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The power of digital

It sounds futuristic, but the day could be coming when most test flights leading to a type certification are conducted virtually. Here's how. **PAGE 16**

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AIAA
SHAPING THE FUTURE OF AEROSPACE

Certification by analysis would involve replacing many of today's costly and time-intensive physical test flights with virtual versions. Advocates report progress toward this goal. This A350 XWB test aircraft was one of five used by Airbus to conduct 2,600 hours worth of test flights over 14 months to win type certification for the design.

Airbus

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AIAA
SHAPING THE FUTURE OF AEROSPACE

IN THIS ISSUE

Keith Button

Keith has written for C4ISR Journal and Hedge Fund Alert, where he broke news of the 2007 Bear Stearns scandal that kicked off the global credit crisis.
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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.
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Aaron Karp

Aaron is a contributing editor to the Aviation Week Network and has covered the aviation business for decades. He was previously managing editor of Air Cargo World and editor-in-chief of Aviation Daily.
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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.
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Paul Marks

Paul is a 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.
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DEPARTMENTS

The risks of Mars Sample Return

United States environmental law wisely gives the public an opportunity to comment about government initiatives that could affect our health and safety. That includes the NASA-European Space Agency proposal to bring samples of Martian dust and rocks back to Earth for analysis. Our story about the public comments, "Calls grow for a safer Mars Sample Return," got me thinking about how much uncertainty policymakers should be willing to accept and in which scenarios.

When it comes to predicting outcomes, the University of Pennsylvania's Philip Tetlock, the father of "superforecasting," has noted the "power of preconceptions to shape our perceptions."

In other words, our preconceptions can corrupt our ability to forecast outcomes accurately. We hear about a monkeypox outbreak after two years of the covid pandemic, and some of us reflexively brace for the possibility that this will be the next big one. We hear about a plan to bring pieces of Mars home, and some of us sound the alarm over the possibility of bringing deadly pathogens back with them.

These seem like classic examples of what Tetlock, in the context of world affairs, has called "pseudo-diagnostic news to which the crowd overreacts."

I would agree that our heightened sensitivity won't improve our ability to accurately predict whether Mars Sample Return will in fact harm any of us. The risk is probably small, but our sensitivity to the possibility is not an overreaction. The covid experience has likely focused more of us on the unknowns about Mars and the risk those entail. Even Tetlock's supeforecasters, after all, are not perfect at predicting outcomes. The stakes of a prediction being wrong should loom large in the policy realm. If you think climate change is a hoax, and you are wrong, the planet is ruined. If those on the other side are wrong, we have a cleaner planet. This is how uncertainties should be judged.

Luckily, the wisdom of the crowd is pointing us at a way around the Mars Sample Return impasse: Collect the samples at a space laboratory of some kind and study them there, safely away from Earth. It won't be easy, but it will be safest. ★

▲ A sample of Martian rock collected by the Perseverance rover last year, photographed by the pair of zoomable cameras on the rover's mast that act as its "eyes."

NASA/JPL-Caltech/MSSS

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

Solutions for space debris

After reading the space debris report in the April issue ("Hope for solving space debris"), I'd like to offer my own experiences studying this tough problem. In the '60s at Rockwell International, I worked on a NASA contract studying what to do with orbital debris and dead satellites. We looked at all sorts of ideas and didn't find any that would work, technically and economically. Later, in the mid-'70s, Krafft Ehricke, Tom Logsdon and myself (consulting with many others) worked on another contract, "Space Industrialization; Industries in Space to Benefit Mankind." This time, we went a different way: "space industrial parks," like those on Earth, whereby someone would rent a "pad" and pay rent for location, services and utilities. Low-Earth orbit facilities would have human attendants; geosynchronous facilities would have "telecommuted astronauts" hardened against radiation. If a customer did not pay the rent, the park management would carefully de-orbit the machinery and rent the pad to someone else.

Of course, some space endeavors would not fit this model, but this philosophy would greatly reduce the number of things flying around. I am indeed fearful that we may mess up orbital space and deny ourselves the many benefits it offers!

Charles (Chuck) Gould
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Let us hear from you

Send letters of no more than 250 words to letters@aerospaceamerica.org. Letters may be edited for length and clarity and may be published in any medium.

Realizing Our Full Potential

What a remarkable time this is for AIAA and our members. I am honored to be leading the Institute during this time of such great promise for the future.

AIAA has undergone numerous changes to manage through the global pandemic while continuing to provide forums for sharing scientific discoveries, engineering advances, and new technical capabilities, and never slowing down on celebrating our aerospace history and achievements. These activities have been successful in spite of ongoing COVID-related constraints on travel and physical gatherings. Throughout this incredibly challenging period, AIAA has maintained a high standard of service to the industry and our members by rapidly flexing and learning to work in new ways thanks to the leadership of Immediate Past President Basil Hassan and the creativity of the AIAA staff.

We now have the opportunity to embrace the lessons of the last two years to build on the strengths of AIAA with new capabilities and expanded models for technical engagement. We can increase and simplify the ability of members to access ideas and information that are relevant to their work.

As I proposed when I put my name on the ballot, I want every member to realize the benefits of AIAA membership that have been so much a part of my life and career for the past 30+ years. I want each of you to leverage AIAA offerings to easily:

- Expand your knowledge and skills in ways that are relevant to your career direction
- Share your ideas with colleagues working in your field of interest or on similar projects, wherever they reside, to advance technology and the performance of the systems that you are working to develop and support
- Publish the results of your work in archival records that will in turn generate further ideas and advancements
- Engage decision makers to inform and influence aerospace and defense policy
- Participate in the development of standards that improve efficiency and safety across the industry
- Recognize your colleagues at all levels for their technical and leadership contributions to aerospace, and for supporting the career growth of fellow members

These activities have always been strengths of AIAA, but may not have been easy for all members to access and navigate. I will work to advance our infrastructure and offerings so members will feel motivated to connect routinely using a refreshed AIAA multipronged digital presence, allowing them to access current information and live events relevant to their technical discipline and the aerospace programs that they support. Our new tools will better unite people with common interests. Members will be able to engage seamlessly at local, national, and international levels.

To accomplish this, I will focus on four areas:

- Providing tools and resources that meet the needs and expectations of today's technical professionals
- Supporting career advancement and furthering the success of our members by helping them build technical and leadership skills that are applicable to their chosen career paths
- Enabling members to explore multiple interest areas by providing content-rich forums and events, and increased opportunities to engage with others who are working in related fields and areas of discovery
- Recognizing our members publicly and within their home organizations for technical and leadership contributions to advance aerospace, and for their volunteer efforts that enhance our activities.

Throughout my professional life, AIAA membership has allowed me to engage in numerous technical and leadership activities that have enhanced my skills and brought great personal satisfaction. I've been able to influence aspects of the aerospace and defense industry that were sometimes unrelated to my work. I've developed deep professional relationships that have sustained and grown, independent of changing job assignments. I've been heartened to see colleagues ascend to the highest levels of leadership and be lauded for their innovations to address critical problems, advance the state of the art, and contribute to the performance and capabilities of leading-edge systems. I've been exhilarated to see teams who took on and succeeded at missions that tested the limits of our technology and ingenuity.

I want all our members to be similarly inspired and value their membership as much as I do. There is incredible strength in AIAA, and unlimited opportunity for the future. For the next two years, I will be focused on advancing our products and capabilities, to assist you – our exceptionally talented members – to realize your full potential in your aerospace endeavors. ★

Laura McGill
AIAA President (2022–2024)

Do you have a puzzler to suggest? Email us at aeropuzzler@aerospaceamerica.org.

Tailless flight

Q: Paper airplanes fly pretty well without tails. Why, then, do most full-scale aircraft have them?

SEND A RESPONSE OF UP TO 250 WORDS that someone in any field could understand to aeropuzzler@aerospaceamerica.org by noon Eastern June 20 for a chance to have it published in the next issue.

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

FROM THE MAY ISSUE

LIFE WITHOUT FLAP TRACK FAIRINGS

We asked you to write a letter on behalf of the members of fictional band Flap Track Fairings describing the purpose of the component that inspired the band's name.

WINNER Ignorance is always a great tragedy. Society steps backward when ignorance reveals itself. Recently a critic of our band, Flap Track Fairings, deemed the aircraft component after which we are named to be devoid of function. We do not mind the constructive criticism of our music. We only take issue with the custodians of culture who dare to lecture the world about the utility of things they do not understand. Flaps change the shape of the wings of aircraft so that they can take off and land slowly, and therefore safely. The machinery used to articulate the flaps, however, is so enormous that they protrude into the wind even when stowed for cruising flight. This disturbs the airflow and causes large amounts of drag, decreasing range and increasing fuel consumption. A life without flap track fairings would mean that the critics of the variety that we speak would not be able to travel quite so far as they do now in comfort, speed and style to meet their friends and colleagues around the world to share their art and together decry the influence of "inhuman" science and engineering. Music certainly did not advance when the sole mode of global transport was a rotting wooden sailboat under siege by pirates. Or an ocean liner that had hit a small iceberg. We hope the person of whom we speak can learn to appreciate our engineering art and therefore no longer suffer the embarrassment of having this lack of knowledge exposed.

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Building tomorrow's firefighting tankers

BY CAT HOFACKER | catherineh@aiaa.org

▲ ST Engineering of Singapore is finalizing the design of a 757 firefighting tanker, shown here in an illustration, that could dump 26,000 liters of fire retardant to slow the spread of wildfires.

ST Engineering

Key to the U.S. Forest Service's strategy for containing and quenching the wildfires that raged across New Mexico in May were the scores of aircraft that soared over the blazes, dumping thousands of liters of retardant and water.

Many of these aircraft have been in service for decades, and with wildfires across the world projected to burn longer and more intensely compared to past decades, the U.S. Forest Service and its contractors need to expand their fleets.

Enter ST Engineering of Singapore, which in February announced a contract to convert a former Boeing 757 passenger airliner into a firefighting tanker for Galactic Holdings, an Arkansas fire suppression startup founded in 2020. With a planned capacity of 26,000 liters, the 757 would carry more retardant than the C-130s on loan from the U.S. Air Force — which hold 11,000 liters — but less than the DC-10s that carry roughly 45,000 liters, about half the capacity of a public swimming pool.

Being newer than the DC-10s and other converted planes, "we are thinking that 757 will give you more fuel efficiency, better kind of capacity as well as more optimal operations," including the ability for pilots to fly at lower altitudes over fires, says Leon Tan, ST Engineering's program manager for the 757 conversion.

Also, the 757 was designed to take off from shorter runways — all the better for deploying from small airports near wildfires that break out in rural areas, he says.

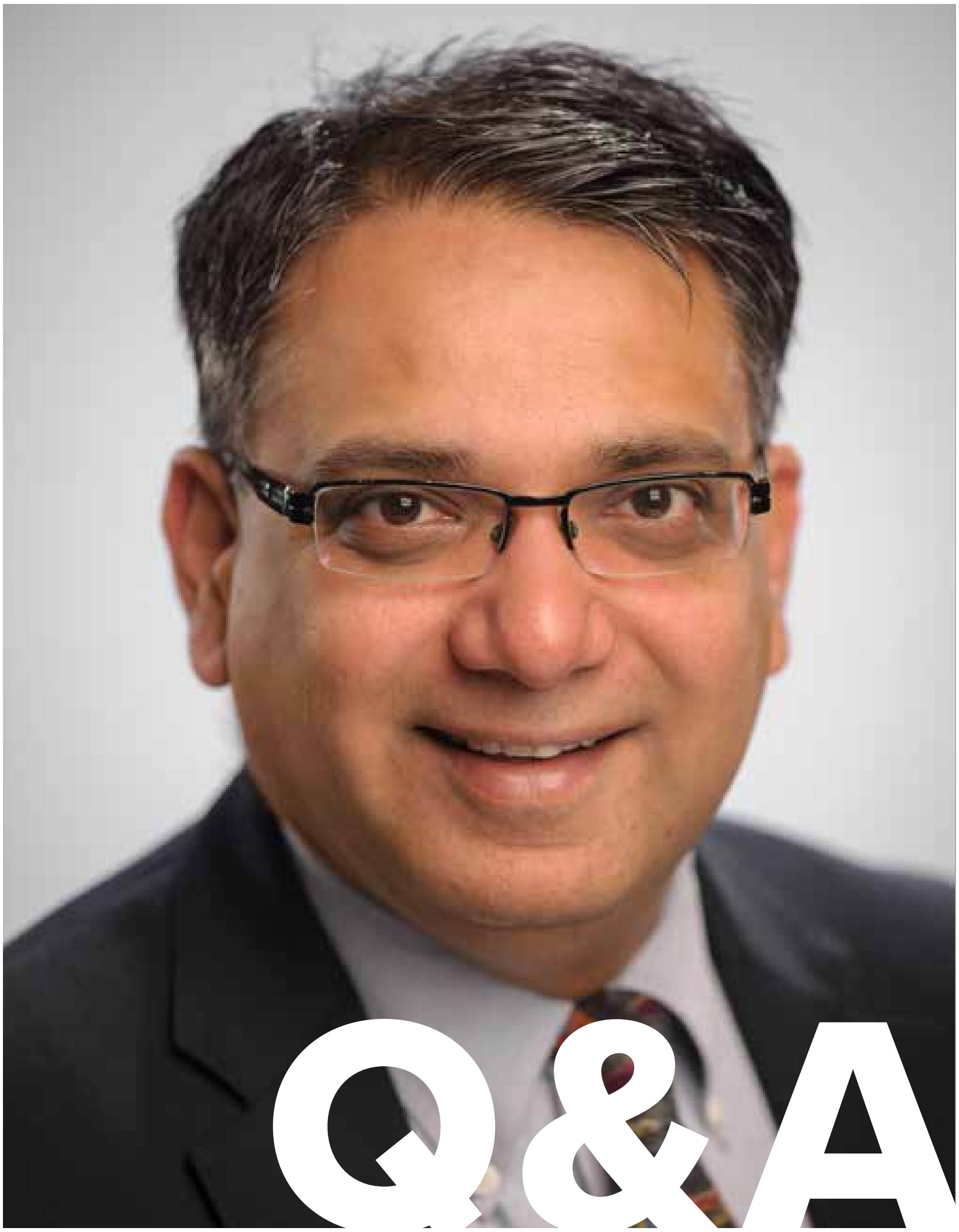
The tanker is scheduled to be delivered to Galactic in 2024, so plans call for finalizing the design later this year, then beginning modification at one of ST Engineering's U.S. facilities; the company has facilities in Alabama, Florida and Texas.

Technicians will begin by tearing out the 200 seats to make room for one of two 13,000-liter tanks that would hold the retardant. The other tank would go in the cargo hold below. The aircraft's windows must also be removed and the holes plugged with cover plates. ST plans to use plates instead of sealing the windows so its technicians can take advantage of the openings as access points to the upper tank when maintenance is needed, Tan says.

In parallel, ST Engineering will work with FAA to determine what ground and flight tests would be required for the design to earn the supplemental type certification that verifies the modifications meet FAA's standards for airworthiness and do not significantly change the performance of the aircraft.

"There might be some test requirements, but we are trying to keep inside the envelope of the passenger aircraft in the sense that you'll still be doing the same kind of flight maneuvers," Tan says.

If approved, this design would be used as a blueprint for future 757s ST Engineering converts for Galactic Holdings. Tan says the terms of the contract specify between 10 and 12 aircraft in total, "depending on the needs." ★



Airspace innovator

Futuristic aircraft tend to present unprecedented management challenges. When that happens, NASA's go-to expert is Parimal Kopardekar, better known as PK. After leading development with FAA of the Unmanned Aircraft Systems Traffic Management system for drones, a digital-license-plate concept now in field testing, he's moved over to advanced air mobility. As director of the NASA Aeronautics Research Institute, he leads a team of engineers and industry working groups who are devising standards for safety and noise for this coming breed of aircraft, while searching for solutions to supply chain issues that threaten to slow down introduction of the aircraft in the United States. I reached him by phone to discuss the emergence of the air taxi industry and how the nation will manage its growth. Here is our conversation, compressed and lightly edited. — *Paul Brinkmann*

PARIMAL KOPARDEKAR

POSITIONS: Since 2019, director of NASA Aeronautics Research Institute (NARI) at Ames Research Center in California. NARI acting director, 2018-2019. NASA senior technologist for air transportation system, 2016-2021. Began career at NASA as manager of the Strategic Airspace Usage Project, 2004-2006, and has held multiple concurrent titles regarding advances in aviation and airspace use since then. Since September 2021, adjunct faculty at Northeastern University in San Francisco. Since May 2020, chair of the UAS Advisory Group for the International Civil Aviation Organization. Since 2018, adjunct faculty member at Colorado State University Global. Since 2012, co-editor-in-chief of the Journal of Aerospace Operations.

NOTABLE: Inventor and patent holder for the U.S. airspace management system for drones, known as Unmanned Aircraft System Traffic Management (UTM), which is being incorporated into the national airspace system. Royal Aeronautical fellow since March. AIAA fellow since 2018. Came to the United States from the Mumbai area in India. Became a U.S. citizen in 2001.

AGE: 54

RESIDENCE: San Francisco area

EDUCATION: Ph.D. in industrial engineering, University of Cincinnati; Master of Science in industrial engineering, University at Buffalo; Bachelor of Engineering, Victoria Jubilee Technical Institute (now Veermata Jijabai Technological Institute in Mumbai).

Q: Air taxis have been a popular science fiction topic for decades, and you are now at the forefront of work to make them a reality. Do you really believe we will have these services in cities soon, or is this all just a pipe dream?

A: Yes, I believe in the scalability and ability for advanced air mobility to transform our society. We don't all have to commute to big cities. Offices, workplaces and residences can be geographically distributed and don't need to be confined to only road access. We need to work hard to enable the scalability of airspace, supply chain and community acceptance. The best way to summarize it is that our ability to scale will depend on how fast we can address airspace, vertiports, supply chain, maintenance and charging infrastructure, and community acceptance. I am upbeat; it just depends on how fast we can address all these items.

Q. How far away are we from having operational air taxi service?

A: It's sort of unfair for me to give you one date because that's probably going to be wrong [laughs]. If I did that, you're not going to look good, and I'm not looking good. The way I think about it is "What are the things that need to be in place to be able to have initial operation, beyond just a onesie, twosie couple of flights here and there?" Because this will all happen gradually in stages. Let's say you're talking about Orlando and Miami and you have 100 flights a day — that's sustained operations. But then we talk about everywhere, which is pervasive operations, really realizing the true value of advanced air mobility — not just in the urban airspace, but also locations that are hard to reach. That's the true value of AAM, to be able to support rural firefighting, or for medical delivery in rural areas, or cargo into areas that are hard to reach.

