin A. DiMaggio, Joseph Majdalani and Roy J. Hartfield Jr., Auburn University; and Vivek Ahuja, Research in Flight

2022 AIAA Survivability Best Paper Award
"Ballistic Limit Shot Dependency Testing for Four Commonly Used Composite Materials" (AIAA 2022-0871) by Clayton Hankins and Michael M. Walker, Air Force Institute of Technology

2022 AIAA Thermophysics Best Paper Award
"Direct molecular simulation of rovibrational relaxation and chemical reactions in air mixtures" (AIAA-2022-1010) by Erik Torres, Eric C. Geistfeld, and Thomas E. Schwartzentruber, University of Minnesota

2022 AIAA/CEAS Aeroacoustics Best Paper Award
"Extension of Traditional Beamforming Methods to the Continuous-Scan Paradigm" (AIAA-2022-1154) by David Morata and Dimitri Papamoschou, University of California, Irvine

BEST STUDENT PAPERS AND STUDENT PAPER COMPETITIONS

2021 AIAA Small Satellite Best Student Paper Award
"Quantifying Characterizations of CubeSat Swarms Based on Chaotic Circuit Analysis" (AIAA 2021-1255) by Alec C. Nichols and John Baker, University of Alabama, Tuscaloosa; and Jeffrey W. Hudack, Air Force Research Laboratory

2022 AIAA Atmospheric and Space Environments Student Paper Competition - 1st Place
"Experimental and Numerical Investigation of Ice Crystal Icing on a Heatable NACA0012 Airfoil" (AIAA 2022-3534) by Yasir A. Malik, Technische Universitat Braunschweig; Lokman Bennani, Office National d'Etudes et de Recherches Aerospatiales; Alexandros, E. J. Vorgias, Technische Universitat Berlin; Pierre Trontin, Universite Claude Bernard Lyon 1 Service Commun de la Documentation; and Philippe Villedieu, Office National d'Etudes et de Recherches Aerospatiales

2022 AIAA Atmospheric and Space Environments Student Paper Competition - 2nd Place
"An Experimental Investigation to Assess the Effectiveness of Various Anti-Icing Coatings for UAV Propeller Icing Mitigation" (AIAA 2022-3964) by Nianhong Han, Haiyang Hu, and Hui Hu, Iowa State University

2022 AIAA Atmospheric and Space Environments Student Paper Competition - 3rd Place
"A Comparative Study to Characterize the Effects of Adverse Weathers on the Flight Performance of an Unmanned-Aerial-System" (AIAA 2022-3962) by Anvesh Dhulipalla, Nianhong Han, Haiyang Hu, Hui Hu, Iowa State University

2022 AIAA Computational Fluid Dynamics Student Paper Competition - 1st Place
"On Peculiar Behaviors of Captured Very-Weak Moving Shockwaves" (AIAA 2022-4127) by Gaku Fukushima, Nagoya University; Keiichi Kitamura, Yokohama Kokuritsu Daigaku; and Akihiro Sasoh, Nagoya University

2022 AIAA Computational Fluid Dynamics Student Paper Competition - 2nd Place
"Roles of Multi-Dimensional Velocity Components in All-Speed Numerical Flux SLAU" (AIAA 2022-4033) by Yoshikatsu Furusawa, Yokohama National University; Yoshikatsu Furusawa and Keiichi Kitamura, Yokohama Kokuritsu Daigaku

2022 AIAA Computational Fluid Dynamics Student Paper Competition - 3rd Place
"Aerodynamic Analysis Of Yvyraro (Pterogyne nitens) Seed Drop On A Steady- State Applied To A Design Of A High-Altitude Balloon Descend Speed Reducer" (AIAA 2022-3465) by Luis O. Ruiz Diaz, María P. Rivas, Carlos Mendez, and Jorge H. Kurita, National University of Asunción

2022 AIAA David Weaver Thermophysics Best Student Paper Award
"Numerical Investigation of Film Coefficient Engineering Methodology for Dissociated, Chemically Reacting Boundary Layers" (AIAA-2022-1907) by Justin Cooper, NASA Johnson Space Center; Giovanni Salazar, Corvid Technologies; and Alexandre Martin, University of Kentucky

2022 AIAA Guidance, Navigation and Control Undergrad and Grad Student Paper Competition
"Reinforcement Learning to Control Lift Coefficient Using Distributed Sensors on a Wind Tunnel Model" (AIAA 2022-0966) by Ana Guerra-Langan, Sergio Araujo Estrada, and Shane Windsor, University of Bristol

2022 AIAA Multidisciplinary Design Optimization Student Paper Competition - 1st Place
"Sensitivity-based Geometric Parameterization for Aerodynamic Shape Optimization" (AIAA 2022-3931) by Neil Wu, Charles Mader, and Joaquim R. Martins, University of Michigan

