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AVIATIONWEEK[↑]

& SPACE TECHNOLOGY

Robinson EVOLVES



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EXCLUSIVE



Canada Puts F-35
in the Crosshairs

Interview

GE Aerospace's
Larry Culp

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Grand Laureate
Winners 2025

THE SPACE REPORT

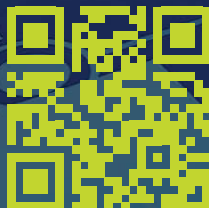
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Virgin Atlantic has switched to Joby Aviation from Vertical Aerospace to launch air taxi service in the UK.



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ON THE COVER

Robinson Helicopter Co.'s newly revealed R88 multimission rotorcraft represents a significant growth step beyond the company's four-seat R66 and is designed to undercut the operating costs of larger single- and twin-turbine-powered competitors. Our report on the R88 and other developments at this year's Verticon show by Senior Defense Editor Tony Osborne and Senior Editor Guy Norris begins on page 28. Robinson Helicopter photo.

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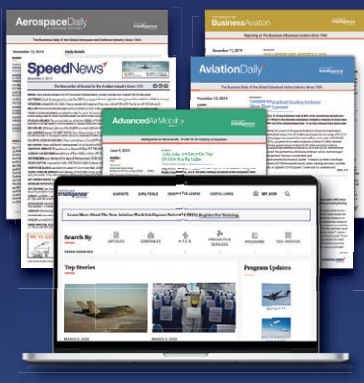
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NASA



DUST DEVILS

NASA's investigation of moondust is way overdue (*"NASA Faces the Promise and Peril of Moondust," Feb. 24-March 9, p. 52*), but if the U.S. is serious about sending humans to Mars, it should also be studying dust there. In my opinion, dust on Mars is a much more serious problem than moondust. The soil on Mars has 0.5-1.0% concentrations of calcium perchlorate and magnesium perchlorate, according to measurements made by the Phoenix Mars lander in 2008 and the Curiosity rover in 2023.

High and repeated exposure to perchlorates could affect the thyroid (causing decreased thyroid hormones), white blood cells, red blood cells and kidneys. Since they are oxidizers, perchlorates can be an explosive hazard as well.

Huge dust storms on Mars deposit dust on the solar cells that charge the batteries on rovers there. The individual dust particles are electrostatic and cling to everything, just like moondust. All Mars landers have been affected by dust, and the Opportunity rover was killed by a dust storm after operating for 14.5 years.

These dust storms occur most frequently during the southern hemisphere's spring and summer, when Mars is near perihelion. About every five years, a dust storm becomes global, and most of the surface of Mars cannot be seen from space at visible wavelengths. A global dust storm on Mars in November 1971 obscured nearly all surface features that Mariner 9 imaged from orbit.

There are also dust devils on Mars that can create small dust storms.

David Pitts, Houston

FARCICAL CREATURES

In his recent Viewpoint, "Airbus' Smoke and Mirrors" (*Feb. 24-March 9, p. 66*), William Todts states: "The first lesson is that industry's promises are not worth the paper they are written

on. Only regulation can achieve environmental goals." He goes on to cite electric cars, clean energy and chemical pollution as examples of regulatory "success."

The lesson of net-zero emissions is that regulation in a vacuum achieves only economic destruction when the realities of engineering, physics and economics weigh in. Regulators who think they can make the world as they wish it to be by burping up some writing on paper with no idea of how their dreams are to be achieved are the farcical creatures, not Airbus.

G. H. Schirtzinger, Hayden, Idaho



COMMUNIST MOON?

After reading "With Mars in Mind, Will Trump Put the Moon on the Back Burner?" (*Feb. 10-23, p. 56*), I thought of what then-President Lyndon Johnson said more than 60 years ago: "I do not believe that this generation of Americans is willing to resign itself to going to bed each night by the light of a Communist Moon."

Will Trump risk being the president who surrenders the Moon to China?

Richard Macey, Pendle Hill, Australia

ON AVIATIONWEEK.COM, in response to "U.S. Airpower Debate Opened by NGAD Hiatus Nears Resolution" (*Feb. 24-March 9, p. 30*), **JULIOJJIMENEZ23** writes:

Expecting that digital tools would significantly lower the cost of very complex aircraft is total nonsense at best.

AND PAUL.SIMADAS comments:

The development of the Ghost Bat collaborative combat aircraft by the Royal Australian Air Force, in collabo-

ration with Boeing, provides an affordable option to force-multiply the Australian fleet of Lockheed Martin F-35s (and Boeing EA-18G Growlers) in operational missions in the Indo-Pacific theater. It's less ambitious than what is covered in this report but shows how middle powers could also employ "teaming" concepts for crewed aircraft/collaborative combat aircraft missions.

The mission sets for the Ghost Bat are not clear. It will not be an exquisite aircraft—that would be too expensive to field in numbers. It is likely to encompass intelligence, surveillance and reconnaissance and decoy but not lethal strike.

Hope to see and learn more at the Avalon 2025 airshow in March.

AND "Hypersonic Ammo Could Increase Lethality of Gunships and Helicopters" (Feb. 24-March 9, p. 34) garnered comments on AviationWeek.com from **MSAROFF3**:

I've always thought that some sort of combustible sabot would be the solution for aircraft use.



U.S. AIR FORCE

AS WELL AS from **KURT**:

Oh, gosh, 1-2 mi. per second? That's incredible, but you would need to deal with recoil. Yes, having rocket propellant fire can cut that down. I wonder if the lead computers can be programmed to deal with it, as in some situations you might still need a minuscule lead to hit the target. If the electronics aren't up to the task, things might not turn out so well. Hope the engineers (who are likely much smarter than me) take that into consideration.

Address letters to the Editor-in-Chief, *Aviation Week & Space Technology*, 2121 K Street, NW, Suite 210, Washington, DC, 20037 or send via email to: awstletters@aviationweek.com Letters may be edited for length and clarity; a verifiable address and daytime telephone number are required.



Manuel Escalante has been promoted at *Indra* to chief technology officer from managing director of defense and security, succeeding Miguel Angel Morell. Before

Indra, Escalante was general manager of the Spanish National Cybersecurity Institute and director of business development at S21Sec Thales.

Relativity Space has tapped **Eric Schmidt** as CEO, succeeding co-founder Tim Ellis. Currently the chairman of the Special Competitive Studies Project think tank, Schmidt was CEO of Google in 2001-11 and executive chairman in 2011-17.

Donatas Dockus has been appointed as CEO of *Wright International*, a Canadian subsidiary of Vilnius, Lithuania-based maintenance, repair and overhaul provider FL Technics. He was commercial director of the company's wheels and brakes division and before that was CEO of its Chinese subsidiary, FL ARI.

The *Latin American and Caribbean Air Transport Association* has named **Peter Cerda** executive director and CEO, succeeding Jose Ricardo Botelho. Cerda remains regional vice president for the Americas at the International Air Transport Association, where he has worked for almost 20 years.

Dennis Woodfork

has been promoted at the *Johns Hopkins Applied Physics Laboratory* to mission area executive for national security space from deputy mission area executive. He has worked with the laboratory since 2016, specializing in military space, before which he was assistant division technology chief at NASA Goddard Space Flight Center.

Paris airports operator *Groupe ADP* has announced a slate of promotions.

Philippe Pascal has been confirmed as CEO, succeeding Augustin de Romanet. He was deputy executive officer for finance, strategy and administration, a role he leaves to **Christelle de Robillard**.

Justine Coutard has been promoted to deputy CEO from managing director of Paris-Orly Airport. **Laurence Faure** succeeds her in the latter role, moving

up from technical and baggage manager at the airport.

Patty Chiang-Chien has been appointed vice president and chief engineer of space, intelligence and weapon systems at *Boeing Defense, Space and Security*. She was vice president and general manager of Boeing Research & Technology. Before joining Boeing, she worked for more than 20 years at Northrop Grumman.

Terran Orbital has hired **Richard Ullman** as senior vice president of finance and business operations. He was senior director of finance and division chief financial officer for Boeing Space Mission Systems and before that held financial leadership positions in other Boeing units.

Pascal Lee has been named vice president for planetary development at the *National Space Society*, where he is a longtime member. He is also a planetary scientist at NASA Ames Research Center and the SETI Institute.

National security and aerospace private equity investment company *AE Industrial Partners* has hired **Andrew Boyd** as an operating partner. Boyd is a board member at CASE and REDLattice, which are AE Industrial Partners portfolio companies. He also is a contributor at CBS News and was an adjunct professor at the Johns Hopkins University School of Advanced International Studies. Before that, he worked for more than a decade at the CIA, ultimately becoming director of the agency's Center for Cyber Intelligence.

Gulfstream Aerospace has appointed **Courtney Valentine** senior vice president and general counsel. She was assistant general counsel and director at parent company General Dynamics, and before that she worked at Gulfstream as chief anticorruption compliance officer.



JetBlue has hired **Josh Weiss** as vice president of technology products and promoted **Steve Olson** to head of system operations and airports from vice president of system operations. Weiss was vice president of guest digital products at IHG Hotels & Resorts and before that worked at Hilton Hotels & Resorts and Delta Air Lines. Before joining JetBlue, Olson worked at American Airlines and U.S. Airways prior to its acquisition by American.

Amber McIntyre has joined the *Aero-space Industries Association* as senior director of civil space. She was director of international space policy on the National Space Policy Council and before that was counselor for inter-agency and international relations at NASA.

StandardAero has appointed **Derek Kerr** to its board of directors. Before his retirement, he was vice chair at American Airlines and president of its American Eagle regional carrier brand, and previous to that he was the carrier's chief financial officer. Kerr also served as chief financial officer at America West Airlines and U.S. Airways.

Rob Mionis has joined the board of directors at *Textron*. He is president and CEO of electronic manufacturing services company Celestica. Before that, he worked in private equity at Pamplona Capital Management and was president and CEO of StandardAero.

Sustainable electric vertical-takeoff-and-landing aircraft developer *Vertical Aerospace* has tapped **Eamonn Brennan** as an advisor to the board. He also is a nonexecutive director at Ryanair and board member at ANRA Technologies, was director general of Eurocontrol in 2018-22 and before that was chief executive of the Irish Aviation Authority. ✈



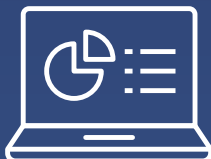
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FIRST TAKE

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JOBY AVIATION

VERTICAL FLIGHT

Joby Aviation has partnered with Virgin Atlantic to launch electric vertical-takeoff-and-landing

(eVTOL) air taxi service in the UK, an extension of its U.S. plans with Delta Air Lines, which holds 49% of the carrier.

Chinese automotive supplier Wanfeng has acquired German eVTOL startup Volocopter from insolvency for \$11 million via its Austrian subsidiary, Diamond Aircraft (page 36).

Robinson Helicopters unveiled the eight-seat R88, upgrades to the R66 and plans to triple production to 1,000 light helicopters annually, at the Verticon show in Dallas on March 10-13 (page 28).

Leonardo Helicopters has resumed flight tests of its AW09 single-engine light helicopter after suspending trials due to nonconforming parts.

DEFENSE

Canada's new prime minister will consider alternatives to the Lockheed Martin F-35A as a national backlash grows against U.S. President Donald Trump's trade war and threats to Canadian sovereignty (page 16).

Leonardo is preparing to spin up local assembly of rotorcraft in Algeria after securing an order for seven AW139s from the country's military.

Russia is looking to extend the service life of Antonov An-26 military transports by a decade to 60 years as Western sanctions prevent imports of alternatives.

The U.S. Air Force is seeking turbopfan concepts in the 35,000-50,000-lb.-thrust range for potential Boeing C-17 reengining and to power a commercial-derivative blended wing body transport-tanker.

Kratos Defense broke ground March 18 on a new facility in Crane, Indiana, to

support its work on the U.S. Navy and Missile Defense Agency's Multi-Service Advanced Capabilities Hypersonic Testbed program.

Denmark says its F-35As will take on air-defense roles starting April 1, gradually replacing the Lockheed Martin F-16s that perform the mission now.

The U.S. Defense Innovation Unit has awarded four Artemis project contracts to develop cheap, long-range, one-way uncrewed aircraft.

COMMERCIAL AVIATION

The FAA is permanently restricting non-essential helicopter flights near Ronald Reagan Washington National Airport after the January fatal midair collision of an American Eagle Bombardier/MHI RJ Aviation CRJ700 and a U.S. Army Sikorsky UH-60L (page 41).

South Korean investigators have said a battery power bank in an overhead bin was the most likely cause of the Jan. 28 fire on an Air Busan Airbus A321.

The engine of an American Airlines Boeing 737-800 caught fire while taxiing to the gate at Denver International Airport March 13 after diverting due to high engine vibration.

U.S. low-cost carrier Spirit Airlines has emerged from Chapter 11 restructuring, having reduced its debt by approximately \$795 million.

Southwest Airlines is to end its "bags fly free" policy, a perk that helped differentiate the brand from competitors for decades.

Jackson Square Aviation has placed a firm order for 50 Airbus A320neos, marking the lessor's first direct purchase from the airframer.

China's Yitong UAV System has flown the TP1000 uncrewed cargo aircraft, designed to carry a 1,000-kg (2,200-lb.) payload 1,000 km (620 mi.).

UK-based Straightline Aviation has placed a \$50 million order for the first

VIEW FROM THE FLORIDA GULF COAST

Crew-9 Returns



The SpaceX Crew-9 Dragon capsule carrying three NASA astronauts and a Russian cosmonaut—including the Boeing CST-100 Starliner extended Crew Flight Test (CFT) mission's Barry "Butch" Wilmore and Sunita "Suni" Williams—splashed down at 5:57 p.m. EDT March 18 in the Gulf of Mexico off the Florida coast, where they were greeted by a pod of dolphins.

It marked the end of a 286-day mission for Wilmore and Williams, whose anticipated eight-day CFT launched on June 5, 2024, to certify the Starliner for regularly scheduled crew transportation to and from the International Space Station (ISS). Safety concerns about the spacecraft's propulsion system issues prompted NASA to return the capsule uncrewed, and Wilmore and Williams joined the ISS crew.

Williams, Wilmore, Nick Hague and Aleksandr Gorbunov were replaced as members of ISS Expedition 72 after the March 14 launch and docking of the Crew-10 Dragon with NASA astronauts Anne McClain and Nichole Ayers, Japan Aerospace Exploration Agency astronaut Takuya Onishi and Roscosmos cosmonaut Kirill Peskov.

NASA

UP FRONT

KEVIN MICHAELS



THE TRUMP ADMINISTRATION HAS shocked and unsettled the aerospace industry with its plans for five significant tariffs.

Two target aluminum and steel, while three target the U.S.' largest trading partners: Canada, Mexico and China. On March 7, the administration announced a temporary pause on most Canadian and Mexican tariffs that had begun three days before, while the aluminum, steel and China tariffs will move forward. What are the potential costs of these taxes, and who will pay?

Tariff Whiplash

Aerospace confronts uncertainty and up to \$5 billion in taxes

Aluminum is the most popular material in aerospace. Most aerospace alloy in the U.S. comes from domestic mills, but most of the pure aluminum purchased by mills comes from foreign smelters—particularly in Quebec. Aluminum tariffs will cost a minimum of \$500 million and possibly much more if downstream products are included. Aircraft OEMs, aerostructures suppliers and fragile subtier suppliers will be the main bill-payers. U.S. mills might have to eat part of the increase.

The story is much the same in steel. Aerospace's second most popular material is used all over aircraft, and the cost to the supply chain will be lower—an estimated \$50 million—since most is domestically produced. It is not clear which derivative aerospace products (e.g., forgings, castings and extrusions) will be included.

This takes us to the three country-oriented tariffs. The least impactful is China, for which tariffs were increased to 20% from 10%. Its factories export just over \$2 billion worth of aerospace products to the U.S., amounting to about \$200 million in new taxes, mostly on metallic parts and aerostructures. Many of these factories are owned by U.S. and European OEMs, which will drive up their costs. But the larger risk is retaliation against Boeing in jetliners.

About \$8 billion worth of aerospace products are imported from hundreds of factories in Mexico owned by U.S. OEMs and suppliers that make labor-intensive intermediate goods there to remain competitive. The baseline cost of the Mexican taxes is \$2 billion, assum-

ing parts cross the border once. The true cost will be markedly higher because many parts cross the border several times; for example, a steel gear machined in Mexico might travel to California for heat treatment then back to Mexico for integration into a gearbox before heading to a U.S. customer. In this scenario, the gear could be taxed twice.

Finally, there is Canada, whose aerospace exports to the U.S. total roughly \$10 billion. Most of these are finished goods, and about half are Bombardier business jets purchased by U.S. customers. Other notable exports include Pratt & Whitney Canada engines and auxiliary power units and CAE simulators, aerostructures and landing gear, including components used on U.S. military aircraft, such as the Lockheed Martin F-35. Not factored in this potential \$2.5 billion tax is the impact on maintenance, repair and overhaul. The risk of retaliation is very high. How long will it be before Canada imposes a tariff on U.S. business jets to level the playing field or cancels the more than \$20 billion in orders for the F-35 and Boeing P-8?

In aggregate, the five tariffs would add up to \$5.3 billion in taxes, most of which would be borne by OEMs and suppliers, as their capacity to pass on costs to customers is low. On top of this are the indirect costs of complying with tariffs. Meanwhile, many capital allocation and strategic decisions are frozen until some certainty is gained.

The Trump administration appears to have a thin understanding of how complex B2B supply chains function. Its recommendation to move aerospace operations to the U.S. would take years, given the high certification requirements, and it is unclear where the labor would be found. The U.S. needs Mexican labor and Canadian expertise to maintain its competitive edge in aerospace and defense, where it has the second-largest trade surplus—a stag-

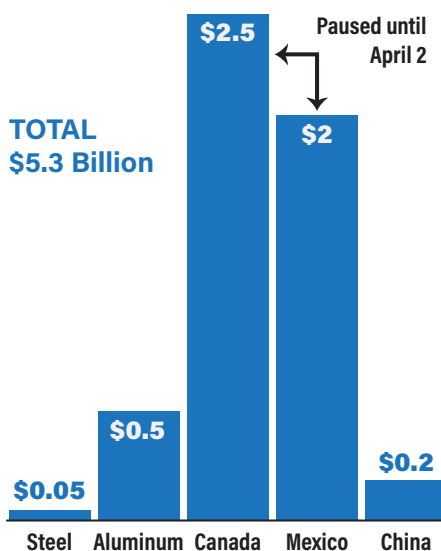
gering \$114 billion—of any industry. The implications of the tariff whipsaw are too long to list, but the biggest could be the wasteful activity needed for tariff compliance throughout the supply chain.

It is time for our leaders and industry associations—some of which are primarily focused on currying favor with the new administration—to elevate their advocacy against these dangerous policies before it is too late. ☞

Contributing columnist Kevin Michaels is managing director of AeroDynamic Advisory in Ann Arbor, Michigan.

U.S. Aerospace Industry Annual Cost of Tariffs*

(U.S. \$ Billions)



*Based on single border crossing; true cost is higher.

Source: AeroDynamic Advisory



GOING CONCERNS MICHAEL BRUNO

MEAT IS BACK ON THE MENU IN

the aerospace and defense supply chain. While far from perfect, a key theme coming out of industry events and the latest earnings reports in the first two months of 2025 is that the supply chain is finally on the mend from its COVID-19 pandemic disruption.

"Fourth-quarter 2024 calls marked the first time in a while that management teams sounded bullish about supply chain performance," Melius Research analyst Scott Mikus said in February. "Boeing noted improving performance from Spirit AeroSystems in delivering 737 fuselages, and Lockheed Martin even stated that some parts of its supply chain are now performing better than they were pre-COVID."

Boeing and Lockheed are hardly the only big names to report improvements in their aggregate supply chains. Although they admittedly still play whack-a-mole trying to tamp down individual issues, industry leaders do see overall improvements.

"From the first half to the second half of 2024, we did a meaningful improvement as material inputs increased 26% across our priority supplier sites," GE Aerospace Chairman and CEO Larry Culp told investors and analysts.

"At Raytheon, we've seen the seventh quarter in a row of material receipt growth, so happy about that," RTX CEO and soon-to-be Chairman Chris Calio told Wall Street about his conglomerate defense division.

"The supply chain is now performing much better to schedule," General Dynamics Chairman and CEO Phebe Novakovic said about Gulfstream. "Even though we continue to be surprised by some quality escapes, the time it takes to identify and fix these faults has significantly improved."

The optimistic sentiment continued at the Pacific Northwest Aerospace Alliance's (PNAA) annual Advance conference in Seattle, a key supply chain gathering in February. "I think, overall, the supply chain is in better shape than it was last year at this time," keynote speaker and AeroDynamic Advisory Managing Director Kevin Michaels said. "It's in better shape now than it was two years ago, but it's still incredibly fragile."

Therein lies the rub. Even with widespread recognition that the supply chain is generally improving, there are no proclamations that suppliers are healthy and robust. In his speech, Michaels led the PNAA audience on a proverbial tour around industry, noting carnage among business models in the last 20 years.

"Aerostructures—this is a slightly controversial way

to phrase it—but I think the Tier 1 suppliers are a failed market," Michaels said. Since Spirit AeroSystems is in the middle of being broken up and sold to Airbus and Boeing, and Triumph Group's sale to private equity investors was announced the day before the Advance conference, Michaels fingered OEM supply chain squeeze programs as the reason no one else wants to be in the business.

Of course, aerostructures is not the only corner of aerospace manufacturing still struggling to fix itself. "Boeing and Airbus production rates are still constrained by supply chain issues, primarily engines but

also interiors, heat exchangers, structures," TD Cowen analysts said in the first installment of their Heavy Metal quarterly monitor report on Feb. 11. GE, for instance, still counts 15 or so troublesome suppliers. And aircraft groundings related to RTX geared turbofan engine problems remain "the biggest gating factor." RTX divisions are also still behind in interior systems, as is rival Safran.

What is more, deeper down in the supplier base, pandemic-era fiscal concerns remain as strong as ever. "You mentioned supply chain getting stronger;

I'm not seeing it now," an executive from a small Seattle-area machine shop responded to Michaels. "Granted, I'm in finance, but I see prices going up at record, record bases, and I see lead times—especially on commodities like bearings and forgings—just continue to increase, to a couple of years in some parts."

Michaels acknowledged that his observations about an improving supply chain were at a macro level. "This is part of the reason we're not as optimistic as Airbus and some analysts, and where Airbus is going to get in production rates, because it's in the Tier 3 of aerostructures."

Airbus now expects to reach monthly production of 75 new A320-family narrowbodies in 2027. The company averaged about 50 in 2024. It was around rate 60 in 2019. Boeing plans to begin production of as many as 42 new 737s per month by the end of 2025 after averaging delivery of about 22 monthly last year, most of which was from inventory of stockpiled fuselages and parts. Boeing managers believe they have access to enough inventory in their ecosystem to get to at least rate 38. The pre-pandemic, pre-MAX crises rate was 52.

In other words, the OEMs are forecasting a huge jump in their respective supply chain's actual monthly production quantity and quality, probably no later than 2026. Doing that, versus simply recovering from the pandemic's disruption, remain distinct challenges. A stress test is looming for the supply chain in the next few years, so maybe don't order the filet mignon just yet. ☛

Stress Test

Will the supply chain be able to keep up as aircraft-makers ramp up?



DAVID RYDER/GETTY IMAGES

AIRLINE INTEL

JENS FLOTTAU



STEVEN UDVAR-HAZY CAN CLAIM

something few people can. He invented an industry sector: aircraft leasing. The Hungarian-born-and-California-raised

businessman did so more than 50 years ago, when air travel was a tiny fraction of what it is today in terms of passenger volume or in-service aircraft. His career built two industry giants. Now Hazy—or simply Steve to many—has announced his retirement.

Air Lease Corp. (ALC) said March 13 that Hazy will step down as executive chairman at the next annual general meeting and move into a new role as nonexecutive chairman for a year before retiring from the company. The decision marks the start of what is likely to be a multi-year transition period for ALC.

Hazy's longtime business partner and friend, John Plueger, is continuing as CEO for the time being and will take full charge of the daily running of the company after the May 2 meeting. But ALC will have to look for a successor to Plueger in due course. Hazy is turning 80 in 2026; Plueger is 10 years younger but past the typical retirement age. The board surely will try to organize the transition in sequence rather than lose both at the same time.