Q: How else do you think AAM can benefit society?

A: Businesses and homes can be much more spread out. Communities can be integrated with green space; they don't all have to go through congested roads all the time in the same direction all the time. There's one example in Washington where a hotel had to change its location, even though the location was really great for travelers. But people who wanted to work there, they had to take three modes of transportation — metro and bus and taxi or Uber — so they couldn't find people to work there. That problem would not happen if we are able to travel through air. If we can realize that, it could have a transformative effect on the way people live and work.

Q: Have you seen any examples of such potential to transform lives?

A: NASA has supported a couple of projects that really opened my eyes to the benefits of advanced mobility. We did a project for our student interns during covid shutdowns. Restaurants were closed and farmers were throwing away food. We connected the farmers with food banks in California and got 20 volunteer pilots. We loaded the [general aviation] aircraft and landed them as close as possible to the food banks to deliver the food. And we repeated that experiment last Christmas with the Zuni tribe in New Mexico, delivering food and water. That is the true power of advanced mobility, urban mobility — not just to reduce transportation and commute times. We really want to see advanced air mobility transform society.

Q: What is the current maturity level of AAM preparations?

A: We have a system to gauge where we are in terms of preparations, which we call Urban Air Mobility Maturity Level or UML. We are still in the initial stage on that scale, which is exploration and demonstrations in limited environments. We need to make sure that aircraft, aerospace, infrastructure and communities all are going to be ready when the air taxis are ready. It doesn't do us any good if the vehicles are ready, but we don't know operational procedures or airspace or we don't know how the communities will react. A good example is the Segway.

"That's the true value of AAM, to be able to support rural firefighting, or for medical delivery in rural areas, or cargo into areas that are hard to reach."

▲ Noise is among the characteristics NASA wants to assess during flight trials of its Advanced Air Mobility National Campaign, so participant Joby Aviation flew its pre-production aircraft over dozens of ground microphones last year to record noise levels during different phases of flight. Joby says the aircraft emitted 45.2 A-weighted decibels flying at an altitude of 500 meters, a level the company says "will barely be perceptible" against the background noise of busy cities.

Joby Aviation

Segway was introduced, but communities were not sure if they wanted it because it could be a safety hazard. And then you have bike-sharing and scooters just showing up one night in some places where people objected. That's not a good way to introduce something, and aviation doesn't work like that. We want to make sure that the system as a whole is ready: the airspace integration and infrastructure and community.

Q: What will NASA's AAM research focus on over the next few years?

A: We are putting the focus on where the gaps and the research needs are for the community. We are especially focused on working with original equipment manufacturers, in terms of how do you enable them to ensure safety while also helping them scale up production. We are also looking at a method to ensure the safety of operations for certain contingencies, for example, operating in an area where GPS is not reliable. Sometimes the comm links could fail, things like that. We are taking a three-prong approach. The first is working groups. We have one focused on safety, one on community acceptance, one on airspace and one on the aircraft. The working groups are public, and they provide firsthand information not just about NASA, but also the communities of interest and how we are collaborating with all stakeholders. Second, we have active research teams inside NASA researching noise levels, airspace, aircraft safety and high-density vertiport operations. Finally, later this year, we will have the National Campaign, when we will do more testing with Wisk Aero and other companies, and we'll announce more details on that soon. The tests we've done already with Joby Aviation on noise levels, the data is being analyzed and we expect papers to be published on that this summer. There will be more collaboration opportunities through a very open process. We are also collaborating with FAA and Department of Defense. With FAA, we have a research transition team to ensure that the learnings through our simulations, the research and flight tests can be shared with them so that their concept of operations can incorporate the things that we learned together.

Q: So there will be very limited markets, cities where this will happen first, or will it start first in rural areas?

A: I don't think we have thought through whether we will require that or whether that will be organically happening between the industry players and certain cities. Our role is more on the manufacturers' side and making sure this can all work with FAA, making sure that it can be integrated into the airspace — to allow operations to scale up without overloading their traffic controllers, for example. And currently the supply chain is not ready to support large-scale operations. In terms of cities considering AAM operations, our role might be that we will say, "Here are the requirements," and then cities and states can figure out how to adapt it to their preferences, because it's up to them really to approve the landing and takeoff locations, the vertiports.

Q: Why is the supply chain such a big challenge?

A: If you look at the history of aerospace, there have been many instances of supply chain issues causing disruption. When small drones got popular, we didn't have a good supply chain and we had to depend on some other countries. There have been shortages of microprocessors, APUs — application processing units — ball bearings, casings and castings. The Eclipse Aviation aircraft company failed in 2009 partially because they didn't have a good supply chain. We see a lot of gaps in the AAM supply chain — for fuel cells, also magnets, ball bearings. So we need to build capacity so that we can actually make these vehicles. We are building the bridge between the needs, the suppliers and the folks who need that. If we want to see a day when there are 10,000 eVTOLs, 6 million drones, what are the supply chain capacities we need? Are we dependent exclusively on cobalt from the Democratic Republic of Congo? Maybe we are going to run out of cobalt, so can we change to different materials? We need to be much more proactive than reactive.

Q: What other growing pains do you anticipate for the industry?

A: These vehicles will operate at local and regional levels. So unlike the larger aircraft that go to big

▲ Lilium of Germany's plan to connect Florida's major cities via a network of about a dozen vertiports is one example of how advanced air mobility could have a "transformative effect on the way people live and work," as Kopardekar puts it. If all goes as planned, Lilium's network would place 20 million Floridians within 30 minutes of a vertiport.

Lilium

▲ While passenger air taxi flights are still a few years away, cargo drones are taking off. Alphabet subsidiary Wing is delivering food and other goods in a handful of locations in Australia, Finland and the United States. Customers order via the Wing app, and autonomous drones lower their goods via a tether.

Wing

airports regularly for maintenance, eVTOLs will require spare parts and maintenance technicians wherever they are. It will be more like taking your car to a local repair shop. The whole system needs to be built for these vehicles to be able to sustain these operations.

Q: What is NASA doing to boost the supply chain?

A: We set up an electronic exchange platform to connect the equipment manufacturers with would-be suppliers. In many cases, we see AAM companies who cannot go to the larger manufacturers because they say we only need three parts at this point. That is a very fulfilling mission for me personally, because if you can bring more companies into aviation, aeronautics, that's great. For example, I have car companies coming to me and asking about the industry and how they can get involved. Can they make batteries, can they make composites, and so on. We connect people who can hopefully help each other.

Q: You've been involved in so much during your career. How does tackling advanced air mobility rank in terms of your experiences over the years?

A: I think my absolute favorite project was developing the UTM, Unmanned Aircraft System Traffic Management, which sort of changed the paradigm. I was fortunate to get a patent on it and the UTM is going to many, many countries, so I feel very fortunate about that particular idea. It was the main pivotal moment in my career because it was totally new and there was a resistance, and we went through the resistance. It's everywhere now and it's cascading into other altitudes, higher altitudes, 50,000 feet and up. It's even being considered for space traffic management. AAM is more complicated in the sense there's people on board and it's larger aircraft than drones. But I struggled with UTM for quite some time, and still, my work is not done.★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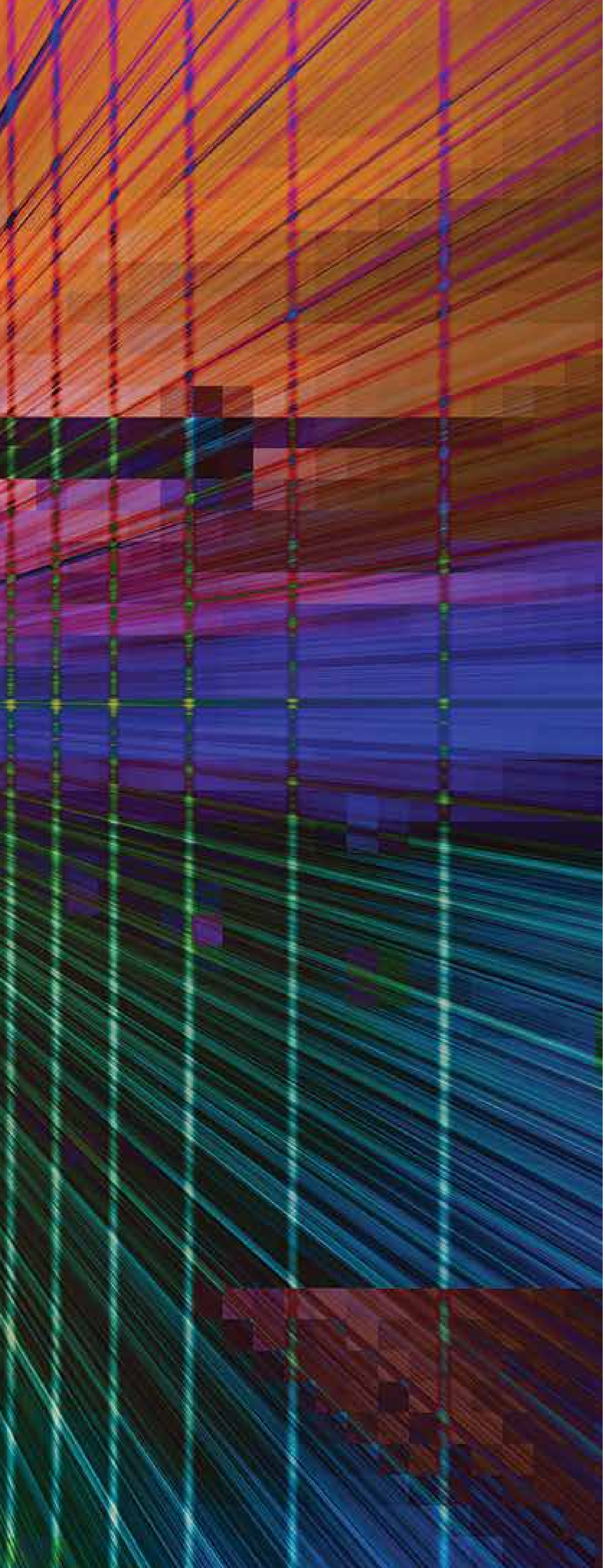


Today, earning type certification for a new kind of passenger jet culminates with months of expensive test flights, some of them harrowing. Keith Button spoke to aerospace engineers who aspire to change this with a bold idea: certification by analysis.

BY KEITH BUTTON | buttonkeith@gmail.com

On a clear morning in April 2011, an experimental Gulfstream G650 rolled down the runway with two pilots and two flight test engineers aboard. One of the pilots slowed the right engine back to idle, just as planned. Gulfstream was in the midst of gathering data on the multitude of performance points required by FAA to earn type certification for the G650. Of special concern for Gulfstream, accident investigators would later note, was demonstrating that the G650's slow stall speed would permit it to climb into the air safely on one engine, even on a relatively short runway of 6,000 feet (1,800 meters). The key for that would be the V2 takeoff safety speed, the velocity required to climb off the runway to a safe altitude once the plane had gone too far down the runway to abort. For the G650, a slow V2 was desirable, because Gulfstream intended to certify the G650s for shorter runways. Otherwise, the design would be limited to operating out of large airports.

As the plane lifted off a few feet, it rolled to the right due to an outboard wing stall that sent the wingtip into the runway. The aircraft spun off the runway and into a concrete structure and a weather station before skidding hundreds of meters and bursting into flames. All aboard were killed in the crash at Roswell International Air Center, New Mexico.

Many lessons were drawn from the crash. Gulfstream appointed an aviation safety official who reports directly to the company's president, and it set about improving communications throughout the company. Another lesson had to do with the power of computer simulations to avert tragedies like this one. As the U.S. National Transportation Safety Board put it, "Gulfstream did not validate the speeds using a simulation or physics-based dynamic analysis before or during field performance testing. If the company had done so," it could have recognized that the pilot could not have gotten the plane safely into the air at the targeted V2 speed, NTSB concluded.

Flash forward 11 years, and a loose-knit group of computer scientists and aerospace engineers in the United States and abroad want to embed simulations more deeply into the certification process, and not just for business jets but also for future generations of airliners built by Airbus and Boeing. To do it, they are running experiments and demonstrations aimed at sharpening the simulations that underlie their "certification by analysis" or CBA concept, in which computer models would substitute for many of the individual flight tests or ground tests now required to earn a type certification.

Today, CBA has earned only limited acceptance from FAA and the European Union Aviation Safety Agency, which certify the bulk of the world's passenger aircraft types. Wider adoption could reduce the number of high-risk flight tests, although accidents during certifications remain thankfully rare. The Gulfstream crash was the last fatal accident anywhere in the world during certification tests of an airliner or corporate jet, according to aircraft records maintained by the Aviation Safety Network, a unit of the Flight Safety Foundation of Virginia. While adopting CBA would likely never completely replace all physical flight tests, proponents say it would increase the pace of innovation by shortening the certification process and lowering the costs of certification, thereby opening up new design possibilities.

Manufacturers typically need 12 to 18 months to run through all the flight maneuvers required to certify that an aircraft meets each of the hundreds or thousands of requirements for its overall certification, says Juan Alonso, an aerospace professor at Stanford University. Longer, if things go wrong. Gulfstream, for instance, earned the type certification for the G650 in September 2012, about a year later than planned.

Of course, it's not just flight tests that are required for type certification: Manufacturers must demonstrate through ground testing that their planes and components will hold up under extreme forces. For example, a requirement might specify that wings must stay intact under a maximum of 2.5 Gs, plus a margin of safety to 3.75 Gs. In such a case, a manufacturer will put the plane in a test rig and pull up on the wings with cables to the 3.75-G standard and beyond, until the wings snap. CBA could play a role, here, too, say advocates.

Gauging uncertainty

In the design phase, engineers predict the aerodynamic performance of an airplane with computational fluid dynamics, or CFD, modeling. The model does this by processing factors including the shape, speed and operating conditions. But relying on a model to simulate a flight test in a particular set of operating conditions would be even more complex. The model must show the lift and drag, how quickly the plane turns, whether it is stable or unstable, and other characteristics that would be required by a regulator to certify the plane for that particular set of conditions. For instance, builders must show the plane could remain in stable flight with an engine out at a specific speed, altitude and angle of bank. Similarly, engineers can predict structural performance — how much a wing will bend under a certain amount of force, for example — with computational structural mechanics modeling, or CSM.

The problem is that for many of the scenarios a plane must be certified for, a model's prediction of performance isn't accurate enough to replace flight testing, and the margin of error is not known, says Alonso, one of the authors of a NASA-sponsored 2021 report "A Guide for Aircraft Certification by Analysis."

▲ FAA in 2018 accepted Reynolds-Averaged Navier-Stokes models in place of physical flight testing to make sure that the addition of internet antennas and radomes, like the ones atop this Airbus A350, would not negatively affect performance of previously certified Airbus A330-200s and Boeing 737-800s.

Gogo Inflight Internet

"Quantifying uncertainties, I believe, is absolutely necessary in order to be able to have any credibility with the regulators," Alonso says. He means uncertainties that could come from slight temperature or wind speed differences, for example, or from imperfections in the model itself. Computing uncertainties is "kind of the holy grail" for CBA, showing regulators the margin of error for CBA predictions while also proving that CBA can be faster and more effective than physical testing. However, he says, currently there is a lot of research into quantifying model errors, and none of the research is "ready for prime time."

"If you're a regulator, you want that value and a real uncertainty distribution coming from all of the sources," Alonso says. "As a member of the flying public, I would say I don't want to get on an airplane that does not prove things to me beyond a reasonable doubt. And reasonable doubt typically is four to five nines" — simulations that can guarantee that 99.9999% to 99.99999% of the time, the airplane will meet the safety threshold that it is being tested against, the 3.75-G load on its wings without breaking, for example.

"I only want these airplanes to fail once every several million hours of flight."

Flight tests also have uncertainties, but to a lesser degree than today's computer simulations, Alonso says. For example, the results of a flight test may be thrown off by slight variations in wind speeds, temperature or air density, or tiny imperfections in a wing's leading edge, and these could affect the accuracy of the flight test's prediction.

"All one should ask from simulations used for certification purposes is that they are as good as the flight test," he says.

Regulators' view

FAA didn't respond to questions about CBA, but Rob Gregg III, chief aerodynamicist for Boeing's commercial airplanes division, says the agency accepts CBA as part of earning certification for minor design changes, such as the addition of an antenna when the same antenna had already been certified on a derivative model of that plane. In those cases, CBA typically reduces the number of flight tests required. As more trust is established in the CBA predictions, Gregg says, he expects regulations will allow for more applications of CBA.

By allowing CBA to replace flight testing for some type certification tasks, Gregg says, the matrix of conditions for the physical flights could be thinned out to eventually replace 50% of them. And the combination of flight testing and CBA could expand the scope of a type certifications to cover a wider range

of situations, such as multiple engine failures or other combinations of failures or scenarios that would be difficult or impossible to have a test pilot perform.

Another advantage of CBA: The computer models that perform the analyses could also help designers bring their concepts to fruition faster and avoid surprise problems during the development of an aircraft that otherwise wouldn't be revealed until flight testing, Gregg says.

EASA and FAA are "very much aligned" on their view of CBA, says Willem Doeland, a structures and materials specialist at EASA. "Our thinking is the same in terms of what it takes to accept tools, to accept analysis results, when to do a test or not."

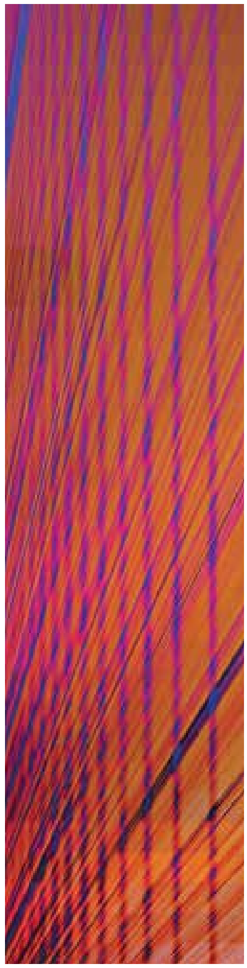
EASA decides on a case-by-case basis whether it will accept virtual in lieu of physical testing for a particular certification requirement. For derivatives of certified aircraft, virtual tests have begun to replace some of the physical ones for aspects of the aircraft that are similar to the certified version, provided the manufacturer's computer model has been validated with flight tests and ground testing, Doeland says.

"It's quite difficult; it takes engineering judgment to draw the line" for where physical flight testing should be required, he says.

For that decision, EASA considers whether there are changes from previous versions in structures and materials and in the electrical, flight control and hydraulics systems. Aircraft must be certified to fly within certain ranges of altitude, speed and temperature, so the agency considers proposed adjustments in those. Also considered are previous experience with the applicant and the software tools it applies in lieu of physical testing.