2022 AIAA Multidisciplinary Design Optimization Student Paper Competition - 2nd Place
"Aerodynamic sensing for hypersonics via scientific machine learning" (AIAA 2022-3717) by Julie Pham, University of Texas at Austin; Bryan J. Morreale, Texas A&M University; Noel Clemens and Karen E. Willcox, University of Texas at Austin

2022 AIAA Plasmadynamics and Lasers Student Paper Competition
"Experimental and numerical characterization of a lean premixed flame stabilized by nanosecond discharges" (AIAA 2022-2255) by Victorien P. Blanchard, Nicolas Minesi, Yacine Bechane, Benoît Fiorina, and Christophe O. Laux, Laboratoire Energetique Moleculaire et Macroscopique Combustion

2022 AIAA Small Satellites Student Paper Competition
"The University of Colorado Earth Escape Explorer CubeSat: Mission Overview and Status" (AIAA 2022-0237) by Brodie T. Wallace and Scott Palo, University of Colorado Boulder; and John Sobtzak, National Center for Atmospheric Research

2022 American Society for Composites Student Paper Award
"Process Modeling of Woven Textiles" (AIAA 2022-1008) by Kalima B. Bukenya and Michael N. Olaya, University of Massachusetts Lowell; Evan J. Pineda, NASA Glenn Research Center; and Marianna Maiaru, University of Massachusetts Lowell

2022 Harry H. and Lois G. Hilton Student Paper Award in Structures
"Bioinspired Patterns from a Generative Design Framework for Size and Topology Optimization" (AIAA 2022-0102) by Sarah N. Hankins and Ray S. Fertig, University of Wyoming

2022 Jefferson Goblet Student Paper Award
"Aeroelastic Wing Demonstrator With A Distributed And Decentralized Control Architecture" (AIAA 2022-1551) by Tigran Mkhoyan, Xuerui Wang, and Roeland De Breuker, Technische Universiteit Delft Faculteit Luchtvaart- en Ruimtevaarttechniek

2022 Lockheed Martin Student Paper Award in Structures
"Fail-safe design optimization of an aircraft fuselage-wing section using the DamageCreator software" (AIAA 2022-1277) by Clara Cid Bengoa, Aitor Baldomir, Miguel Rodríguez-Segade, and Santiago Hernández, Universidade da Coruña Escuela Tecnica Superior de Ingenieros de Caminos Canales y Puertos

2022 SwRI Student Paper Award in Non-Deterministic Approaches
"Inverse Design of 2D-Mechanical Metamaterials with Spinodal Topologies under Uncertainty" (AIAA 2022-0811) by Kiara L. McMillan, Virginia Polytechnic Institute and State University; Doğacan S. Öztürk, University of Alaska Fairbanks; and Pinar Acar, Virginia Polytechnic Institute and State University

UNITED STATES POSTAL SERVICE®

Statement of Ownership, Management, and Circulation (All Periodicals Publications Except Requester Publications)

1. Publication Title	2. Publication Number	3. Filing Date
Aerospace America	35080	09/23/2022
4. Issue Frequency	**5. Number of Issues Published Annually**	**6. Annual Subscription Price**
Monthly except July-August	11	$200 members/$230 nonmem

7. Complete Mailing Address of Known Office of Publication *(Not printer) (Street, city, county, state, and ZIP+4®)*
American Institute of Aeronautics and Astronautics, 12700 Sunrise Valley Drive, #200, Reston, VA 20191

Contact Person
Rodger Williams

Telephone *(Include area code)*
(703) 264-7560

8. Complete Mailing Address of Headquarters or General Business Office of Publisher *(Not printer)*
American Institute of Aeronautics and Astronautics, 12700 Sunrise Valley Drive, #200, Reston, VA 20191

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor *(Do not leave blank)*

Publisher *(Name and complete mailing address)*
Rodger Williams, American Institute of Aeronautics and Astronautics, 12700 Sunrise Valley Drive, #200, Reston, VA 20191

Editor *(Name and complete mailing address)*
Ben Iannotta, American Institute of Aeronautics and Astronautics, 12700 Sunrise Valley Drive, #200, Reston, VA 20191

Managing Editor *(Name and complete mailing address)*
Catherine Hofacker, American Institute of Aeronautics and Astronautics, 12700 Sunrise Valley Drive, #200, Reston, VA 20191

10. Owner *(Do not leave blank. If the publication is owned by a corporation, give the name and address of the corporation immediately followed by the names and addresses of all stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, give the names and addresses of the individual owners. If owned by a partnership or other unincorporated firm, give its name and address as well as those of each individual owner. If the publication is published by a nonprofit organization, give its name and address.)*