The process is going to take place at a time when ALC's business model is tougher to execute than it used to be. In simple terms, the model is to buy new aircraft from the manufacturers and then sell them when they are around eight years old. The supply chain and production disruptions at Airbus and Boeing mean that few, if any, aircraft ordered today are expected to be delivered before 2030, and even then, not many slots are available. That horizon is not conducive to leasing, so ALC has stayed away from big new orders since 2021. At some point, the company will have to become active again beyond picking up orders placed by airlines that no longer want to keep them.

Interest rates also have stayed higher than expected for longer. On the other hand, the COVID-19-era airline rescue leases are slowly expiring. Hazy highlighted on a recent analyst call that there is a big upside for ALC when these aircraft are put on their next lease or lease extension at much higher rates.

Hazy's achievements cannot be measured only by the success of ALC, set up in 2010, and the earlier International Lease Finance Corp. (ILFC). His deep knowledge

of airline business models helped numerous carriers take off. Through him, many airlines were able to access aircraft they could actually afford through leasing. In that sense, Hazy and other lessors that followed played an important role in the growth of civil air transport over the past half-century.

For perspective, global revenue passenger kilometers were a little more than 500 billion in 1973, when Hazy entered the scene. This year, the International Air Transport Association expects that number to reach around 9 trillion. And lessors, nonexistent in the early 1970s, now control more than 50% of the in-service fleet.

ALC and other lessors helped airlines stay in business many times when they were in trouble, most recently during the COVID-19 pandemic, when lessors served as the industry's lifeline. But Hazy played that role much earlier—Aer Lingus is one of the carriers he supported through a sale-and-leaseback transaction, in that case of Boeing 737-500s.

He also has had (and continues to have) a big impact on aircraft design. Famously, Hazy “redesigned” the Airbus A350 when he did not like the A330-derivative plan that the airframer originally pursued. Somewhat ironically, Hazy later became a launch customer of the A330neo. Recently, he has been one of the most outspoken executives criticizing Boeing for the 737 MAX and 777X crises and Airbus for its constant delivery delays.

But few remember—or are even aware of—another of Hazy's biggest achievements: He managed to place aircraft with Ryanair, the carrier set up by Irish aircraft leasing tycoon Tony Ryan, whose Guinness Peat Aviation lessor was obviously a big Hazy rival.

“They needed jets to fly from Stansted to Dublin but would not do business with me because I was the enemy,” Hazy told Aviation Week in 2023. So he created a paper company in Bermuda called Atlantic Aviation Holdings that was owned by ILFC, a small but important detail that escaped Tony Ryan. Ryanair leased the aircraft, and Ryan, who died in 2007, never discovered the identity of the lessor behind the lessor.

Current Ryanair CEO Michael O’Leary found out at some point and sent Hazy a signed €20 (\$22) bill addressed to “the poor Hungarian farmer that helped start Ryanair.” 🇮🇪

Leasing's Godfather Lets Go

Steven Udvar-Hazy plans to retire in 2026



UDVAR-HAZY FAMILY



LEADING EDGE

GRAHAM WARWICK

WHY SHOULD A BRITISH AUTO- maker's choice of battery for a prototype electric sports car matter to aviation?

Because storied Caterham Cars' choice of an immersion-cooled battery pack for its Project V concept car highlights a technology that could tackle many of the challenges facing electric aircraft.

Direct liquid cooling of battery cells enables faster charging, longer life and safer operations, particularly with the high-power, high-energy batteries required for electric vertical-takeoff-and-landing (eVTOL) aircraft. Immersion cooling also enables cells to be packed more closely, increasing energy density.

Batteries generate heat in operation and, if not adequately cooled, at high charge and discharge rates

Cooler Is Safer

Could immersion-cooled
batteries help electric aviation?

they can risk approaching temperatures that could cause a cell to catch fire and trigger a thermal runaway in the pack. Most eVTOL battery modules are cooled by forced air or by water via cold plates.

Immersion cooling is used now for data center processors and energy storage systems to reduce electricity consumption and enhance safety. Last September, South Korea's Hanwha Aerospace unveiled the first energy storage system for ships to use the technology, and Taiwan's Xing Mobility launched its Immersio battery packs in February, with Caterham as the first announced customer.

"The history of these immersion fluids goes back to transformer fluids, which are basically oils," says Venkat Viswanathan, a battery expert and associate professor at the University of Michigan. "What you want is a fluid that has a higher dielectric constant, so it doesn't have electrical breakdown. At the same time, you want it to have low density so it's not heavy, from an aviation perspective. And then, of course, you want very high heat capacity and thermal conductivity."

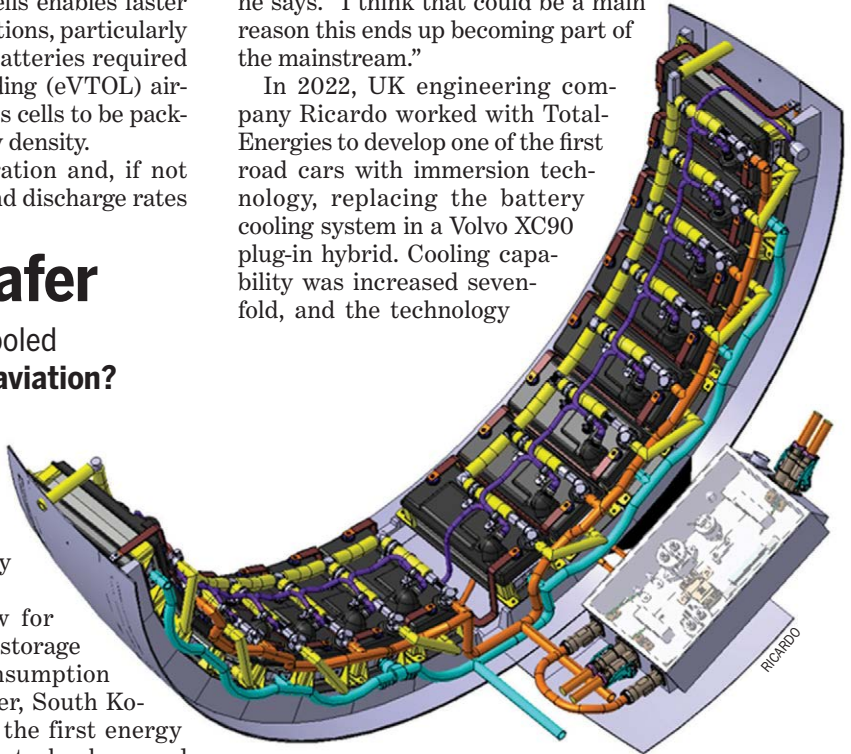
There is a lot of innovation going on in immersion cooling across other industries, totally disconnected from aerospace, Viswanathan notes. "All the oil companies are super-excited by this, because the fluids that they need are similar to lubricants and oils," he says. Dow, Shell and 3M all have product lines. "There's a lot of activity going on in terms of these immersion fluids," he adds.

The reason Viswanathan thinks immersion cooling could be a game changer for electric aviation is its ability to prevent thermal runaway. "If a cell is going into thermal runaway, the certification requirement is to

block it from propagating to adjacent cells," he explains. This protection increases pack weight, however.

This thermal runaway protection was demonstrated in a study by the Southwest Research Institute in Texas. "What they showed was that with an immersion-cooled battery pack, you can block [thermal runaway] reliably because it can take the heat away so quickly," he says. "I think that could be a main reason this ends up becoming part of the mainstream."

In 2022, UK engineering company Ricardo worked with TotalEnergies to develop one of the first road cars with immersion technology, replacing the battery cooling system in a Volvo XC90 plug-in hybrid. Cooling capability was increased seven-fold, and the technology



had the potential to reduce mass by 4% and cost by 5.6% while preventing thermal runaway propagation through the pack.

Ricardo has since applied the technology to aerospace under UK government-funded Project Inception to develop an electric ducted fan propulsion system that incorporates a battery pack, motor and power electronics into a single power-dense immersion-cooled module (pictured). Project Inception is targeted at electrifying conventional-takeoff general aviation and subregional aircraft as well as eVTOLs.

"What we have seen from our own work is that, if you take a conventional eVTOL mission like Joby or Archer, you start at [a cell temperature of] 25-30C [77-86F], and by the time you complete the mission, the cell temperature is anywhere between 50 and 70C, depending on the demands for the landing segment," Viswanathan says. "And that's awfully close to the thermal limit of safe operation. If you put it in an immersion-cooled battery pack, then it might heat up to 45-50C, but nothing like 70-80C. So I think this is an exciting area." 🚀

EUROPE TAKES AIM

- > EUROPEAN UNION SHIFTS DEFENSE INTO HIGH GEAR
- > GERMANY SUSPENDS DEBT LIMITS TO BOOST MILITARY SPENDING
- > LEONARDO EXPLORES CAPACITY INCREASES

Robert Wall London

For decades, the principal problem for Europe's defense industry was a lack of investment. Now the region's new-found appetite for rearmament is creating a different headache: scaling up fast enough to meet surging demand.

Italian aerospace supplier Leonardo will spend the next few months defining investment plans to meet an anticipated demand wave from higher defense spending in Europe, CEO Roberto Cingolani said at a recent investor meeting. Each percentage point that European Union member states raise defense spending as a percentage of GDP could add €4-6 billion (\$4.4-6.5 billion) to the company's top line, Cingolani said.

Rheinmetall, a German manufacturer of armored vehicles and missile

motors, also is looking to scale up further. The company is undertaking a bottleneck analysis to assess where incremental investments could yield big gains in output, CEO Armin Pappeger said March 12. "We have to do it now to prepare ourselves to grow faster," he said. Rheinmetall projects that European NATO defense spending could jump to almost €1 trillion in 2030 from €440 million last year if countries allocate around 3.5% of GDP to national security accounts.

European military spending is rising because of Russia's invasion of Ukraine and concerns that Moscow's imperial ambitions may not end there. Spending increases have gained a sense of urgency in recent weeks as the Trump administration has said the U.S. would step back from the role of security partner for Europe it has played since the end of World War II. Europe also wants to

France, Italy and the UK have agreed to buy more air and missile defense interceptors from the Eurosam joint venture.



EUROSAM

end its dependence on U.S. weapons.

"We all know there was an underinvestment in defense for too long," European Commission President Ursula von der Leyen said March 18. While EU members have boosted defense spending 31% since 2021, she noted, "that is better—but not enough."

The European Commission this month unveiled measures to add €800 billion to the region's defense spending. That includes €150 billion in loans for member states to spend on European defense equipment and an easing of the bloc's tight fiscal rules for defense investments for four years.

In a defense white paper issued March 19, the European Commission calls for "a massive ramp-up of European defense industrial production capacity." The 23-page "European Defense Readiness 2030" document warns of growing threats to Europe "in its region and beyond" and recommends bolstering its military muscle. "The moment has come for Europe to rearm," it states.

The white paper identifies seven priority areas for Europe to fill gaps, including air and missile defense, drone and counterdrone systems, and strategic enablers, such as airlift, air-to-air refueling and space.

The European Commission is working with companies to find areas to reduce regulatory burdens and address industry challenges, including swifter approvals for defense projects, reduced obstacles to private investment in defense and mutual recognition of certifications. That plan should be ready by June, it said. The EU also aims to develop a European Armament Technological Road Map this year, initially focused on artificial intelligence and quantum technologies.

The white paper underscores Europe's support for Ukraine, too, including through an air defense initiative to accelerate production of interceptors and enhance Kyiv's access to EU space assets from positioning, navigation and timing to Earth observation. "The EU should also fund Ukrainian access to services that can be provided by EU-based commercial providers," the paper states. The move comes after the U.S. temporarily suspended Ukraine's access to some government-furnished commercial satellite imagery.

"This is not just about military strength—it is about our readiness,

strategic autonomy and the future of Europe as a global player," Andrius Kubilius, Europe's first commissioner for defense and space, said as he unveiled the white paper.

European states are acting as well. German legislators approved a constitutional change on March 18 that partially suspends debt limits so the country can invest more in defense and provide support to Ukraine. The easing of the debt break allows Berlin to increase investments in defense, intelligence services, cybersecurity and civil security.

Likely incoming Chancellor Friedrich Merz said the money would underpin an effort by the country to rebuild its defense capabilities, in some cases from scratch. That would

"The UK also pledged to bring defense spending to 3% of GDP in the next parliament."

include focusing on technology, automation, independent European space-surveillance capabilities and armed drones. New contracts should go to European industry where possible, he said in the parliamentary debate ahead of the vote.

London is adding to the spending uplift as well. After previously laying out a vague ambition to spend 2.5% of its GDP on defense, the government put a 2027 deadline on that goal in February. The UK also pledged to bring defense spending to 3% of GDP in the next parliament, effectively sometime after 2029, if financial conditions permit.

Estonian Prime Minister Kristen Michal, whose country is on the front line with Russia, also said on March 18 that Tallinn would aim to boost its defense spending to 5% of GDP.

The need for more spending is likely to become even clearer at the annual NATO summit in June, when leaders from member states are expected to raise the alliance's military capability targets.

Europe is moving to field equipment more quickly to address those challenges. The Eurosam joint venture between MBDA and Thales secured an order from France, Italy and the UK in March to accelerate delivery of

air and missile defense interceptors and buy more missiles.

MBDA expects its production to be double its 2023 level by year-end, since €13.8 billion in order intake last year has grown its backlog to €37 billion. The company is spending €2.5 billion on new facilities and equipment over the coming five years to expand capacity in France, Germany, Italy and the UK.

To meet increasing demand, MBDA has started producing batches of subsystems and other missile components ahead of orders so it can churn out new missiles quickly, should a customer need them, CEO Eric Beranger says.

Saab is doing the same in some areas. The company is seeing strong interest in its Giraffe 1X air surveillance radar, which can support counterdrone efforts, and is building them absent firm orders. "We are actually manufacturing on speculation, rather than sort of contract-by-contract-wise, to make sure we can support the market," CEO Micael Johansson says.

Some European companies are looking to the region's struggling automotive industry as a possible source of production relief, drawing on the sector's high-volume production capabilities. MBDA is in talks with undisclosed car manufacturers about whether they could support production, particularly of loitering munitions, reflecting the expected rising demand for such systems, Beranger says.

Rheinmetall, also an automotive parts supplier, is exploring shifting its internal capacities to defense, including potentially more than 1,000 staff, Papperger said.

Europe's efforts to become more self-reliant in defense have a long road ahead. Member states more than tripled their U.S. arms imports in 2020-24 compared with 2015-19 and now represent the largest destination for American weapon shipments in two decades, according to the Stockholm International Peace Research Institute. Germany was the region's largest exporter to other European states.

Sixty-four percent of European NATO member states' arms imports were from the U.S., the think tank found. Despite the push in Europe for change, the backlog of fighters and helicopters already ordered from the U.S. suggests any meaningful shift will not happen quickly. ☼

—With Tony Osborne in London

Trump Moves Prompt International Lockheed Martin F-35 Buyers To Reconsider

- CANADIAN AND PORTUGUESE OFFICIALS RAISE CONCERNS
- OTTAWA'S F-35 REVIEW COMES EIGHT YEARS AFTER ITS BOEING ORDER CANCELLATION

Canada selected the F-35A after a circuitous, 13-year-long process but could start the search yet again for a new fighter.

STAFF SGT THOMAS BARLEY/U.S. AIR FORCE

Steve Trimble Washington

Calls are mounting in Canada and Europe to shun the Lockheed Martin F-35 fighter and other U.S. defense exports amid a backlash against controversial foreign policy changes in Washington.

Canadian Prime Minister Mark Carney, who is locked in an escalating trade war with the U.S., ordered a review of the F-35A procurement within hours of his swearing-in ceremony on March 14.

On the same day, Portuguese Defense Minister Nuno Melo questioned the wisdom of acquiring F-35s in the face of U.S. President Donald Trump's policies on trade and doubts about NATO. However, Lisbon has not yet budgeted for a Lockheed F-16A/B replacement, and Melo spoke on behalf of a now fallen government.

The growing pressure from existing and potential F-35 customers comes at a delicate time for the Lockheed-led program. The fighter's global supply chain is already struggling with modernization delays and facing uncertainty about the Trump administration's commitment to the U.S. order plan, which accounts for roughly 60% of overall scheduled deliveries each

year. The international orderbook has provided a reliable backstop for fluctuating U.S. orders over the years, even after the removal of Turkey from the program and subsequent cancellation of Ankara's 100 orders over concerns about exposing the F-35 to advanced Russian military radars delivered to Turkey.

At the same time, the calls in Ottawa and European capitals have exposed the complexities of unwinding foreign arms deals, which often come with penalties for breaking contracts and risk depriving domestic participants in the program's industrial supply chain of future revenues. Any disruption also imperils scheduled fleet replacement plans as demand rises for additional fighter capacity and lengthy queues are in place for alternative aircraft.

Despite those possibilities, Trump's targeted tariffs against Canada and calls to annex the northern neighbor as the 51st state have proven at least equally alarming.

"[The F-35] was the fighter jet identified by our air force as the platform that they required, but we are also examining other alternatives—whether

we need all of those fighter jets to be F-35," Defense Minister Bill Blair told the Canadian Broadcasting Corp. in a March 14 interview. "The prime minister has asked me to go and examine those things and have discussions with other sources, particularly where there may be opportunities to assemble those fighter jets in Canada."

The situation could set up a repeat of a 2017 episode in the circuitous history of the Canadian fighter modernization program. Late that year, then-Prime Minister Justin Trudeau canceled a plan to order 18 Boeing F/A-18E/F Super Hornets as a stop-gap replacement for the Royal Canadian Air Force's (RCAF) oldest F/A-18A/Bs. The cancellation came after Boeing launched an ultimately unsuccessful legal challenge against Bombardier over allegations of unfair pricing for airliners. Bombardier was forced to sell off its commercial aircraft division to Airbus before Boeing lost the case in a U.S. courtroom, prompting furor in Canada.

Trudeau instead ordered 18 F/A-18A/Bs from the Royal Australian Air Force as interim replacements for even older aircraft and then launched

the Future Fighter Capability Project (FFCP) to select a contractor to deliver 88 new fighters to Canadian bases on a tight timeline between 2028 and 2032, with deliveries to training bases in the U.S. to start in 2026.

Blair's newly launched review reopens the door for the FFCP competition also-rans. Dassault and the Eurofighter consortium participated in the early stages but quickly withdrew from the bidding process. The French manufacturer cited concerns about Ottawa's requirements for interoperability and intelligence-sharing with the U.S. military. Canadian officials eliminated the Super Hornet bid during the last phase, leaving only the Saab F-39E Gripen in the race.

Had the Swedish offer won the contract, Saab would have assembled Gripen fighters in Canada through a partnership with Halifax-based IMP Aerospace. If Blair revives a competition to deliver some portion of the 88-aircraft requirement for the FFCP contract, Carney's government could consider local assembly of Gripens or other fighters.

The impact of Trump's rhetoric and actions could extend beyond the F-35 in Canada's security relationship with its neighbor, NATO ally and partner in the binational North American Aerospace Defense Command (NORAD). In a possible case of coincidental timing,

Saab offered to assemble the Gripen fighter in Canada in a losing bid for the F/A-18 Hornet replacement.

Carney announced on March 18 the selection of Australia's Jindalee Operational Radar Network to bolster surveillance gaps in NORAD's North Warning System. The award passed over a rival U.S. option—the RTX Next Generation Over-the-Horizon Radar.

Politicians are taking aim at other U.S. defense contracts with the Canadian military. Jagmeet Singh, leader of the minority New Democratic Party, released a statement calling for cancellation of orders for 16 Boeing P-8A maritime patrol aircraft, which the Canadian government selected over a rival bid by Bombardier Defense and General Dynamics Mission Systems-Canada.

Not all Canadian industry leaders support a ban on F-35 orders. Bombardier CEO Eric Martel warned at a Montreal business event on March 17

that more Canadian financial interests may be at stake than the \$3 billion in contracts awarded to 30 domestic companies in Lockheed's global F-35 supply chain. Bombardier itself delivers business jets to the U.S. Air Force and Army, which convert them into special-mission aircraft.

"Canceling the F-35s might be a good idea, but we need to think about it," Martel said. "We have contracts with the Pentagon. Will there be reciprocity there?"

An order cancellation also could be devastating for the RCAF's aging force structure. The F-35A was originally selected in 2009 to replace the CF-18 by then-Prime Minister Stephen Harper, but controversy arose over the lack of a competition immediately before the decision. By the time his government fell in the 2015 election, Harper still had not signed any orders. Trudeau's new government voided the

Parliamentary Budget Officer forecast would total CAD\$52.2 billion (\$36.4 billion) by 2030.

As Blair continues reviewing future F-35 orders, work is underway on support infrastructure to receive the F-35. Canada's National Defense Department has outlined plans to upgrade 12 bases around the country to host or support the aircraft, including building a new Quick Reaction Alert facility in Canadian Forces Base Cold Lake and new hangars for Cold Lake and Bagotville.

The Canadian review has reverberated among F-35 operators in Europe. Denmark in particular is caught in the geopolitical crossfire; Greenland, a Danish possession with self-rule, is another annexation target for Trump. Copenhagen has signed orders for all 27 F-35s in its program of record, but some Danish politicians are having second thoughts.



2009 selection, setting in motion another lengthy selection process. Trudeau's government eventually came to the same conclusion Harper's had made 13 years earlier and announced the F-35A selection in 2022.

But Trudeau's deal set up a challenging, backloaded schedule for the acquisition. The contract called for 66 aircraft deliveries in 2030-32, an annual pace considerably faster than for any other F-35 operator outside the U.S. The plan could put significant pressure on Canada's defense budget, which a 2023 report by the country's

"As one of the decision-makers behind Denmark's purchase of F35s, I regret it," Rasmus Jarlov, a conservative member of parliament, posted on X, suggesting Trump could cut off the fleet's weapons and spare parts in the event of a refusal to transfer Greenland to the U.S.

"Therefore, buying American weapons is a security risk that we cannot run," Jarlov stated. "We will make enormous investments in air defense, fighter jets, artillery and other weapons in the coming years, and we must avoid American weapons if at all possible." 🇩🇰



Trump's Defensive Shield Plan Raises Command Questions

- > PENTAGON GOLDEN DOME ARCHITECTURE IS DUE TO THE WHITE HOUSE BY MARCH 28
- > MDA SAYS THE TRACKING SPACE SENSOR PROGRAM OFFERS A GLIMPSE INTO AN ACQUISITION MODEL

NORTHROP GRUMMAN

Steve Trimble Washington

With the Pentagon still days away from sending the White House an architecture for a continent-spanning air and missile defense system, the full scope of the Golden Dome concept is coming into view with staggering clarity.

Beyond the technological innovations necessary to realize President Donald Trump's vision of a Israeli-like missile shield for the U.S., the promised architecture raises the prospect of dramatic functional and organizational reforms needed to unify into a coherent structure a set of balkanized defense systems scattered across multiple agencies, commands and services.

The executive order signed by Trump on Jan. 27 gives the Pentagon until March 28 to submit a reference architecture, requirements-based capabilities and an implementation plan for the "Iron Dome for America," now recast as the Golden Dome. The system must be able to defeat ballistic, hypersonic, advanced cruise missiles targeting the 3.8 million mi.² of the U.S., an area more than 400 times the size of Israel.

The order also adds to the list of

threats any "next-generation aerial attacks from peer, near-peer and rogue adversaries," a catchall phrase that mandates that the Golden Dome concept defeat a plethora of possible weapons, ranging from one-way attack munitions to China's fractional orbital bombardment system.

The wide array of threats and the vast territory to be defended transcend the way the Pentagon divides control over acquisition and operation of various components of program architecture. Somehow, the architecture must organize systems split among the U.S. Air Force, Army, Navy, Space Force, Missile Defense Agency (MDA) and intelligence community, including several technologies that have yet to be defined.

"Our biggest challenge is going to be organizational behavior and culture," U.S. Space Force Gen. Michael Guetlein, vice chief of space operations, said at the National Security Innovation Base Summit here on March 5. "We are not accustomed to having to integrate at the level that's going to be required. This is on the order of magnitude of the Manhattan Project."