"The further you move away from where you are comfortable with, the more the need for additional testing is apparent," Doeland says.

One question EASA has faced is how it can come to trust the findings of software tools when the agency does not have a knowledge base to do so, nor the resources to develop that knowledge. As a solution, EASA is pushing software developers to develop their own industry quality assurance standards. Tools that are widely used by aerospace companies are probably already well-vetted, the thinking being that any problems would be uncovered because there are so many users. There's more of a potential for bugs in software that is developed internally by



“All one should ask from simulations used for certification purposes is that they are as good as the flight test.”

— Juan Alonso, Stanford University

▲ A Gulfstream G650 test aircraft suffered aerodynamic stall and crashed shortly after takeoff during type certification flights of the design in 2011. The National Transportation Safety Board determined that Gulfstream failed to validate safe takeoff speeds for the test program. Advocates of certification by analysis say computer modeling could eventually reduce the number of flight tests needed for certification.

NTSB

aerospace companies and restricted to in-house use only, Doeland says.

The good news is that the tools have been improved steadily over the past 10 to 15 years through innovations inspired in part by the competition between Airbus, Boeing and others to shorten development and certification cycles, Doeland says. The airplane builders apply the simulation tools in design and development, build experience with the tools and then apply the tools to certification, where permitted.

Wanted: Better models

Today’s computer models have a glaring limitation: They don’t do a good job of predicting the behavior of the air flowing around an aircraft when its wings have a high angle of attack in an extreme maneuver or near-stall conditions, Alonso says. “We really want to have simulation capabilities that are far more accurate than what we have today.”

Simulations cannot yet accurately predict the maximum lift coefficient when airflows become highly separated, which occurs during edge-of-the-envelope flight maneuvers. Without that coefficient, the velocity minimum unstick, meaning the minimum takeoff speed, can’t be confidently calculated, nor can the minimum runway length for takeoff, for example.

Such highly separated airflows are especially tough to predict with one of the most commonly employed aerodynamics model for new airplane designs: the RANS model, short for Reynolds-Averaged Navier-Stokes. Aerodynamics software that implements the RANS model can predict aerodynamics well for smooth air flows, such as air flows that are not separated.

Another commonly used method for predicting aerodynamics, the Large Eddy Simulation model, or LES, has shown significant promise for predicting aerodynamics during edge-of-the-envelope flight, Alonso says. LES makes fewer assumptions than RANS, so software based on LES is more accurate in modeling separated flows. LES results are more credible than those of RANS, Alonso says, and therefore have a better chance of being employed for CBA.

RANS uses more estimated values in its calculations for some of the smaller three-dimensional cells in the grid that covers the space it is simulating. LES is more detailed and more accurate for computing the actual values for all of the cells in that grid. For predicting

CONTINUED ON PAGE 25

OPINION

The case for more virtual testing

Developers are improving finite element analysis software so these tools can be included where they would have the greatest impact on budgets and timelines: the type certification process. Anthony Waas of the University of Michigan explains why the time is right to begin embracing virtual testing in the development cycle.

BY ANTHONY WAAS | awaas@umich.edu

Boeing touched off a design revolution nearly 20 years ago when it incorporated carbon fiber reinforced plastic (CFRP) and other composites in the design of the 787 as a lightweight alternative to metals. Today, about half the structure of each 787 consists of composites. The Airbus A350 followed with a similar emphasis on composites, as did the Boeing 777X, with the largest composite wingspan.

As beneficial as the shift to composites has been for increased payload capacity and fuel efficiency, the embrace of composites also came with a downside. It showed that introducing a new material and new methods of airplane construction can be fraught. For each of these designs, large numbers of expensive and time-consuming physical tests were required at each stage of development to get things right. In fact, on average it has taken a decade to bring a new airliner design from conception to inception, meaning entry into service. Of those 10 years, several of them involve earning FAA type certification. The U.S. Defense Department has discovered much the same in its development of new warplanes, although it self-certifies its aircraft.

There is a way out of this cycle, and it is virtual testing. Among the many stakes, decarbonizing air travel might be the most critical. New designs won't enter service in time unless a significant portion of physical testing for design and certification is shifted to virtual testing. In the military realm, the U.S. Air Force's vision of attritable (low cost and expendable) airplanes also demands an extremely fast design cycle of months rather than years.

At the technology level, this shift will require creating a digital replicate of an actual test. A computer model of the part would be subjected to the same loading conditions, for instance, but digitally. Aircraft manufacturers are doing this now to some degree during the design phase, but they could do more of it. Also, virtual testing has yet to be incorporated in a large way into the process of obtaining a type certification. Doing so will save money and time, given that a physical test can cost 100 times more than a virtual one, and ahead of that test, components must be procured and prepared, measurement and diagnostic tools set up. That process can take several months, whereas a virtual test can be done on a high-performance computer in hours.

Accurate predictions are, of course, essential, and

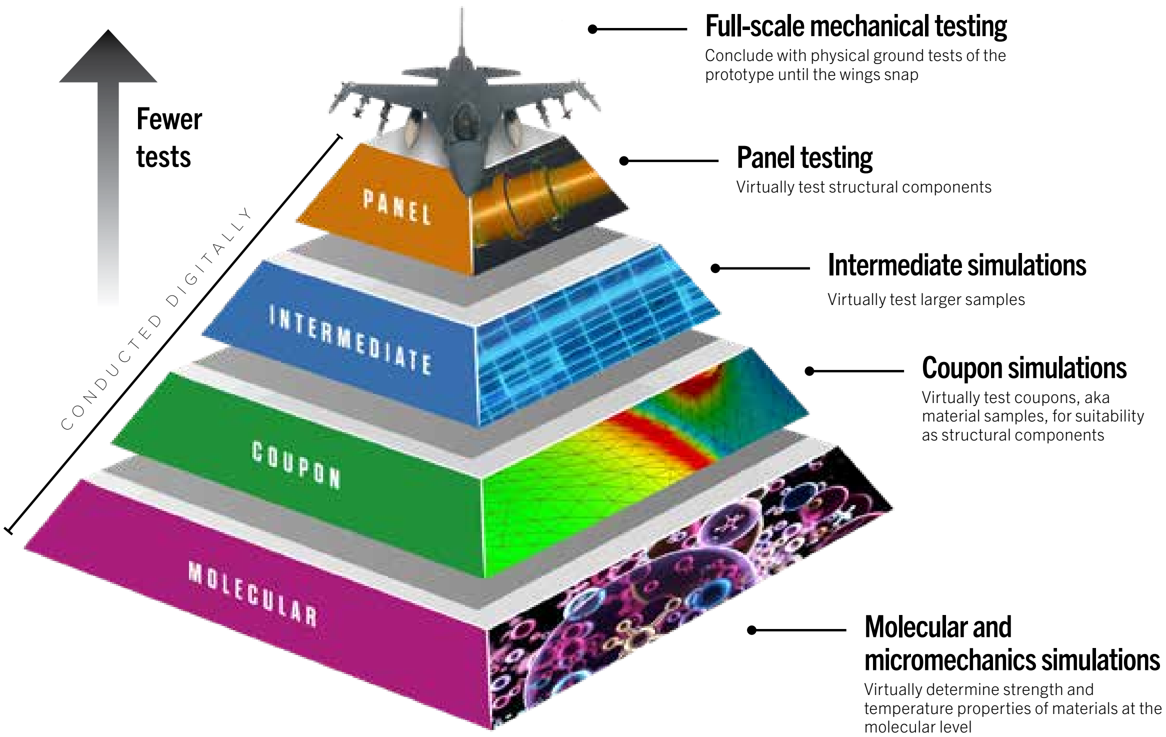
▲ Boeing needed eight years to type certify its 787 Dreamliner design under FAA regulations in what was "the most exhaustive certification effort" in Boeing's history, the company says. This was in part because of the 32,000 kilograms of carbon fiber reinforced plastic in each airliner. Wider acceptance of virtual testing could reduce certification times for future aircraft.

Boeing

this is especially challenging for CFRP with its complex layering of carbon fiber tape and plastic. Lead engineers and aircraft managers know that current simulation tools cannot accurately capture the way CFRP structures fail when design limits are exceeded. Those of us in the field of computational mechanics and modeling are improving the accuracy of such virtual tests daily through intellectual property agreements that allow us to hone and refine the finite element analysis, or FEA, software created by firms such as ANSYS, Dassault Systems, ESI and NASTRAN. The ABAQUS FEA software that I use divides a component or structure into small elements, and assembles governing equations whose solutions represent how each element should deform during a stress test, for example. Millions of such equations are solved using a high-performance computer that runs the FEA software. All of the FEA software functions are automated, which rapidly predicts how the component should perform under a range of load scenarios. By comparing those results to physical tests, we can gauge the accuracy of the prediction.

Changes of course must be done cautiously, and that can't be achieved by any one entity acting alone. Aircraft manufacturers, the Defense Department, FAA, parts suppliers, software developers and universities must work together to make this shift to virtual testing a priority. In particular, FAA, which grants certifications permitting flights in U.S. airspace and in some cases beyond through agreements with other regulatory agencies, should permit more virtual tests for those cases in which predictive power has been demonstrated.

Today, manufacturers plan their physical test



Going virtual

Above is a hypothetical planning pyramid describing how design testing could unfold largely virtually. In this example, the only physical testing would be ground testing of a prototype. Today, companies rely on such pyramids to plan physical testing of materials, structures and, ultimately, prototypes.

Graphic by THOR Design, reporting by Cat Hofacker | Source: Anthony Waas

programs by listing items in a hierarchical manner, starting with coupon-level tests and graduating to component-level tests that have structural joints, for example, in a protocol called a testing pyramid. The width of each layer of the pyramid is proportional to the number of anticipated tests on the items within that layer. At the base of the pyramid, numerous coupons — samples — of the proposed aircraft's materials would be tested until the materials with the desired properties are identified. At the top would be the completed prototype aircraft. Because of the voluminous testing at lower layers, relatively fewer tests would be required to verify its performance.

Replacing all layers of such a pyramid with virtual testing is unlikely anytime soon, but significant cost savings can be realized by replacing as many layers as possible. The middle layers of such a pyramid correspond to testing large structural parts. It's those layers that show the most promise for virtual testing. The result could be a combined physical-virtual test pyramid in which several layers are executed virtually, leading to significant cost savings. Also, a new layer could be added: virtual testing of materials at the molecular level.

Today, the industry has a strong FEA foundation for such a shift. Also, aerospace engineers routinely employ FEA in their design and development work to optimize structures and materials. Likewise, airframe and engine makers use FEA-based predictive tools during development.

Relying on experimental data as is done currently and tribal knowledge that is passed on from generation to generation of engineers is not sustainable in the long run. ★

Anthony Waas chairs the Aerospace Engineering Department of the University of Michigan. An AIAA fellow, he holds a doctorate in aeronautics and applied mathematics from Caltech.

“The further you move away from where you are comfortable with, the more the need for additional testing is apparent.”

— Willem Doeland, European Union Aviation Safety Agency

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the minimum takeoff speed for an aircraft, for example, the maximum lift coefficient predicted by RANS would be 10% to 15% different than the LES prediction, which would be more accurate, Alonso says.

The problem with LES is that it is computationally expensive, requiring vastly more time and computing power to predict the aerodynamics of an airplane or wing compared to RANS. Researchers are spending a lot of time trying to figure out when to apply LES and how to speed it up, Alonso says.

To simulate the aerodynamics of an entire airplane in cruise flight — flying straight and level — a RANS simulation would typically take two to four hours running on 500 central processing unit cores, dividing the three-dimensional space of the simulation into a mesh of 150 million cubes of various sizes, down to 1-millimeter cubes where the most detailed predictions were required. Meanwhile, an LES simulation of the same airplane under the same flight conditions would take 10 times longer. Both simulations would produce the same predictions, because the airflows during cruise flight are smooth and well-behaved.

It is currently possible to run a LES simulation for an entire airplane making an edge-of-the-envelope maneuver, though it would be a supercomputing task, requiring 10,000 to 100,000 CPU cores to complete in a reasonable time, Alonso says. He predicts that in five to 10 years, the cost of a LES simulation could be brought down to cost the same or less than a RANS simulation, and take about as long to run as a RANS simulation today.

“Eventually, I think we’ll be able to replace RANS with LES and have the accuracy, but at much lower cost,” Alonso says. As the cost of running LES simulations comes down, it has a better chance of being used for CBA.

Deploying graphical processing units, or GPUs, instead of CPUs for LES simulations is a “no-brainer”— a much faster way of computing, Alonso says. But the model’s computer codes have to be rewritten from scratch to take advantage of the GPU’s resources, such as the different types of bandwidth with a GPU and the different costs of moving data around with a GPU. GPUs can be easily 30 times faster than CPUs and could lower the cost of LES to make it comparable to the cost of RANS today.

Once the time is reduced, engineers or designers running computer models could run many more simulations at the same level of fidelity, or they could turn up the level of fidelity for a single simulation — such as running meshes that are much more fine. Or they could do some combination of both: more simulations and greater fidelity.

3,000 times faster

Data science, also referred to as machine learning, and artificial intelligence applications will improve the predictive capabilities of LES and RANS, but probably not for five to 10 years, Alonso predicts.

"It is still early days. It's kind of the Wild West. Everybody's trying different ideas, different approaches."

Alonso favors using data science to improve the models, but not trying to replace the models with a purely data science and machine learning approach.

"Use what you know works well and then complement it with data science/AI machine learning to improve the models that as engineers and physicists we've introduced into these predictive capabilities," he says. "The stuff that you model is what carries errors. So whatever you can do with more data in order to improve those models is very helpful."

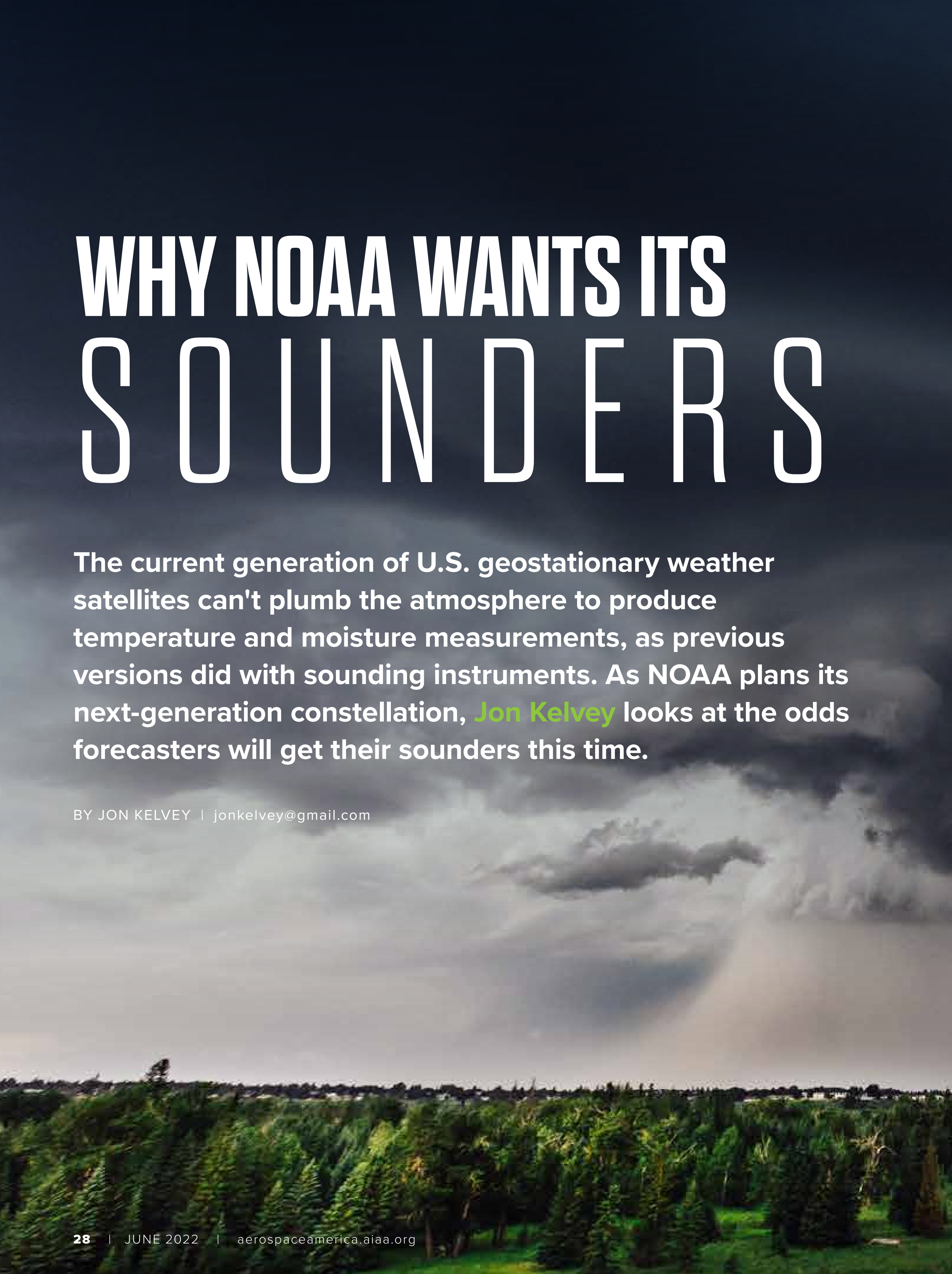
As the cost of designing semiconductor chips comes down, another technology with great potential for improving the computer modeling of aircraft is ASICs, application-specific integrated circuits. Unlike CPUs and GPUs, which are chips designed to be programmed to solve any problem, ASIC chips can be designed to perform the operations of particular algorithms — so an aircraft modeling algorithm, in this case, could be etched directly on a chip rather than programming a general purpose chip to perform the calculations of the model. Today, it would cost $10 million to $30 million to burn an aircraft modeling algorithm directly into ASIC chips, but Alonso expects the price will drop into more reasonable territory, $500,000 to $1 million, within 10 years.

With ASIC chips performing calculations 100 times faster than GPUs, which are 30 times faster than current CPU chips, simulations would be 3,000 times faster than the processing speeds of today's chips. So a simulation that today takes 48 hours to run would be shortened to less than a minute.

In 10 to 15 years, running 100,000 simulations could become "a pretty normal proposition," Alonso says. "That's when I think certification by analysis gets exciting."

Designs could be certified more quickly at the same or higher level of confidence compared to flight testing, and at much lower cost. Bold concepts, such as blended wing bodies, truss-braced wings and hybrid-electric power, would have new life.