Full Name	Complete Mailing Address
American Institute of Aeronautics and Astronautics	12700 Sunrise Valley Drive, #200, Reston, VA 20191

11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check box → ☐ None

Full Name	Complete Mailing Address

12. Tax Status *(For completion by nonprofit organizations authorized to mail at nonprofit rates) (Check one)*
The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes:
☒ Has Not Changed During Preceding 12 Months
☐ Has Changed During Preceding 12 Months *(Publisher must submit explanation of change with this statement)*

PS Form **3526,** July 2014 *[Page 1 of 4 (see instructions page 4)]* PSN: 7530-01-000-9931 **PRIVACY NOTICE:** See our privacy policy on *www.usps.com.*

13. Publication Title	14. Issue Date for Circulation Data Below
Aerospace America	09/01/2022

15. **Extent and Nature of Circulation**			**Average No. Copies Each Issue During Preceding 12 Months**	**No. Copies of Single Issue Published Nearest to Filing Date**
a. Total Number of Copies *(Net press run)*				
b. Paid Circulation *(By Mail and Outside the Mail)*	(1)	Mailed Outside-County Paid Subscriptions Stated on PS Form 3541 (Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies)	14987	13914
	(2)	Mailed In-County Paid Subscriptions Stated on PS Form 3541 *(Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies)*	0	0
	(3)	Paid Distribution Outside the Mails Including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside USPS®	1403	1372
	(4)	Paid Distribution by Other Classes of Mail Through the USPS (e.g., First-Class Mail®)	0	0
c. Total Paid Distribution *[Sum of 15b (1), (2), (3), and (4)]* ▶			16390	15286
d. Free or Nominal Rate Distribution *(By Mail and Outside the Mail)*	(1)	Free or Nominal Rate Outside-County Copies included on PS Form 3541	177	177
	(2)	Free or Nominal Rate In-County Copies Included on PS Form 3541	0	0
	(3)	Free or Nominal Rate Copies Mailed at Other Classes Through the USPS (e.g., First-Class Mail)	0	0
	(4)	Free or Nominal Rate Distribution Outside the Mail *(Carriers or other means)*	364	56
e. Total Free or Nominal Rate Distribution *(Sum of 15d (1), (2), (3) and (4))*			541	233
f. Total Distribution *(Sum of 15c and 15e)* ▶			16931	15519
g. Copies not Distributed *(See Instructions to Publishers #4 (page #3))* ▶			213	453
h. Total *(Sum of 15f and g)*			17144	15972
i. Percent Paid *(15c divided by 15f times 100)* ▶			96.8%	98.5%

* If you are claiming electronic copies, go to line 16 on page 3. If you are not claiming electronic copies, skip to line 17 on page 3.

PS Form **3526,** July 2014 *(Page 2 of 4)*

UNITED STATES POSTAL SERVICE®

Statement of Ownership, Management, and Circulation (All Periodicals Publications Except Requester Publications)

16. Electronic Copy Circulation	**Average No. Copies Each Issue During Preceding 12 Months**	**No. Copies of Single Issue Published Nearest to Filing Date**
a. Paid Electronic Copies ▶	0	0
b. Total Paid Print Copies (Line 15c) + Paid Electronic Copies (Line 16a) ▶	16390	15286
c. Total Print Distribution (Line 15f) + Paid Electronic Copies (Line 16a) ▶	16931	15519
d. Percent Paid (Both Print & Electronic Copies) (16b divided by 16c × 100) ▶	96.8%	98.5%

☒ **I certify that 50% of all my distributed copies (electronic and print) are paid above a nominal price.**

17. Publication of Statement of Ownership

☒ If the publication is a general publication, publication of this statement is required. Will be printed in the 11/1/22 issue of this publication.

☐ Publication not required.

18. Signature and Title of Editor, Publisher, Business Manager, or Owner

Rodger Williams
Deputy Publisher/VP Product, Market, and Revenue, Development

Date
09/23/2022

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

PS Form **3526,** July 2014 *(Page 3 of 4)* **PRIVACY NOTICE:** See our privacy policy on *www.usps.com.*

ASSISTANT PROFESSOR FACULTY POSITIONS

The Department of Aerospace Engineering and Mechanics (AEM) at The University of Alabama invites applications for multiple tenure-track faculty positions at the rank of Assistant Professor, but applications from candidates with appropriate experience and a strong record of scholarly productivity and impact who would seek appointment at higher ranks are also encouraged to apply. Candidates with particular research emphasis and interests in the areas of solid mechanics & materials, space systems, space structures, and additive and advanced manufacturing (including in-space and point-of-need manufacturing) are of particular interest for one or more of these positions, but applicants with research interests across all domains relevant to aerospace engineering and mechanics are encouraged to apply. The applicants should build upon and/or expand the strengths of our faculty (**https://eng.ua.edu/departments/aerospace-engineering-and-mechanics/**). Candidates from under-represented groups in engineering are strongly encouraged to apply.