The various stovepiped command-

A massive effort comparable with the Manhattan Project would be needed to shield the U.S. from new threats under the Golden Dome concept.

and-control (C2) systems designed to orchestrate the sensors and interceptors involved in air and missile defenses present a major obstacle to integration. The MDA's Command, Control, Battle Management and Communications suite directs the Army's Ground-Based Interceptors against incoming ICBMs. The Army's maneuver units rely on the Integrated Air and Missile Defense Battle Command System to coordinate shoot-downs of ballistic missiles in theater. The Navy's Cooperative Engagement Capability, meanwhile, defends the fleet from air and missile attacks. Finally, the Air Force's Cloud-Based Command and Control system guides the North American Aerospace Defense Command.

"We need the right C2 battle management construct, which does not exist today," U.S. Air Force Lt. Gen. Heath Collins, director of the MDA, said at the AFA Warfare Symposium in Aurora, Colorado, on March 5.

But a path to a fully integrated system had formed long before the Golden Dome executive order. A Lockheed Martin F-35 demonstrated the ability to pass a missile track from its radar to a Navy warship's Aegis fire control system, Collins said. The F-35 used the Joint Track Management Capability bridge, an initial step to connecting almost any sensor to the U.S. military's dozens of interceptor weapons. The next step is to implement the Joint Tactical Integrated Fire Control in Guam's defense system, which now serves as a microcosm of the Golden Dome concept.

Even if an integrated fire control system can be implemented, a fundamental question still lurks over the architecture: Who is in charge? The question breaks down into an internal Pentagon debate over whether the Golden Dome should be assigned to a lead agency or service, or be supervised directly by the Office of the Secretary of Defense (OSD). The executive order does not state who should take the lead.

Speaking at different events on the same day thousands of miles apart, Collins and Guetlein took different positions.

Collins called for delegating leadership to an agency or service below the OSD level. "I think that a single agency or service needs to have the authority to make the decisions for the entire system," he said. "I think they need to have the resources and funding and manning, and that does seem to be happening."

Guetlein prefers a multi-agency and multiservice effort coordinated at the OSD level. "I think it's got to be an all-government [effort] reporting directly to the [deputy defense secretary] or the [defense secretary], with full presidential support," he said.

The executive order calls for the Pentagon to have the architecture in place to inform the fiscal 2026 budget, but full implementation of the Golden Dome concept will take several years. In his remarks on March 5, Collins offered the "2030s" as a notional target by which to achieve the defense vision.

"In the 2030s, our full missile defense enterprise and missile defeat enterprise will be in place," Collins said. "It'll be 360 [deg.] against all threats. It'll be agile. It'll be fast. It will be able to scale and adjust to the threat as the threat changes."

The executive order prescribes several features of the Golden Dome architecture. A notable insertion is a proliferated constellation of space-based interceptors that can shoot down missiles during the boost phase, a period when they are most vulnerable due to a lack of speed, maneuverability and countermeasures. Incoming missiles that evade the space-based interceptors would then face an underlayer of interceptors from land and sea. The White House order also stipulates that interceptor missiles must be augmented with nonkinetic systems, such as high-powered microwaves and high-energy lasers.

"We're also looking into nonkinetics—directed energy and other things," Collins said. "Depending on the target, some of these other capabilities—nonkinetics especially—could really help get us after that magazine depth problem that we have."

system that could generate intercept-quality tracks of hypersonic glide vehicles from space. It then selected four of the nine proposals to perform a ground demonstration, proving out a new class of software algorithms designed to detect the dim signature of a hypersonic target against the moving backdrop of the Earth from LEO. Two companies then moved into a prototyping phase, which led to satellite launches 37 months later. The prototypes have collected data on two hypersonic testbed events from more than 350,000 images so far, the MDA says in the *Defense Acquisition* magazine March-April issue.

The MDA plans to follow a similarly nontraditional approach to developing new capabilities with the Golden Dome. "Traditional acquisition approaches are nonstarters and will not keep up with the speed of advancing threats," the agency states in the article. The

In addition to the space-based overlay, an underlayer of theater and point-defense batteries, such as these Patriot launchers, would shoot down incoming missiles.



U.S. AIR FORCE

The executive order calls out specific sensors. Development of the MDA's Hypersonic and Ballistic Tracking Space Sensor (HBTSS), which features a medium-field-of-view infrared camera, must be accelerated and deployed, along with a future low-Earth-orbit (LEO) constellation of Space Development Agency satellites that maintain custody of enemy missile batteries before they launch their weapons.

The HBTSS in particular offers a window into the MDA's preferred acquisition strategy for Golden Dome capabilities. The agency invited traditional and nontraditional companies to help develop the concept for a

approach could introduce new challenges for traditional missile defense contractors. SpaceX, Anduril and Palantir are reportedly teaming to compete for Golden Dome contracts. A plan for a Rapid Hypersonic Defense Demonstration also was included in the MDA's request for information issued in January.

Asked to elaborate on the agency's plans for the demonstration, a spokesperson said: "MDA is supporting a [Department of Defense]-coordinated [Golden Dome] plan with a focus on rapid development, test, demonstration and fielding of initial capabilities. The plans are still in development at this time." 🌐

U.S. Air Force Hones In On NGAD, But the Next CCA Remains Cloudy

- > WARGAMES SHOW NEXT-GENERATION AIR DOMINANCE IS NEEDED
- > CCA PROTOTYPES RECEIVE UNCREWED FIGHTER DESIGNATIONS

Brian Everstine Aurora, Colorado

The roller-coaster ride that has been the U.S. Air Force's future fighter—on pause since last summer—appears to be reascending under the new administration ahead of the next budget request.

can,” Allvin said March 3 at the Air and Space Forces Association's Air Warfare Symposium here. “So that means yes, keep on the modernization. Yes, NGAD.”

When then-Air Force Secretary

Kunkel said. “What this study told us is: We tried a whole bunch of different options, and there's no more viable option than NGAD to achieve air superiority in this highly contested environment.”

The NGAD analysis was combined with similar in-depth looks at a future tanker and the next increment of the Collaborative Combat Aircraft (CCA) program—the uncrewed “loyal wingman” planned to fly alongside NGAD and other fighters. While requirements and a path forward for the crewed fighter seem to be firming up, the same cannot be said yet for CCA Increment 2.

Kunkel told Aviation Week that it is still early for this increment. “We're still learning how to use them,” he said. “We know a significant amount about CCA. We know in an analysis we have it's a game changer on the battlefield. It enables the joint force; it keeps our blue forces much more survivable. It has an impact on this mass that we're going up against in these highly contested environments. But we're still working on what this whole suite of CCAs look like.”

As part of the analysis, the Air Force is establishing an experimental operational unit at Creech AFB, Nevada, to start working with the first increment's aircraft. This will help the service identify what the next iteration and the flight performance of the first increment should be. The Air Force will need to move quickly to keep its planned pace of fielding, with prototype contracts expected this year.

“What that looks like, we're still figuring out, and we are working with industry on that,” Kunkel said. “And industry, frankly, has got a lot of operational analysis that's telling us where this thing needs to go. There are some folks that are like, ‘CCA Increment 2 has got to be more exquisite, it's got to be stealthy, it's got to have more capability.’ . . . Others say, ‘Actually, no, it's got to be cheaper, it's got to be less expensive, it's got to be expendable.’ We're kind of all over in this space.”

“What I think we're going to find out in the end is that CCA Increment 1 is kind of like the Goldilocks, right in the middle,” Kunkel continued. “We may find we need some that are higher-end, and I'm pretty sure we're going to need a lot that are lower-end.”

Industry representatives at the conference seemed to take different ap-

U.S. AIR FORCE CONCEPT



The U.S. Air Force is moving quickly on the first phase of the Collaborative Combat Aircraft program as the service decides on its future fighter.

The Air Force is expected to lay out how it wants to proceed on the Next-Generation Air Dominance (NGAD) penetrating counter-air fighter; the crewed aircraft planned to replace the Lockheed Martin F-22 that was halted in July because of cost concerns and growing adversary capabilities. Air Force Chief of Staff Gen. David Allvin is putting his weight behind proceeding with NGAD as expected as part of a broader assertion that the nation needs to put more resources into the service.

“If we're in this dangerous and dynamic time, I want to give the president as many options as we possibly

Frank Kendall announced the pause in July, he said there would be an in-depth review of NGAD's mission. Maj. Gen. Joseph Kunkel, the service's director of Force Design, Integration and Wargaming, said March 4 that this analysis showed NGAD is necessary. Studies explored the need for the Air Force to provide air superiority for the joint force in contested environments. Despite NGAD's cost, which is expected to be about \$300 million per copy, it was still deemed to be the most effective.

“What we found is, not only in the past, not only the present but in the future, air superiority matters,” Kun-

proaches to the open-ended requirements discussion. General Atomics Aeronautical Systems Inc. (GA-ASI) and Anduril are the finalists for CCA Increment 1. For GA-ASI, having the aperture open is a positive, and company President David Alexander told Aviation Week he does not want to be told what to do for the next round, for which the company is building a “very mature” offer that differs from the first version.

“If you write a spec, all black and white, you’re going to get a bunch of people who will just bid on the same thing,” Alexander said. “I like it, I think it’s the right thing, I applaud what they’re doing. Maybe there are some that are feeling like they need to be told what to do. General Atomics Aeronautical Systems does not need to be told what to do.”

Anduril similarly has not shared much about its approach for the next round. Andrew Van Timmeren, senior director of air dominance systems, said the company is having conversations “where there is a

unique opportunity for somebody like us to contribute.”

Some companies in the space are pushing for a more solid direction to allow them to tailor research and development more accurately. Within the past years, there has been a series of new announcements and teaming agreements focused on propulsion for CCAs representing a wide range of thrust and cost targets. One senior industry source says there has been mixed messaging from the Air Force, with one leader in the Pentagon providing a different answer from another.

“This is a big cloud, which is Increment 2, and we’re trying to figure out where in the cloud we need to position ourselves,” the industry official says. “So I’ve got to place a couple bets, and that’s why . . . we’re placing multiple bets. We don’t have a single solution.”

In the meantime, Anduril and GA-ASI are preparing for their CCA Increment 1 offerings’ first flights, which are expected this summer. At the conference, the two companies’ proto-

types received official designations—the YFQ-44A for Anduril and the YFA-42A for GA-ASI.

Van Timmeren said Anduril continues to build and test subsystems on its aircraft, also called the Fury. “We’re burning down risk every day,” he said. “Nothing we’re doing is denying our ability to stay on schedule.”

Alexander said that although the first flight of the YFQ-42A will happen in the summer, GA-ASI has proved its design with the similar XQ-67A Gambit Off-Board Sensing Station (OBSS). That system, developed with the Air Force Research Laboratory, first flew in February 2024. The CCA design takes the OBSS and focuses more on internal weapon carriage and more angled wings for speed.

“I think everybody’s missing the point when they go, ‘Hey, when is your first flight?’” Alexander asserted. “And I always thought it was last year, February. Now we’re doing our first flight of our productionalized design, and we’re going into mass production.” 🗞

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Europe Is Recognizing Turkey as a Potential Defense Supplier

➤ AKINCI UAS IS FIRST FOCUS OF LEONARDO-BAYKAR JOINT VENTURE

➤ BAYKAR EXPLORES EUROPEAN PRODUCTION OF UAS WITH PIAGGIO

Tony Osborne London

Formation of a joint venture between Italy's Leonardo and Turkey's Baykar alongside a potential Spanish buy of Turkish Aerospace Industries Hurjet advanced jet trainers suggest that Europe is beginning to take Turkey's military industrial capability more seriously.

Already suppliers to Central Asia and the Middle East, Turkey's defense companies have struggled to penetrate the European market, accomplishing only limited sales of the Bayraktar TB2 tac-

posed by Russia and the unwillingness of the new administration in Washington to underwrite European security.

Leonardo believes the arrangement could short-circuit European MALE UAS development after years of failed attempts to compete with Israeli and U.S.-made platforms. Leonardo is supporting development of the Eurodrone with Airbus and Dassault, but that platform is an 11-metric-ton, twin-turboprop large platform, less versatile and far more costly than aircraft like the Akinci.



tical uncrewed aircraft system (UAS) to Croatia, Poland, Romania and Ukraine.

Now Leonardo leaders believe Baykar could fill yawning gaps in European UAS capabilities. After five months of negotiations, the two companies signed a memorandum of understanding (MOU) on March 6 to form a joint venture that will lead to cooperation on design, development, production and maintenance of Baykar-made platforms and outfit them with Leonardo-made sensors, electronics and flight control systems.

The first step is to offer a new variant of Baykar's Akinci twin-turboprop medium-altitude, long-endurance (MALE) system equipped with Leonardo's systems.

Over the next 10 years, Europe is expected to spend about €100 billion (\$108 billion) on armed surveillance drones, loitering munitions and what the two companies refer to as uncrewed fighters as defense spending accelerates in response to the threat

Leonardo CEO Roberto Cingolani says the relationship was shaped by new transatlantic geopolitics and is not focused on Leonardo's domestic customers. "Drone [capability] is one of the areas where Europe should be stronger and safer," Cingolani says. "I think we should make the right alliances to find a shortcut, because we have lost quite a lot of time."

Sibel Duz, a researcher at Turkish think tank SETA, says the Leonardo-Baykar deal is "pivotal" in recognition of Turkish defense and aerospace capabilities.

"Until recently, Turkey's drone industry, led by Baykar, was primarily viewed as a disruptive force in asymmetric warfare, with its UAVs making a global impact in conflicts from Libya to Ukraine," Duz explains. "This partnership signifies a deeper shift. Instead of trying to reinvent the wheel, they're turning to Baykar, which already has a battle-proven product line and a strong research and development pipeline."

Selcuk Bayraktar, Baykar's chairman and chief technology officer, says Leonardo has been collaborating with Baykar for several years, and the two companies have identified a "synergy" and "chemistry" that aligns "with the geostrategic shifts in the world."

In the longer term, the two companies also see Baykar's Kizilelma jet-powered uncrewed combat aircraft—in development now—possibly acting as an adjunct to fifth- and sixth-generation crewed combat aircraft, a capability Cingolani previously has said should be added to the scope of the Global Combat Air Program with Japan and the UK.

Bayraktar says the collaboration is not linked to Baykar's takeover of troubled Italian business aircraft manufacturer Piaggio, but he notes that Piaggio will be involved in production of Baykar's platforms. Haluk Bayraktar, Selcuk's brother and the CEO of Baykar, says the initial focus on surveillance UAS and loitering munitions is key because they are playing "pivotal roles" on the battlefields of today.

Baykar is churning out Akinci UAS for export customers. A new version with Leonardo equipment could appeal to European customers.

Baykar has exported its UAS to 36 countries, and Duz asserts that a "Made in Europe" label made possible by the relationship with Leonardo and the acquisition of Piaggio could bypass political roadblocks for European sales.

Meanwhile, Turkish Aerospace may be closing in on an export sale of its Hurjet advanced jet trainer to Spain after the country's air force chief, Gen. Francisco Braco Carbo, declared the aircraft to be "well positioned" as a replacement for the country's Northrop SF-5 lead-in fighter trainers.

The Hurjet appears to have taken the lead over competitors, which include the Leonardo M-346, when the Spanish defense ministry signed an MOU in December with Turkey's Defense Industry Agency about development of "an advanced training system for Spanish air force fighter pilots." A Spanish order for the Hurjet would be an enormous boost for that program, which is still in early stages of development following launch of the program in 2017 and first flight in early 2023. 🌐

Singapore Seeks Submarine-Hunter Replacement



SINGAPORE DEFENSE MINISTRY

- REGIONAL SUBMARINE THREAT IS INTENSIFYING
- THE CITY-STATE'S NAVY AND AIR FORCE ARE LOOKING FARTHER OFFSHORE

Chen Chuanren Singapore

Singapore is replacing its aging maritime patrol aircraft in hopes of a performance jump to confront a more challenging geopolitical environment, including the proliferation of regional submarine threats. The country is also looking farther afield to protect its sea lines of communication, underpinning its goal for a more capable system.

The island nation seeks to replace the Fokker 50 Enforcer maritime patrol aircraft (MPA) that its air force has had in service for more than 30 years. Singapore's Defense Minister, Ng Eng Hen, disclosed the plans in March during a budget debate in the legislature, noting that the service is "intently evaluating appropriate replacements." Options include the Boeing P-8 Poseidon and Airbus C295, he said.

Israel Aerospace Industries, which has deep ties to Singapore's defense ministry, has shown interest in offering a business-jet-based MPA. Saab pursued the MPA market with its Swordfish program at one point but shelved the effort after it failed to gain traction.

Singapore is undergoing a far-reaching modernization drive to enhance its navy's surface, subsurface and uncrewed capabilities, too. The service is acquiring two submarines, expanding its fleet to six, and plans to introduce the Multi-Role Combat Vessel, envisioned as a mother ship for uncrewed systems. Singaporean Navy frigate communications are being enhanced to link them more directly with air force systems.

"Given the growing threats in the undersea domain, such as critical undersea infrastructure, it's necessary to upgrade existing capabilities to keep pace," says Collin Koh, senior fellow at Singapore's Institute of Defense and Strategic Studies.

The naval advancements strengthen Singapore's effort to ensure its security beyond its immediate littoral area and protect its role as a key node in global maritime trade. That

Singapore's defense chief, Vice Adm. Aaron Beng (center), was briefed on the Royal New Zealand Air Force (RNZAF) P-8A on a visit to RNZAF Base Ohakea in March.

responsibility is also driving requirements for the new MPA with which Singapore intends to support large-scale naval operations at greater distances. The program would require a platform that can deliver advanced processing capabilities for maritime surveillance and sufficient data link bandwidth to enable seamless integration with both crewed and uncrewed assets.

Singapore is expected to retain its focus on the ability to use the aircraft to engage targets if needed. Its Fokker 50 is still the only MPA in Southeast Asia equipped with anti-ship capabilities, and the military is unlikely to forgo this feature. In fact, the Singaporean Navy may seek additional offensive capabilities—particularly anti-submarine warfare systems—to support its expanding submarine fleet in the more contested underwater environment.

Fielding a longer-range submarine-hunting capability would fit in with the Republic of Singapore Air Force's other steps to expand its reach. Those plans include introducing Airbus A330 Multi-Role Tanker Transport aircraft and setting up an operational detachment in Guam to elevate air-sea training.

The P-8 could be the front-runner in Singapore, in part because it offers close ties with the U.S. Navy and is operated by security partners Australia, New Zealand and the UK. Singapore gained a close look at the P-8's capabilities in 2019 when the U.S. Navy sank a decommissioned ex-USS Gerald R. Ford frigate during an exercise off the coast of Guam.

Local industry also appears to be expecting a nod in favor of the U.S. platform. ST Engineering, the Singapore Air Force's principal maintenance, repair and overhaul provider, signed a preliminary agreement with Boeing in 2023 on collaboration in systems integration, training, local parts distribution, support and sustainment work for the platform. Under the agreement, Singapore could serve as a regional P-8 service center in an arrangement similar to one that Boeing struck in Australia as part of that country's purchase of the P-8 system. 🌐

Sea Change

- NEW CARRIERS SPARK CHINESE NAVAL AVIATION TRANSFORMATION
- THE FUTURE CHINESE AIR WING RESEMBLES U.S. NAVY STRUCTURE
- LAND-BASED AVIATION UNITS HAVE BEEN TRANSFERRED TO THE CHINESE AIR FORCE

Steve Trimble Washington

Amid the hoopla around the Zhuhai Airshow last year, a key moment passed almost unnoticed. Two Shenyang J-15Ts and one J-15D flew over the crowd in formation. One of the J-15Ds dangled a refueling hose-and-drogue basket, showcasing a carrier-based air refueling capability and the recent transformation of China's naval aviation branch.

For all but the last 12 of its 73-year history, the aviation branch of China's Navy stayed strictly land-based, featuring a mix of bombers, fighters and patrol aircraft not dissimilar to the country's air force—except for a maritime focus.

That changed on May 10, 2013, when China's Navy activated the 1st Carrier Air Wing, consisting of prototypes of new J-15 fighters. These clones of Soviet-era Sukhoi Su-33 fighters entered service to operate from the Liaoning, which itself is a recommissioned,

short-takeoff-but-assisted-recovery (Stobar) Kuznetsov-class aircraft carrier. For the first time since the founding of the naval aviation branch in 1952, China boasted a seagoing aviation wing.

After spending a decade establishing its sea legs, the next evolution of the naval aviation branch is underway. The 10th Carrier Aviation Brigade is now training to operate from the Fujian, China's first catapult-assisted-but-assisted-recovery carrier that is currently in sea trials.

The scheduled first deployment of the conventionally powered Fujian aircraft carrier next year is planned to display Chinese naval aviation at its full strength. China's first two Stobar carriers—Liaoning and Shandong—deployed with only the J-15 fighter and the J-15D, a variant optimized for electronic warfare. By contrast, the Fujian and the newly launched Type 004—China's first nuclear-powered carrier—will feature a more diverse carrier air wing that bears a striking resemblance to its U.S. Navy counterpart.

Options for the combat element of the 10th Carrier Aviation Brigade include the newly delivered Shenyang J-35 for the penetrating strike role, the J-15 for fleet defense, the J-15D for jamming support and the Xian KJ-600 for airborne early warning.

A near facsimile of the brigade can be found in the composition of the U.S. Navy's Carrier Air Wing 2, with the Lockheed Martin F-35C, Boeing F/A-18E/F, Boeing EA-18G and Northrop Grumman E-2D, respectively, playing comparable roles. Indeed, in some cases the similarity is more than func-

The carrier-based J-35 is expected to join the Chinese Air Force fleet by the end of the decade.



MICHAEL JERDEV

Z3144228/WIKIMEDIA

Three J-15T fighters flying in formation over the Zhuhai Airshow in November revealed a new, carrier-based air refueling capability for the Chinese Navy.

tional, with the J-35 and KJ-600 near copies of the U.S.-made F-35C and E-2D. As the nuclear-powered Type 004 carrier enters service this decade, Beijing could feasibly boast a capability matching Washington's airpower at sea on a singular basis.

The advances by China's carrier-based navy coincide with a major shift in the aviation wing's force structure. On the last day of the China Naval Aviation Development Forum in September 2022, Dong Qing, director of the Aviation Bureau of the Navy General Staff, told Chinese reporters of the change, speaking of the transformation from a shore-based to ship-based aviation capability.

Last year, U.S. military analysts marked the change in their annual re-

port to Congress on China's military strength. "In 2023, shifting missions for [Chinese Navy] naval aviation triggered the transfer of significant portions of [Chinese Navy] shore-based, fixed-wing combat aviation units, facilities, air defense and radar units to the [Chinese Air Force]," the report's authors wrote.

"Given time, this shift will probably enable better [command and control] over [China's] integrated air defense systems as well as the network of ground-based air domain awareness radars," the report added.

Specifically, the policy transferred nearly all of the navy's shore-based aviation to the air force, including three fighter brigades, two bomber regiments and five radar and air defense brigades, according to a July 2023 analysis by the U.S. Air Force's China Aerospace Studies Institute (CASI). The new owners repainted the aircraft—primarily a mix of Xian H-6 and JH-7 bombers and Shenyang J-11 fighters—in Chinese Air Force colors, while the crews swapped navy uniforms for air force apparel. Of the navy's original land-based aviation fleet, only the Xian Y-9 anti-submarine warfare and special mission aircraft remained under naval command.

The U.S. Air Force observers also noted the larger implications of the shift. "The transfer of [Chinese Navy] JH-7 and H-6 aircraft strips [the navy] of most of its minelaying aircraft," the 2023 CASI report states. "Unless the

[Chinese Air Force] integrates mine-laying topics into its own training outline, this leaves [the Chinese Navy] Y-9 anti-submarine warfare aircraft as the only aircraft that train to conduct minelaying."

In other ways, the two-year-old reorganization may have strengthened a once-fragmented coastline air defense network. Until 2023, air defense operations along China's coast belonged to the air force, except for Hainan Island and a 250-km-long (155-mi.) swath of Zhejiang province, CASI says. Now, all ground-based air defenses and land-based aviation are consolidated under control of air force units, with additional long-range fire support provided by the army's ballistic missile-wielding rocket force.