"The excitement for me, as an academic, is that [CBA] opens up the door to much more advanced designs that we don't know how we're going to certify today," he says. ★



WHY NOAA WANTS ITS SOUNDERS

The current generation of U.S. geostationary weather satellites can't plumb the atmosphere to produce temperature and moisture measurements, as previous versions did with sounding instruments. As NOAA plans its next-generation constellation, Jon Kelvey looks at the odds forecasters will get their sounders this time.

BY JON KELVEY | jonkelvey@gmail.com

From its position 35,000 kilometers over the equator, NOAA's newest geostationary weather satellite can record lightning strikes over half the globe at 500 frames per second and take a snapshot of the Western Hemisphere every 10 minutes, not just in visible bands but also in infrared ones, and with enough fidelity to see the billowing smoke from wildfires burning throughout New Mexico in early May.

But what GOES-18 can't do is profile the temperature and humidity of the atmosphere by altitude. Doing that would require a sounder, a camera-like device whose detector materials would be chosen for their sensitivity to numerous fine-scale ranges of infrared wavelengths, or bands. Most ideally, the sounder would be a hyperspectral one, meaning it would be sensitive to thousands of such bands. Back in 2007, a consulting group hired by NOAA concluded that geostationary satellites equipped with powerful cameras and hyperspectral sounders could save "millions if not billions of dollars for any given storm" by improving forecasts and avoiding needless evacuations from river flooding and coastal storm surges.

NOAA published this economic analysis during what was at times an emotional debate over which instruments should go on the GOES-R series of school bus-sized satellites. The proposed sounders were dropped by NOAA for reasons of budget pragmatism during that formulation phase. NOAA does fly sounders today on satellites that orbit from pole to pole, but those instruments don't provide the nearly constant eye of geostationary spacecraft.

But now, 2022 could be the year of the rebound for geostationary sounders. In about a decade, a far more sensitive hyperspectral sounder than the one proposed for GOES-R could ride on a satellite dedicated to it, according to NOAA's early plan for its next-generation weather satellites, the Geostationary Extended Observations, or GeoXO, constellation.

This would be a huge shift from NOAA's approach since the 1970s of positioning one GOES satellite over the East Coast to watch the Atlantic Ocean and another over the West Coast to watch the Pacific Ocean.

This time, NOAA plans to fly one in the east, one in the west and a third between them over the central part of the country. That's the one that would be equipped with the sounder — a compromise because NOAA doesn't have the funding to put sounders on the two satellites in the east and west posts. From the central position, the sounder could detect and track severe weather including flash floods and tornadoes as they form, and indicate when residents need to be warned to take shelter or evacuate. The satellite could aid with tropical and coastal storm forecasting, but would be less ideal than if there were sounders in the east and west slots.

NOAA is considering buying six GeoXO satellites in total, with the first to be launched in the 2030s.

This plan would be a welcome turnaround for forecasters.

"That was a big disappointment when [the sounder] didn't get on the GOES-R series," says Tim Schmit, a NOAA research meteorologist and sounder design instrument scientist for the GeoXO program. The proposed GeoXO sounder would do an even better job of measuring vertical changes in temperature and moisture, he adds, which are "the key to forecasting convection" and related severe weather.

But the sounder isn't a done deal yet. NASA, which oversees the design, construction and launching of NOAA's weather satellites, awarded two $8 million study contracts in October to Ball Aerospace and L3Harris to come up with competing designs and "really help us understand exactly what can be built, let us finalize the requirements, and will inform ultimately the final program," says Pam Sullivan, program director for GeoXO and GOES-R.

The decision on the final collection of instruments for GeoXO is scheduled to be made in December in the form of a Milestone 2 review "where the Department of Commerce and NOAA agree, 'This is the program I want to build, this is the money I'm willing to pay,'" Sullivan says. "That would be formal approval of the program."

That's about the same point in the development process, she adds, where the GOES-R sounder was nixed.

Plumbing the atmosphere

A sounder is all about obtaining information as a function of altitude, or depth, depending on how you think of it, says David Johnson, an instrument scientist at NASA's Langley Research Center in Virginia, who has joined the GeoXO program as the instrument scientist for the GeoXO sounder, or GXS.

"I'm not sure of the origins of that word, but it makes me think of people on ships and depth sounding, dropping stuff overboard," Johnson says of sounding. But rather than plumbing ocean depths, an instrument like GXS produces atmospheric soundings.

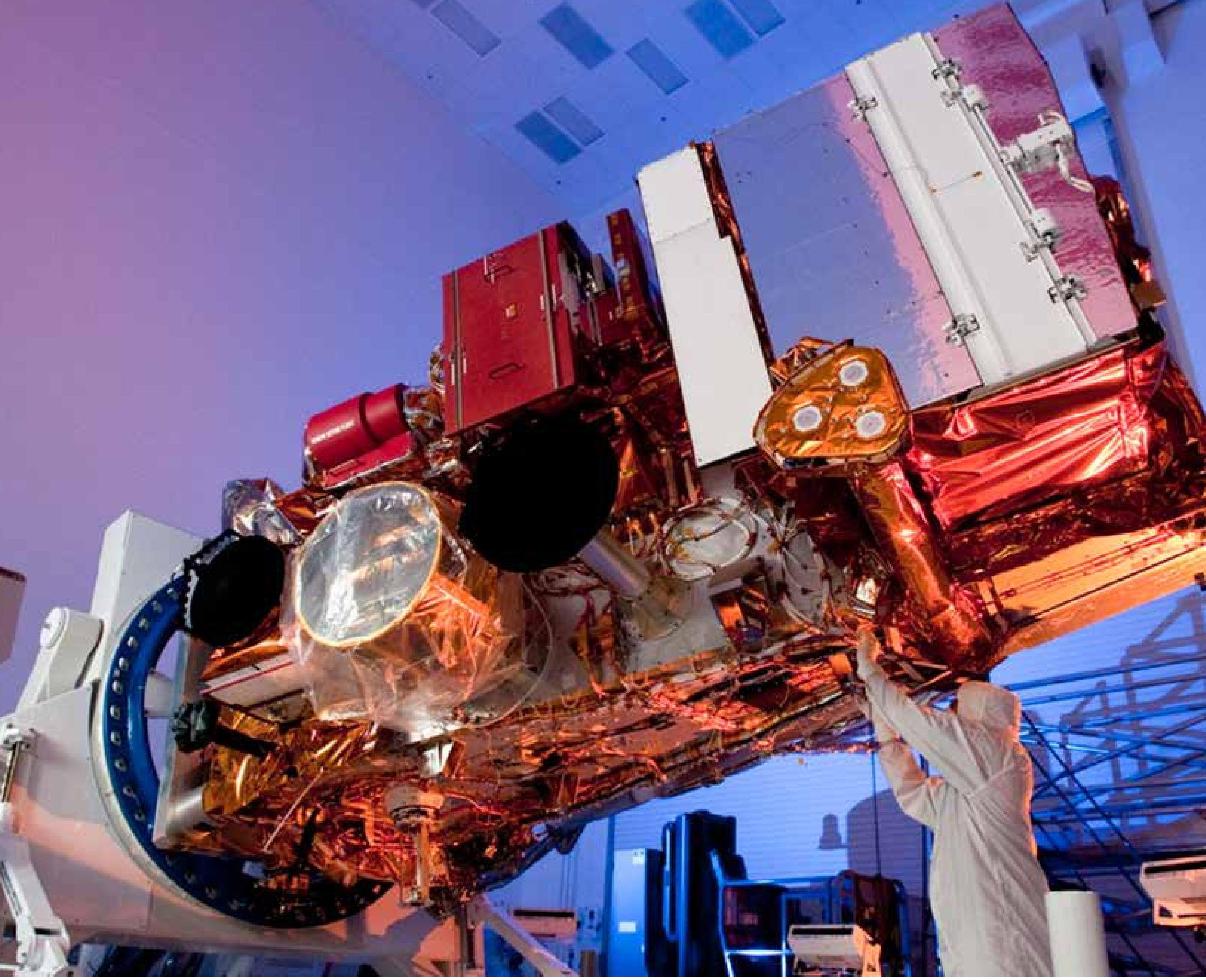
For satellites equipped with infrared detectors, sounding relies not on weights and ropes but on the relative opacity of the atmosphere below. That is, how much infrared light emitted by the ground and clouds

FACT

DURING DEVELOPMENT, the GeoXO satellites will be named "Geo-I1," "Geo-I2," and so on, the I referring to each satellite's primary payload, an imager. The sounder satellites would be named "Geo-S1" and so on.

The GOES-R satellites are NOAA's first geostationary weather satelliites without sounders since GOES-4, launched in 1980. The third GOES-R satellite is pictured here in the clean room ahead of its March launch atop a United launch Alliance Atlas V rocket. Designated GOES-T during development, the satellite was renamed GOES-18 a few weeks after launch.

NASA/Ben Smegelsky



▲ From geosynchronous orbit, a hyperspectral sounder could record atmospheric temperature and moisture of the same area every 30 minutes to one hour, compared to the 12 hours between observations for the Cross-track Infrared Sounders on the multiagency Suomi National Polar-orbiting Partnership satellite. Pictured above, Suomi was launched in 2011.

Ball Aerospace

reaches the sounder instead of being absorbed by carbon dioxide, water vapor and other atmospheric constituents along the way.

"Consider an infrared photon emitted at the surface of the Earth at a wavelength corresponding to a CO_2 absorption feature," Johnson says. "The photon is quickly absorbed by the atmosphere, emitted again, absorbed again, and so on until it reaches an altitude where the atmosphere is thin enough that the photon can escape to space."

Since CO_2 strongly absorbs infrared light in the 15-micrometer wavelength, he adds, a sounder monitoring the 15-micrometer wavelength only "sees" the highest levels of the atmosphere. Infrared light emitted by the Earth's surface at around 11 micrometers, however, can reach the sounder with little attenuation if the sky is clear.

So "by observing the Earth in a range of wavelengths where CO_2 absorbs more and less strongly," Johnson says, "one can observe the brightness higher and lower in the atmosphere, and from that one can derive the temperature."

A sounder applies the same process to water vapor, which strongly absorbs infrared light at the 6.7-micrometer wavelength. Once scientists calculate temperature as a function of opacity, they can use the well-known abundance of CO_2 in the atmosphere to estimate temperature as a function of pressure and altitude. Then do the process again with respect to water vapor to get a profile of water vapor by altitude.

"Those are the two really, really important things for weather guys, to get temperature and water vapor," Johnson says.

With temperature and humidity, weather forecasters have new insights into convection and precipitation. Monitor these over time or plug them into weather models, and they can determine wind velocity. All key ingredients for knowing where severe weather is right now — and where it will be in the future.

Bringing back sounding

Sounders go back nearly to the origin of the GOES satellites. GOES-1 reached orbit in 1975 with a rudimentary instrument package that provided no information on cloud depth, moisture or temperature by altitude. But GOES-4, launched in 1980, carried a demonstration version of a sounder to geosynchronous orbit: the Visible Infrared Spin-Scan Radiometer Atmospheric Sounder.

That sounder with its 12 spectral bands was deemed a success, Schmit says, and a sounder with 18 infrared spectral bands was included on the GOES-8 satellite launched in 1984.

NOAA flew similar sounders through GOES-15, and in the early 2000s began to plan for the next-generation instrument that would have flown on the GOES-R series: the Hyperspectral Environmental Suite. It would have consisted of a hyperspectral sounder and a coastal waters imager. The combination may have been too ambitious, Schmit says, and the combined hurdles of funding and technical difficulty ultimately led to NOAA removing the sounder from GOES-R.

NOAA has also flown hyperspectral sounders aboard low-Earth orbit satellites in polar orbits, such as the Suomi National Polar-orbiting Partnership, a multiagency climate and weather satellite, and NOAA-20, both part of Joint Polar Satellite System. The data they provide has proven valuable, Schmit says, but with a revisit time of 12 hours, their utility in monitoring severe weather events is limited.

"A lot of weather can have hit in 12 hours," he says. "You can go from clear to clear, if you will, with a big storm in between."

The legacy sounder that flew on GOES-15, the last satellite of the generation that came before GOES-R, could beat a hyperspectral sounder on a polar orbit in terms of temporal resolution. Instead of 12 hours, the GOES sounder could scan the continental U.S. about every hour.

If approved, the GeoXO sounder by contrast would represent a huge jump forward in terms of temporal, spectral, and spatial resolution, capable of scanning a "full disk" of the Earth every 30 minutes, Schmit says, and doing so with finer spatial resolution than the sounders in LEO.

"We're looking at something on the order of 4 kilometers for the GeoXO sounder, compared to something like 12 to 16 kilometers with current LEO satellites," he says.

And while the GOES-15 sounder viewed 18 spectral bands, the GeoXO sounder would view 1,564 spectral bands, according to Johnson. Combined with the faster revisit times, it could produce 80 times the data of a sounder in LEO. "That's 7 million pieces of information per second, versus 86,000 from LEO," he says.

▲ NOAA planned to use the same Advanced Baseline Imager design on all four satellites in the GOES-R series, but a clogged cooling system on the GOES-17 camera prompted a redesign. NOAA

A cool new design

At a glance, GOES-18 appears identical to the first two satellites in the GOES-R series, but the cooling system for the satellite's primary instrument is of a different design because of problems that arose shortly after the launch of GOES-17 in March 2018.

By April, mission controllers realized that the cooling pipe assembly for the GOES-17 Advanced Baseline Imager was "not transferring heat as it was designed to from the instrument electronics to the external radiator," GOES-R program director Pam Sullivan says. The result? The camera's infrared detectors weren't staying cool enough to provide consistently clear images.

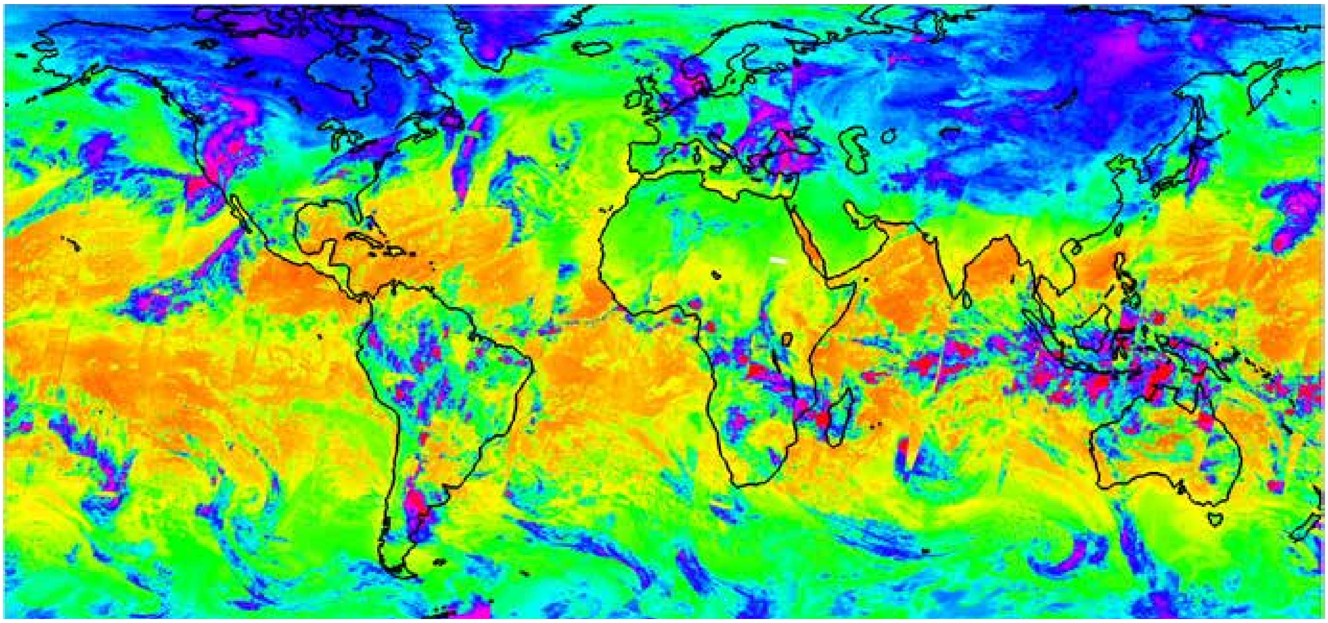
Operating adjustments were made so that GOES-17 could collect images, although with some limitations, in the GOES-West slot off the U.S. West Coast starting in 2019. NOAA later determined the culprit to be clogged filters within two 5-millimeter diameter aluminum cooling pipes.

With GOES-18 still in development at that time, ABI contractor L3Harris redesigned the cooling assembly to eliminate the filters. As of May, the tweaked pipe design on GOES-18 was performing well, Sullivan says, though the satellite is scheduled to remain in a checkout and calibration phase through December.

In the meantime, GOES-18 will be moved close to GOES-17 in June to assist with coverage from the GOES-West slot.

"We plan to deliver the GOES-18 ABI data to our users during the times when the GOES-17 ABI overheats due to the loop heat pipe anomaly," Sullivan says. "That's how it will assist GOES-17 before finally becoming operational."

If all goes as planned, GOES-18 will become fully operational next year, at which time GOES-17 will be placed in on-orbit storage as a spare. — *Jon Kelvey*



▲ The sounder on the multiagency Suomi National Polar-orbiting Partnership satellite has been gathering data on temperature, atmospheric pressure and moisture since 2012. In this composite of three days of observations, the orange represents warmer sea surface temperatures and the magenta represents colder temperatures.

NASA/NOAA

Real-time forecasting

With that kind of resolution and data flows, GeoXO could move into the domain of nowcasting — weather predictions delivered within a few hours of data collection — and advanced weather modeling. This could help decision-makers pre-position utility workers, food and water, or other resources before severe weather hits and make adjustments in real time, says James Yeo, the sounder user scientist for the GeoXO program.

"If you've ever had power out after a storm of any kind, you appreciate how quickly linemen get out there and restore services," he says. "Having them at the right place in the right number is just a huge, huge factor."

The more severe the weather, the bigger the potential impact. Yeo works within the National Centers for Environmental Prediction within the National Weather Service, which include the Aviation Weather Center, Climate Prediction Center, Storm Prediction Center and Hurricane Prediction Center, among others, all of which share a mission to provide forecasts to help protect lives and property. The GXS could help enhance that forecasting, and support or supplant existing techniques for gathering data on extreme weather, such as hurricanes.

NOAA hurricane reconnaissance aircraft release dropsondes — aerodynamically shaped cylinders loaded with instruments and dropped under parachutes — to acquire the exact sort of information about major storms that the GXS could provide from space, Yeo notes. While such a flight can provide great data, releasing perhaps 30 dropsondes every 15 minutes over the course of an 8.5-hour flight, the GXS could obtain data every 30 minutes, no aircraft required.