Candidates must demonstrate a clear potential to successfully pursue and attain grants from external funding sources and to lead a highly productive research group with significant scholarly impact. An ability to collaborate with existing faculty in the key focus areas both within the AEM Department and the College of Engineering is also highly desirable.

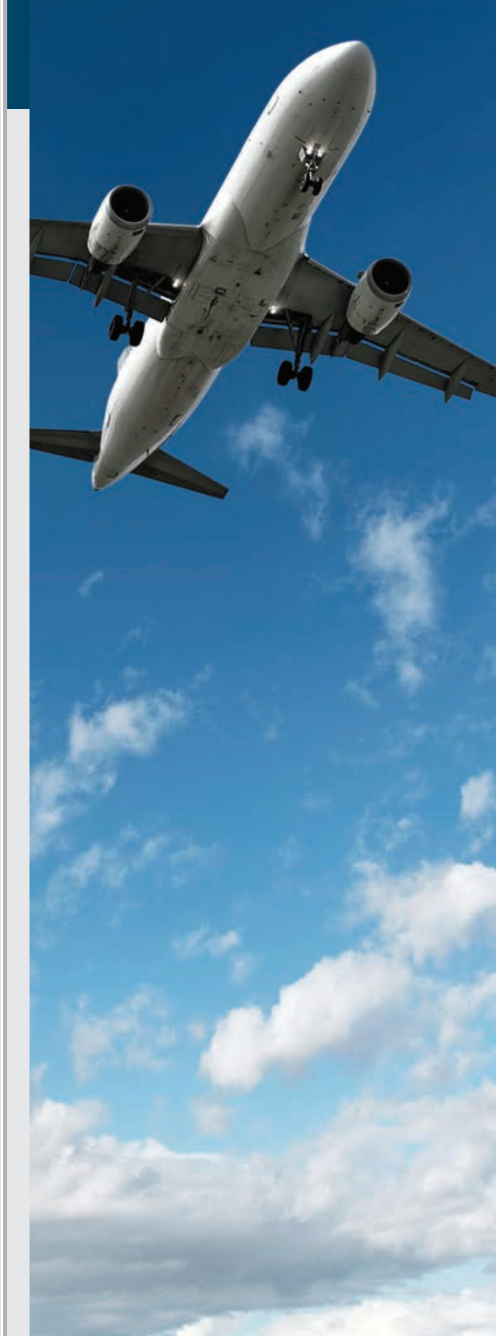
The AEM Department has a sustained enrollment of about 500 BSAE students and has recently appeared on the ASEE list of the top 20 BSAE producers in the nation. The Department also has an active MS and PhD program in Aerospace Engineering and Mechanics supporting both residential and distance education students with a total graduate enrollment of over 150 students.

Applicants must have an earned doctorate in aerospace engineering, engineering mechanics, or a closely related field. Applicants should identify their specific area(s) of research interest and the rank (assistant/associate/full) of the position to which they are applying in the cover letter that should accompany their application materials. In addition to the cover letter, applications should include a full curriculum vitae (CV), a statement of research interests and plans with future goals, a statement of teaching interests, and a list of at least four professional references. Review of applications will begin immediately and continue until the positions are filled, with an expected start date of August 16, 2023. Electronic submission of application materials via The University of Alabama employment website is required (**https://careers.ua.edu/jobs/search/college-of-engineering**). For additional information regarding The University of Alabama, the Department of Aerospace Engineering and Mechanics, or this search, please contact:

Dr. Mark Barkey, Professor and Head, Department of Aerospace Engineering and Mechanics, **mbarkey@eng.ua.edu**.

The University of Alabama is an equal-opportunity employer (EOE) including an EOE of protected vets and individuals with disabilities, and women and under-represented minorities are encouraged to apply. Salary is competitive and commensurate with experience level.

College of Engineering
Aerospace Engineering and Mechanics



AUBURN UNIVERSITY
SAMUEL GINN
COLLEGE OF ENGINEERING
Aerospace Engineering

Multiple Open Rank Tenure-Track Faculty Positions

The Department of Aerospace Engineering at Auburn University invites applications for multiple **open rank tenure-track faculty positions (Assistant, Associate or Full Professor)**. Applications are invited in all areas related to aerospace engineering. Candidates are especially encouraged to apply with expertise in: flight dynamics; aerospace structures and mechanics of materials in extreme environments; aerodynamics and propulsion; and space systems and hardware. Candidates will be expected to fully contribute to the department's mission through (i) the development of a strong, nationally recognized, funded research program, (ii) teaching aerospace engineering related courses at both the undergraduate and graduate level, and (iii) professional service. Successful candidates will have a demonstrated track record of scholarship, a creative vision for research, an active interest in engineering education, and strong communication skills. For applications at the rank of Associate or Full Professor, an emphasis will be placed on the strength and caliber of the candidate's existing research program and the candidate's ability and desire to provide mentorship and leadership to junior faculty members in a rapidly growing department. Candidates must have an earned Ph.D. in aerospace, mechanical, electrical engineering, or a closely related field at the time of employment.