Meanwhile, the navy's aviation branch continues adapting to its new role as a carrier-based force. During a training drill in early February, a naval aviation fighter practiced how to jam an enemy ship's radar, then dove down to sea level to launch a sea-skimming missile attack on the target.

"The department's leaders introduced that in low-altitude penetration training at sea," the *People's Liberation Army Daily*, the Chinese military's newspaper, reported in a Feb. 14 article. "Pilots not only have to overcome difficulties such as few reference points and complex airflow changes but also have to deal with a variety of special situations on the spot." ☒



The Type 003 Fujian carrier launched sea trials in May ahead of a scheduled 2026 deployment date.

Calls Swell for the U.S. Military To Invest in Space Superiority

- SPACE FORCE LEADER SEES DOMAIN CONTROL AS NO. 1 PRIORITY
- ONGOING BUDGET DELAYS HINDER NEW CAPABILITY INVESTMENT

Vivienne Machi Aurora, Colorado

The U.S. Space Force is ready to invest in the offensive capabilities needed to maintain its edge in a vast and contested environment—if Congress loosens its purse strings.

The service was established in 2019

warfare and counterspace operations must be harnessed for both offensive and defensive purposes, Saltzman said in a keynote speech, adding that the service plans to share new doctrine and guidance on space control soon.



Space Force leaders say the service must treat space as a warfighting domain.

in recognition that the domain beyond Earth's atmosphere requires a singular focus and budget on par with that given to air, land and sea. But even before its launch, military officials had long hesitated to make any reference to a potential war in space—or the offensive capabilities required to wage one.

That is changing. The Space Force must think of space “as a warfighting domain rather than just a collection of support activities,” Chief of Space Operations Gen. Chance Saltzman said on March 3 at the Air and Space Forces Warfare Symposium here. Although the service is still responsible for designing satellites that can conduct lengthy on-orbit operations in harsh environments, “it’s not enough,” he said.

Space control is now Saltzman’s No. 1 priority, encapsulating all mission areas that allow the military to counter adversary capabilities “by disruption and degradation—even destruction, if necessary,” he said.

Orbital warfare, electromagnetic

The Space Force is watching its adversaries develop a broad mix of space- and ground-based weapons to hold U.S. forces at risk, Saltzman told reporters at the conference. That includes directed-energy platforms, radio-frequency-jamming capabilities and kinetic weaponry. “They’re pursuing all of those,” he said, singling out China as the pacing challenge.

Beijing has built a space-enabled targeting architecture that includes hundreds of satellites spanning orbital regimes. To counter it and other threats, the U.S. military is building more resilient space-based architectures to make enemy targeting as difficult as possible. That includes developing proliferated satellite constellations, dispersing those capabilities across multiple orbits and studying on-orbit maneuverable spacecraft.

The Space Force will also be heavily involved in the Golden Dome, the Trump administration’s vision for a wide-scale missile defense architec-

ture, establishing a cross-functional team of experts dedicated to the executive order (page 18). That team will examine how the service might contribute available platforms and technologies to the architecture, which relevant systems are in development and where gaps remain, Saltzman said.

A disconnect exists, however, between the plans to maintain space superiority and the operational reality, he noted. The service does not have all the training tools to prepare its personnel for a warfighting scenario. The Space Force is making these investments with lower funding levels than its fellow services and in an uncertain budget environment. Indeed, it was born lean and crafted from space-focused elements of the U.S. military—namely, the Air Force.

The Space Force’s fiscal 2025 budget request was \$29.6 billion, about 3.5% of the Defense Department’s total budget for the period, down from the previous year.

Space Force advocates have called for funding increases. The National Security Space Association in a recent report recommended boosting the budget evenly across fiscal 2026-30 to \$60 billion. This would support the service’s Golden Dome initiatives, bolster operational capabilities and expand resources for U.S. Space Command, the unit responsible for military operations in space.

Even if the next budget request were to double Space Force funding, no more money would be available if lawmakers continue to punt the passage of a new bill and instead issue continuing resolutions to maintain government spending at current levels. Trying to operate under such budgetary constraints is like “fighting with one hand tied before your back,” Saltzman told reporters. Any efforts to pivot away from current contracts and start new programs are hamstrung until a new budget is passed.

Space acquisition officials are trying to do more with less by exploring commercial options for legacy systems where viable, Maj. Gen. Stephen Purdy, military deputy at the Office of the Assistant Secretary of the Air Force for Space Acquisition and Integration, said in Washington on March 11. The Space Force is analyzing the potential trade-offs of using existing technologies to replace large spacecraft programs with lengthy schedules and high costs, Purdy said. ☛

FAST 5

GE Chairman and CEO Larry Culp

A year into becoming a pure-play aerospace and defense company, GE Aerospace is one of the most consequential providers in industry. After the company announced 2024 earnings, Aviation Week Executive Editor for Business **Michael Bruno** talked with **Culp** about GE's dramatic supply chain improvement and why a sizable amount of work remains to be done.

During the last quarterly call with investors and financial analysts, you talked about one "priority supplier" that GE worked with to improve deliveries to you. You said it was part and parcel to Flight Deck, your lean business operating approach, but this example stood out. What happened?

I actually went out and spent a day during the course of that Kaizen event. I'm going to try to refrain from mentioning who it was, but it is a name you would know. We basically went on-site with a team, including one of our top lean sensei, and basically Monday to Friday did what we do in any of these kinds of events as part of Flight Deck. [We] focus on a few areas, try to really understand the work being done, talk to the operators and pull out as much waste and create as much flow as we possibly can. Now the 50% bump that we talked about sounds Herculean, admittedly, but having being there that Thursday, I could see that there was a lot of opportunity we still hadn't touched.

Still, a 50% improvement from an established legacy supplier is a massive change. How did GE do that? The operators in that instance . . . I'm not sure had ever really been asked about improvement. There were a number of things that were relatively straightforward to fix in terms of machines. There was a cleanup of the facility to allow better flow. What happens with a lot of these manufacturing operations, you grow numb to your environment. It happens inside our company, as well—I'm not strictly describing

something in the supply base. But if you can bring fresh eyes, teach people to see the waste, to understand the merits of single-piece flow as opposed to batch manufacturing, you really can melt away a lot of waste. And that's what happened there.

You have said this was not a singular event when it comes to fixing supply chain issues. So you must be seeing dramatic supplier improvements?

When we talk about this sequential improvement in input from our priority suppliers—26% from the first half of last year to the second half—that is pretty darn good when you're talking about physical product. And the way we were able to do that is akin to the Kaizen that I described. We really went in hard [across GE's supplier base], with 550-plus [GE] engineers and supply chain professionals working with our suppliers, trying to identify the exact issue in their own operations, understand the constraint, break the constraint and unlock that flow.

That took a thousand different forms because no two issues, no two constraints were the same. But in real collaboration—not finger-pointing, not table-pounding and shouting, "I want more"—really going to the place where the real work is completed. I think we drove much better collaboration such that the suppliers that were responsible for three-quarters of our delays early last year are responsible for less than half of them at the end of the year. They basically are now delivering roughly 90% of their com-



CHRIS GILL

mitments, as opposed to a far lower number earlier in the year.

When will those 550 personnel return to GE? When do you get to stop spending as much time and talent on helping fix other companies? I'm not going to be one of these people who will tell you that the supply chain challenge is going to cease in the third quarter of 2025 or the first half of 2026. I think we're going to be at this for a while, because thankfully we have all of this demand, we have this tremendous tailwind—new-make, aftermarket, commercial, defense. So we'll be at this for a while, but if nothing else, I know we come into 2025 smarter, better and better prepared than we did coming into 2024.

Indeed, you told investors and financial analysts that fixing the supply chain is a "game of inches." If we could just push a button and have a thousand parts for a new Leap engine appear tomorrow, somebody else would be doing it. The operational challenge is hard. A lot of other people say it's kind of binary; it's not perfect and then one day it will be perfect.

If we can continue to drive sequential improvement, we can continue to eliminate waste, and we can continue to be a great collaborator with our suppliers. I'm highly optimistic that we'll be able to keep pace with the airlines, the airframers and the like as we look forward through the rest of this decade. But it will be work. But hey, that's what we do, and actually, it's not a problem. It is a true opportunity. A problem is like back in the COVID-19 pandemic, when [air travel] demand goes to zero, and you've got to look people in the eye and send them home. That's a problem. This I'll take seven days a week. This is a generational opportunity. 🌟

PRACTICAL PERF

- > AIRBUS AND ROBINSON REVEAL NEW HELICOPTERS AMID A ROTORCRAFT RESURGENCE
- > R88 DEVELOPMENT FOLLOWS MARKET DEMANDS FOR A LARGER AIRCRAFT
- > AIRBUS HAS DEVELOPED THE H140 BY ADAPTING ITS EXISTING H135

Tony Osborne, Dallas and Donauworth, Germany, and **Guy Norris** Dallas

Since the rotorcraft market is buoyant with growth after several years in the doldrums, manufacturers have decided now is the time to expand their offerings.

Airbus Helicopters and Robinson Helicopter Co. each lifted the veil on new products at the first Verticon industry gathering in Dallas, the first

major launch of new commercial rotorcraft since the Airbus H160 a decade ago.

Although neither new rotorcraft is revolutionary, they each represent a balance of trade-offs to address a market segment that values lower costs, proven systems, maintainability and reliability over new technology.

Airbus took a low-risk route with its H140 by adapting an existing product, the H135, then enlarging it and increasing its performance to appeal to emergency medical service providers,

whose orders have now guaranteed the first three years of production.

Robinson's R88, meanwhile, breaks the mold for the California manufacturer. The aircraft weighs twice as much as the company's R66 Turbine and seeks to appeal beyond the airframer's traditional customer base of the general aviation, flight training and utility markets, but it relies on familiar, trusted technology and a configuration not dissimilar to that of the 1960s-era Bell 205/UH-1 Iroquois.

CONSIDERABLE RISK

The R88 represents a significant gamble for Robinson. Can the manufacturer make its brand appeal to operators that have previously flown only Airbus, Bell or Leonardo types? Can it encourage current Robinson operators to take a leap of faith and fly a much larger machine?

With its expected \$3.3 million price, the R88 punches Robinson up into new territory above the company's traditional light rotorcraft market sector and aims to undercut the operating costs of larger single- and twin-turbine-powered competitors.

Powered by a single 1,000-shp Safran Arriel 2W turboshaft, the R88 will feature a payload capacity of 2,800 lb. and a range of more than 350 nm. Robinson has yet to disclose its empty and maximum takeoff weights. The aircraft will seat up to eight passengers and two crewmembers, while the reconfigurable 275-ft.³ cabin is designed to accommodate multiple seating layouts and be accessible through large, sliding side doors and a truck-bed-style rear door for simpler cargo and stretcher loading.

FRENCH CONNECTION

In line with the rest of the Robinson product line, the R88 has a two-blade main rotor and a twin-blade tail rotor, a configuration that will limit the aircraft's cruise speed compared with the multiblade rotor competition. The R88's rotor mast is a slightly shorter version of its R44/R66 stablemates, whose engines are located aft of the cabin. The R88's turboshaft is aligned

ROBINSON HELICOPTER CO. PHOTOS



Robinson presented this mockup of the R88 without its twin-blade main rotor or tail boom at the Verticon exposition in Dallas to give potential customers an idea of the scale of the company's latest market offering.

ORMANCE

with the transmission and enclosed in a fairing above the cabin roof. "That's a big change for us," Robinson President and CEO David Smith told Aviation Week ahead of Verticon. "It means that we were able to have the cowling and lines above the roof deck, fairing in that mass quite a bit."

Smith said the aircraft will retain all the hallmarks of the Robinson brand, including ease of operation, predictability and affordability of maintenance. "Our goal is to give you [operators] superior performance for an affordable price," he said.

THINKING BIGGER

After more than two years in gestation, the R88 has grown larger as the concept evolved, Smith noted. "The team started to lay it out as a smaller aircraft at one point," he explained. "But as we gained knowledge about both the available performance of this new Arriel variant and we understood better our own architecture on the powerplant, drive train, gearboxes, all that, it gave us the flexibility to say, 'No, we can do more.'"

Targeted at roles ranging from aerial firefighting and air medical transport to utility and passenger transport, the R88 will be available with standard skids or optional high skids for increased ground clearance and compatibility with a firefighting water tank. Optional equipment is planned to include a 3,000-lb.-rated cargo hook, utility basket, wire strike protection kit and pop-out floats.

The R88 cockpit will be dominated by a Garmin G500H TXi avionics suite and a four-axis autopilot system with such functions as level mode, hover assist, limit cuing and low-/high-speed protection. New for Robinson will be dual cyclic controls with removable controls on both sides, allowing the pilot in command to be in either the left or the right seat with a passenger in the other seat. Also new are dual hydraulics for pitch and roll flight controls. The dual cyclic feature is "a big difference that you're going to notice right away," Smith said.

The change from the center cyclic

configuration traditionally used in Robinson designs was driven by the extra width of the R88.

This helicopter is "so large that the teeter cyclic was going to be very tall on one side and very tall when you tip it over on the other," he added.

CONNECTED COPTER

Robinson also intends to seek optional single-pilot instrument flight rules certification for the R88 as a key element of keeping the helicopter's operating costs low. Furthermore, the R88 will be configured with standard data recording with a data link and a health

[inspections] at 100 hr., like our R66 is today."

Another feature to keep costs low is the "Serenity" package, which comes with the Arriel engine and provides operators with unscheduled maintenance for five years or 2,000 flying hours as well as health monitoring and digital services.

COLLECTIVE DEMANDS

The decision to launch the R88 follows persistent requests for a larger family variant from many dealers and operators within Robinson's loyal community base, Smith said. "They've been begging us to do something like this, though most of them thought we would go a half step to this point, so maybe a direct competitor to an [Airbus H125] AStar or [Bell] 407," he explained. "But when we got down to it, we feel like there's



Robinson plans to make use of Garmin's G500H TXi avionics suite for the R88. The aircraft will also be the first Robinson product with dual cyclics as well as dual hydraulics for pitch and roll flight controls.

and usage monitoring system for predictive maintenance and safety.

Smith said low maintenance costs will be a main pillar of the R88's expected affordability. "Our goal is to have [these systems] so that you don't need a mechanic touching the aircraft frequently at all," he remarked. "You might go weeks at a time before you see a mechanic for a 100-hr. or 200-hr. inspection. We're trying to get to a 200-hr. [interval] on this one, but initially we'll probably start with phased

an opportunity here to offer much more payload."

Robinson's competitors expressed surprise at the size of the R88; many of them had presumed the company would look at a 5-6-seat aircraft, leaving a gap that would benefit the competition. Operators argue that the R88 is unlikely to wean them away from the H125 because of that aircraft's performance, but it could have an impact on the H130 market, particularly in aerial tourism.

At Verticon, Robinson presented a mockup without rotor blades or a tail boom, attracting significant interest ahead of the flight testing expected to begin in 2026.

CUSTOMER SHAPED

In contrast to Robinson's R88 reveal, Airbus unveiled a mockup of an aircraft it has been flying for nearly two years.

Some 50 firm orders were collected at Verticon for the company's new H140. Many of those had come from operators with which the manufacturer had worked closely through customer advisory boards to shape the new aircraft.

"The H140 is designed by our customers, for our customers . . . addressing new market expectations, raising the bar and bringing more value, performance and comfort," Airbus Helicopters CEO Bruno Even told journalists ahead of the unveiling in Dallas.

Derived from the H135, the H140 features an enlarged cabin, higher cruise speed and smoother flight characteristics as well as operating costs comparable with its slightly smaller sibling. It aims to reinvigorate customer interest in Airbus' smaller twin-engine offering, just as adding a five-blade rotor did for the H145.

Although Airbus is internally designating the new helicopter the H135T4 to reflect its H135 heritage, the H140 will complement rather than replace that type, explains Dirk Petry, head of the H135 and H140 programs. The



AIRBUS HELICOPTERS PHOTOS

The H140 has adopted a five-blade main rotor and a sleek, swept vertical and T-tail horizontal stabilizer for improved aerodynamics.

H140 will appeal primarily to commercial and parapublic users, whereas the H135 will continue to be the airframer's "value proposition for military training," Petry states.

SLICK AESTHETIC

Externally sleeker than the H135, the H140 features a newly designed tail boom and vertical stabilizer; a T-tail replaces the horizontal stabilizer slotted through the tail boom on the H135. Moving the horizontal stabilizer to the top of the fin adds an extra 80 kg (176 lb.) of payload capacity because of download from the main rotor, while the sweep reduces drag. The tail boom also is raised slightly higher to give improved and safer access to the rear

clamshell doors. A new bearingless five-blade main rotor, like that on the H145, improves ride quality, while a 10-blade fenestron shrouded anti-torque system enhances yaw performance and reduces noise.

A key priority for engineers was to maintain a compact footprint. The aircraft is just 1 m (3 ft.) longer than the H135 from the tip of the main rotor blade to the tip of the tail rotor.

Unlike the H135, which has two engine options, the H140 will have just one: a new version of Safran's Arrius turboshaft. The airframer says the 700-shp Arrius 2E delivers lower operating costs than earlier versions of the powerplant and improves high-altitude and single-engine-inoperative performance. The Arrius 2E won its way onto the H140 after a competitive tender, Petry explains.

"By offering a single engine to our customers, we can propose the best solution in terms of economics. . . . But if you need to offer two engine options, it comes with a cost," he says.

ROOM TO MANEUVER

At 6.1 m³, the H140 cabin volume is 20% larger than the H135's—a 20-cm (8-in.) plug lengthens the fuselage—and width has increased by 10 cm. Airbus has removed a column behind the pilots that contained the control lines, which have been rerouted up through the center of the windshield. The changes allow six passengers to sit comfortably, while wider doors improve access to the cabin for stretchers. Larger windows enhance visibility and act as emergency exits in the event of ditching.

Airbus hopes the H140's larger cabin, 20% bigger by volume than the H135's, will be a selling point for operators, especially those in emergency medical services.



Like Robinson, Airbus says it is developing an optimized maintenance plan that will harmonize airframe and engine maintenance schedules and allow longer intervals between inspections, reducing operating and maintenance costs. The company is also adopting the Helionix avionics suite used across its rotorcraft range.

The H140's maximum takeoff weight is 3,175 kg, up from the H135's 2,980 kg and very close to the 7,000-lb. certification weight limit for the FAA's Part 27 and European Union Aviation Safety Agency's (EASA) CS-27 standards for normal-category rotorcraft. Airbus is eager not to make the mistake Bell made in pushing its twin-engine 429 into a different certification category through gross weight increases. Some countries approved the 429 weight increase with an exemption, but the FAA and EASA did not.

WEIGHT CONSCIOUS

Although the H140's empty weight has not been disclosed, Petry says Airbus Helicopters is working in a "conscious way" on weight optimization, expanding use of composites in what he calls a hybrid composite and metal structure. Among the weight-saving features planned for serial production is a one-piece composite tail boom.

Development of the H140 began in 2021 as Project X8, and a first flight followed in June 2023. Three more prototypes are planned to undergo flight testing in support of EASA certification and service entry in 2028. A second prototype is expected to follow in the latter half of 2025, and the remaining two prototypes, including a production-standard-conforming fourth prototype, are slated to emerge in 2026. Market entry is expected first in the emergency medical services sector, and a corporate VIP version, to be marketed by Airbus Corporate Helicopters, should be available by decade-end.

Final assembly of the H140 will be carried out alongside the H135 and H145 at the company's facilities in Donauwörth, Germany, marking the first time that Airbus has manufactured more than two commercial products in the country. 🗣️

Check 6 *Aviation Week* editors discuss highlights of this year's Verticon show: [AviationWeek.com/Check6](https://aviationweek.com/Check6)

Offshore Industry Explores Ways To Bring New Rotorcraft to Service

➤ AIRBUS H160 ENTERS OPERATIONS IN THE GULF OF MEXICO

➤ OMNI TO TEST BELL 525 IN GUYANA AFTER FAA CERTIFICATION



The Airbus H160 started offshore operations in the Gulf of Mexico after an extensive route-proving trial. Other manufacturers plan to follow a similar route to offshore service entry.

THIERRY ROSTANG/AIRBUS HELICOPTERS

Tony Osborne Dallas

Operational evaluations to build maturity and new models for capital investment are emerging to help bring new rotorcraft and technology into the offshore support business.

With helicopter utilization and demand at record levels—but supply of aircraft, spares, and manpower taut—operators and energy companies are keen to introduce new, more capable helicopters even while they are challenged by the increased cost of financing, and some are hesitant to be the first user of an aircraft. In response, operators are increasingly working with clients and manufacturers on operational evaluations and route-proving trials to mature new types.

One such initiative by Airbus, PHI Aviation and Shell paved the way for the airframer's H160 twin-engine medium helicopter to enter service in the Gulf of Mexico on March 6 after several hundred hours of route-proving flights since last summer. With the H160 proven, other operators plan to put the aircraft into offshore service. Omni Taxi Aereo aims to fly five on offshore services in Brazil in May.

Bell has a similar initiative in the works with Omni Taxi Aereo's parent company, Omni Helicopters Interna-

tional, to prove out its new 525. In the 500-hr., six-month, Bell-funded trial, the fly-by-wire twin-engine 525 rotorcraft is to begin flying between ExxonMobil platforms off the coast of Guyana, as soon as the latter half of this year.

The trial will "showcase" the aircraft, David Martin, Bell's senior product manager for commercial helicopters, told *Aviation Week* at the Verticon rotorcraft industry gathering here. "Omni is going to try to break it, and we're going to try and show we did a good job building it," he said.

As with the early H160 testing, the 525 needs to be certified ahead of the trials and will be flying no passengers. Instead, the aircraft will be loaded with representative mission weights and shadow Omni's existing Sikorsky S-92 flying program.

The trials aim to "short-circuit" acceptance of the new aircraft into offshore flying, says Duncan Moore, Omni's chief operating officer and design lead for the test program.

The operational evaluation will steadily become more complex, flying into more challenging weather and missions, including multistop trips to platforms that require refueling on the rigs. Omni will also test Bell's

approach to maintenance in both controlled environments and off base, Moore says.

Omni states that the results of the trials will inform its own 7-10-year fleet strategy. The operator is considering the 525 as a possible replacement for the S-92, which has similar passenger capacity and range performance. Bell sees S-92 replacements as the biggest addressable market for the 525, and the results of Omni's trial will be crucial to proving a level of maturity to meet the demands of the first 525 customer. Norway's state-owned energy company, Equinor, signed for 10 aircraft last year as part of an effort to diversify the country's offshore rotorcraft away from total reliance on the S-92.

Equinor itself financed the purchase of both 525s and AW189s, as being a larger company allowed it to acquire the aircraft at much lower rates than those available to the operators. Several offshore operators that had previously struggled through Chapter 11 bankruptcy protection face onerous borrowing rates. Equinor transferred ownership of the AW189s in January to rotorcraft lessor Milestone Aviation, which will in turn lease them to the selected operator, Lufttransport RW (AW&ST Feb. 10-23, p. 45).

Bell Chief Commercial Officer Danny Maldonado said on March 10 that such financing initiatives would likely "open the door" to more potential sales.

"The whole industry is looking at different [financing] models," said

others in the air (AW&ST Nov. 13-26, 2023, p. 26).

Leon Silva, Sikorsky's vice president of global commercial and military systems, told journalists at Verticon that the company has been ramping up overhauls of gearboxes and increasing time between overhauls for their housings. This has helped to return several grounded aircraft to operation. The airframer has also been redesigning, in-sourcing and leaning on the wider enterprise at parent Lockheed Martin to address fragility in its supply chain.

"We've learned a lot, not only in the aftermarket but also on the production side," Silva said. "And our level of visibility and ability to predict the challenges has significantly improved over that experience."



BELL TEXTRON

Omni Helicopters International will fly the first production Bell 525 on an operational evaluation in Guyana, where the company has a substantial operation flying on behalf of ExxonMobil.

Bell appears confident that it can wrap up 525 FAA certification this year. The company has finalized flight testing but still needs to complete a handful of ground tests as well as the regulator's mandated function and reliability (F&R) trials.