And while existing satellite data is helpful for forecasts of storms and icing that affect aviation, Yoe says, the GeoXO sounder's finer spatial resolution will improve the fidelity of real-time monitoring and response to atmospheric conditions, allowing airlines to better avoid costly turbulence.

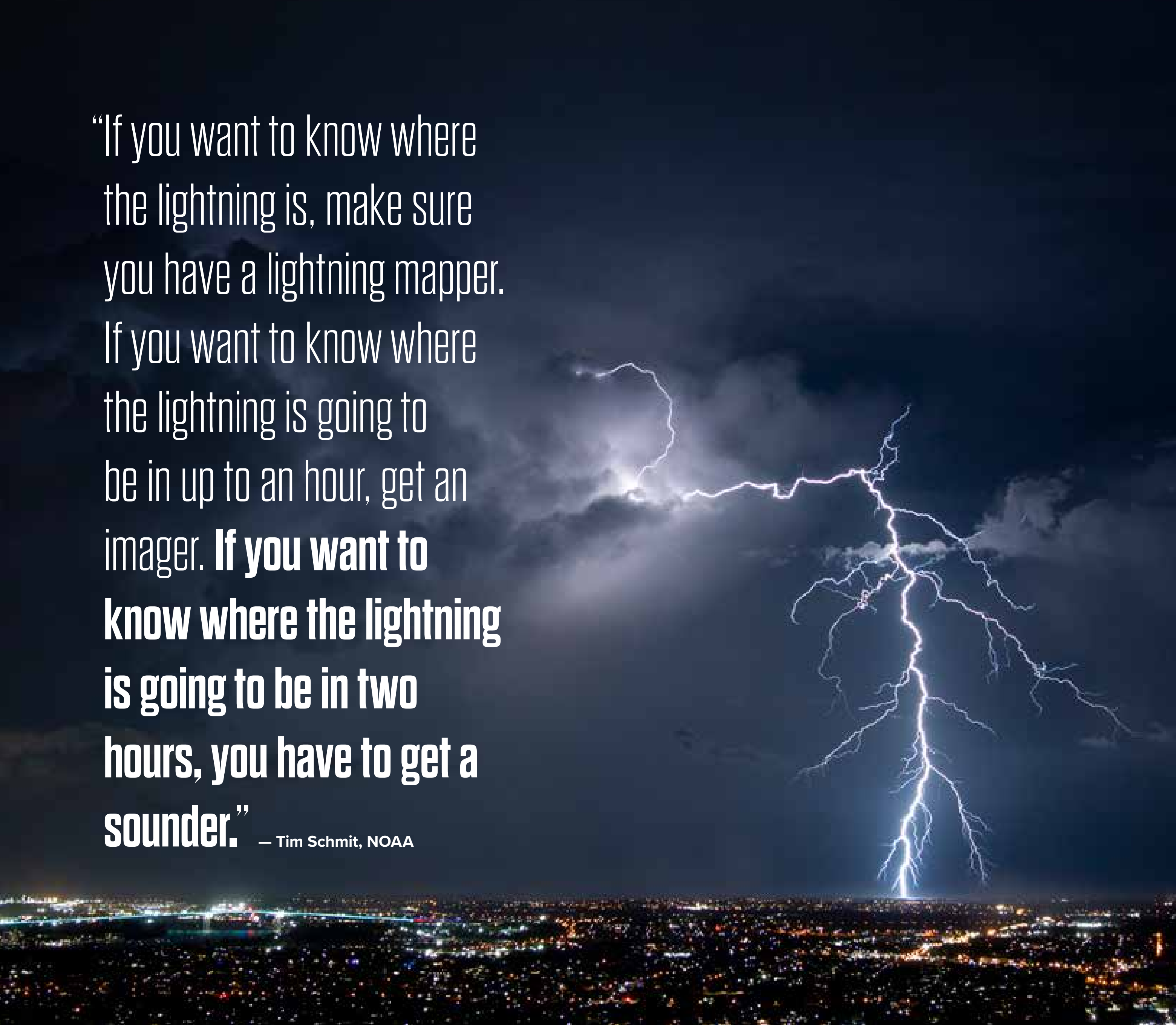
"When you know the wind speed and direction with some degree of accuracy at different levels, then you can infer where the shear is," he says, referring to the change of wind speed over short distances that often occurs during storms. "And where the shear is, from an aircraft's point of view, that's where turbulence is going to be."

But perhaps the most exciting application for a hyperspectral GEO sounder, from the point of view of forecasters and meteorologists like Yeo and Schmit, is how the data will enhance models to predict severe weather farther into the future than is currently possible.

"If you want to know where the lightning is, make sure you have a lightning mapper. If you want to know where the lightning is going to be in up to an hour, get an imager," Schmit says. "If you want to know where

FACT

AFTER COMPLETING A REVIEW IN DECEMBER, NOAA will decide whether it's ready to take the next steps in planning its Geostationary Extended Observations, or GeoXO, constellation. Plans call for a preliminary design review in 2023, a critical design review in 2029 and the launch of the first satellite in 2032. If all goes as planned, the satellites could operate through 2055.



"If you want to know where the lightning is, make sure you have a lightning mapper. If you want to know where the lightning is going to be in up to an hour, get an imager. **If you want to know where the lightning is going to be in two hours, you have to get a sounder."** — Tim Schmit, NOAA

the lightning is going to be in two hours, you have to get a sounder."

But even if the sounder is approved as part of the GeoXO design in the Milestone 2 review in December, twin challenges of congressional funding and technological hurdles could force NOAA to descope GeoXO in some fashion, which could include dropping the sounder.

The current estimated cost for GeoXO — consisting of six satellites, 24 instruments, grounds systems, development, and 20 years or more of operation — is about $18.6 billion, says Sullivan, slightly more than the $11.7 billion cost for the GOES-R series, when adjusted for inflation.

"There's no question that we're going to have a next-generation GOES satellite," she says. "I think the question is, 'how capable?'"

NOAA's Schmit, for one, is fairly optimistic about the sounder's chances of making it into the final GeoXO satellites. Since the decision to take the sounder off GOES-R, other countries have launched weather satellites with similar instruments, so the U.S. will have time to learn from others and build the best instrument possible.

China in 2016 launched an experimental sounder on one of its Fen-Yun 4 weather satellites, and the European Organization for the Exploitation of Meteorological Satellites is studying the potential of including a hyperspectral sounder on one of its GEO Meteosat satellites scheduled to launch in 2023.

If it makes the cut, the GeoXO sounder would become "kind of part of this global ring," Schmit says. "It's our contribution to the global ring of advanced geostationary sounders." ★

Calls grow for a safer Mars Sample Return

In 2033, NASA and the European Space Agency want to robotically bring home rock and soil samples from Mars. In recent public consultations, however, some suggest diverting samples to a space station or a lunar base to avoid any contamination risk to Earth. Can it work? Paul Marks investigates.

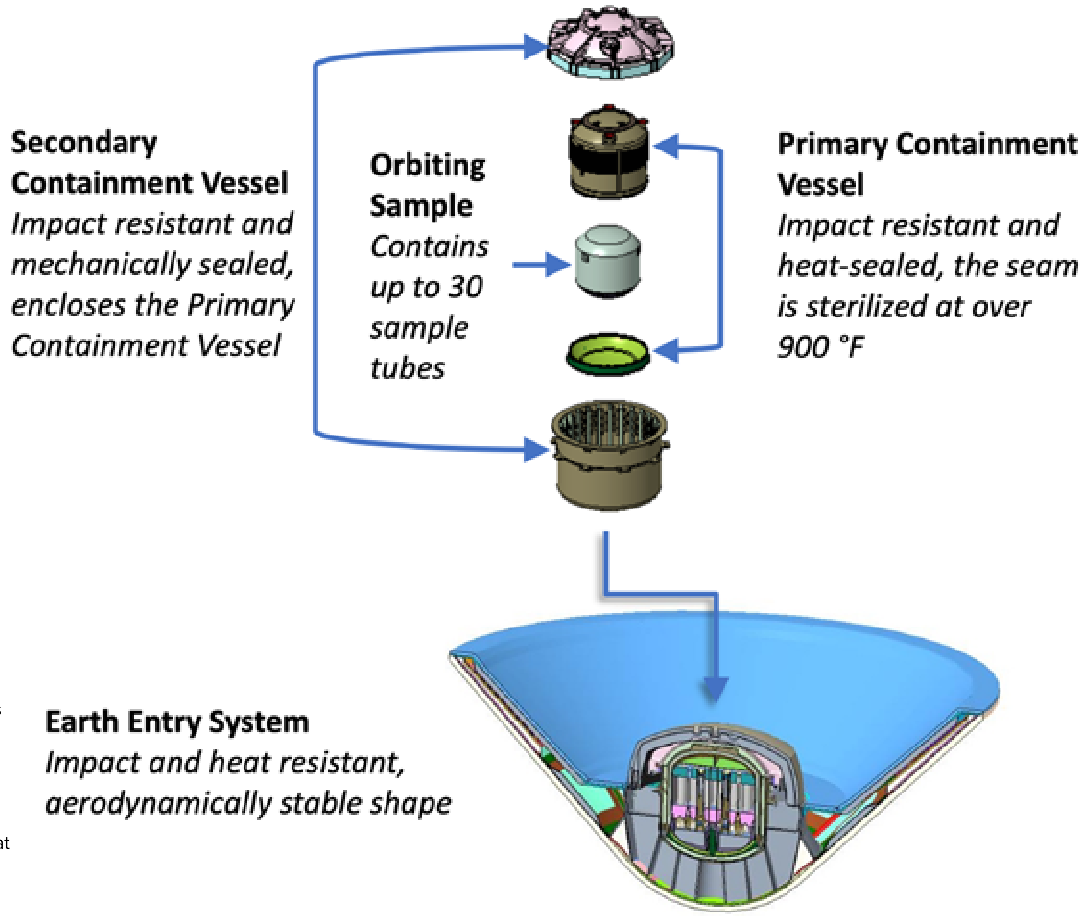
BY PAUL MARKS | paulmarksnews@protonmail.com

On the face of it, NASA and the European Space Agency's plan to return Martian rock and soil samples to Earth in 2033 seems straightforward enough. On Mars, the Perseverance rover has been collecting rock and soil samples for retrieval by a future rover that will, in turn, insert them in an ascent rocket. The samples will be boosted to Mars orbit to rendezvous with an Earth return orbiter, where they will be captured and wrapped in a containment vessel that's designed to withstand plowing through the atmosphere and thumping to rest on the desert floor.

At least, that's the theory. Mars Sample Return's multidecade spaceflight ballet must be more than the choreography of guidance, dynamics and control. It must also guarantee the safety and security of Earth's biosphere. So thoughts are now turning to whether all the multifarious containment steps can work.

The reason for concern? No one knows what biologically active organisms might exist on Mars, and, if they do exist, whether they pose any threat to life on Earth. After the onset of the covid-19 pandemic, space agencies would not be forgiven for importing a Martian pathogen — perhaps one of unknown extraterrestrial biology that human medicine has no defenses against.

This could happen, says the International Committee Against Mars Sample Return (ICAMSR), a New York-based group of astrobiological environmentalists, if the Earth return sample containment vessel proves inadequate or if the Earth Entry System reentry spacecraft it sits in breaks up on impact, as NASA's Genesis probe did in 2004.



This graphic showed during one of NASA's public briefings on the environmental risks of Mars Sample Return illustrates how the samples would be ensconced inside two vessels within the Earth Entry System spacecraft that would return them to Earth.

NASA

Alternatively, the EES could be breached at altitude — perhaps after a space debris collision — spilling Martian pathogens across the planet as it descends, warns ICAMSR.

Instead, says the group's director Barry diGregorio, a former astrobiologist, the group backs the idea of analyzing Mars samples in a biosecure lab on the International Space Station, NASA's planned Lunar Gateway or a future lunar base.

The alarm over the risks of returning samples from Mars was first sounded in 1973 by Carl Sagan, founder of The Planetary Society who died in 1996. In his book "Cosmic Connections," he wrote that "it is possible that on Mars there are pathogens, organisms which, if transported to the terrestrial environment, might do enormous biological damage — a Martian plague, the twist in the plot of HG Wells' War of the Worlds, but in reverse. This is an extremely grave point."

NASA agrees that there is the "potential for past or present indigenous lifeforms on Mars" to piggyback on returned samples. And in a December 2020 paper in the International Journal of Astrobiology, a 14-person Mars sample Sterilization Working Group convened by NASA says: "The potential risks associated with returning samples from Mars are likely to be low-probability, yet high-consequence risks."

And, the working group notes, sterilizing Mars samples on Mars and Earth (such as with heat and radiation) will be performed "on the basis of biology as we know it," the suggestion being that there's still a chance an alien biology exists that can cope with more extreme conditions than terrestrial microbes.

So, because it is a federal agency, NASA must prepare an environmental impact statement for the Mars Sample Return (MSR) mission. As part of that, it has had to seek the views of the public on the risks involved in its $8 billion mission with ESA.

On April 15, NASA opened itself up to a 30-day public comment period on MSR risks by publishing a public notice in the Federal Register, the U.S. government's official journal, inviting people to post their views online or attend two live virtual NASA briefings where they could also ask questions of NASA's MSR experts and leave comments.

NASA says a draft impact statement will be published, based in part on these comments, and considered in a further 45-day public comment period "in late 2022" — with a final statement to be published in 2023.

Of the 170 public comments received by NASA, some themes emerge: Some said Martian samples should not come to Earth but rather should be analyzed on a space station or a lunar base. Others were incred-

ulous at the perceived audacity of NASA's plan, as the havoc that invasive species cause between nations is already well known: "I cannot even bring fruit into the U.S. from Mexico!" says one. Others say all such analysis should be done on Mars itself.

Some example comments include:

- "Bringing Martian soil back to earth to study is irresponsible. We have a perfectly good space station. Can we study it there first?"
- "Stage initial microbial analysis of Mars samples on the Moon, or an isolated module on the ISS."
- "We know relatively very little about Mars, much less the bacteria, organisms or viruses Mars hosts. [Bring them to] the Lunar Gateway instead."

But listening to such views and acting on them are two different things, and observers say it is unclear how much NASA is willing or able to be swayed, if at all, by ideas of samples returning to space stations or the moon, especially in light of the costs already sunk into MSR's Earth-return mission architecture.

In any case, analyzing Mars samples in a high-containment biosafety-level-4 lab (BSL-4) on a space station is far tougher than it sounds, says Cassie Conley, a NASA astrobiologist who studied the matter as the agency's planetary protection officer from 2006 until 2018.

"Building instruments to operate in microgravity is extremely challenging, and the reliability, sensitivity and accuracy of microgravity instrumentation is much lower than the same instruments on Earth," Conley told me by email. "The sorts of instrumentation failures that often happen on the ISS would make this impossible."

"If somehow these cost and technical concerns were solved, the only location that would make sense for an orbiting facility would be in a fail-safe orbit near one of the Lagrange points — where the orbit would decay away from the Earth-Moon system if the facility lost power."

And Conley says placing a lab with equivalent containment to a BSL-4 lab on the moon could be problematic if it fails and leaks. "To preserve the ability for humans to travel between the Earth and the Moon, without needing decontamination protocols, it would be nearly as bad if the Moon got contaminated, as if the Earth were," she says.

"So if there is anything hazardous in Mars samples, a failed facility could not be allowed to contaminate either the Moon or the Earth."

Wherever Mars samples eventually travel to after reaching Mars orbit — be it Earth, a space station or the moon — the package of 30 sealed tubes of rock and soil samples sent up by the Mars Ascent Vehicle rocket has to be encapsulated in such a way that any Martian dust on it is completely contained within some kind of all-encompassing shroud.

Until now, that was to have been done by robotically brazing a containment vessel around the sample package while in orbit. But in NASA's environmental presentation on May 4, it was revealed that this highly experimental method has now been abandoned.

"It represents an option we considered, but chose not to implement," says Brendan Feehan, mission systems engineer on MSR's Capture, Containment, and Return System.

"We have moved to a heated shrink-fit design for sealing the primary containment vessel," he says.

It is not entirely clear yet how this heat shrink technology works, but it appears to be a more reliable sealing method than what was essentially an unwieldy, automated welding-based technique.

At ICAMSR, however, diGregorio is unimpressed by this technological switch. "This is just NASA avoiding the issue — using Earth as a Mars Sample Return reception point to make it cost efficient and easier to do rather than sending it to the Lunar Gateway," he says.

"It's putting cost ahead of safety again." ★

▲ NASA's Langley and Ames research centers are leading development of the disk-shaped Earth Entry System spacecraft and heat shield that would protect the sealed container of Martian dirt and rocks samples as they plow through the atmosphere upon return to Earth. Engineers in April dropped a test article of the heat shield outfitted with sensors from an altitude of 365 meters to simulate the impact.

NASA

FLYING OVER TRAFFIC JAMS

Korean Air is part of an effort to develop air taxi infrastructure to ease traffic in congested Seoul starting in 2025. Aaron Karp spoke to executives about the work ahead.

BY AARON KARP | aaronkarp74@gmail.com

Sitting in a car in slow-moving bumper-to-bumper traffic, watching large video boards on the sides of buildings intended to help alleviate the boredom of frustrated automobile drivers and passengers was an inevitable part of my several trips to Seoul. The bustling city of 10 million residents is forever plagued by stalled road traffic. Getting between Gimpo International Airport, the domestic hub located in Seoul, and Incheon International Airport, the international hub located 50 kilometers from the city, is often quite trying.

Seoul does have a robust subway train system, but the city's density and high population mean roadway traffic is still intense — a prime candidate for whisking passengers above the congested roadways in small electric aircraft providing urban air mobility services, a subset of advanced air mobility.

That's the eventual goal of the South Korean government, but no concrete decisions have been made about whether such a service would consist of government-owned public transit, like a subway in the air, or a collection of private companies operating their own fleets of air taxis to provide scheduled or on-demand flights.

Whichever ends up being the choice, the Ministry of Land, Infrastructure and Transport is working with the private sector to develop the necessary support infrastructure including vertiports, software and equipment for traffic management and rules that would enable air taxi flights.

Korean Air in April joined the effort and will provide everything from a flight operation simulator and flight control system for managing schedules, to a computerized traffic management system that would deconflict flights and a digital replica of the UAM airspace. The work will begin in Seoul to assess safety.

"The airline believes UAM will revolutionize the future of air transport," Soo-Keun Lee, Korean Air's chief safety and operating officer, told me in an email exchange. "The airline seeks to build a strong foundation in the UAM field through extensive research and development, and secure its position as a pioneer in the industry."

Lee noted that Korean Air performs maintenance on South Korean military helicopters, so it is not unfamiliar with rotorcraft. The airline has also developed and built its own drones, so autonomous flight is not foreign to the company. (Even though initial air taxi flights will be piloted, air taxi developers say the future of the technology is autonomous or remotely piloted flight.)