Auburn University (www.auburn.edu/) is one of the nation's premier public land-grant institutions. In 2022, the college of engineering was ranked in the Top 35 of public universities by U.S. News and World Report. The Department of Aerospace Engineering at Auburn University is in the midst of unprecedented growth with overall enrollment increasing by over 70% in last eight years to 662 students. This growth has been complemented by aggressive faculty hiring with the department now consisting of four full professors, two associate professors, nine assistant professors and two lecturers. Candidates should log in and submit a cover letter, CV, research vision, teaching philosophy, statement on diversity, equity and inclusion, and three references at https://www.auemployment.com/postings/32330. Cover letters may be addressed to: Dr. Brian Thurow, Search Committee Chair, 211 Davis Hall, Auburn University, AL 36849. To ensure full consideration, candidates are encouraged to apply before December 1, 2022 although applications will be accepted until the positions are filled. The successful candidate must meet eligibility requirements to work in the U.S. at the time the appointment begins and continue working legally for the proposed term of employment.

Auburn University is understanding of and sensitive to the family needs of faculty, including career couples. See "Guidelines for Dual Career Services" http://www.auburn.edu/academic/provost/policies-guidelines/#guidelines

Auburn University is an EEO/Vet/Disability Employer

JAHNIVERSE

CONTINUED FROM PAGE 64

of all space activities conducted by the nonstate actors it licenses. This legal leverage is codified in the Outer Space Treaty of 1967, specifically the description of national responsibilities in Article VI.

Also, many satellites have onboard GPS receivers to calculate position and velocity, and onboard computers to assess operational health. This information is embedded in the telemetry, tracking and command data, or TT&C, that's sent to the ground. However, owners and operators are not required by law to install GPS receivers or health software, or to share that information if they do have those things onboard. They should be required to do so if they expect their national governments to authorize them to operate in space. Once that oversight is fixed, this data could be combined and fused with the U.S. government's own sensor data to achieve a much more accurate and precise state of knowledge of, at least, the actively controlled satellites or ASOs. Obviously, debris do not transmit their location or anything else by definition, so the U.S. government could acquire independent data from partners via agreements and purchases from those companies that wish to make this part of their business models.

Here in the U.S., Space Policy Directive-3 provides clear direction for the Department of Commerce's Office of Space Commerce to lead the space traffic management enterprise by taking responsibility for the free and "publicly releasable portion of the DoD catalog and for administering an open architecture data repository." This architecture must meet operational standards for accuracy, timeliness, validity, consistency and completeness, among other requirements, but achieving that will require ingesting, combining and fusing multisource heterogeneous data. Such an approach would make space more transparent and predictable and add up to a body of evidence that would empower governments to hold satellite operators legally accountable for their behaviors in space.

To be sure, creating such a powerful repository will be a herculean task, but humanity faces an impending tragedy of the orbital commons unless governments recognize that space is a finite resource and therefore step up to their responsibilities for ensuring all of us can use space freely without hindrance in perpetuity. There are many companies that are proposing to do all of this for or instead of governments for the right amount of money. Doing that would be preposterous, given that governments, not companies, have all the legal responsibilities in space, including liability for any damages or harmful interference resulting from objects launched to, in, and from outer space. These companies should be encouraged to make a business of providing advanced commercial orbital safety services and products that go beyond the government services, which could include near-real-time orbital maneuver support or the like.

Per Section 3 of Space Policy Directive-3, the U.S. government must provide basic space traffic management services "free of direct user fees," and the Commerce Department's Open Architecture Data Repository needs to be accurate and precise enough to keep people from crashing their satellites into each other or being hit by debris. ★

LOOKING BACK

COMPILED BY FRANK H. WINTER and ROBERT VAN DER LINDEN

1922

1 **Nov. 13** The Imperial Japanese Navy launches its first ship specifically designed as an aircraft carrier. The Hōshō has an unobstructed flight deck and horizontal smokestacks and can carry 15 aircraft. **Jane's All the World's Aircraft, 1923**, p. 58a.