To prepare for the European market and Equinor's requirements, Bell "reinvigorated" its engagement with the European Union Aviation Safety Agency (EASA) last October, 525 Program Head Mike Deslatte said, adding that the company hopes to have a better idea this year of any additional work the European regulator might demand.

Equinor's deal for the 525 and a fleet of Leonardo AW189s, announced last February, also confirmed a growing trend in financing new aircraft for offshore use. Rather than relying on operators to acquire new aircraft,

Tony Cramp, managing director of Shell Aircraft and former chairman of the aviation subcommittee of the International Association of Oil and Gas Producers (IOGP). "We are looking for that best model that fits the operation, but it depends on the maturity, how long the aircraft is going to be there and the return on investment."

Industry officials appear increasingly confident that supply chain issues that had threatened to throttle offshore operations are stabilizing, although they note that new issues have sprung up. One industry executive at Verticon compared the situation to "whack-a-mole"—as one issue is solved, two more pop into view.

Sikorsky's S-92 offshore fleet had drawn particular attention from the IOGP, as a shortage of main gearboxes left aircraft on the ground and forced operators to cannibalize parts to keep

Sikorsky is unhappy, however, about offshore industry's perception that its offshore workhorse is becoming long in the tooth. Silva said the operational S-92 fleet is only 40% through its life, based on the airframe certification limits of 30,000 hr. So far, just one S-92 has reached that, and only one or two more will do so over the next five years, he stated. "Some of the anticipated retirements of the S-92, I think, are a little aggressive compared to what the reality will be," Silva said.

Sikorsky is predicting the need to ramp up S-92 production but is not expecting much demand from offshore operators despite the recent investments in a new main gearbox and an increased-gross-weight option to support the S-92A+. All new S-92s will be built to the A+ standard, and the version is expected to enter service in 2027. ☛

New Rotary-Wing Propulsion Options Emerge at Verticon

➤ **MAGNIX UNVEILS A LIGHTWEIGHT ELECTRIC ENGINE FAMILY**

➤ **SAFRAN EXPANDS ITS TRADITIONAL ROTARY OFFERINGS**

Guy Norris Dallas

The rotorcraft engine business, like the helicopter industry it serves, has been notoriously slow to develop new models and refresh its products over the decades. But now, as new propulsion concepts emerge, updates may be accelerating.

Signs of the transformation emerged appropriately at Verticon, the industry gathering formerly known as Heli-Expo that was rebranded to embrace the broadening scope of electric and hybrid-powered vertical lift. At the event, propulsion startup MagniX announced the launch of a range of electric engines for helicopters and for airborne power generation.

Safran expects to deliver the first Arriel 2W to Robinson for R88 flight tests in 2026.

Dubbed the HeliStorm, the lightweight, high-speed electric engine family builds on MagniX's development experience of fixed-wing powerplants and will cover the 6,000-7,000-rpm range.

The first engine will provide a peak power of 330 kW and leverages lessons learned from flight tests of a re-engined Robinson Helicopter Co. R44 with the Washington-based company's 350-kW Magni350 electric propulsion unit. United Therapeutics (UT)-backed Tier 1 Engineering conducted flight tests of the eR44, which marked the first point-to-point flight by an electric helicopter in 2022.

Although Robinson has since partnered with UT subsidiary Unither Bioelectronics to develop a hydrogen-electric version of the R66, the California-based helicopter-maker says it is supporting the MagniX initiative. "We look forward to continuing our collaborative efforts to deliver market-leading sustainable helicopters," Robinson CEO David Smith says.

MagniX says the HeliStorm electric engine, combined with the company's Samson energy density batteries, will be applicable across a range of light single-engine and larger hybrid-electric twin-engine rotorcraft. In addition to being lightweight, the electric motor has built-in redundancy that enhances safety, the company says.

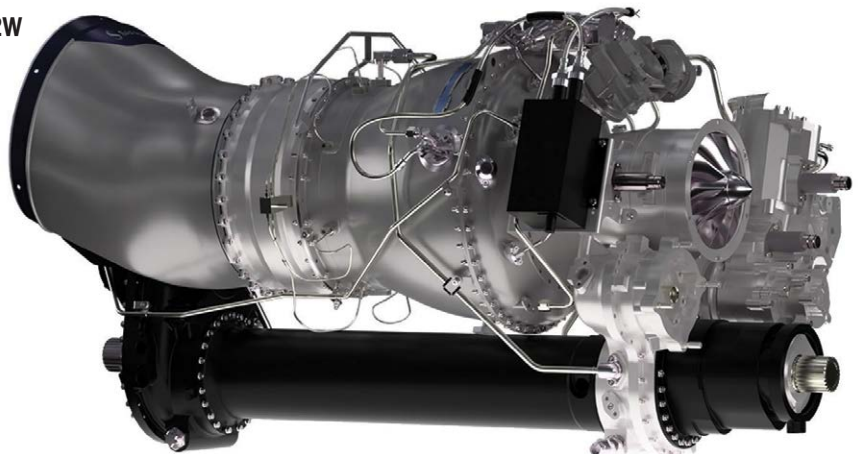
Flight tests of the eR44 included sustained hovering with one set of the two windings in the Magni350 disabled, effectively demonstrating the ability to maintain height with 50% of the unit operational. The company adds that this benefit would be extended for applications using the larger Magni650.

"It's all the same core technology," says Riona Armesmith,

MagniX chief technology officer. "It's the same architecturally—so it's two inverters and one motor that's electrically two motors. In the helicopter space, there's a big difference between max takeoff and cruise power and about where you optimize [your engine] and where you are able to provide some extra headroom. One of the things we saw with the R44 is that when we replaced the piston, our engine was 60 kg [132 lb.] lighter and could deliver twice the power."

While the necessary addition of batteries or a fuel cell negates much of this immediate weight benefit, the doubling of installed power provides some "interesting possibilities when you start to think about the operational and safety aspects of single-engine helicopters," Armesmith says. "We think that's a powerful thing to be able to do, to be lighter than the engine that's currently installed for two times the power. It can do interesting things in the industry."

MagniX's electric engines for helicopters are lighter than those for fixed-wing aircraft because they do not require beefing up to handle the large torque loads associated with powering a propeller through direct drive rather than through a gearbox. "In a rotorcraft, you don't need to take that load, and you already have a gearbox, so it's really about matching the speed input to the gearbox and slimming down the engine,"



SAFRAN HELICOPTER ENGINES

Armesmith says. "If you spin a motor faster, you can get more power out of it for less weight—that's just physics."

Because the helicopter market is sensitive to weight, MagniX aims to develop a broader range of tailored engines rather than rely on derivatives of the two Magni350/650 baseline units developed for the initial fixed-wing applications. "What if someone wants 450 kW or 470 kW?" Armesmith asks. "Do they really want to pay the weight of a 650-660-kW engine? Because of that, I think we're looking for a couple more products in this range but with common building blocks so that it isn't a completely new development each time."

Beyond modified Robinson helicopters, "there is other customer interest," Armesmith says. "This is the first time that we're really doing development that is based on customer demand, rather than back in 2016-17, when we started out by showing the world what was possible with the technology." Flight tests of the first 330-kW HeliStorm are expected to begin on an unidentified platform by midyear.

Meanwhile, traditional gas turbine developers also are working on new developments, with both GE Aerospace and

Safran Helicopter Engines actively seeking to expand their commercial footprints. U.S. engine-maker GE is working with Airbus Helicopters to define an advanced, new centerline turboshaft design for future light rotorcraft, while Safran announced it will power two new helicopters—the

MagniX plans to tailor versions of the Helistorm engine family to suit multiple rotorcraft power brackets.

Airbus H140 and Robinson R88—with its Arrius 2E and Arriel 2W, respectively (page 28).

GE's new engine study is being conducted as part of the Airbus Disrup-



tiveLab (D-Lab) initiative launched in 2022 to test technologies aimed at improving aircraft performance and reducing CO₂ emissions. Although the D-Lab was initially focused on an Airbus H135 flying laboratory, the overall effort has been expanded to include smaller and larger rotorcraft.

Centered on an advanced turboshaft in the 1,000-shp-range for an Airbus H125-size aircraft, the study is “trying to push the numbers in terms of overall efficiency, and some of that has to do with the aircraft configuration and some with the engine,” says John Martin, director of turboshaft advanced programs for GE Aerospace.

SPACE

With the Onset of Lunar Night, Firefly's First Moon Mission Ends

> THE COMPANY MAY HAVE BONUS SCIENCE FOR SALE

> THE BLUE GHOST LUNAR LANDER MAY RISE AGAIN

Irene Klotz Cape Canaveral

Firefly Aerospace is no stranger to adversity. The company went through bankruptcy and recovered from three troubled Alpha rocket launches. An angel investor was forced to sell it over foreign ownership concerns. Last year, its former CEO was sidelined amid allegations of misconduct.

So success was all the sweeter when Firefly's debut spacecraft not only landed on the Moon but operated for more than 14 days on the lunar surface, fulfilling a \$101.5 million flight services contract for NASA.

“When this small team started on this program in 2021, they had never built or flown a spacecraft,” Firefly CEO Jason Kim says. “To achieve these milestones on the first attempt is a feat that has even eluded nations. Firefly proved that space exploration is limitless, even for the smallest of teams.”

Launched by SpaceX on Jan. 15, Firefly Aerospace's Blue Ghost lunar lander spent 45 days in transit before touching down March 2 in Mare Crisium, a 345-mi.-wide basin on the Moon's near side. On board were 10 NASA science experiments and technology demonstrations as part of the

agency's Commercial Lunar Payload Services (CLPS) program.

“The Firefly Blue Ghost Mission 1 [BGMI] is what I would call an existence proof of how we wanted CLPS to work,” says Joel Kearns, NASA's deputy associate administrator for exploration in the Science Mission Directorate.

Of four CLPS missions conducted so far, only the Blue Ghost was completely successful, with seven more lunar surface sorties in development for NASA. To date, the agency has committed about \$1.4 billion through the initiative, which is intended to seed a lunar services and delivery industry. Under the CLPS, vendors design, fly and operate lunar landers to meet NASA's science needs.

Firefly is the third U.S. company to attempt landing on the Moon, following Intuitive Machine's partly successful IM-1 mission in February 2024. As the Blue Ghost mission was underway, Intuitive Machines touched down for a second time March 6, but its Athena lander toppled over, bringing operations to a close after one day. NASA's first CLPS mission, conducted by Astrobotic in January 2024, failed to make it to the Moon due to

a spacecraft propulsion problem.

The Blue Ghost transmitted more than 119 GB of data back to Earth during its mission, including 51 GB of science and technology data, significantly surpassing mission requirements, Firefly said March 17.

Key payload milestones include:

■ Tracking signals from the U.S. GPS, the European Union's Galileo and other Global Navigation Satellite System constellations, an achievement that suggests GPS-like signals could be used to navigate future missions to the Moon and beyond.

■ Reflecting laser pulses from Earth with the Next-Generation Lunar Retroreflector, allowing scientists to measure the Moon's shape and distance more precisely.

■ Taking X-ray images to study the interaction of solar wind with the Earth's magnetic field.

■ Deploying a 6-ft. mast from the top of the lander and four tethered Lunar Magnetotelluric Sounder electrodes on the Moon's surface—reaching a distance up to 60 ft. from the lander—to measure electric and magnetic fields.

■ Demonstrating a computer that can withstand space radiation while in transit to the Moon.

■ Studying how lunar regolith sticks to a range of materials exposed to the Moon's environment.

■ Imaging the spacecraft's descent and touchdown on the Moon to provide insights into the effects engine plumes have on the surface for future robotics and crewed lunar landings.

■ Drilling about 3 ft. into the surface

The work ultimately could lead to a new commercial offering, opening up a new market for GE, which has developed turboshafts traditionally for larger civil helicopters, including variants of the CT7 that power the Bell 525, Leonardo AW189 and Sikorsky S-92. “We’d love to be on an Airbus helicopter,” Martin adds. “They do tremendously in the helicopter market, especially the smaller ones.”

“Right now, it is still very conceptual, so I’d say it’s early in the study,” says Elissa Lee, director of commercial turboshaft engines for GE Aerospace. “But we’ll continue through up until the point where we want to make the decision to continue. It’s at the foundational research stage.”

Safran is already the dominant player in the light helicopter power market, and its new relationship with Robinson on the R88 will extend this reach with the 950-shp Arriel 2W, the newest variant of the Arriel family, of which 15,500 units have been produced for more than 40 helicopter types. The Robinson agreement includes a support and service

package that will cover scheduled servicing of the engine after five years or 2,000 flight hours—whichever comes first.

The package comes automatically with the R88 and “was something we crafted with Robinson because it’s been 15 years since they launched a new helicopter, and they wanted to ensure the attractiveness of the R88,” Safran Helicopter Engines CEO Cedric Goubet says. The first engine for flight testing is to be delivered to Robinson “as soon as possible next year,” he adds.

For the H140, the Arrius 2E is planned to deliver about 10% more power for the same fuel burn at maximum continuous power than earlier-generation Arrius 2 engines. Development of the 2E has been underway since 2020, and more than 10 engines are running in the initial test program. The engine incorporates a redesigned hot section, revised combustor, dual-channel full-authority digital engine control system and additively manufactured hydro-mechanical unit. 🌀



FIREFLY AEROSPACE

to measure the temperature and flow of heat from the Moon’s interior.

■ Demonstrating a sample collection system that uses pressurized nitrogen gas to collect, transfer and sort lunar regolith.

■ Demonstrating the use of electrodynamic forces to lift and remove lunar regolith from glass and thermal radiator surfaces, a promising solution for dust mitigation.

After 14 days on the lunar surface and 5 hr. after the onset of lunar night, Blue Ghost operations came to an end with a final download of data at 7:15 p.m. EDT on March 16. “Firefly met 100% of its mission objectives . . . after performing the first fully successful commercial Moon landing on March 2,

completing more than 14 days of surface operations,” Firefly noted in a statement. “This achievement marks the longest commercial operations on the Moon to date.”

Firefly’s contract with NASA for BGM1 is worth \$101.5 million, but the company may be able to parlay bonus science data, such as imaging the onset of lunar night, for additional payment.

“One of the things scientists will be looking for in some of the imagery is to see if they can identify a phenomenon called horizon glow or a mechanism called dust lofting, which is when lunar dust particles can become charged through exposure to solar ultraviolet radiation and experience what we think is electrostatic repulsion, causing

Firefly Aerospace’s Blue Ghost lander captured high-resolution images of a lunar sunset before it shut down on March 16, ending its two-week mission.

them to lift off from the lunar surface,” Kearns says. “It’s going to take some time to go through these images, but I think these are the first high-definition images looking at sunset and transitioning into the dark, so this is going to provide a valuable opportunity.”

“There was so much data collected as part of this successful mission, and we’re interested in so much of it, so that’s something we’re going to have to work through,” NASA CLPS Project Manager Adam Schlesinger adds.

Firefly is under contract for two more missions to the Moon for NASA, and commercial customers are expected to join. “We’re getting a lot of inquiries,” Kim says. “Since we’re a private company, we hold our wins proprietary.”

Firefly will look for one more piece of data from the Blue Ghost. After daylight returns to the landing site in early April, engineers will attempt to contact the spacecraft, which was not designed to survive the cold lunar night.

“I’d say the probability is very low that we do power back on, but this lander has surprised me multiple times over the last two months, and things have gone extremely well,” Firefly Spacecraft Program Director Ray Allensworth says. “I’ll remain optimistic. Maybe we will get a signal.” 🌀

INNOVATION MEETS



- JOBY AND ARCHER EXTEND THEIR eVTOL INDUSTRY LEAD
- UNITED ARAB EMIRATES TARGETED AS COMMERCIAL LAUNCH MARKET
- POTENTIAL DEFENSE INTEREST PIVOTS TO HYBRID eVTOL

JOBY AVIATION

Graham Warwick Washington, **Ben Goldstein** Boston and **Garrett Reim** Seattle

In the Silicon Valley startup world, the mantra is “move fast and break things.” But in the world of electric air taxis, the reality of the moment is “move fast and brake.”

After a rapid start, developers of electric vertical-takeoff-and-landing (eVTOL) aircraft have had to slow down as they work to certify their products. That process is taking more time and money than anticipated, cannibalizing resources that could be spent on scaling manufacturing and flight operations.

“The old adage in aviation is that nothing happens until the paperwork happens,” says Dean Rudolph, advanced air mobility practice lead for the Collinear Group consultancy. “You can have the best design, and you can have the best ideas, but doc-

umenting those . . . it’s incredibly time-consuming.”

The biggest hurdle is demonstrating conformity—proving to the regulator that the aircraft conforms with the type design so they can grant type inspection authorization (TIA) to begin flight testing for credit toward type certification.

“Several of these organizations are coming to certification . . . through the eye of the needle backward,” Rudolph says, referring to the eVTOL industry generally. “They started with flying a full-scale prototype, and now they’re trying to certify. They’re trying to challenge all of the assumptions they’ve had, from hundreds to thousands of flight hours.”

Industry leaders acknowledge that the timeline to certify a passenger-carrying eVTOL aircraft is longer and harder than they could have imagined. They praise the FAA’s progress, with

the U.S. taking the lead as Europe’s eVTOL pioneers stumble. But there is trepidation that disruption from the Trump administration’s efforts to downsize the U.S. government could yet impact schedules.

Joby Aviation has built four S4 eVTOL vehicles on its production line in Marina, California, and it reached its target of producing parts equivalent to one aircraft per month by the end of 2024. But the company will not roll the first conforming aircraft off the line and begin for-credit flight testing before early 2026.

Virgin Atlantic has switched to Joby Aviation from Vertical Aerospace to launch air taxi service in the UK.

“The thing we are focused on this year is ensuring that an increasing number of those manufacturing lines, and parts that come off those manufacturing lines, are conforming—that is, built to FAA specifications,” Joby Executive Chairman Paul Sciarra said on a Feb. 26 earnings call.

The startup has begun for-credit ground testing of conforming components and through this year plans to use its fleet of production-representative, nonconforming prototypes to practice flying the certification test cards that conforming aircraft will use once the FAA grants TIA.

This way, Joby hopes to compress a certification flight-test schedule that SMG Consulting’s Sergio Cecutta estimates could be 14-19 months from TIA to type certification, based on recent light helicopter programs. The startup has not given a schedule, but Cecutta estimates Joby could certify by the end of 2026.

Joby also hopes to compress the post-type certification operational suitability and certification phase, which Cecutta estimates could take 9-15 months, based on past programs. CEO Joe Ben Bevirt tells Aviation Week that Joby should be able to begin Part 91 route-proving flights before it adds the eVTOL aircraft to its existing Part 135 air operator certificate and launches commercial air taxi service in the U.S.

REALITY

Rehearsing TIA flight tests through this year is also key to the startup's plan to deploy eVTOL aircraft to Dubai and fly passengers ahead of launching operations in the U.S.

Joby also plans this year to continuing ramping up production in Marina and bringing online its new facility in Dayton, Ohio, to produce parts to supply the California assembly line. Supported by a \$9.8 million grant from the state of California, the company is doubling its manufacturing footprint there, which it expects to more than double its annual production capacity, Sciarra told analysts.

Archer Aviation has moved its first piloted Midnight eVTOL prototype to Salinas, California, for ground testing in preparation for first flight. This is not a conforming aircraft. "There's a set of onboard system components which have been conformed, along with some aerodynamic measurements we made on the aircraft, all to support the testing we plan for that aircraft," founder and CEO Adam Goldstein said on the Feb. 27 earnings call. "Subsequent aircraft will have the increased level of conformity."

Archer plans to build up to 10 aircraft this year at its new manufacturing plant in Covington, Georgia, and the first is slated to be completed by early summer. Three will be instrumented for flight testing and the rest labeled as Launch Edition aircraft for early commercial deployment.

Under the Launch Edition program, Archer plans to deploy small fleets of precertification aircraft with partners in early-adopter markets over the next 18-24 months to establish air taxi operations and generate early revenue. The first agreement, signed with Abu Dhabi Aviation in the United Arab Emirates (UAE), is valued at around \$20 million.

"The concept of the Launch Edition was: How do we deploy and monetize every single aircraft that we can build?" Goldstein tells Aviation Week. "I think we found a pathway to do that. My whole theory is that we have to monetize these businesses at some point, and that means finding the

most efficient path to certification. I think that's a pretty big difference compared to what some other competitors have done."

Amid delays, the program is a way to generate revenue from the tens of aircraft Archer expects to produce over the next two years as it works with the FAA to certify the Midnight and launch commercial service in the U.S. Archer has not given a schedule for certification, but Cecutta estimates mid-2027.

In Brazil, Eve Air Mobility's schedule continues to slip. The Embraer spinoff's full-scale engineering prototype is now expected to fly by midyear, beginning with tethered hovers and progressing to transition flights with the simplified vehicle being piloted remotely.

Eve plans to build five conforming prototypes and to begin flight tests in

will clear the up-and-away flight envelope ahead of transition testing. The company plans to complete a full piloted transition by year-end.

A third prototype, a carbon copy of the second, is being assembled at GKN Aerospace's Global Technology Center and is expected to join the flight-test program this year. "The next aircraft we build will be our certification aircraft," CEO Stuart Simpson said on the March 11 earnings call, adding that Vertical expects to begin manufacture this year. "The regulations [under which we will certify] for Special Condition for VTOL are clear, transparent," he said, referring to the European Union Aviation Safety Agency-developed airworthiness standard to which Vertical plans to certify the VX4. "This is why we are confident and comfortable putting out a clear certification date in 2028."

LAUNCHING IN THE UAE

Absent conforming prototypes with which to begin certification flying, Archer and Joby plan to deploy aircraft to the UAE this year to begin testing under their respective agreements.

The main landing gear of the piloted Midnight has been redesigned to ease runway takeoffs and landings.



2026, leading to type certification and service entry in 2027. The startup's preorder backlog stands at about 2,800 aircraft with nonbinding letters of intent from 28 customers, a slight reduction due to changes in the customer lineup.

In the UK, Vertical Aerospace expects to begin wingborne flight testing of its second full-scale piloted prototype within the next 3-6 months, having completed thrustborne hover and low-speed tests in 2024. Taking off and landing on a runway, wingborne tests

"This summer, we'll deliver our first piloted Midnight to Abu Dhabi and begin flight testing in country," Archer Chief Technology Officer Tom Muniz said on an earnings call. "With that aircraft, we'll focus our efforts on testing it in high-temperature operations, as conditions there can exceed 110F during the day. . . . The two things that are different about over there are the higher temperatures . . . as well as the additional dust and sand considerations."

"The first part will be doing those experimental tests to ensure the air-

craft is safe,” Muniz added. “We don’t anticipate needing to make any changes, but we need to do the testing first.” Muniz said Archer intends to start flights subsequently in and around cities in the UAE, operating proving runs to and from locations in its network and eventually performing market survey flights “with limited passenger operations.”

Archer has finalized its project specific certification plan with the UAE General Civil Aviation Authority (GCAA). “This document outlines the steps needed to bring Midnight to market in the country, which we are well

continues to target flight with its first passengers by early 2026. The first of four vertiports in the initial network is under construction by the RTA and partner Skyports Infrastructure near Dubai International Airport.

Approval from the UAE regulator to begin flying passengers is to be based on the pre-TIA flight testing in Marina. “We are seeing fantastic momentum and a great lean-in from the GCAA, but there’s still work to do,” Bevirt said on the earnings call. “And once we get the aircraft there and begin in-market testing, we’ll have better fidelity on that timeline.”

tions, and they are targeting a potential U.S. Defense Department program of record.

The startup subsequently raised \$730 million to establish Archer Defense and develop the hybrid aircraft platform. “We’re in the process of building the aircraft,” Goldstein told analysts on the earnings call. “The goal is to leverage a lot of the core capabilities that we have from the Midnight aircraft program and to meet some of the existing needs that we see happening.”

With the pivot to hybrid eVTOL, work under U.S. Air Force’s Agility Prime is expected to end early. Bevirt says Joby has accomplished much of what it had hoped for under the program, including delivering two aircraft to Edwards AFB in California and training Air Force pilots to fly them

Eve has ground-tested the pusher-propulsor on its remotely piloted, full-scale eVTOL engineering prototype.

and mechanics to maintain them. The company also has ticked the hybrid box, flying a modified prototype with a hybrid hydrogen-electric propulsion system that demonstrated a 561-mi. range in July 2024.