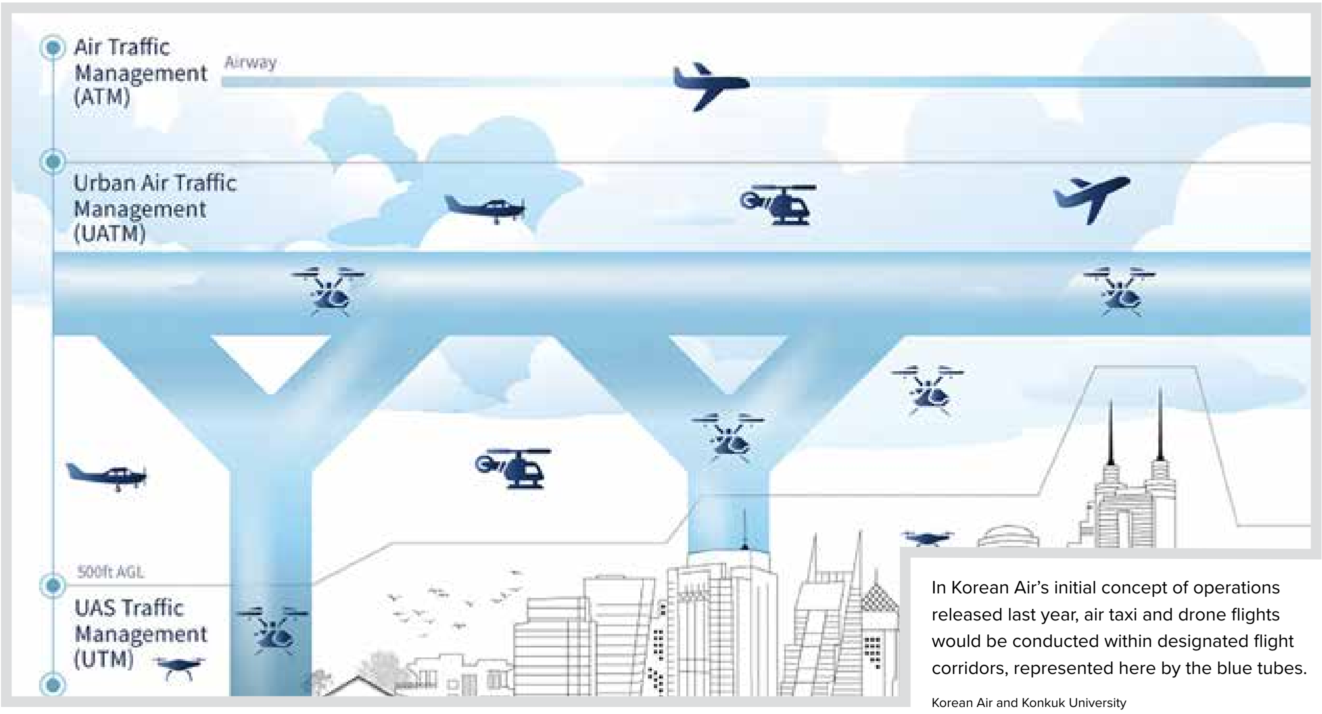
Other participants in the South Korean UAM project include Hyundai Motor Co., whose Supernal subsidiary is developing an electric vertical and landing vehicle, eVTOL, air taxi design as well as an electric short takeoff and landing, eSTOL, aircraft.

Korean Air has not decided whether it will operate air taxis itself, but it does see ties between its mainline airline operations and possible eVTOL flights in Seoul.

"Travel to and from the airports is hampered by traffic jams," Lee explained. What Seoul needs, he said, are flight management systems, prescribed routes, supporting infrastructure and air traffic rules so the city is ready to handle electric air taxi operations

▲ Hyundai Motor Co. subsidiary Supernal is among the air taxi developers working with the South Korean government to establish passenger services in the country. Supernal is also working with U.S. cities including Los Angeles to begin passenger service with its proposed electric vertical takeoff and landing concept, a mockup of which was displayed at the 2020 Consumer Electronics Show in Las Vegas.

Hyundai Motor Co.



In Korean Air's initial concept of operations released last year, air taxi and drone flights would be conducted within designated flight corridors, represented here by the blue tubes.

Korean Air and Konkuk University

as soon as 2025.

"With the limitations of the existing ground transportation, we expect UAM to provide an ideal solution for those wishing to move faster through the city," Lee said. "We expect for UAM routes to begin by connecting passengers from Incheon Airport and Gimpo Airport into Seoul, and later expand to cover areas close to Seoul as the vehicle's performance improves."

The digital twin of the air taxi environment in Seoul will be a high priority.

"UAM flight operations require the establishment and approval of flight plans for each route. While the safety of each route needs to be verified, it is difficult to accomplish this with flight tests alone," Lee said. "The digital twin is expected to play a vital role in verifying the safety of each route through the use of big data and AI."

Korean Air is focused on developing a series of fixed routes in which air taxis would operate — in essence, a series of airline routes on a much smaller scale. The airline believes this is crucial to safely deconflicting flights in the crowded city.

Indeed, Korean Air is bringing an airline mindset to the air taxi concept. It plans to develop an airline-style flight control system that will include flight schedule management and flight planning. The system will provide air taxi operators with information on weather, approved routes, airspace conditions and the location of vertiports.

According to Lee, "UAM still significantly lacks the necessary infrastructure, safety regulations and social acceptance" to begin operations, necessitating a great deal of work over the next two to three years if Seoul is going to have air taxis flying over traffic by the middle of this decade.

"As an airline and aviation company, I believe Korean Air understands the UAM industry the best in Korea," Lee added.

But the implications of the work could extend beyond South Korea.

"Korean Air will actively participate in creating international standards for UAM transportation using its expertise, experience and technology," Lee said.

For now, residents of and visitors to Seoul will continue to contend with extreme road congestion. But the South Korean government and Korean Air are trying to create a better transportation future. ★

▲ Korean Air says its prior experience developing drones is a good foundation for research and development into the flight controls and traffic management for passenger air taxis, given the aspiration for air taxis to someday fly autonomously. The airline in late 2021 demonstrated this swarm of drones designed to autonomously inspect large airliners.

Korean Air

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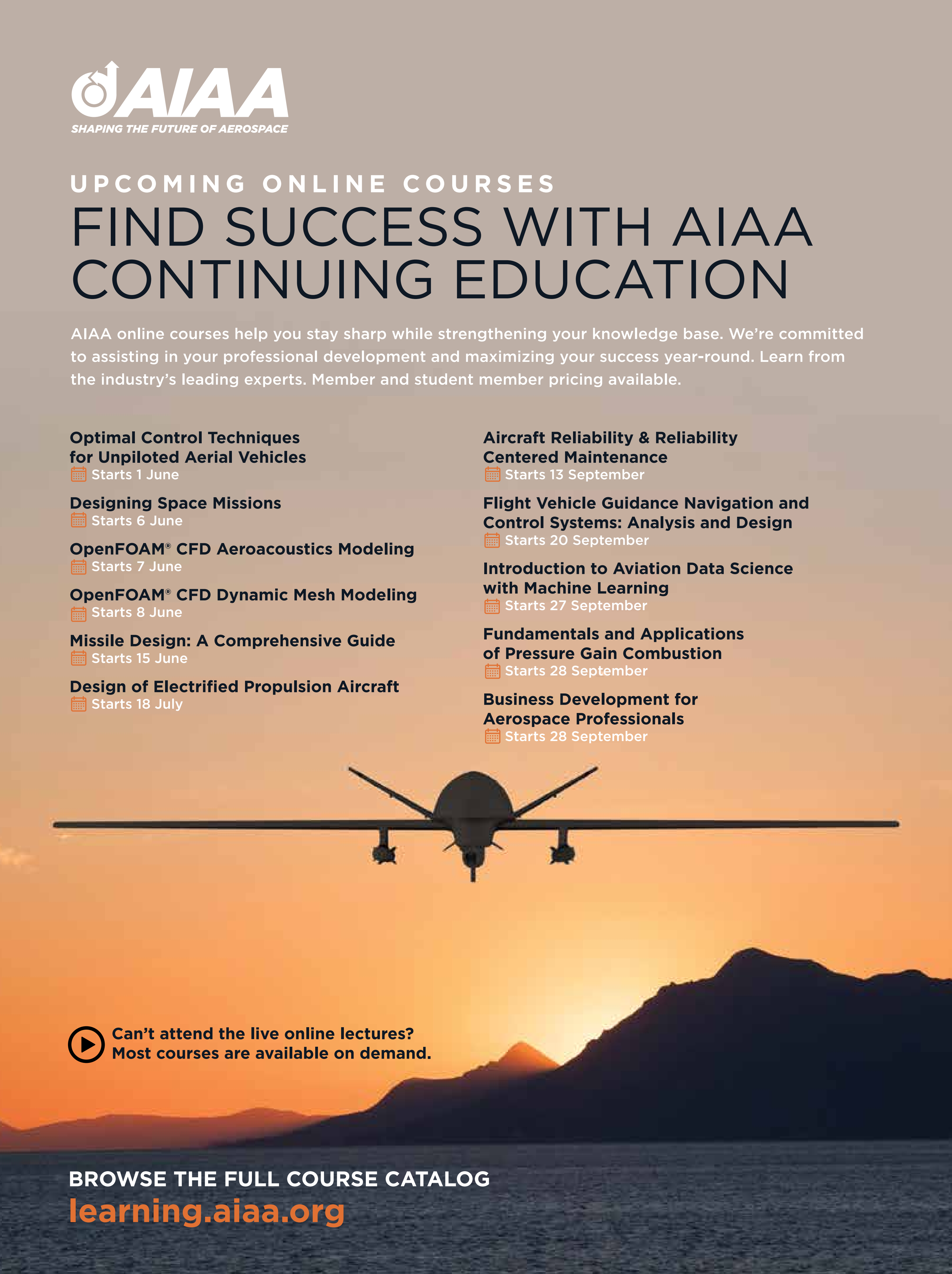
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Calendar

FEATURED EVENT

27 JUNE–1 JULY 2022

Chicago, IL, and Online

There's no shortage of challenges facing the aviation industry: the supply chain is at a pivotal point, there is a downturn in demand, environmental sustainability is critical, and experts warn of a talent shortage. We have the opportunity to reset expectations, redefine roles, and accelerate change. Join us as we explore the next golden age of aviation with the theme, Challenging Times, Unique Opportunities.

aiaa.org/aviation

DATE	MEETING	LOCATION	ABSTRACT DEADLINE
2022			
1–22 Jun	Optimal Control Techniques for Unpiloted Aerial Vehicles (UAVs) Course	ONLINE (learning.aiaa.org)	
6–9 Jun	Designing Space Missions Course	ONLINE (learning.aiaa.org)	
7 Jun	OpenFOAM CFD Aeroacoustics Course	ONLINE (learning.aiaa.org)	
8 Jun	OpenFOAM CFD Dynamic Mesh Modeling Course	ONLINE (learning.aiaa.org)	
8 Jun	ASCENDxSustainability: Sustaining Space for the Next Generation	Online (ascend.events)	
14–17 Jun*	28th AIAA/CEAS Aeroacoustics Conference	Southampton, UK (aeroacoustics2022.org)	12 Jan 22
15 Jun–10 Aug	Missile Design: A Comprehensive Guide to Propulsion, Aerodynamics, Weight, Flight Performance, Guidance, Lethality, System Engineering, and Development Course	ONLINE (learning.aiaa.org)	
25–26 Jun	7th AIAA Drag Prediction Workshop ("DPW-VII: Expanding the Envelope")	Chicago, IL	
26 Jun	2nd AIAA Workshop for Multifidelity Modeling in Support of Design & Uncertainty Quantification	Chicago, IL	
27 Jun–1 Jul	AIAA AVIATION Forum	Chicago, IL	10 Nov 21
16–24 Jul*	44th Scientific Assembly of the Committee on Space Research and Associate Events (COSPAR)	Athens, Greece (cospar-assembly.org)	11 Feb 22
19 Jul–11 Aug	Design of Electrified Propulsion Aircraft Course	ONLINE (learning.aiaa.org)	
7–11 Aug*	AAS/AIAA Astrodynamics Specialist Conference	Charlotte, NC	1 Apr 22
1 Sep	2022 Section Awards Presentation	Online	
4–9 Sep*	33rd Congress of the International Council of the Aeronautical Sciences (ICAS 2022)	Stockholm, Sweden (icas2022.com)	10 Feb 22

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
2022			
13–22 Sep	Aircraft Reliability & Reliability Centered Maintenance Course	ONLINE (learning.aiaa.org)	
18–22 Sep*	73rd International Astronautical Congress	Paris, France (iac2022.org)	
18–22 Sep*	Digital Avionics Systems Conference (DASC)	Portsmouth, VA (2022.dasconline.org)	
20 Sep–13 Oct	Flight Vehicle Guidance Navigation and Control Systems (GNC): Analysis and Design Course	ONLINE (learning.aiaa.org)	
27 Sep–3 Nov	Introduction to Aviation Data Science Course	ONLINE (learning.aiaa.org)	
28 Sep–21 Oct	Business Development for Aerospace Professionals Course	ONLINE (learning.aiaa.org)	
28 Sep–21 Oct	Fundamentals and Applications of Pressure Gain Combustion Course	ONLINE (learning.aiaa.org)	
4–20 Oct	Overview of Python for Engineering Program Course	ONLINE (learning.aiaa.org)	
4–27 Oct	Propeller Aerodynamics for Advanced Air Mobility: Fundamentals and Integration Effects Course	ONLINE (learning.aiaa.org)	
11–20 Oct	Higher Fidelity Designs for the Aerospace Industry w/ Fluid-Thermal Structural Interaction (FTSI) Course	ONLINE (learning.aiaa.org)	
12, 13, 14 Oct	Understanding Cybersecurity in the Space Domain Course	ONLINE (learning.aiaa.org)	
24–26 Oct	ASCEND Powered by AIAA	Las Vegas, NV	7 Apr 22
28–29 Nov	AIAA Region VII Student Conference	Adelaide, Australia	31 Aug 22
2023			
15–19 Jan*	33rd AAS/AIAA Space Flight Mechanics Meeting	Austin, TX (space-flight.org/docs/2023_winter/2023_winter.html)	
23–27 Jan	AIAA SciTech Forum	National Harbor, MD	1 Jun 22
4–11 Mar*	IEEE Aerospace Conference	Big Sky, MT (www.aeroconf.org)	
11–13 Apr	AIAA DEFENSE Forum	Laurel, MD	18 Aug 22
12–16 Jun	AIAA AVIATION Forum	San Diego, CA	
27–30 Jun*	ICNPAA 2021: Mathematical Problems in Engineering, Aerospace and Sciences	Prague, Czech Republic (icnpaa.com)	
2–6 Oct*	74th International Astronautical Congress	Baku, Azerbaijan (iac2023.org)	
23–25 Oct	ASCEND Powered by AIAA	Las Vegas, NV	

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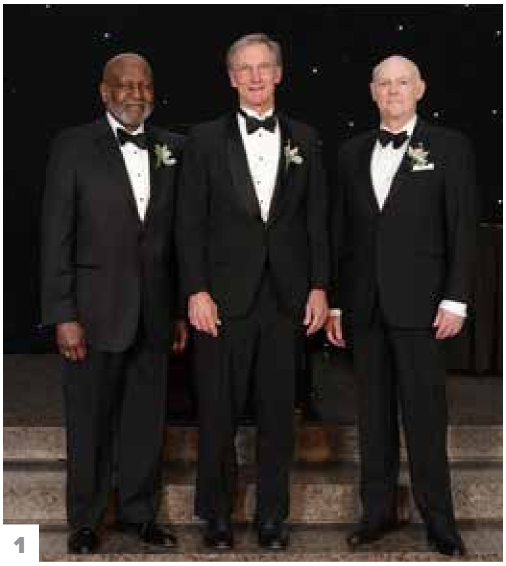
● AIAA Continuing Education offerings

2022 AIAA Awards Gala Held in April

AIAA presented its premier awards at the AIAA Awards Gala, 27 April, at the Ronald Reagan Building and International Trade Center in Washington, DC. The Class of 2022 AIAA Fellows and AIAA Honorary Fellows also were recognized. In addition, Immediate Past President Basil Hassan passed the gavel to incoming President Laura McGill at the event.



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1 Class of 2022 AIAA Honorary Fellows: (left to right) Wesley L. Harris, Roger A. Krone, and Tory Bruno.

2 Class of 2022 AIAA Fellows (not pictured: William J. Devenport, Marillyn A. Hewson, Felix R. Hoots, Walter H. Rutledge).

3 Immediate Past President Basil Hassan (left) and incoming AIAA President Laura McGill (right) with Kyle Terry Alfriend, recipient of the 2022 AIAA Goddard Astronautics Award.

4 Immediate Past President Basil Hassan (left) and incoming AIAA President Laura McGill (right) with Peretz P. Friedmann, recipient of the 2022 AIAA Reed Aeronautics Award.

5 Immediate Past President Basil Hassan (left) and incoming AIAA President Laura McGill (right) with David A. Throckmorton, recipient of the 2022 AIAA Distinguished Service Award.

6 Immediate Past President Basil Hassan (left) and incoming AIAA President Laura McGill (right) with Lori B. Garver, recipient of the 2022 AIAA Public Service Award.

7 Immediate Past President Basil Hassan (left) and incoming AIAA President Laura McGill (right) with Michael P. Snyder, recipient of the 2022 AIAA Lawrence Sperry Award.

8 Immediate Past President Basil Hassan (left) and incoming AIAA President Laura McGill (right) with Paul R. Gradl, recipient of the 2022 AIAA Engineer of the Year Award.

9 (Left to right) AIAA Foundation Chair John Langford with the 2022 Trailblazing STEM Educator Award winners—Jackie Blumer, Jennifer Cheesman, Kellie Taylor, Cedric Turner, and Katrina Harden Williams

10. 2022 Roger W. Kahn Scholarship recipients: (l to r) Favianna Colón, Nchenui Moundae Jamila, Elizabeth Kung, and Mariah Tammera.

11 Immediate Past President Basil Hassan passes the gavel to 2022–2024 AIAA President Laura McGill.

Dominique Collin, recipient of the 2022 AIAA International Cooperation Award, and Alan C. Brown, recipient of the 2021 Daniel Guggenheim Medal, were unable to be in attendance.