Nov. 18 U.S. Navy Cmdr. Kenneth Whiting, flying a Consolidated PT seaplane, makes the first successful catapult-assisted takeoff from a U.S. aircraft carrier. E. Emme, ed., **Aeronautics and Astronautics, 1915-1960**, p. 16.

Also in November Qantas begins its first regularly scheduled service in Australia, flying from Charleville to Cloncurry. **Air Dates**, p. 42.

1947

Nov. 13 Armstrong Whitworth's A.W.52 tailless research aircraft makes its inaugural flight at Boscombe Down, England. Powered by two Rolls-Royce Nene turbojet engines, the A.W.52 is a flying testbed for determining the characteristics of swept-back wings with a tailless configuration. **The Aeroplane**, Nov. 21, 1947, p. 660, and Dec. 26, 1947, pp. 808-809.

2 **Nov. 15** Consolidated Vultee's Model 118 car with a detachable wing makes its first flight near the company's San Diego plant. Piloted by Reuben Snodgrass, it remains aloft for about two hours. In another flight three days later, the plane runs out of fuel and makes a forced landing in which the car body is destroyed. Consolidated remains interested and draws up plans for mass production, but later models experience tail shake and weight problems, and the company abandons the flying car concept. J. Wegg, **General Dynamics Aircraft**, pp. 184, 186-187.

Nov. 24 The first full-scale Aerobee sounding rocket is fired from White Sands Proving Ground in New Mexico. The flight is terminated after 35 seconds due to excessive yaw. E. Emme, ed., **Aeronautics and Astronautics, 1915-60**, p. 58.

Nov. 26 The first hypersonic flow wind tunnel is activated at the National Advisory Committee for Aeronautics' Langley Laboratory. It reaches Mach 7. E. Emme, ed., **Aeronautics and Astronautics, 1915-60**, p. 58.

Nov. 28 The USS Norton Sound is assigned as an experimental rocket firing ship by the U.S. Navy's Operational Development Force. After modifications are completed in 1958, the ship is used as a launch platform to test Loon and Lark missiles, as well as Aerobee sounding rockets. E. Emme, ed., **Aeronautics and Astronautics, 1915-60**, pp. 58, 61-62, 63-64, 70, 101.

1972

Nov. 1 The Soviet Union launches eight Cosmos satellites atop a single booster, the second such launch since July. Western observers believe that this latest series of Cosmos satellites are part of a global communications network for the Soviet military. **New York Times**, Nov. 2, 1972, p. 11.

3 **Nov. 1** The Smithsonian Institution announces the forthcoming retirement of Fred Whipple, director of the Smithsonian Astrophysical Observatory since 1955 and one of the world's leading authorities on comets and meteors. Whipple received the President's Award for Distinguished Federal Civilian in 1963 for his leadership in developing the network of Baker-Nunn cameras to photograph and track satellite launches. During World War II, Whipple developed a method of cutting aluminum foil into thin strips, called chaff, that Allied aircraft would release to confuse enemy radars. **New York Times**, Nov. 5, 1972, p. 12.

Nov. 8 NASA announces a $64 million contract to North American Rockwell Corp. for the design, development and testing of a docking module system and modification of the Apollo command and service module for the upcoming Apollo-Soyuz Test Project. A joint U.S.-Soviet Union rendezvous and docking is scheduled for mid-1975. **NASA Release** 72-218.

Nov. 9-15 Canada's first domestic communications satellite is launched by a Thor-Delta launch vehicle and later placed in a near-synchronous circular orbit of 36,470 kilometers apogee and 189 kilometers perigee. Named Anik 1 — Eskimo for "brother" — it is the first of two satellites built by Hughes Aircraft Co. to provide transmission of TV, voice and data throughout Canada for seven years. It is to provide 10 color TV channels or up to 9,600 telephone circuits. **NASA Release** 72-206.

4 **Nov. 9** The ERTS 1, Earth Resources Technology Satellite, launched in July is judged successful in its primary objective: the acquisition of synoptic and multispectral images over a three-month period. The satellite is later renamed Landsat 1, and its data is used for investigations in agriculture, forestry resources, mineral and land resources, among other topics. NASA, **Aeronautics and Astronautics, 1972**, p. 380.

Nov. 10 During a press briefing, Apollo 17 Commander Eugene A. Cernan announces that the command module for the last Apollo lunar mission is named "America" and that the lunar module is named "Challenger." **New York Times**, Nov. 12, 1972, p. 24.

Nov. 10 The directors of North American Rockwell Corp. propose that the company be renamed Rockwell International Corp. The company was founded in 1928 as North American Aviation and merged with Rockwell-Standard in 1967. **Los Angeles Times**, Nov. 12, 1972.