The modified aircraft was equipped with a fuel cell and liquid-hydrogen tank but retained some of the baseline eVTOL’s batteries, showing Joby’s ability to hybridize the aircraft.

“For example, we can put a turbine in place of the fuel cell to start,” Bevirt says. “It’s plug-and-play with our aircraft,” he adds, noting that liquid hydrogen “is far harder technically” than a turbine hybrid. Joby acquired automated flight system startup Xwing in June 2024, which could open the door to introducing the technology into a hybridized eVTOL aircraft for missions including long-range autonomous logistics.

FUNDING DISPARITY

Joby and Archer remain the best-funded companies in a nascent eVTOL industry that has begun to experience casualties. Lilium is in bankruptcy a second time after a financial rescue failed to materialize. Insolvent Volocopter has been sold to Chinese automotive parts and equipment manufacturer Wanfeng for a fraction of its value.

Joby ended 2024 with \$933 million



down the path of executing against,” Muniz said. “We have already begun submitting compliance data to the UAE for review and acceptance.”

“In the UAE, we’re working with the GCAA to certify those aircraft locally,” Goldstein said on the call. “And from Archer’s perspective, this allows us to deploy, monetize these aircraft, and we can build them pre-FAA type certification.” In addition to the aircraft, the company will provide an operational support team of pilots, technicians, engineers and local leadership.

“The main high-level goal is to take aircraft and stand up all the necessary ecosystem to launch the broader network,” he said, by delivering aircraft and teaching customers how to train pilots and maintainers as well as to plan routes and engage the local community. “And we’re trying to have that assembled in a way that can be margin-positive for Archer but also very beneficial to the customers themselves.”

Joby plans to have one of its existing pre-production prototypes in Dubai by midyear under its exclusive agreement with the emirate’s Roads and Transport Authority (RTA). Joby

“We are expected to be seen as the first country that will operate a commercial eVTOL in Dubai and Abu Dhabi,” Yousuf Hashim Al Azizi, GCAA assistant director general of strategy and international affairs, said on the sidelines of the International Civil Aviation Organization symposium in Abu Dhabi on Feb. 10-12. “This year, there might be an experimental phase of some of our key eVTOL projects. An official commercial operation is expected maybe by the end of 2026 or early 2027.”

Industry insiders characterize the statement as the regulator being conservative, but it flags the possibility that launching commercial air taxi services in the UAE may take longer than the companies anticipate.

DEFENSE PIVOT

In the last three months, activity has ticked up markedly around defense applications of eVTOL, and customers have pivoted to hybrid-electric aircraft with longer range and greater capability. In December, Archer announced a strategic partnership with Anduril Industries to develop a hybrid eVTOL aircraft for military applica-

Vertical is building the third VX4 full-scale prototype at GKN Aerospace's Global Technology Center.

in cash, having raised an additional \$350 million over the year. The company is working through the final steps of an agreement with its largest shareholder, Toyota, to access the first of two \$250 million investment tranches expected this year. These will increase its cash on hand to around \$1.4 billion.

At the same time, Joby's expenses are growing as it moves into certification testing. The startup used \$450 million in cash in 2024 and is forecasting a cash burn of \$500-540 million this year. But Bevirt says the funding should be sufficient to see Joby through FAA certification and into revenue-earning commercial service. "With the \$933 million we had on the balance sheet at the end of the last quarter and the additional \$500 million committed by Toyota, we have the runway," he says.

Archer ended 2024 with \$835 million in cash. After raising another \$300 million in January, its liquidity stands at more than \$1 billion. "We've continued to see strong investor demand," Goldstein told analysts. "It is important to note that our current liquidity of \$1 billion does not include any of the up to



VERTICAL AEROSPACE

\$400 million of additional capital. Stellantis has agreed in principle to commit to help scale the manufacturing of our Midnight aircraft." He expects that agreement to come this quarter.

Cantor Fitzgerald Senior Equity Analyst Andres Sheppard attests to the high levels of investor interest in Archer and Joby, referring to the two as the "Pepsi and Coke" of the eVTOL sector. But he acknowledges that investment dollars have not been flowing evenly across the sector.

One particular problem affecting some publicly traded companies with lower valuations—like Eve and Vertical—is a lack of float, or a shortage of available shares on the market, which makes it difficult for institutional in-

vestors to move in and out of positions easily without causing large price swings.

Perhaps most important, Sheppard says investors are confident that Archer, Joby and Beta Technologies have enough cash on hand to survive at least another few years until type certification. "They have enough runway to assure investors that they're still going to be around in one, two, three years' time," he explains.

Austin Moeller at Canaccord Genuity says investors are increasingly focused on the small handful of companies that have demonstrated technologically mature and economically viable designs, with substantial flight hours and test data as well as good performance.

EHang: Leader and Outlier

Graham Warwick Washington

CHINA'S EHang HAS PROVIDED A TASTE OF WHAT ELECTRIC air taxi developers hope is to come. It is the first to certify an electric vertical-takeoff-and-landing (eVTOL) aircraft—one that not only carries passengers but is autonomous, a milestone not widely expected to be achieved in the West before the end of the decade.

Founded in 2014, Guangzhou-based EHang in 2024 became the first eVTOL manufacturer to achieve profitability as its revenues rose almost 290% on delivery of 216 two-seat EH216-S eVTOLs for the year. The startup is ramping up production and anticipates revenues will almost double again in 2025.

Armed with type and production certificates for the EH216-S, EHang is awaiting final approval of operator certification, the first under interim regulations for uncrewed passenger aircraft in China. This will enable the launch of commercial eVTOL services by its subsidiary EHang General Aviation as well as Heyi Aviation, its joint venture with the municipal government of Hefei.

This year, the startup is expanding and automating its first production facility in Yunfu in south China to produce 1,000 units annually, up from its current 300, and has manufacturing bases planned in Hefei in eastern China as well as in Weihai and in Beijing's Fangshan District in northern China. Each will be responsible for different product lines, including passenger transport, logistics, emergency response and firefighting.

EHang is developing both fast-charging and solid-state batteries with partners. The November flight test of the EH216-S with solid-state batteries showed a 60-90% increase in endurance, with production and installation planned by year-end, founder and CEO Huazhi Hu told investors on March 11. The longer-range VT-35 eVTOL prototype is in final assembly and will fly soon, he added.

"Our domestic demand is very strong," Hu said. EHang's focus for the first 2-3 years will be aerial tourism as the company gathers operating data and Chinese cities build the vertiports and other ground infrastructure required for air taxi operations. The EH216-S has flown in 19 countries, and EHang is exploring "innovative pilot-first approaches" to expedite international operations, Hu said. 🌐

“There is definitely robust investor interest in urban air mobility right now, but I think there has been some consolidation around designs that are viewed as technically mature and could be first to market,” Moeller says.

Eve ended 2024 with \$303 million in cash, having raised \$270 million in a mix of debt and equity over the year. Including a long-term credit facility with Brazilian development bank BNDES, “our total liquidity of \$430 million as of the end of 2024 is very comfortable, and it’s enough to sustain our operations at least for 2025 and 2026,” CEO Johann Bordais told analysts on the March 11 earnings call.

The company expects to consume \$200-250 million of cash this year, up from \$141 million in 2024. This is likely to include an initial \$30 million of a planned \$100 million capital expenditure in its first eVTOL manufacturing plant in Taubate, Brazil, supported by the BNDES credit line.

Vertical relaunched in November 2024, turning half of a \$130 million floating rate convertible loan note

from Mudrick Capital into equity, extending the term of the other half and fixing the conversion rate. The deal, with Mudrick as the new majority owner, cleaned up the startup’s balance sheet to make it easier to raise additional financing.

Vertical ended 2024 with just \$28 million in cash but raised \$90 million from existing and new investors in January after restructuring. “This secures our funding through 2025,” Simpson said on the earnings call, noting that it plans additional fundraising this year. The startup expects to spend \$110-125 million this year, up slightly from 2024, on increased flight testing.

Vertical holds preorders for more than 1,200 aircraft and intends to re-open its orderbook this year. Discussions on firming up orders will begin once the company has flown its first certification prototype. “A couple of months after that, when we’ve done some testing on it . . . I think we’re in a great position to start those discussions with customers around who wants to be at the front of the queue,” Simpson said.

Volocopter filed for insolvency at the end of 2024 after failing to raise additional funding to complete certification of the VoloCity eVTOL aircraft. Founded in 2011, the startup did not go down the special-purpose acquisition company route others took to a public listing and instead raised more than \$760 million from private investors, according to SMG Consulting.

Chinese automotive supplier Wanfeng announced in a March filing that it had agreed to acquire the German startup’s assets for €10 million (\$11 million). Volocopter’s assets, valued at €46 million, have been acquired via subsidiary Wanfeng Aviation, which owns Austrian general aviation manufacturer Diamond Aircraft.

Last year, Wanfeng also acquired the rights to Volkswagen Group China’s V.MO piloted four-passenger eVTOL aircraft. Volocopter’s two-seat VoloCity and uncrewed VoloDrone are complementary, and Wanfeng says the acquisition will accelerate its eVTOL product development and give it a new growth engine. 🚀

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AVIATION WEEK
NETWORK

MISSED SIGNALS?

- > NTSB PROBE LEADS TO RESTRICTIONS AROUND WASHINGTON NATIONAL
- > WARNING SIGNS HAD LONG POINTED TO RISKS POSED BY HELICOPTERS
- > THE FAA USES AI TO DETECT SIMILAR PATTERNS AT OTHER AIRPORTS

Sean Broderick Washington

New restrictions near Ronald Reagan Washington National Airport have eliminated the risk of another midair collision similar to January's accident involving a regional jet and a U.S. Army helicopter. Investigators and the FAA are still piecing together why such risk persisted for years despite warning signs and whether other precursors were missed.

The NTSB in a March 11 safety recommendation letter called on the FAA to prohibit helicopter operations east of National Airport (DCA) along a section of helicopter Route 4 when the airport's secondary runway, Runway 15/33, is in use. The board also recommended that the FAA designate an alternate helicopter route when 15/33 is in use. The NTSB labeled both recommendations "urgent" and suggested that the FAA work with stakeholders, notably the Defense Department, to develop safe alternatives. The FAA, which had issued temporary restrictions soon after the accident through March 31, immediately accepted the recommendations.

New restrictions will limit helicopter flying and air traffic protocol around DCA.

"The existing separation distances between helicopter traffic operating on Route 4 and aircraft landing on Runway 33 are insufficient and pose an intolerable risk to aviation safety," NTSB Chair Jennifer Homendy said in a March 11 briefing.

Route 4 runs along the Potomac River's east bank and crosses the arrival end of Runway 33 at about 200 ft. above the river, or within 75-100 ft. of where an inbound aircraft should be (see diagram). This location is where American Eagle Flight 5432, a Bombardier/MHIRJ CRJ-700, and the Sikorsky UH-60L Black Hawk, call sign PAT-25, collided on Jan. 29 as the regional jet was on final approach to Runway 33. The collision occurred at 8:48 p.m. local time, in the dark. All 64 occupants on the regional jet and three on the helicopter were killed.

The Route 4-Runway 33 intersection is the only area around DCA where approved helicopter routes and conven-

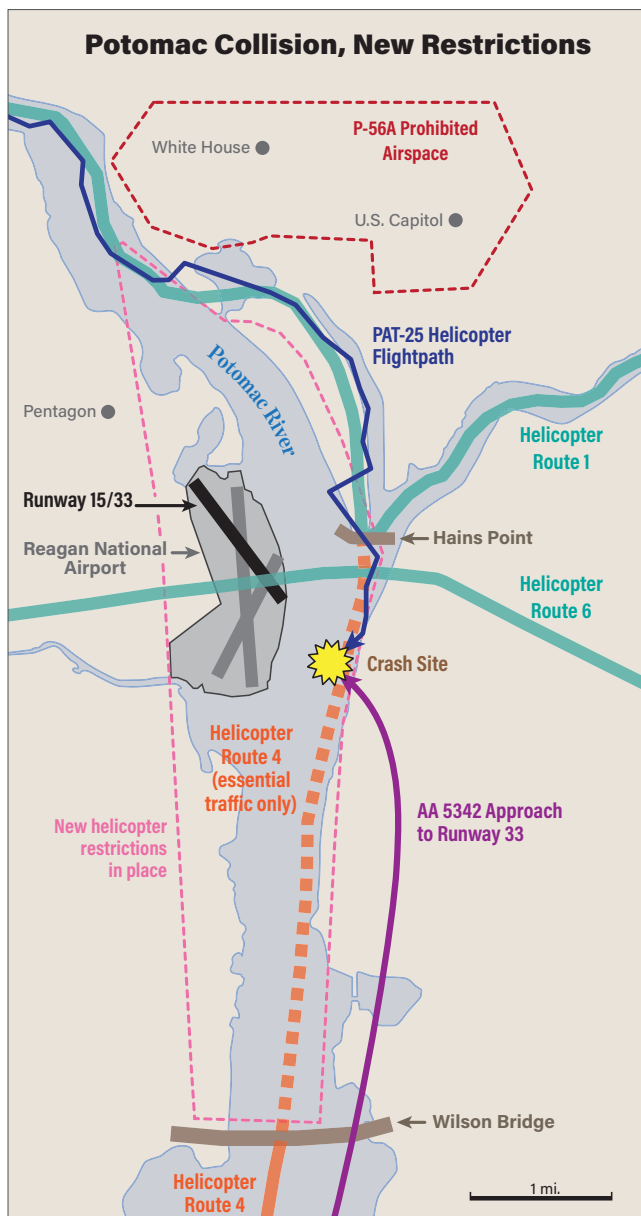


Diagram sources: NTSB and FAA. Illustration: Colin Thom/AW&ST

tional airways fly this close together. The minimal separation is a worst-case safety margin and was never meant to support simultaneous operations. But an NTSB examination of pilot reports and other incident data shows that the risks of mixing helicopters and commercial aircraft near DCA extends well beyond the midair collision location.

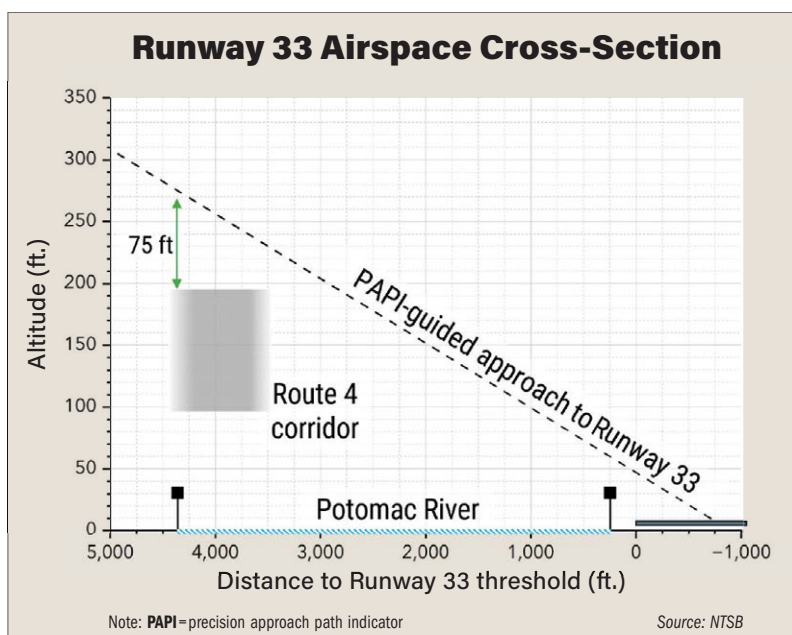
The NTSB review found that from 2011 through 2024, commercial aircraft received an average of one traffic collision avoidance system (TCAS) resolution advisory (RA) per month due to conflicts with helicopters near DCA. Most of these incidences happened during approaches, and

two-thirds occurred at night. Many of these conflicts involved helicopters flying higher than authorized.

RAs are TCAS' last line of defense. An RA signals an imminent collision and provides commands—such as “climb,” “level off,” “descend”—for pilots to maintain separation from another aircraft.

Investigators found that commercial aircraft and helicopters came within 1 nm laterally and 400 ft. vertically about 15,200 times in 974,000 total operations from October 2021 through December 2024. On 85 occasions, the separations were less than 1,500 ft. laterally and 200 ft. vertically. “There clearly were indicators where safety trending could have occurred,” Homendy said.

“Why this information wasn’t studied and known before Jan. 29 is an important question,” Transportation Secretary Sean Duffy said in a March 11 briefing in response to the NTSB recommendations. “But based on that information and this crash, we are going to continue with our restrictions.”



The restrictions, which go beyond the NTSB recommendations, effectively ban all nonessential helicopter traffic on Route 4 from Hains Point, 0.6 nm east of the airport, to the Wilson Bridge, 2.8 nm due south of the airport. If essential operations, such as active first responders or air defense missions, are required, all commercial traffic—notably, flights in and out of DCA—must pause. Use of visual separation air traffic control (ATC) protocol will be limited to certain helicopter operators. The FAA issued its temporary bans, which expire on March 31, and said it would wait for input from the NTSB based on the investigation. The new, permanent restrictions were slated to be codified in a Notice to Airmen, or NOTAM, within days, Duffy said.

The secretary acknowledged that the FAA's lack of action before the collision needs to be examined. “I think the question is, ‘When this data comes in, how did the FAA not know?’” Duffy said. “How do they not study the data to say, ‘Hey, this is a hot spot. We’re having near misses, and if we don’t change our way, we’re going to lose lives.’ That wasn’t done.”

How the FAA responded to the incident reports will be

one of the NTSB's primary focus areas as its investigation expands. Events that trigger RAs fall under the FAA's category of occurrences that require formal reports and evaluations. The FAA's Air Traffic Organization has a safety management system that lays out specific protocols for investigating incidents and evaluating risks. Several FAA orders codify the process for FAA employees.

Voluntary reports, such as entries in NASA's Aviation Safety Reporting System—including dozens of records that recount occurrences between aircraft and helicopters around National Airport—are considered unverified data and are not automatically escalated for review (*AW&ST* Feb. 10-23, p. 16). However, individuals involved can file formal reports.

But the formal reporting of an event does not ensure that it goes through a prescribed risk analysis process. If an occurrence does not meet specific thresholds, such as two aircraft coming within a certain proximity or obvious mistakes by front-line workers, it may not receive additional scrutiny. “It’s not out of the realm of possibility that [these reports] just didn’t go any further,” one source with ATC experience tells *Aviation Week*.

Duffy said the FAA has adopted a proactive approach to flagging air traffic risks, starting at airports that, like DCA, have significant transiting traffic mixed with departures and arrivals. The agency is using artificial intelligence (AI) to analyze traffic patterns at a dozen airports in eight cities with charted helicopter routes, Duffy said. Plans call for expanding AI monitoring nationwide within weeks, he added.

“A lot of information comes, and it’s hard to parse through it,” Duffy said. “AI will help us look at it and see what information we can draw from it to make changes moving forward.”

The FAA said it is “using machine learning and language modeling to scan incident reports and mine multiple data sources to find themes and areas of risk.”

The changes to DCA's airspace and analysis of other airports had industry backing before Duffy's announcement. “We support permanently suspending those helicopter flights around DCA with certain exceptions,” Airlines for America President Nick Calio told lawmakers during a March 4 House aviation subcommittee hearing on ATC staffing and safety. “We also think that helicopters around other major airports that are busy should be reevaluated and looked at for permanent change.”

National Air Traffic Controllers Association (NATCA) President Nick Daniels offered no specifics on the accident, citing the association's status as a party, or designated participant, in the NTSB probe. But he cautioned that safety-related procedural changes, such as traffic bans, should be based on collaborative analysis of specific risks.

“It is imperative that we remember that we have safety processes in place today, and we have a local safety council that deals not only at DCA but across the entire National Airspace System,” Daniels told the subcommittee. “It’s imperative that the FAA and NATCA continue to work. That way, we can make that determination at the local level of what the safest approach is, rather than rote mandates.”

The decision to ban helicopter flights following the acci-

dent was made based on safety council input, he suggested. "Right after that accident was [an example of] working together to implement change in temporary procedures because we had this process in place," Daniels said.

Former NATCA President Paul Rinaldi suggested that while a collaborative approach can be effective, the FAA needs to act more quickly to mitigate known risks. "That area where the accident happened is a known conflict area," Rinaldi told lawmakers. "It's been a known conflict area for years. The FAA should look at these known conflict areas and deconflict them so we don't have to worry about [them]."

The NTSB recommendations stem from the ongoing probe. A preliminary report on the investigation released along with the recommendations adds some new details about the accident sequence. Investigators concluded that both aircraft had illuminated their routine navigation and collision lights. The CRJ also had its right- and left-wing landing lights and upper and lower beacon lights on, the report added. None of the aircraft's lights were LEDs.

The helicopter's active lights included the left, right and tail pylon position lights, the report said.

The CRJ crew received one aural TCAS traffic advisory (TA), 19 sec. before the collision, at a radio altitude of about 850 ft. The UH-60L was 0.95 nm away, the report said. TCAS RAs are inhibited below 900 ft., while aural TAs cease below 400 ft.

Detailed altitude data on the helicopter is still being compiled, Homendy said. Details verified so far indicate that the helicopter was above 200 ft.—the collision occurred at about 300 ft.—and investigators are still working to determine why.

A review of communications between the local controller in DCA's tower and both crews confirms that the controller and the Black Hawk crew twice exchanged messages about the inbound CRJ. Both times, someone in the helicopter confirmed having the aircraft in sight and requested visual separation, which was granted. This effectively made the helicopter responsible for ensuring separation, although controllers can always intervene.

Investigators determined that key parts of messages from the controller to the helicopter did not get through, which could help explain why the UH-60L crew seemingly never saw the CRJ-700 regional jet, despite assuring controllers they had the correct aircraft in sight.

One instruction, issued about 2 min. before the accident, informed the helicopter pilots that the CRJ—5.5 nm away at the time—was in the area. The controller provided the jet's approximate location and altitude as well as a note that it would be changing course from its Runway 1 arrival and "circling to Runway 33" for its approach, a switch that meant the regional jet would intersect Route 4.

"[Cockpit Voice Recorder (CVR)] data from the Black Hawk indicated that the portion of the transmission stating the CRJ was circling may not have been received by the Black Hawk crew," Homendy said during a Feb. 14 media briefing. "We hear the word 'circling' in ATC communications, but we do not hear the word 'circling' on the CVR of the Black Hawk."

Then, just 17 sec. before the collision, the controller told the Black Hawk crew to pass behind the CRJ, which was coming from the southbound Black Hawk's east, or left, side as it

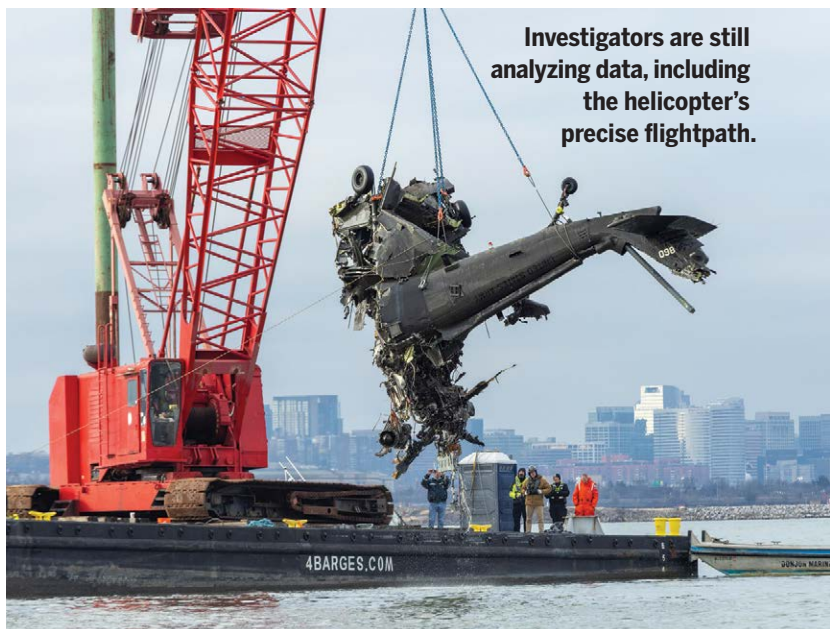
approached Runway 33. But the helicopter crew apparently did not receive the key "pass behind" part of the message.