11

SAT OC – A Time for Celebration

By Amir S. Gohardani, SAT OC Chair

Due to the many activities of the Society and Aerospace Technology Outreach Committee (SAT OC), 2022 has proven to be a fantastic year. A testament to this statement is an increasing level of SAT OC membership as verified by a 32% growth of committee members since 2021. SAT OC's membership has also become increasingly diverse; they are active in for-profit organizations, nonprofit organizations, and government agencies, and we have also seen a climb of members identifying as females, now at 34% of its membership (a 12% hike from 2021). The committee is revisiting the topics it has been involved in to capture the interests of all its membership. Such efforts can potentially lead to the formation of new subcommittees.

SAT OC Spotlight

Professor William A. Crossley, J. William Uhrig and Anastasia Vournas Head of Aeronautics and Astronautics, and Professor of Aeronautics and Astronautics, Purdue University, and Swaine.

The SAT OC is proud to highlight a member whose leadership, commitment, and skills make a difference in the aerospace community: **Suzanne Swaine**.

Swaine, a graduate student in the School of Aeronautics and Astronautics at Purdue University, was awarded this year's Estus H. and Vashti L. Magoon Award for Excellence in Teaching along with Arch Pleumpanya (an AIAA Student Member). We congratulate them both.

Swaine joined SAT OC with many bold ambitions. She is a full-time Ph.D. student at Purdue studying aerospace systems in the Aerospace Systems Design, Analysis, and Optimization Laboratory. Her research aims to determine how AAM and conventional aviation technologies can best be implemented to address the needs of underserved remote and isolated communities in Northern Canada.

Swaine spent six years as an Aircraft Performance Technical Specialist with Gulfstream Aerospace, where she worked on the G650ER, G700, and G800 programs. She was heavily involved with the AIAA Savannah Section, including as chair for the 2017–2018 year, and she is a member of the AIAA Aircraft Design Technical Committee. Originally from Nova Scotia, Canada, Swaine earned her Masters of Applied Science in 2014 from Carleton University as a member of Professor Robert Langlois' Applied Dynamics Laboratory. She earned her Bachelor's in Aerospace Engineering from Carleton University in 2011.

Swaine hopes to become a professor after graduation and her passion for teaching is reflected in her words: "After spending some time in the industry and working with co-op students, I knew I wanted teaching to be a bigger part of my life. I've had incredible teachers and mentors who have impacted my life in profound and positive ways, and I would like to do the same for my students. I am lucky to be studying under Professor Crossley who is a phenomenal teacher both in and out of the classroom. ... [I've] enjoyed the challenge of working with a variety of students who learn in different ways, have different levels of experience, and who come from different backgrounds. I hope these experiences will help me become a better professor after graduation."

SAT OC is thrilled about a future where driven, motivated, and highly skilled individuals such as Swaine will positively impact and shape society.

Diversity Corner

NAME: Lieutenant Colonel Bree Fram

NOTABLE CONTRIBUTIONS:

Lt Col Bree Fram is the President of SPARTA and an active-duty lieutenant colonel in the U.S. Space Force. SPARTA advocates and educates about transgender military service and is dedicated to the support and professional development of over 1,300 transgender service members. A member of SPARTA since 2014, she focuses on policy and advocacy work to develop a more inclusive military. Lt Col Fram came out as transgender on the day the transgender ban in the military was dropped in 2016. She is currently the highest ranking out transgender officer in the Department of Defense. She is assigned to the Pentagon to lead space acquisition policy development for the Department of the Air Force.

POTENTIAL SOCIETAL IMPACT OF CONTRIBUTIONS:

Lt Col Fram previously served in a wide variety of Air Force positions including a Research and Development command position and an oversight role for all Air Force security cooperation activity with Iraq. In earlier assignments, she served in the Air Force Directorate of Strategic Plans, as a Legislative Fellow at the U.S. Capitol on the staff of Congresswoman Madeleine Bordallo, several tours as a program manager for satellite and technology programs, and deployed to Qatar and Iraq as part of Operation Iraqi Freedom.

In collaboration with the AIAA Diversity Group and Claudine Phaire, SAT OC is highlighting prominent members of the wider aerospace community in the Diversity Corner.

ASCEND Continues Its Growth

AIAA had a successful ASCENDxTexas event in April to discuss accelerating the business of space exploration and the growing Texas space ecosystem. Over 300 attendees from around the world gathered to hear from a diverse group of experts and industry luminaries from organizations including NASA, Blue Origin, Voyager Space, The Boeing Company, Sierra Space, Redwire Space, SpaceX, and Lockheed Martin. Speakers and panels provided new insights on the lunar exploration market, explored space commercialization efforts, identified and debated technology gaps, and learned how NASA is evolving its approach to industry to enable faster outcomes.

Thank you to our 13 supporting sponsors and partners, including our Signature Sponsor, SAIC.

Join us on 8 June for a free virtual discussion on all aspects of space sustainability.

ASCENDxSustainability will feature industry luminaries and experts examining how to build and expand our off-world future in a more sustainable and deliberate fashion as we share a myriad of sustainability best practices and lessons learned. RSVP at www.ascend.events.

MAKING AN IMPACT

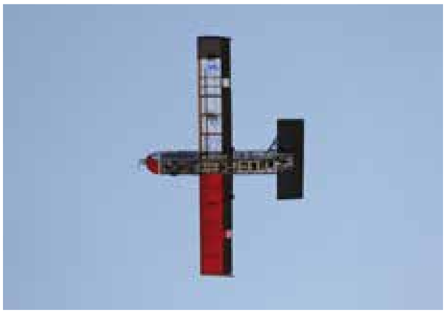
2022 AIAA Design/Build/Fly Competition Takes Flight Again

AIAA held its 26th annual Design/Build/Fly (DBF) Competition 21–24 April at Textron Aviation in Wichita, KS. DBF encourages excellence in aerospace engineering skills at the undergraduate and graduate levels by challenging teams to design and fabricate a radio-controlled aircraft, submit a written report about the aircraft's design, and fly their aircraft over a defined course while carrying a payload and landing it without damage.

Sixty-four teams comprising 700 students and faculty participated in the competition, where teams had designed aircraft capable of transporting vaccination syringes and components on the designated course across four missions. This year, 152 flight attempts were made, with 87 resulting in a successful score, 40 of which completed one successful flight, and 15 teams completed all four missions (one ground and three flight missions). Georgia Tech won first place, followed by Embry-Riddle Aeronautical University – Daytona Beach in second place. Austria's FH Joanneum University of Applied Sciences came in third, and also won the award for best design report. In addition, a new award was introduced in honor of longtime DBF Organizing Committee member Stan Powell, who passed away in late 2021. The Stan Powell Memorial Award for Most Meaningful Lessons Learned was given to the University at Buffalo for their efforts to keep their plane in competition after some early setbacks.

Thank you to our sponsors: Primary: Raytheon Technologies and Textron Aviation; Gold: Aerovironment, General Atomics, Spirit Aerosystems, MathWorks, AIAA Foundation. Get involved in next year's DBF in Tucson, AZ!

The AIAA Foundation supports DBF to advance aerospace and to ensure the next generation of aerospace professionals is equipped as they prepare to enter the workforce. More information on DBF can be found at aiaadbf.org. For information on how your organization can engage with and sponsor this event, please contact alexandrad@aiaa.org

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PENGUINS

AIAA GHS Hosts Rocket City Invitational Quiz Bowl Tournament

By Robin Osborne, Pre-College Outreach Director, AIAA Greater Huntsville Section

On 26 March the AIAA Greater Huntsville Section (GHS) hosted the first AIAA Rocket City Invitational academic quiz bowl for Alabama schools at the University of Alabama in Huntsville (UAH). The tournament attracted a total of 18 teams, consisting of 84 students from 15 high schools and two middle schools. Volunteers included members of AIAA GHS, the AIAA UAH Student Branch, NASA Marshall Space Flight Center, Jacobs Space Exploration Group, ERC, Paragon TEC, SAIC, TriVector Services, and Mississippi State University.

The event consisted of an online, pre-tournament Buzzword Challenge open to all AIAA GHS members, and a traditional, in-person quiz bowl tournament for the 18 teams. Through a grant provided by The Boeing Company, the National Academic Quiz Tournament (NAQT) was commissioned to write a question set for the Buzzword platform covering a wide variety of topics in aerospace and aviation. Players were organized into middle school, high school, college, and open (non-student) divisions.

Jared Sauer, winner of the Buzzword college division, had the highest score across all four divisions. Sauer is a junior studying aerospace engineering at UAH.

The quiz bowl tournament began with three pools of teams playing five round-robin preliminary games to determine which teams would advance to the afternoon varsity playoffs. The two middle schools had their own head-to-head playoffs, and Monrovia Middle School won the double-elimination middle school finals.

The varsity playoffs were seeded based on the results of the preliminary games. The winners were: Hoover High School, 1st place; Alabama School of Cyber Technology and Engineering, 2nd place; Sparkman High School, 3rd place; and Spain Park High School, 4th place. The top ten individual scorers were also recognized with medals. Trophies, team cash awards, and individual medals were made possible through generous sponsorships provided by Jacobs Space Exploration Group and ERC.

Clockwise from top left: high school varsity champions from Hoover High School with coach Tim Caine; Dr. Tracie Prater, AIAA GHS vice chair, with Buzzword top scorers Owen Bruyns, Discovery Middle School; Benjamin Lattner, U.S. Army Redstone Test Center; Jared Sauer, UAH; and Ella Duus, New Century Technology High School.

The Monrovia Middle School team with Coach Gene Cox show off their new RS-25 engine pins.

AIAA K-12 STEM Co-Chair Karen Berger teaching how to make straw rockets.

HRS Members Drive Interest in Aerospace at JLHR Tour of Trucks

On 10 April, AIAA members attended the Junior League of Hampton Roads (JLHR) Tour of Trucks event with an activity for foam gliders and straw rockets. The event was held at Langley Speedway and included several different types of vehicles ranging from trash trucks to street cleaners to police vehicles. AIAA members **Robert Haynes**, **Zack Owens**, **Vanessa Aubuchon**, **Karen Berger**, and **Amanda Chou** manned the AIAA booth and taught children and their families how to make their own straw rockets and foam gliders. Some spontaneous competitions on who could fly their glider the farthest or launch their rocket the farthest happened between groups that arrived. Children were allowed to experiment and modify them to fly better, especially in the very windy conditions!

Obituaries

AIAA Honorary Fellow and Former AIAA President Fuhs Died in December 2021

Allen Fuhs died on 20 December 2021, at the age of 94.

Dr. Fuhs was a graduate of the University of New Mexico, where he received his degree in Mechanical Engineering. After serving in the U.S. Navy during the Korean Conflict, he earned M.S. and Ph.D. degrees in Mechanical Engineering from the California Institute of Technology.

After serving as Chief Scientist at the Aero-Propulsion Laboratory at Wright-Patterson Air Force Base, Dr. Fuhs began a 21-year career at the Naval Postgraduate School (NPS). He chaired both the Aeronautics and Mechanical Engineering departments, becoming Distinguished Professor Emeritus before he retired. His research interests ranged from rarefied gas dynamics for reentry vehicles to anti-prism geometries in structures.

Dr. Fuhs was the first chairman of the Space Systems Academic Group at the NPS, and designed the curriculum. He taught courses in high-energy lasers, aircraft design, missile configuration and design, and spacecraft design. He also served as chief scientist of Orbital Sciences Corporation from 1987 to 1990.

He served on the Space Policy Advisory Board for the National Space Council during the George H.W. Bush administration and also served on Vice President Dan Quayle's Space Policy Advisory Board and on the Advisory Committee for the House Committee on Science, Space, and Technology.

During his long involvement with AIAA, he served as AIAA President (1986–1987), was editor-in-chief of the AIAA *Journal of Aircraft* (1974–1979), Vice President, Publications (1979–1981), Editor of the AIAA Progress in Astronautics and Aeronautics book series (1998–2001), and served on several technical committees.

Fuhs was named AIAA Honorary Fellow in 2013 for his outstanding contributions in the field of aeronautics. Over his career, he authored 120 technical articles and wrote over a dozen books ranging from magnetohydrodynamics, fluid dynamics, to hybrid vehicles. He was also a Fellow of the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the British Interplanetary Society. In 1990 he received the U.S. Navy Distinguished Civilian Service Award for his work at the Naval Postgraduate School.

AIAA Fellow DeJarnette Died in May

Fred DeJarnette died 2 May. He was 88 years old.

Dr. DeJarnette's fascination with airplanes and physics led him to the engineering school at Georgia Tech where he earned his Bachelor's and Master's degrees in Aerospace Engineering. After serving in the U.S. Army, he earned his Ph.D (1965) in Aerospace Engineering from Virginia Tech, where he received the Sporn Award for excellence in teaching. Dr. DeJarnette also served as interim head of the Aerospace Department at Virginia Tech and worked at NASA Langley Research Center.

In 1970, he joined the faculty at North Carolina State University's Department of Mechanical and Aerospace Engineering. He taught there for 45 years until 2012 and was department head from 1993 to 2000, and then Professor Emeritus.

Through his experimental and theoretical research, Dr. DeJarnette made important contributions to the design of the Space Shuttle *Columbia* and contributed to projects that were instrumental in the design of hypersonic planes able to travel from the East Coast of the United States to Tokyo in four hours. As director of Mars Mission Research Center at North Carolina State University and North Carolina A&T State University, he guided research funded by NASA. The research pioneered by Dr. DeJarnette and other brilliant engineers and the research center has greatly contributed to mankind's efforts to reach Mars.

At NC State, Dr. DeJarnette developed new courses and supervised graduate research, assisting many former students in rising to high-level positions in the government and in the engineering industry. To honor his outstanding accomplishments and contributions to science, engineering and education, Dr. DeJarnette was awarded the 1990 Oliver Max Gardner Award.

Dr. DeJarnette was an AIAA Fellow and winner of the 1995 AIAA Thermophysics Award. He also served on the AIAA Committee on Higher Education (1996–2021) and the AIAA Thermophysics Technical Committee (2000–2003). Additionally, he was a member of the Society Automotive Engineering. Dr. DeJarnette's technical contributions to the fields of computational fluid dynamics and heat transfer are well known and still in use today throughout the aerospace engineering industry.

Nominations for AIAA Election Being Accepted Through 8 July 2022

The Institute is currently seeking nominations for the following positions.

AIAA President-Elect Nominations

The AIAA Executive Nominating Committee (ENC) will compile a list of potential nominees for the position of AIAA President-Elect. This list will include nominees who will be selected to go to the next step of competency review and interview held by the nominating committee. The ENC will select specific candidates for the position who will be voted on by the AIAA membership. The final slate of candidates will be publicized by December 2022 for the election that will be held January 2023.

To nominate an AIAA member in good standing for AIAA President-Elect, please submit the nominee's bio and/or CV, history of AIAA activities and/or engagement with other professional societies, and a statement from the nominee of willingness and ability to serve if elected.

AIAA Board of Trustees – Members-at-Large Nominations

The AIAA Executive Nominating Committee (ENC) will compile a list of potential nominees for the Board of Trustees – Members-at-Large. The list will include nominees who will be selected to go to the next step of competency review and interview held by the nominating committee. The ENC will select specific candidates for the Institute's Board of Trustees – Members-at-Large in November 2022. The Board of Trustees – Members-at-Large will be elected by the Council of Directors in March 2023 and announced soon thereafter.

The skills and competencies being sought for the Board of Trustees are:

- **Vision:** Persons who have the ability to understand present states, clearly define what they should be in the future, and identify steps to achieve those ends.
- **Diverse Business Acumen:** Persons who have the knowledge and understanding of the financial, accounting, marketing, communications, human resources, policy, and operational functions of an organization as well as the ability to make good judgments and quick decisions.
- **Domestic and International Aerospace Knowledge and Experience:** Board membership reflects: a) the breadth of the various major sectors of aerospace both domestic and international; b) all levels of technology and systems development from basic research through all technology readiness levels to product development and deployment; and c) from different disciplines within aerospace.
- **Leadership/Strategy/Execution:** Persons who have the ability to create a shared vision, obtain participation and buy-in, and achieve successful results.
- **AIAA Leadership and Participation:** Board membership reflects experience in successful participation in a wide variety of leadership positions within AIAA, as well as knowledge of the governance model.
- **Experience in Adjacent Aerospace Areas**: As the Institute broadens its reach beyond the traditional "Breguet Equation" disciplines, Board members who have experience and strategic perspectives in these adjacent areas will broaden the Board's view on new and emerging areas.
- **Young Member Knowledge and Experience:** As the Institute evolves, it is important that Board members have knowledge and understanding of issues relevant to young members in the aerospace industry.
- **Experience with Organizational Growth**: Persons with experience in significantly growing organizations will serve as a resource to the Board as the Institute seeks to grow.
- **Experience with Change or Transition Management**: Board members with prior experience in organizational change or transition will serve as a vital resource to the Board as it seeks to execute its role.
- **Demographic Diversity**: In addition to reflecting the membership's diversity in the industry and volunteer involvement, it is important that the new Board membership be seen as reflecting demographic diversity (e.g., gender, ethnicity, age, etc.) as well.

AIAA members may nominate qualified individuals for the AIAA Board of Trustees – Member-at-Large positions by submitting a nomination package of not more than three pages consisting of:

- Nominee's Bio and/or CV and history of AIAA activities and/or engagement with other professional societies
- Statement from the nominee addressing how he/she meets the sought competencies
- Statement from the nominee of willingness and ability to serve if elected

AIAA Division Chiefs Nominations

Nominations are being accepted for Chief of the Regional Engagement Activities Division (READ) and Chief of the Technical Activities Division (TAD). The AIAA Council of Directors Nominating Committee (CNC) will compile a list of potential nominees for these two open Division Chief positions on the AIAA Council of Directors who will go to the next step of competency review and interview held by the CNC. The CNC will select specific candidates for the two open Chief positions that will be voted on by the division's membership. The final slate of candidates will be publicized by December 2022 for the election that will be held January 2023.

Chief of the Regional Engagement Activities Division (READ)

Regions coordinate the activities of geographically related sections to facilitate cooperative efforts between the various geographical areas. The Regional Engagement Activities Division (READ) is composed of the Regional Directors. The Chief of the READ will lead the division and shall be elected by a simple majority vote of the Regional Directors. The Chief will not be a current Regional Director; however, the Chief must have served as a Regional Director in the past. The term of the Chief shall be three years and there shall be a limit of the Chief serving one consecutive term.

Please go to AIAA Nominations and Elections (aiaa.org/about/Governance/nominations-and-elections) to learn more and submit nominations no later than 8 July 2022, 1800 hrs ET.

Chief of the Technical Activities Division (TAD)

Technical Groups coordinate the activities of related Technical Committees to facilitate cooperative efforts between the various technical disciplines. The Technical Activities Division (TAD) is composed of the Technical Group Directors. The Chief of the TAD will lead the division and shall be elected by simple majority of the votes cast by the Technical Directors and Division committees. The Chief will not be a current Technical Group Director; however, the Chief must have served as a Technical Group Director in the past. The term of the Chief shall be three years and there shall be a limit of the Chief serving one consecutive term.