5 **Nov. 11** This date marks the 400th anniversary of the discovery of Tycho's Star by the Danish astronomer Tycho Brahe. This supernova in the constellation Cassiopeia was the first unusual star ever recorded by European astronomers, according to the Hayden Planetarium. **American Museum-Hayden Planetarium Release**, Nov. 6, 1972.

Nov. 14 NASA announces that more than 70 students from six continents are to witness the Apollo 17 launch and visit major U.S. science centers during a Dec. 4-17 tour sponsored by NASA in cooperation with the U.S. State Department. The students, who range from 15 to 17 years in age, have been selected by their governments. **NASA Release** 72-219.

Nov. 15 The Apollo 17 astronauts begin their three-week preflight quarantine at Cape Kennedy to minimize exposure to disease or illness that could delay the last of the Apollo missions. Meanwhile, launch crews start the final tests of the rocket and spacecraft ahead of the Dec. 6 launch date. **Baltimore Sun**, Oct. 16, 1972, p. A9.

Nov. 15 A four-stage Scout rocket launches NASA's Explorer 48 Small Astronomy Satellite from the Italian-owned San Marco Facility off the coast of Kenya. The primary objective is to measure primary galactic and extragalactic gamma radiation above the atmosphere. **NASA Release** 72-204.

Nov. 20 A groundbreaking ceremony for the Smithsonian Institution's new National Air and Space Museum building is held on the National Mall in Washington, D.C. The building is scheduled to open July 4, 1976, as part of events marking the nation's bicentennial. NASA, **Aeronautics and Astronautics, 1972**, p. 388.

Nov. 24 This date marks the 25th

anniversary of the first launch of an Aerobee sounding rocket. The design has made 900 launches and contributed toward major astronomical studies, including one that measured the Crab Nebula. NASA, **Aeronautics and Astronautics, 1972**, p. 394.

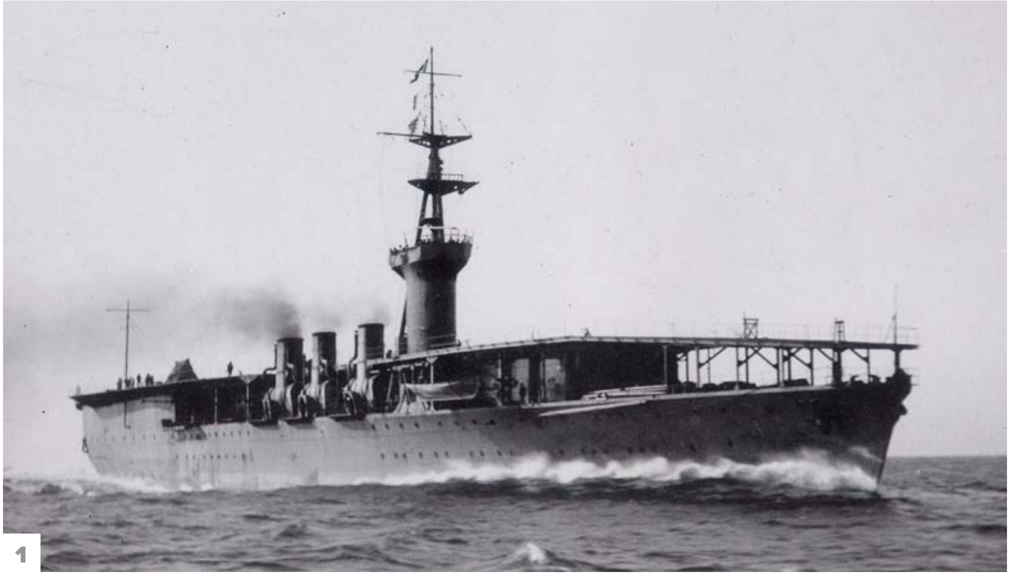
Nov. 30 The Soviet Union launches its Intercosmos 8 satellite to continue global research on the ionosphere, including temperature and concentration of electrons, in a cooperative program with several Soviet bloc countries. Intercosmos 8 carries scientific equipment designed and built by Bulgaria, Czechoslovakia, the German Democratic Republic and the Soviet Union to study different cosmic rays, particles and micrometeoroids that affect the weather, climate, radio communications and biological processes on Earth. NASA, **Aeronautics and Astronautics, 1972**, p. 403.