"Data from the Black Hawk indicated that the portion of the transmission that stated 'pass behind the' may not have been received by the Black Hawk crew because someone keyed a microphone to communicate with the controller," Homendy said. "The transmission was stepped on by an 0.8-sec. mic key from the Black Hawk."

In a follow-up response 2 sec. later, a Black Hawk pilot told the other crewmembers that ATC wanted them to move left, toward the Potomac's east bank.

Information released by the board includes no evidence of messages to the American crew about the Black Hawk or any other helicopter traffic.

The confusion increases the spotlight on communications between ATC and the pilots. Both the CRJ and the Black Hawk were using VHF communication channels, but they were different—one was dedicated to airport arrivals



Investigators are still analyzing data, including the helicopter's precise flightpath.

CHRIS BJULAND/NTSB

and departures, and one was for helicopter traffic. In that scenario, although both crews could hear everything the controller communicated, they could not hear each other. Investigators will look closely at how this could have affected the pilots' situational awareness.

An NTSB review of DCA tower controller staffing on the day of the accident found that the local controller and helicopter controller positions were combined, or handled by one controller, at 3:40 p.m.—about 5 hr. before the accident. A second controller was also working two positions: flight data and clearance delivery. Three other controllers were on duty working single positions: assistant local control, ground control and operations supervisor. Four additional controllers were in the facility but not on duty at the time of the accident, Homendy said.

Such staffing was not uncommon, the experienced ATC source says. The flight data and clearance delivery roles are usually handled by one controller. The helicopter control position will often be combined if rotary-wing traffic is light. Assigning it to the local controller responsible for the runways maximizes situational awareness. 🌐

THE OTHER PART

- > AIRCRAFT LESSORS ARE WORRIED ABOUT TARIFFS AND INFLATION
- > WITH AIRCRAFT IN SHORT SUPPLY, NEW GROWTH PATHS ARE SCARCE AND CROWDED
- > CONSOLIDATION IS EXPECTED TO ACCELERATE

Jens Flottau Phoenix

The aircraft leasing sector has often been portrayed as a group of the lucky few in aviation that were in the right place at the right time. Well-funded, appropriately rated—sometimes, they say—lessors have served as the airlines' bank in bad times, gaining market share in the process, seeing lease rates go up continually and with no end in sight, making returns well in excess of most other parts of the industry.

That is all largely true. But it is also only part of the story. The other part is that structural issues the industry is facing are making lessors' work incredibly complex.

"Most of the larger lessors would prefer a normalized market," ORIX Aviation Group CEO James Meyler told the audience of a panel at the International Society of Transport Aircraft Trading (ISTAT) conference here

Lessors control a growing share of the commercial fleet. But tariffs, inflation and supply shortages pose threats to their business models.

in early March, despite the demand-supply imbalance they currently enjoy. Adding to largely self-inflicted internal industry issues, lessors are becoming increasingly worried about the impact of the new U.S. administration's trade and economic policies. The lessors' take in short is that the policies are likely to mean big trouble.

As Avitas President Adam Pilarski told his audience at ISTAT, two core elements of the Trump administration's economic agenda, tariffs and tax cuts, will lead to higher inflation. Tax cuts will increase demand but not supply in the U.S., and tariffs will make imports more expensive. Add to that a shortage of labor with already low unemployment and potentially many foreign workers forced to leave, and the ingredients for inflation are there. Needless to say, lessors do not like inflation.

"Inflation is not so good, on balance," Dubai Aerospace Enterprise (DAE) CEO Firoz Tarapore said at the conference. The benefits of even higher lease rates in an inflationary environment are well outweighed by the negatives of their impact on the real economic growth and purchasing power that drive air travel demand and ultimately the need for leased aircraft, Tarapore argued.



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OF THE STORY

Robert Korn, Carlyle Aviation Partners chairman and co-founder, said he is “always worried about a recession [and] the knock-on effects of all of this instability created now.” Korn urged the administration: “Let’s not do something that messes up [stability].” Inflation “does not help the working family make ends meet,” he added. If they cannot make ends meet, they will not travel.

“As investors, we make very long-term decisions and significant investments,” Korn said. “A bit of stepping back and waiting to see how this shakes out is probably the best advice for everyone [at this stage].” In that spirit, he noted that he will be “watching, trying to understand what will be enforced and stick.”

ORIX’s Meyler concurred. Tariffs “have the potential to have real short-term effects,” he said, leading to increased costs and inflation in general. “It is clearly not ideal to have these uncertainties [that could] change the thesis,” he added. Meyler even raised the question of whether there could be tariffs for lease rentals.

“What drives airline traffic are global trade flows,” BOC Aviation CEO Steven Townsend

remarked. “It will hurt aviation if global trade is affected.”

While the persistent aircraft delivery delays are good for the value of the in-service fleet, lease extensions (now at an all-time high) and lease rates, they eliminate an obvious route for growth for many lessors: taking new aircraft from manufacturers that have also decided to do business with a much smaller group of bigger lessors. “The constraint on growth is the supply side,” Avolon Chief Risk Officer Jim Morrison said. “It is driving what growth is possible.”

The rest of the industry has to find different paths, but the sale-and-leaseback market is hypercompetitive, with often dozens of lessors bidding for the same financing deal. Airlines are holding onto or even purchasing aircraft from lessors willing to sell them.

“The [lessor] business model was going to the OEMs and purchasing,” AerCap Chief Commercial Officer Peter Anderson said. “But the purchase price has never been higher; the time to delivery has never been longer; and protection has never been less.” Lease rates that benefit lessors’ margins make aircraft “almost unleaseable” under the circumstances. DAE’s Tarapore said placing a new order now “would be pretty crazy.”

Meyler’s view is that placing a single big order now would be a “gamble,” but it could be different if “you have a consistent pipeline [of deliveries] of roughly the same size every year,” he noted, as that averages out the risk over a long period of time.

Avolon is one of the few lessors opting for orders. In 2023, it placed the third most orders globally behind IndiGo and Air India. Air Lease Corp. (ALC) has not committed to a big purchase since 2021, and President and CEO John Plueger said that is unlikely to change soon. ALC instead will go for incremental positions, should they become available in orderbook and production reshuffles.

“I guarantee you that in the whole queue of airlines that are with both Boeing and Airbus, they’re not all going to be there for delivery,” Plueger said. “I’ve never seen any time in the

past where somebody doesn’t fall out of bed, and which case, you know, we have an open checkbook, and we can move instantaneously.”

Many are beginning to redefine what growth means to them. “Acquiring more aircraft is not necessarily what we are focused on,” Anderson said. “We focus on earnings per share.”

As the biggest lessor globally, AerCap is in a comfortable position. But many of its smaller peers are looking to grow through consolidation. DAE just agreed to take over regional lessor Nordic Aviation Capital, and Avolon bought Castlelake Aviation, including a portfolio of 106 aircraft. Many smaller lessors are openly talking about their desire to buy.

“You will see more lessors consolidate,” Korn said. He pointed out that the top 15 lessors do not have a larger share of the overall market in spite of some big deals, such as AerCap’s takeover of GECAS, simply because the overall fleet has grown so much, and many new entrants have emerged. In fact, the share of the biggest players has declined (see chart on page 46).

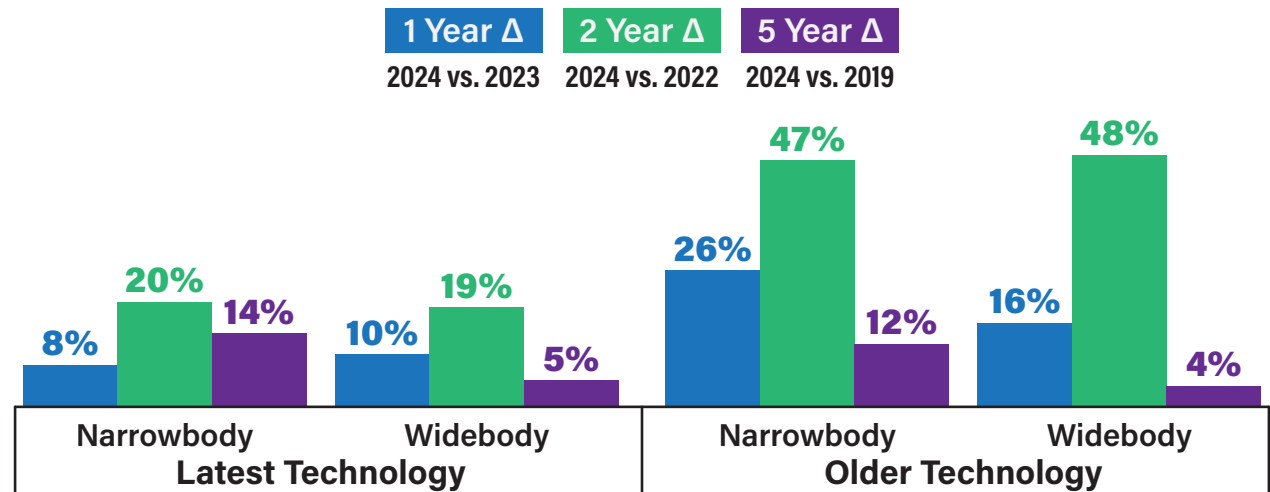
“While aircraft lessors manage half of the world’s commercial aircraft fleet today, the top three lessors manage 12% of the delivered fleet, down from 19% in 2009,” Avolon wrote in its annual industry outlook paper published in January. “The long tail of lessors outside of the Top 10 has driven a growing market share for leasing over the past 15 years.”

“Because of the lack of supply and [high] interest rates, returns are not great at this time,” Meyler said. “Some are struggling to make a profit at all because they don’t have scale, and competition for sale-and-lease-backs is high. Some will sell to the top 15, who all want to grow. We will see a lot of [transactions] over the next 18 months.”

ORIX itself is “a small lessor trying to get bigger,” too, Meyler noted. Why? “Now more than ever, scale matters because of the competitive environment in the sale-and-leaseback market and as lessor trading yields are squeezed,” he said. Meyler sees borrowing costs as the biggest differentiator, which means it is key to have or



Market Lease Rate Increases



Source: Avalon

obtain an investment grade rating so bond market access is available at the lowest possible cost.

Mergers and acquisitions are “inevitable,” Tarapore said. “A lot of value propositions are getting questioned.”

That is in spite of a recent spike in lease rates. According to Avalon, lease rates for Boeing 737 MAX and Airbus A320neo-family aircraft increased 20% between 2022 and 2024. Wide-body rates (such as for the Airbus A350 and Boeing 787) were up 19% over the same period. The increase is even more pronounced for older-generation aircraft. Airbus A320ceos and Boeing 737NG rates grew 47% over the two years, and rentals for older widebodies rose 48%.

Lease rates across all aircraft types are well exceeding 2019 levels, Avalon’s research shows. And lessors expect no easing.

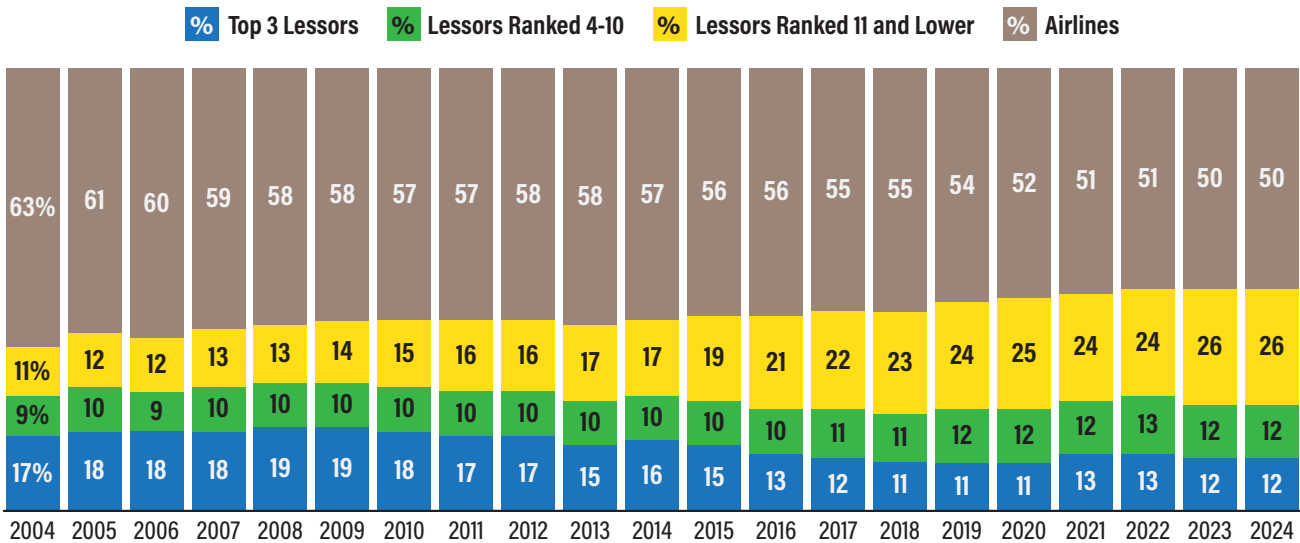
“We are talking 2028 or 2029 before production rates are in keel,” Meyler said, meaning where manufacturers want them to be. And while it would be “good for the industry” to access an increased flow of incoming aircraft, Meyler said they are not going to solve the problems created by those that never delivered in the slow post-COVID-19 ramp-up. He estimated that around 4,000 aircraft expected to have been built and made available to airlines and lessors by 2029 will not be produced by then. Consequently, the positive and negative effects of that

“will go well into the 2030s,” he said.

Given the circumstances—and the threat to values of their own in-service fleet—lessors are pushing back on the idea that Boeing or Airbus should launch a new aircraft soon. It is simply not in their interest. “Launching a new product is a commitment that is enormous,” Tarapore said. “Given the challenges, they should fix all of this before they get distracted by another \$30 billion project.”

The “biggest risk for 2050 [targets] is that they go too soon and only for a 25-30% [fuel burn] benefit,” Meyler said. “I don’t think a 20% step from today is going to cut it. It is going to be 5-10 years before they should even be thinking about it.”

Lessor Share of Delivered Fleet



Source: Avalon

U.S. Airlines Confront 'Parade of Horribles'

> SEVERE WEATHER AND TWO CRASHES BUFFETED THE INDUSTRY IN THE FIRST QUARTER

> ECONOMIC UNCERTAINTY WORRIES AIRLINES

Christine Boynton Boston and **Lori Ranson** Washington

For U.S. airlines, 2025 has been a year of volatility so far. Economic uncertainty, a drop in government demand and fallout from the fatal accident at Ronald Reagan Washington National Airport in January were among the factors major carriers cited in lowering their first-quarter financial projections.

Operators largely described those trends as temporary, projecting brighter prospects for the months to come. However, carriers may not be out of the woods just yet, according to analysis from TD Cowen.

Although Delta had expected first-quarter revenues to be up 7-9% year over year, the carrier is now forecasting an uplift of 3-4% due to increased macroeconomic uncertainty and softness in domestic demand. The airline attributes half of its anticipated \$500 million revenue shortfall for the quarter to transitory costs, including from weather and the California wildfires. That transitory bucket also consists of shaken consumer confidence in air travel, an element Delta believes is improving.

Bastian said the other \$250 million "is going to be something that we've got to address as we move forward into the second quarter and beyond in the year."

Filing its own adjustment, American Airlines projects flat first-quarter revenues instead of its earlier guidance of a 3-5% year-over-year increase. The AA5342 accident was American's primary focus during the quarter.

"I do not believe that this incident will have a long-term impact on the industry or American—though, that said, it has had a real impact on this [first quarter]," CEO Robert Isom told investors at the conference. "When you combine Flight 5342 with the uncertainty in the economy right now,

The four largest U.S. carriers have reduced or are guiding to the lower end of prior projections for the first quarter.



TAFUN COSKUN/ANADOLU/GETTY IMAGES

"We are less optimistic on the drag from U.S. trade policy," TD Cowen analyst Thomas Fitzgerald states in a March 12 report. "The situation is rapidly evolving each day, but it's hard to see how the 'short-term pain' caused by the White House does not impact the coming quarters. We are entering the time of year when many people book their summer travel, which seems like it could be at risk if consumers are concerned about a recession and/or their employment."

SHOCK AND SOFTNESS

Delta Air Lines led the pack in cutting first-quarter guidance after starting 2025 with the "worst snow and ice event . . . in over a decade" in its home city of Atlanta, which cost the carrier roughly \$100 million. A few weeks later, the fatal Jan. 29 crash of American Eagle Flight 5342 (AA5342) in Washington rattled consumer confidence in air travel.

The crash "caused a lot of shock amongst our consumers," CEO Ed Bastian told investors at the JP Morgan Industrials Conference on March 11. "There's a whole generation of people traveling these days that didn't realize these things can happen."

and certainly domestic weakness in March—those are the primary reasons behind our adjustments to revenue."

Following the Jan. 29 midair collision, Delta observed a "pretty immediate stall" in corporate travel and bookings. The carrier's corporate revenues had been growing 10% year over year, but they dropped into the low single digits "quickly," Bastian said. Hoping for a more stable February, the airline instead found close-in booking trends continuing to lag as consumers remained wary. Midway through the month, the wing of a Delta Connection Bombardier CRJ900 hit the runway upon landing at Toronto Pearson Airport and, losing a wing and tail section, the aircraft flipped upside down.

"Fortunately, no one was seriously hurt," Bastian said, but the incident "fed into another round of delay" before "it became pretty quickly obvious to us there was more than just the consumer sentiment coming out of the incidents," he concluded. "There was something going on with economic sentiment, something going on with consumer confidence, and we were seeing that very much in the close-in bookings."

United Airlines did not revise its guidance but expects to

achieve the lower end of prior projections for earnings per share, having initially forecast \$0.75-1.25 for the first quarter. The U.S. government represents about 2% of the carrier's business, while "government-adjacent" companies, including consultants and contractors, represent another 2-3%, CEO Scott Kirby detailed. Revenue from those sectors is "running down about 50% right now," he said.

While United is observing some "low-end consumer leisure weakness," its long-haul international, premium and Hawaiian markets remain strong, Kirby said.

As part of a plan to mitigate some of the demand erosion, United will retire 21 aircraft earlier than planned, saving \$100 million on engine overhauls it would otherwise need to fund. Capacity adjustments will also address what United describes as a "big drop" in Canadian traffic to the U.S., in addition to yield management adjustments to account for the decline in government demand.

Looking ahead, Delta is optimistic. "We're confident that as we move into the second quarter, the worst is behind us," President Glen Hauenstein said.

"We think margins will expand this year," Bastian added. "[The] first quarter, even though we just went through a little bit of a 'parade of horrors,' will still be just as profitable as it was in the prior year."

CLOUDY SKIES

Rounding out the Big Four, Southwest Airlines also lowered its first-quarter targets, now expecting revenue per available seat mile to be up 2-4% versus prior projections of 5-7%.

Southwest attributes roughly one point of its lower unit

revenue guide primarily to a higher-than-expected completion factor, reduced government travel and greater impact from the California wildfires than originally estimated. The carrier pins the remainder on softness in bookings and demand trends.

"[This] looked set to be a blue-sky year for the sector, but the outlook rapidly clouded over due to U.S. policy-induced uncertainty," TD Cowen's Fitzgerald writes in a March 18 report. "Price-sensitive leisure travelers and corporates in sectors that are highly levered to U.S. policy have exhibited more caution in their travel spend. This caught airlines off guard."

Southwest faces big changes as it works to cut costs and boost revenues as part of a three-year transformation plan. After announcing its first-ever round of layoffs in February, the carrier in March disclosed that it would do away with its hallmark "bags fly free" policy, except for certain tiers, beginning in late May.

"Our margin contraction over recent years is in part due to our own cost pressures," Southwest CEO Bob Jordan explained. "Over many years, we also fell behind in revenue generation as our peers introduced a host of things that we did not pursue."

Overall, legacy carriers are positioned better than their leisure-focused counterparts, TD Cowen notes, attributing that to diversified revenue streams and stronger balance sheets. "If demand and consumer sentiment can stabilize, airlines may be able to generate a better peak season than is currently feared," Fitzgerald writes. "However, we acknowledge this is an incredibly fluid dynamic and that airline traffic tends to be a coincident indicator. It's good until it isn't." 🌩

Qantas and Virgin Australia Prepare To Boost Widebody Flying

- > QANTAS LOOKS TO ACTIVATE TWO A380S AND EYES A350 DELIVERIES
- > A WET-LEASE DEAL WILL ALLOW VIRGIN AUSTRALIA TO RETURN TO LONG-HAUL OPERATIONS

Adrian Schofield

Australian airlines are planning to reactivate or wet-lease more widebody aircraft to add international capacity in the near term, although it could still take years for the country's widebody fleet to reach pre-pandemic levels again.

Qantas is preparing to return its last two grounded Airbus A380s to service this year, giving the carrier more options in its international network. Meanwhile, Virgin Australia has gained the approvals it needs to wet-lease Boeing 777-300ERs as part of an expanded relationship with Qatar Airways.

After these additions, there is likely to be a gap in Australia's widebody fleet growth. No new-delivery wide-

bodies are expected until late next year, when Qantas is due to receive the first of its modified Airbus A350-1000s for its Project Sunrise initiative.

Virgin Australia appears much further away from purchasing its own widebodies. While it has signaled it will look to transition from wet-lease to dry-lease operations with the Qatar 777s, the carrier has no widebody orders on the books.

Data from the CAPA – Centre for Aviation fleet database shows Australian airlines had almost 80 widebodies in service in December 2019, before the COVID-19 pandemic hit. Qantas accounted for 57, its Jetstar subsidiary 11 and Virgin Australia 11.

Fast-forward to the present, and the total is 59: 48 are operated by Qantas, and 11 by Jetstar. Despite the smaller widebody fleet, Qantas' international weekly seat capacity is at about the same level as in the first few months of 2020.

Like many airlines, Qantas accelerated the phaseout of some older widebodies during the pandemic, most notably its remaining Boeing 747s. The carrier has since added some Boeing 787s, but not enough to offset the departures. And Virgin Australia opted to end all widebody flying during its restructuring.

Qantas put its 12 A380s into storage in 2020, and these have been its last aircraft to return to service after the pandemic. The airline has reactivated eight, with two more yet to return. Two were retired from the fleet.

One of the remaining A380s is due to reenter service around midyear, and the other toward year-end, Qantas Chief Financial Officer Rob Marcolina said during a media briefing at the end of February. The A380s have been undergoing heavy maintenance and cabin upgrades, and this process



JOHN GREEN/ALAMY STOCK PHOTO

Qantas expects to have 10 A380s in service by year-end.

has taken longer than expected due to supply chain bottlenecks.

Deliveries of the A350-1000s will be the next significant addition of wide-bodies to Qantas' fleet, CEO Vanessa Hudson said during the media briefing. The carrier has ordered 12 of the -1000s with modifications to extend their range, including an extra fuel tank. They are intended for ultra-long-haul routes, such as from Sydney to London and New York under the airline's Project Sunrise.

The initial aircraft is due to enter final assembly in September of this year, with delivery expected in the second half of 2026. After training flights and other preparations, the Project Sunrise flights are slated to begin in 2027, Hudson said.

Development of the long-range variants of the A350-1000 appears to be proceeding as expected, Hudson noted. "We still feel pretty confident that Airbus has maintained the schedule" it committed to, she said.

In addition to the Project Sunrise aircraft, Qantas also has orders for 12 more A350-1000s in standard-range configuration and 12 787s. These wide-bodies are set to begin arriving in 2027.

While there has been a gap in new widebody deliveries for Qantas, the carrier has wet-leased two A330s from Finnair to help serve international routes. This deal is expected to transition to a dry-lease this year, meaning the aircraft will have Qantas crews and liveries. The airline regards this as "bridging capacity for us," Hudson said.

"We feel really happy that [the fleet plans] are sufficient to serve what we

believe are our needs for international," she said.

Meanwhile, Virgin Australia intends to return to long-haul services with the 777s it is leasing from Qatar Airways. This is a key part of a proposed partnership between the airlines that is to be cemented by the Qatari carrier acquiring a 25% stake in Virgin.