A full listing of Division Chief responsibilities, can be found at aiaa.org/about/Governance/nominations-and-elections.

AIAA Directors Nominations

The AIAA Council of Directors Nominating Committee (CNC) will compile a list of potential nominees for the open Director positions on the AIAA Council of Directors. This list will include nominees who will be selected to go to the next step of competency review held by the nominating committee. The nominating committee will select specific candidates for the open Director positions who will be voted on by the AIAA membership. The final slate of candidates will be publicized by December 2022 for the election that will be held January 2023.

Nominations are being accepted for Regional Directors, Integration and Outreach Group Directors, and Technical Group Directors for the term May 2023–May 2026. AIAA members may self-nominate or nominate members qualified for the open position.

Regions coordinate the activities of geographically-related sections to facilitate cooperative efforts between the various geographical areas. A Regional Director shall lead each region. Nominations are being accepted for:

- Region I – North East, Director
- Region II – South East, Director
- Region VII – International, Director

For more information on AIAA regions and sections, visit aiaa.org/get-involved/regions-sections.

Integration and Outreach Groups coordinate the activities of related Integration and Outreach Committees to facilitate cooperative efforts between the various professional areas. Nominations are being accepted for:

- Business and Management Group, Director
- International Activities Group, Director
- Young Professionals Group, Director-Elect

For more information on AIAA integration and outreach, visit aiaa.org/get-involved/committees-groups/Integration-and-Outreach-Division-Committees.

Technical Groups coordinate the activities of related technical committees to facilitate cooperative efforts between the various technical disciplines. Nominations are being accepted for:

- Aircraft Technology, Integration and Operations Group, Director
- Space and Missiles Group, Director

For more information on AIAA technical activities, visit aiaa.org/get-involved/committees-groups/technical-committees.

JAHNIVERSE

CONTINUED FROM PAGE 64

Some of those academics who make it into the TED fellowship program — which effectively covers the cost of getting selectees to give a talk on the big TED stage in Vancouver — do so as non-tenured faculty. Over time, they may come to recognize that, in some ways, the exposure their ideas get by virtue of them being fellows opens clearer paths to making their ideas reality compared to becoming tenured members of universities, where impact is evaluated myopically on publication records and grants. Getting tenured at a top-tier research university means that you've been evaluated for your ability to bring in external funds to support your research program of at least several hundred thousands of dollars per year, you maintain a peer-reviewed publication record of several articles per year, are graduating students with Ph.D.s, and the students you teach don't believe you suck at it. None of that is about collaborative and transformational work that measurably improves the human condition. Therefore, academic TED fellows are left with the challenge of meeting their metrics for tenure while remaining true to the very cause or issue that got them accepted as TED fellows. Some will choose to leave academia for this reason, too.

Others don't want to abandon their inner clarion call of working among and for the people in favor of answering to the ivory tower, meaning the school bureaucracy. Those TED fellows that become tenured tend to still feel constrained because the money they can bring into academia is at odds with how it gets spent. For instance, getting funds that can only be used on basic research cuts off progress when the results could be furthered into applied research and ultimately productization.

To be sure, there are TED fellows who are successful academics, and I'll put my name in that category for now, but I have wondered if I do have a long-term home in academia because I don't see many other faculty as eclectic as myself, with a focus on both technical and public writing. I know other TED fellows that have left or are seriously considering leaving academia because their passion can't be fully expressed and nurtured.

I believe that research universities should have dedicated efforts to find ways to help their TED fellow misfits to have a welcoming and nurturing home within academia. Universities writ large and their students would benefit as a consequence. ★

LOOKING BACK

COMPILED BY FRANK H. WINTER and ROBERT VAN DER LINDEN

1922

June 12 U.S. Army Air Service Capt. A.W. Stevens jumps from a supercharged Martin bomber flying 24,206 feet over McCook Field in Ohio, setting the record for highest parachute jump from an aircraft. Stevens carries an oxygen flask with him for his descent. Eugene M. Emme, ed., **Aeronautics and Astronautics 1915-60**, p. 15.

June 12 Smithsonian Institution scientists use U.S. Navy seaplanes to conduct mollusk research over Florida waters. The project is completed in a few days but would have taken a year by conventional means. Eugene M. Emme, ed., **Aeronautics and Astronautics 1915-60**, p. 15.

June 16 Henry Berliner makes the first controlled horizontal helicopter flight in the U.S. in College Park, Maryland. By July 16, it lifts 12 feet and hovers. Eugene M. Emme, ed., **Aeronautics and Astronautics 1915-60**, p. 15.

1947

June 5 A New York University team conducts the first U.S. Army Air Force research balloon launch under a contract with Air Materiel Command, releasing a cluster of rubber balloons from what is now called Holloman Air Force Base in New Mexico. E. Emme, ed., **Aeronautics and Astronautics, 1915-60**, p. 57.

June 8 American Airlines begins coast-to-coast service between New York and Los Angeles, with a single stop at Chicago. The total elapsed time for each flight with Douglas DC-6s is about 10 hours. F.K. Mason and M. Windrow, **Know Aviation**, p. 52.

1 **June 18** A Lockheed Constellation operated by Pan American World Airways arrives at London Airport from New York, the first leg of the airline's inaugural around-the-world passenger flight. The aircraft, dubbed "Clipper America," carries a party of leading U.S. publishers who are guests of the British prime minister. The flight totals 35,000 kilometers and lasts 93 hours when it ends in San Francisco. **The Aeroplane**, June 27, 1947, p. 692; R.E.G. Davies, **Airlines of the United States**, p. 369.

2 **June 19** A Lockheed P-80R Shooting Star aircraft flown by U.S. Army Air Force chief test pilot Col. Albert Boyd sets the world speed record. The aircraft's General Electric J-33 engine accelerates it to 623.9 mph. Eugene Emme, ed., **Aeronautics and Astronautics, 1915-60**, p. 57.

June 28 The Rocket Research Institute flies the first postwar U.S. civilian rocket mail. Two 15-foot rockets are launched from Winterhaven, California, across the Colorado River to Yuma, Arizona, but one explodes and its payload of 350 envelopes is lost. The other lands after a 1.6-kilometer flight, and its 300 covers are retrieved and canceled by the Yuma postmaster. Two previous postwar mail rocket flights used captured German V-2 military rockets. J. Ellington and P. Zwisler, **Ellington Zwisler Rocket Mail Catalog, 1904-1967,** pp. 218-219.

June 30 The Avions Tipsy junior ultralight aircraft, claimed as the first postwar plane completely designed and constructed in Belgium, makes its first flight at Gosselies. Designed as the cheapest means for student pilots to gain flying time, it weighs 220 kilometers empty, has a wingspan of 6.9 meters and can reach a top speed of 174 mph. **The Aeroplane**, July 18, 1947, p. 66.

1972

June 2 NASA U-2 reconnaissance aircraft on loan to the Virginia Institute of Marine Science will begin a 45-day study of the Chesapeake Bay area to acquire evidence of the path of Hurricane Agnes. Onboard cameras with high-resolution lenses will photograph the bay and the adjacent continental shelf from an altitude of 60,000 feet to trace the flow of fresh water dumped over the Chesapeake basin by the storm. **Washington Post**, June 7, 1972, B2.

June 13 An Atlas-Centaur D launches the Intelsat-IV F-5 communications satellite from Cape Canaveral, Florida. The 1,387-kilogram satellite has 12 C-band transponders and is capable of multiple-access and simultaneous communications. The satellite's first major transmission is to be coverage of the Olympic Games in Munich in August. N**ASA Release** 72-119.

3 **June 18** Aeronautical engineer John Stack, who helped develop the first U.S. high-speed wind tunnel in the 1930s, dies at age 65. He joined the Langley Memorial Aeronautical Laboratory (predecessor of NASA's Langley Research Center) in 1928 and later led the laboratory's high-velocity airflow research. After the creation of NASA, Stack was the agency's first director of aeronautical research from 1961 to 1962, then was vice president for engineering at Fairchild Industries until his retirement in 1971. He received numerous awards for his work in supersonic technology, including the Robert J. Collier Trophy in 1947 for his contributions to the design of the Bell X-1 rocket research aircraft, the first to exceed the speed of sound in level flight. **New York Times**, June 20, 1972, p. 28.

June 18-July 30 The University of Texas Institute of Texan Cultures in San Antonio hosts an exhibit of kinetic art by Frank J. Malina, aeronautical engineer and past director of the Jet Propulsion Laboratory, that reflects the "impact of science, technology and the exploration of space on the world." Malina's work in rocketry in the mid-1930s while studying at Caltech led to his helping establish the Jet Propulsion Laboratory and Aerojet Engineering Corp., later called Aerojet-General. He later moved to France and began a new career as an artist. NASA, **Astronautics and Aeronautics, 1972**, p. 233.

June 23 The Apollo Telescope Mount is shipped from NASA's Marshall Space Flight Center in Alabama to the Johnson Space Center in Texas, where it will undergo alignment tests. Designed as a crewed solar observatory that includes eight major observational instruments along with several lesser experiments, the ATM is launched on the Skylab Orbital Workshop in 1973 to study the sun over long durations. **MSFC Release** 72-77.

4 **June 23** The Northrop F-5E international fighter aircraft is unveiled in a ceremony at Northrop's plant at Hawthorne, California. Powered by two GE J-85-21 engines, the aircraft will be available to all U.S. allies through the Military Assistance Service program aimed at providing effective low-cost fighters to American allies. The F-5E has greater maneuverability, speed, payload and range than the F-5 variant, plus a new fire control system that includes search-and-track radar. **Air Force Systems Command Newsreview**, August 1972, p. 1.

June 28 The Institute of Navigation presents its Thomas L. Thurlow Award to John P. Mayer, chief of the mission planning and analysis division at what is now called NASA's Johnson Space Center, for his leadership in all phases of navigation from NASA's Project Mercury missions through the Apollo lunar landings. **Aviation Week**, July 10, 1972, p. 9.

June 29 The Soviet Union launches its Prognoz 2 research satellite from Baikonur into a highly elliptical orbit to continue research on solar activity and its influence on interplanetary

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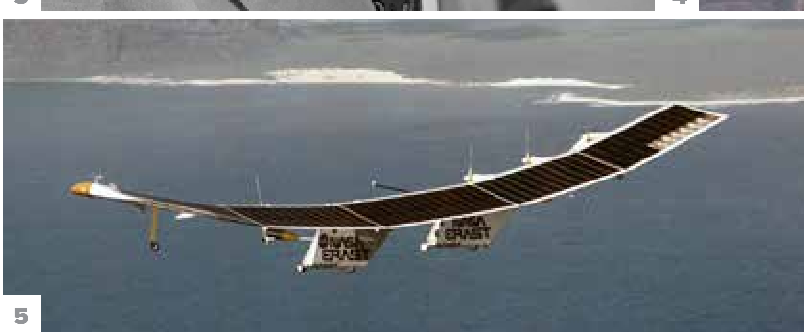

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space and Earth's magnetosphere. Among other instruments, the satellite carries French equipment to study solar wind, the outer reaches of the magnetosphere and gamma rays from the sun. NASA, **Astronautics and Aeronautics, 1972**, p. 242.

June 29 Cuban Premier Fidel Castro and Soviet Union Communist Party leader Leonid I. Brezhnev visit the Yuri Gagarin Cosmonaut Training Center near Moscow. Castro places flowers on a monument to Gagarin, who in 1961 became the first human to go to space. The visitors are also shown a model of the automatic linking of a Salyut space station. NASA, **Astronautics and Aeronautics, 1972**, p. 243.

June 30 The Soviet Union launches three satellites: Cosmos 497 is to be a radar target for anti-ballistic missile tests; Intercosmos 7 carries equipment from Czechoslovakia, East Germany and the Soviet Union to study ultraviolet and X-ray radiation; and Meteor 12 is a weather satellite for "swift forecasting." NASA, **Astronautics and Aeronautics, 1972**, p. 243.

1997

5 **June 9** NASA's Pathfinder solar-powered, remotely piloted research aircraft sets an altitude record for its type, reaching 71,500 feet while flying above the U.S. Navy's Pacific Missile Range in Kauai, Hawaii. Prime contractor AeroVironment was founded by Paul MacCready, creator of the Gossamer Condor, the first successful human-powered aircraft. NASA, **Astronautics and Aeronautics: A Chronology**, p. 76.

6 **June 27** NASA's Near Earth Asteroid Rendezvous - Shoemarker spacecraft is maneuvered into a 25-minute flyby of the asteroid Mathilde. The photos taken from 1,200 kilometers above the surface are the closest encounter with an asteroid to date, though not part of NEAR's original mission. From Mathilde, NEAR's engines fire on July 3 to take the spacecraft back toward Earth, where it uses Earth's gravity to propel it toward its final destination, the asteroid Eros. **NASA Release**, 97-147; **Flight International**, Dec. 4-10, 1991, p. 16.

Why academia needs its TED misfits

BY MORIBA JAH | moriba@utexas.edu

Many researchers and professors who become TED fellows eventually face the difficult choice of whether to leave behind their academic positions to focus exclusively on making the nonprofit's mission of "fostering the spread of great ideas" a reality through their work.

Many will choose to leave academia to pursue measurably impactful work and support themselves through nonprofit fundraising or entrepreneurship. This trend is unfortunate for universities. When a TED fellow leaves, now there's one less person with a passion for change walking the halls, teaching classes and rubbing shoulders with the students who are our future.

The choice is also understandable. Academia rewards becoming a fellow of a technical or professional organization, but TED fellows tend to be considered entertainers by many faculty, and their work looked at pejoratively as lacking academic rigor, whatever that means. It's probably a perspective held, unshockingly, by the many who would never be selected as fellows for TED, short for Technology, Entertainment, and Design.

The fact is, earning that distinction is harder than getting a faculty job or being accepted into an undergraduate program at an Ivy League school. Three percent of doctorate holders will join the faculty of a university, which is not to say the rest tried. The most selective Ivy League schools have acceptance rates of 3% and 4%. Meanwhile, TED says that its fellows program receives "thousands" of applications from across humanity; only 20 people are selected each year, putting the acceptance rate at far under 1%. If you're an academic who is selected as a TED fellow, you are in an especially elite group because you are in the 3% of doctorate holders and also among the less than 1% of TED fellow applicants accepted.

TED fellows run the gamut from epidemiologists to artists to astrodynamicists and space environmentalists like me. My selection in 2019, the program's 10th year, marked the first time an aerospace engineer was selected into the fellowship. We are folks with ideas worth spreading who go beyond being to doing.

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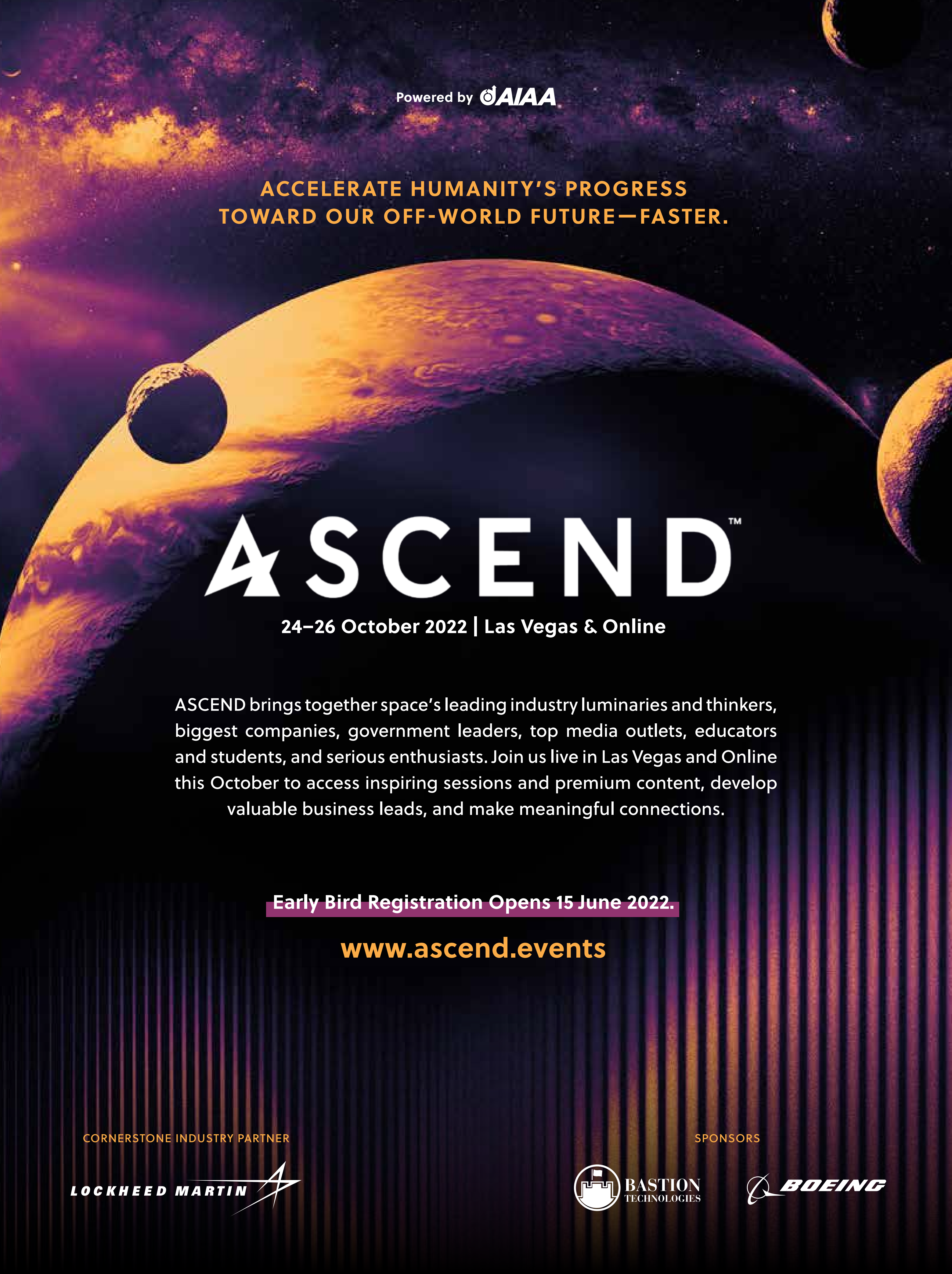
Moriba Jah is an astrodynamicist, space environmentalist and associate professor of aerospace engineering and engineering mechanics at the University of Texas at Austin. An AIAA fellow, he's also chief scientist of startup Privateer and hosts the monthly webcast "Moriba's Vox Populi" on SpaceWatch.global.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