1997

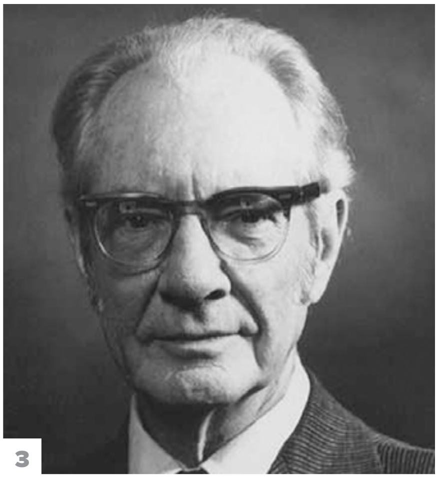
Nov. 4 NASA officially concludes the Mars Pathfinder mission. After the lander touched down on Mars on July 4 and deployed the Sojourner rover, it collected 2.3 billion bits of data and 16,500 images. Communications were lost Sept. 27, and further attempts to research the craft failed. The mission lasted three months, three times longer than planned. NASA, **Astronautics and Aeronautics, 1996-2000**, p. 99.

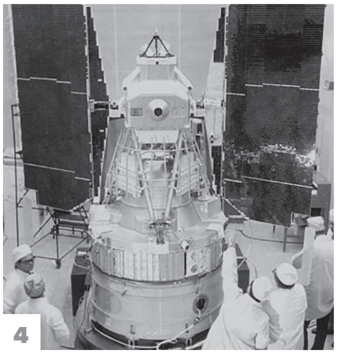
6 **Nov. 19** NASA's space shuttle Columbia launches STS-87. The crew includes Kalpana Chawla, the first Indian-born woman to go to space, and Leonid K. Kadenyuk, the first Ukrainian astronaut to fly on a U.S. spacecraft. Also during the 15-day mission, Takao Doi becomes the first Japanese astronaut to make a spacewalk. NASA, **Astronautics and Aeronautics, 1996-2000**, p. 103.

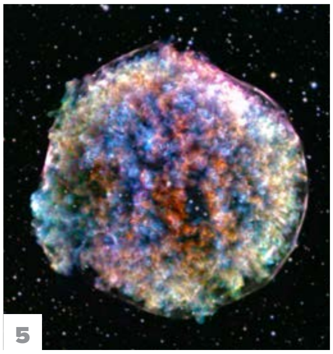
7 **Nov. 27** An H-II rocket launches NASA's Tropical Rainfall Measuring Mission, Japan's first launch of a foreign satellite. TRMM will measure tropical and subtropical rainfall, which makes up two-thirds of the world's rainfall, via microwave and visible infrared sensors. **Aviation Week**, Nov. 25, 1997, p. 65.


1


2


3


4


5


7

6

Industry must help the U.S. government meet its responsibility for orbital safety

BY MORIBA JAH | moriba@utexas.edu

The U.S. Defense Department has, for many years, kept a catalog of data representing the tracks of satellites, spent rocket stages and debris, and has shared much of that catalog publicly. This space situational awareness, or SSA, data has enhanced orbital safety many times but has also proven to be inadequate, most infamously in 2009 when an inactive Russian communications satellite and an operational Iridium satellite collided. This inconsistent performance motivated a host of companies to attempt to make a business out of rapidly processing U.S. government SSA data into their own conjunction analyses, sometimes with the aid of their own private radars and other sensors. As an example, the company that I co-founded, Privateer Space, aims to aggregate, curate and exploit multisourced heterogeneous data in order to draw more insights regarding orbital space and Earth itself. We are already offering some basic space traffic management services.

While bespoke and advanced SSA services should have a thriving marketplace, basic orbital safety information from the U.S. government must be sufficiently accurate and precise to prevent people from crashing satellites into each other on orbit, and this data should be free to all without barriers to access.

Right now, the free and globally accessible U.S. government data is imprecise. That's a problem because to know something, you must measure it. To understand it, you must predict it. If you can't make accurate predictions from measurements, you don't truly understand your data. This is to say that the U.S. government ultimately wants to accurately and precisely predict the behavior of anthropogenic space objects, ASOs, for orbital safety purposes. This ability to predict must come from the statistical inference made from observations of the ASO population. The U.S. government has its own radars and classified sensors, but these are not ubiquitous and, as with all sensors, suffer from biases and performance shortcomings. The ability to confirm or refute a hypothesis confidently is generally strengthened by drawing conclusions from data generated by independent sources of observations. The inconsistency in accuracy and precision in what the U.S. government currently provides to the community could be greatly increased by acquiring observations beyond its own sensors. This includes the demonstrated sensing capabilities found among international allies and partners and the global private industry.

While the U.S. government should use all available means to acquire these additional observations from independent sources beyond its own, not all of these observations need to be purchased. The U.S. government can be one of several customers of commercial space surveillance and tracking, SST, and should acquire other data as part of the agreement to provide authorization and continuing supervision

Moriba Jah is an astrodynamicist, space environmentalist and associate professor of aerospace engineering and engineering mechanics at the University of Texas at Austin. An AIAA fellow, he's also chief scientist of startup Privateer and hosts the monthly webcast "Moriba's Vox Populi" on SpaceWatch.global.

CONTINUED ON PAGE 61