Virgin plans to use the 777s to launch routes to Qatar Airways' Doha

hinted that it could be a step toward adding its own wide-body aircraft. The wet-lease operations will enable it "to assess the longer-term merits and viability of widebody aircraft," the airline said in a statement. CEO Jayne Hrdlicka added that the move "allows us to put our toe in the water regarding long-haul international [flights]."

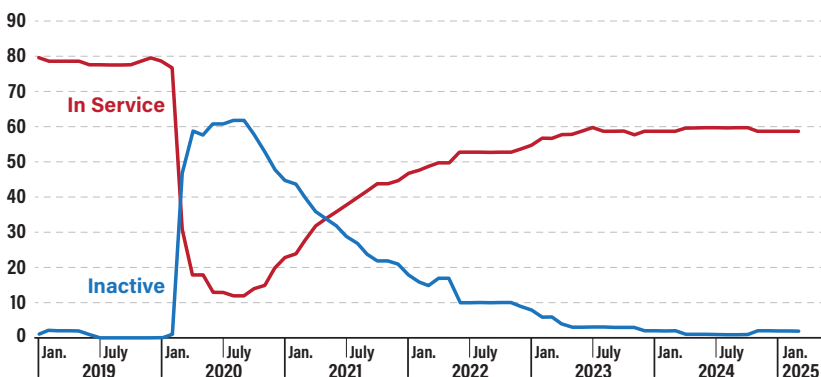
The partnership required approval from multiple Australian authorities. Virgin and Qatar have overcome the major regulatory hurdles, with the Australian Competition and Consumer Commission issuing draft approval on Feb. 18 and the Foreign Investment Review Board

and Federal Treasurer Jim Chalmers granting approval on Feb. 26.

Chalmers said the wet-lease arrangement "will increase Virgin Australia's capacity on key international routes and provides a long-term pathway for the airline to operate its own long-haul flights."

The two airlines have committed to consulting with unions on the potential for Virgin to start dry-lease oper-

Australian Airline Widebody Totals, In-Service and Inactive



Source: CAPA fleet database

hub from Sydney, Brisbane and Perth beginning in June and between Melbourne and Doha starting in December. The services would be operated under a codeshare between the two airlines.

Qatar Airways already operates its own flights to five destinations in Australia but faces limitations under the bilateral aviation agreement between the two countries.

When the wet-lease proposal was first announced in October, Virgin

ations using its own crews no later than three years into the partnership. They intend to create a "structured secondment program" in which 20 pilots and 40 cabin crew from Virgin will be sent to Doha to gain long-haul flying experience.

Any such moves by Virgin will happen under new leadership, however, as Chief Commercial Officer Dave Emerson is planned to replace Hrdlicka as CEO on March 14. 🌐

AVIATION WEEK'S 67TH ANNUAL

LAUREATE



A CROWD OF 350 AEROSPACE LUMINARIES FROM AROUND THE WORLD CONVENED

in Washington's historic National Building Museum on March 6 for Aviation Week's 67th annual Laureate Awards. Continuing a tradition that began in 1957, Aviation Week editors handed out 33 awards and honored two dozen standout students and military cadets who aspire to be the aerospace leaders of tomorrow. Grand Laureates—the best of the best—were announced in five categories: defense, space, commercial aviation, business aviation and maintenance, repair and overhaul.

Many of the 2025 Laureate winners are disruptors, including an aircraft program altering the competitive balance in commercial aviation, a defense startup roiling the market, a space company dramatically cutting launch costs and a CEO who restructured and revitalized a legendary corporate giant. Others are pushing boundaries in aviation, propulsion and safety. And our editors also tipped their hats to two icons who have devoted decades of service to the industry.

ALL PHOTOS: CHRIS ZIMMER PHOTOGRAPHY

E AWARDS



2025 LAUREATE WINNERS

SPACE

Artemis Accords
Kourou Spaceport and CNES
Space Development Agency and York
Space Systems
SpaceX Starship
Varda Space
Grand Laureate:
SpaceX Starship

DEFENSE

U.S. Air Force Adaptive Engine
Transition Program
Airbus Racer High-Speed Compound
Rotorcraft
Air-Launched Rapid Response Weapon
Anduril Industries
Hermeus
Grand Laureate:
Anduril Industries

BUSINESS AVIATION

Bombardier Aerospace
Garmin Runway Occupancy Awareness
Joby Aviation
Zack Anglin, Spartan College
Russ Meyer, Jr., Cessna Aircraft,
for leadership
Grand Laureate:
Russ Meyer, Jr., Cessna Aircraft

COMMERCIAL AVIATION

Airbus A321XLR
Embry-Riddle Safety Center
NASA's Electric Aircraft Testbed
SAS Scandinavian Airlines
CEO Anko van der Werff,
for leadership
Grand Laureate:
Airbus A321XLR

MRO

Aerospace Maintenance Council
Aviation Supply Chain Integrity
Coalition
Embraer Aircraft Maintenance Services
Lufthansa Technik AeroShark
Tarmac Aerosave
Grand Laureate:
Aviation Supply Chain Integrity
Coalition

PATHFINDER

Larry Culp, GE Aerospace
chairman and CEO

LIFETIME ACHIEVEMENT

Norm Augustine, aerospace legend
Patrick Ky, former executive director,
European Aviation Safety Agency



Aviation Week Military Space Editor Vivienne Machi (far left) and Editorial Director Joe Anselmo (far right) flank the 2025 Space Laureates. SpaceX's Starship won the Grand Laureate, which was accepted by **Tim Hughes** (inset), senior vice president of global business and government affairs at SpaceX.



Aviation Week Executive Editor of Business Aviation and MRO Lee Ann Shay (left) and Business Aviation Associate Editor Jeremy Kariuki (far right) flank the 2025 Business Aviation Laureates. **Russ Meyer, Jr.** (inset), accepted the Grand Laureate for his leadership at Cessna Aircraft.





Aviation Week Defense and Space Executive Editor Robert Wall (far left) and Defense Editor Steve Trimble (far right) flank the 2025 Defense Laureate winners. Anduril Industries won the Grand Laureate, accepted by Communications Manager **Jackson Lingane** (inset).



Lori Ranson (left), senior analyst for CAPA – Centre for Aviation, and Air Transport Senior Editor Christine Boynton (right) flank the 2025 Commercial Aviation Laureates. The Grand Laureate went to the Airbus A321XLR, and the award was accepted by **Christoph Zammert** (inset), program head for the A320 family at Airbus.





Aviation Week MRO Managing Editor Lindsay Bjerregaard (left) and Senior Air Transport and Safety Editor Sean Broderick (right) flank the 2025 Maintenance, Repair and Overhaul Laureates. The Grand Laureate went to the Aviation Supply Chain Integrity Coalition, with **Robert Sumwalt** (inset), executive director of the Embry-Riddle Aeronautical University Center for Aviation and Aerospace Safety, accepting the award.

Pathfinder Award

Larry Culp (right), CEO of GE Aerospace, was presented the Pathfinder Award by Aviation Week Executive Editor for Business Michael Bruno.





Philip J. Klass Lifetime Achievement Awards

Patrick Ky (left), former executive director of the European Aviation Safety Agency, received his Lifetime Achievement award from Aviation Week Executive Editor of Commercial Aviation Jens Flottau.



Video Learn more about

Ky's career:

[AviationWeek.com/Patrick-Ky](https://aviationweek.com/Patrick-Ky)



Norm Augustine (center), former chairman and CEO of Lockheed Martin and under secretary of the U.S. Army, with former AW&ST Editor-in-Chief Anthony L. Velocci, Jr. (right), was presented the Lifetime Achievement award by Aviation Week Senior Editor Guy Norris.

Video Learn more about

Augustine's career:

[AviationWeek.com/Norm-Augustine](https://aviationweek.com/Norm-Augustine)



Tomorrow's Leaders



THE 67TH ANNUAL LAUREATE AWARDS EVENT culminated with recognition of Tomorrow's Leaders. The 20 Twenties (above), top students pursuing careers in aerospace and aviation, were profiled in our Feb. 24-March 9 issue. Also honored were four outstanding cadets, one from each of the U.S. service academies; they are (clockwise from top):

Cadet 3rd Class Walter "David" Ulmer III of the U.S. Coast Guard Academy, an electrical engineering major



originally from St. Augustine, Florida. Ulmer's passion for aviation began when his father gifted him a discovery flight for his 12th birthday. He is pursuing his private pilot license and is part of the ground crew for the academy's flight team. As aviation simulator coordinator, Ulmer leads efforts to maintain and enhance the flight simulator program, teaching cadets fundamental aviation skills and ensuring the simulators are operational for training. Beyond his aviation and academic pursuits, Walter is active in the academy's volleyball community, playing for both the indoor and beach volleyball clubs. He also participates in its music programs as a bass player in the cadet jazz band, performing locally and across the East Coast, and as a snare drummer in the newly established Regimental Pipes and Drums. Upon graduation in 2027, Ulmer hopes to be selected for flight school and eventually to fly Sikorsky MH-60T Jayhawks in the Coast Guard and contribute to search-and-rescue missions.

Cadet Lt. Landon Taylor Coker of the U.S. Military Academy, a mechanical engineering major with a minor in aeronautical engineering. He serves as chief engineer of the Space Engineering and Applied Research-Tactical Hypersonic Orbital Rocket capstone team, whose mission is to design, build and launch a two-stage hypersonic rocket. The team launched two rockets in January that exceeded the Karman line (100 km) and achieved Mach 7. Coker has spent the last 3.5 years on the West Point Parachute Team, engaging in cooperative training, competition, outreach and recruiting for the U.S. Military Academy. He spent an exchange semester with the U.S. Air Force Academy, serving as a liaison to the school and its parachute team. He will commission as an aviation officer in May.

Cadet 1st Class Arthur Jackson Rounaghi of the U.S. Air Force Academy, an astronautical engineering major. He is



chief engineer of FalconSAT-11, a small satellite currently under development at the academy's Space System Research Center (SSRC). Rounaghi is researching sparse aperture applications of space systems and previously conducted research on radiation-sensing dosimeters and astrodynamics in geosynchronous orbit. He spent last summer interning at the National Reconnaissance Office and assisted the completion and launch vehicle integration of the SSRC's FalconSAT-Xtra satellite. He currently serves as a flight commander in Cadet Sqdn. 36.

Midshipman 1st Class Zachary Tyler Branam of the U.S. Naval Academy, an aerospace engineering major who was born and raised in Cincinnati. After graduating high school, he chose to continue his academic and football career at the U.S. Naval Academy. During his plebe year, he made the decision to major in aerospace engineering. His football career at the academy was cut short after two years due to injury, but he has continued to pursue his passion for aerospace engineering, specializing in rotorcraft. Branam participated in the Naval Academy's Powered Flight Program, in which midshipmen learn the

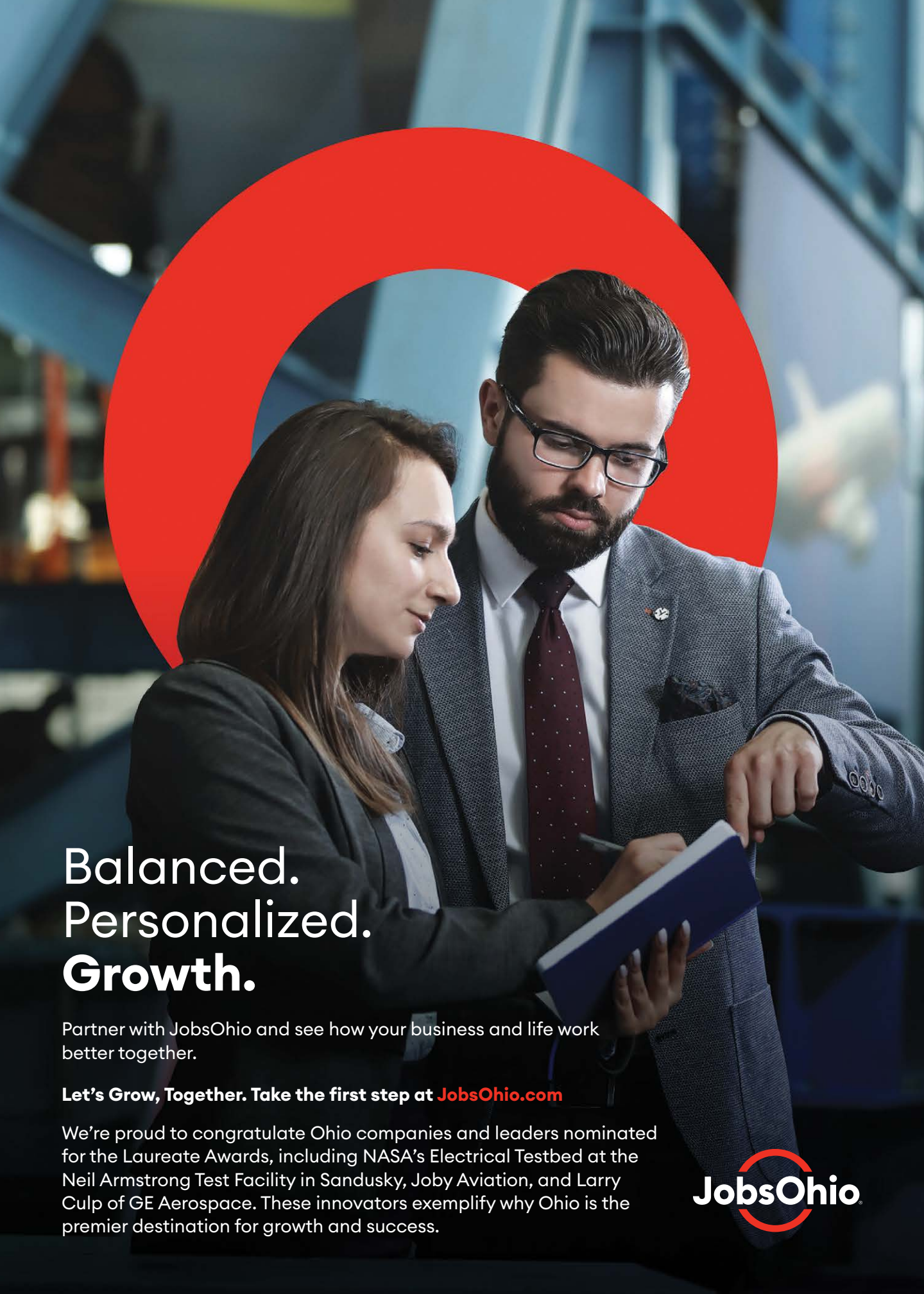
rigors, tempo and expectations of naval aviation and its training pipelines, culminating in a student solo flight in a single-engine Piper Warrior. He is the propulsion lead for the Guardian Angel capstone project, a short-takeoff-and-landing aircraft designed to detect denuded polar bears in the Alaskan North Slope. Following graduation, he will commission as a naval aviator.



(1) Laureates, 20 Twenties winners and guests mingled during the cocktail reception before the Laureates banquet. **(2)** **Greg Hamilton** (left), Aviation Week Network president, opened the Laureates celebration with **John Schmidt**, senior managing director of Accenture, sponsor of Aviation Week's 20 Twenties program.



(3) Anko van der Werff, CEO and president of SAS Scandinavian Airlines (left), talks with Heart Aerospace Chairman **John S. Slattery**. **(4)** 20 Twenties winners **Abraham Atte** (left) with **Elijah Simpson** (center) and **Manmeet Pelia**. **(5)** Civil Aviation Authority of Singapore Senior Director **Kah Han Tan** (left) talks with Aviation Week Senior Editor **Guy Norris** (center) and Senior Air Transport and Safety Editor **Sean Broderick**. **(6)** Accenture's managing director, **Jeffrey Miller** (left), manager **Courtney Schultz** (center), consultant **Sammi Smith** (right) and senior manager **Amy Bahrani** (with back to camera). **(7)** **Karan Singh**, CEO and founder of Future Flight Global (left), shakes hands with Aviation Week Editorial Director **Joe Anselmo** (center) as they talk with National Business Aviation Association President and CEO **Ed Bolen**. **(8)** Embry-Riddle Aeronautical University President **P. Barry Butler** (left) and Embry-Riddle ambassador **Audrey Butler** (right) talk with Aviation Week Senior Air Transport Editor **Christine Boynton**. **(9)** 20 Twenties winner **Yair N. Guerrero** (left) talks with **Alexandre Brun**, president and CEO of Tarmac Aerosave. 🌐



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Europe's Clean Industrial Deal Leaves Airlines Wanting More

> "THE WINDOW FOR DECISIVE ACTION IS CLOSING," AVIATION ASSOCIATIONS GROUP SAYS

> SOME CALL FOR AN EU REVENUE-CERTAINTY MECHANISM FOR SAF

Helen Massy-Beresford Paris



AIRLINES IN EUROPE are pleased about certain elements of the region's newly mapped out industrial decarbonization strategy, but they contend that the package does not go far enough to support the competitiveness of aviation as the industry aims for net-zero emissions.

Transport Investment Plan that will be published this year and will focus on e-fuel as a priority investment, T&E said.

A group of associations representing different parts of the industry also called for more support to ensure that Europe's aviation sector remains competitive even as it goes greener.

four main areas of action: sustainable aviation fuel (SAF), air traffic management (ATM) optimization, new aircraft technology and economic measures. "Each of these requires targeted support from policymakers," the partners said.

Above all others, the Destination 2050 road map focused on the important role of SAF—according to the new road map, 35% of the emissions reductions by 2050 will come from SAF, both biomass-sourced and synthetic or e-fuel.

That is based on a fuel mix of 80% SAF by 2050—a proportion that goes beyond the 70% mandated by ReFuelEU legislation and takes into account airline SAF commitments that often go beyond mandated levels.

"The biggest obstacle, the biggest risk is cost of SAF," A4E Managing Director Ourania Georgoutsakou said in early February.

The detail of the new road map estimates total expenditures of €2.4 trillion, an increase of €510 billion (27%) from the €1.89 trillion in "The Price of Net Zero," a report published in 2023 by Destination 2025, excluding conventional fuel costs.

"The majority of this increase stems from rising premium expenditures, which have grown from €820 billion to €1.3 trillion (57%), driven largely by higher [SAF] market price estimates," the road map says.

To surmount the SAF cost obstacle, measures are needed, including incentivizing investments, SAF allowances to close the cost gap and a book-and-claim system to ensure the uptake of SAF across the region, Georgoutsakou said, stressing that "We need to close that cost gap."

Magda Kopczynska, the European Commission's director general for mobility and transport, agreed there needs to be more effort to boost SAF volumes. "One thing that I'm missing at a national level is the realization that SAF does not fall from the sky," Kopczynska said on Feb. 4. "The ecosystem to have the production on the ground, to have the availability at the right place, has to be created."

Two SAF producers, Arcadia eFuels and LanzaJet, also have flagged EU policy hurdles that hamper progress in their projects: regulations that require eSAF plants either to be located in countries where the grid is more than 90% renewable or to add enough



Sustainable aviation fuel is key, but sufficient volumes remain a concern.

The Clean Industrial Deal (CID), announced by the European Commission on Feb. 26, includes green fuel as one of its main areas of focus. That approach is seen as good news by the aviation industry and climate campaigners alike.

The nongovernmental organization Transport & Environment (T&E) said it welcomes the prioritization of green fuel in the CID. Plans for a hydrogen mechanism—to connect hydrogen suppliers and buyers with financing options—and the prioritization of the shipping and aviation sectors are "crucial," the group said.

The CID set out a Sustainable

"The window for decisive action is closing," the groups said in a joint statement after the publication of the CID. "The EU must take the lead to ensure European aviation remains globally competitive throughout this transition. The time to act is now."

The Destination 2050 partners—Airlines for Europe (A4E), airports group ACI Europe, aerospace and defense manufacturers' association ASD, air traffic control group CANSO Europe and the European Regions Airlines Association—had put forward their own updated road map to net zero earlier in February. They warned that the cost of reaching net zero by 2050 would exceed previous estimates by more than €500 billion (\$546 billion), and they highlighted

renewable energy to the grid to support their project, creating project-on-project risk, and EU backing for carbon capture projects that make CO₂ harder to source.

Speaking on a Sustainable Aviation Futures webinar on Feb. 25, the day before the CID was published, Arcadia eFuels CEO Amy Hebert said sourcing CO₂ is becoming challenging because of government incentives for carbon capture and sequestration.

LanzaJet's partnerships director, Dan Bloch, flagged another regulatory discrepancy that is affecting the alcohol-to-jet production, whereby ethanol is used to create SAF. The problem is that ethanol compliance differs between aviation and road transport.

Both Hebert and Bloch said they would like to see the EU follow the example of the UK, which is working on a revenue-certainty mechanism for SAF, a positive demand signal that would help SAF suppliers secure investment.

The Destination 2050 partners called for more action following the CID publication. "The Clean Industrial Deal falls short of delivering a comprehensive aviation industrial strategy to achieve effective decarbonization whilst preserving the sector's far-reaching socioeconomic benefits and competitiveness," the Destination 2050 partners said.

Aviation decarbonization requires urgent action that spans all four decarbonization pillars outlined in the Destination 2050 road map, the groups said.

The CID focuses on energy-intensive industries and clean tech and identifies business drivers for industry to succeed: lower energy costs, boosting demand for clean products and financing the clean transition.

"Europe's aviation sector welcomes the [CID] as a positive first step toward balancing industrial decarbonization and economic competitiveness but reiterates its call on the European Commission to go beyond and take concrete steps to safeguard the aviation industry's competitiveness with a dedicated strategy and action plan," the groups said.

"The CID is yet another recognition of the need to support low-carbon fuels and charging infrastructure for aviation," they added. "But competitive aviation is about more than just fuels." ☼

—With Victoria Moores in London

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Clean Aviation Project Aligns With New EU Priorities

- > GLOBALLY WANING GREEN FOCUS SPURS COMPETITIVE BID
- > EUROPEAN COMMISSION ENCOURAGES DUAL CIVIL-MILITARY USE OF TECHNOLOGY

Thierry Dubois Brussels

Sustainable air transport—more specifically its decarbonization—previously was the only *raison d'être* for Clean Aviation, a public-private partnership between the EU and the region's civil aeronautics industry. The guiding principle of the research and technology endeavor had not changed since the late 2000s, when the Clean Sky program was launched.

But at the beginning of this year, the new U.S. administration upended the geopolitical context for the EU. The transformation is shaping European policies, and the ramifications are already visible at Clean Aviation, with competitiveness and defense applications emerging.

Competitiveness is now on par with sustainability in the project's goals. As the Trump administration has no appetite for environmental issues, the EU remains the only bloc in which ecology is high on the agendas of political leaders. Sustainability can offer a competitive advantage if every player supports or has to comply with it. If not, the affected companies may see meeting such requirements as a burden.

The EU does not want its industries to believe they are being treated unfavorably, hence the new emphasis on competitiveness.

Dual civil-military use of the technologies demonstrated in Clean Aviation was taboo. That is no longer the case, and the European Commission (EC) is encouraging the Clean Aviation Joint Undertaking (CAJU) project management entity to head in that direction.

The growing Russian threat and weakening support from the U.S. have made reinforcement of domestic armament production in the EU a pressing matter. Geopolitical tensions with those two countries and China have

also brought to center stage sovereignty, for example in raw materials.

In terms of competitiveness, Clean Aviation is progressing along the lines the EC set recently. The EU's Competitiveness Compass, presented in late January, translates the Draghi report—a 2024 document that recommended ways to boost the EU's eco-

with China or the U.S. very difficult."

Ekaterina Zaharieva, European Commissioner for startups, research and innovation, promised simplification. "You will soon notice that the 2025 work programs that we will publish in April will be the shortest and simplest of Horizon Europe," she said, referring to the documents that set out funding opportunities under the EU's program for research and innovation.

"A third element, on top of sustainability and competitiveness, is supporting European security and defense capabilities," CAJU Executive Director Axel Krein said. "Whereas Clean Aviation's technologies and concepts have a primary application in the civil world, some can also be applied in the security and defense environment."

Airbus Helicopters designed its Racer compound helicopter demonstrator in the Clean Sky 2 program, for instance, with civil applications in mind. Company officials now see a future for it in the military.

Clean Aviation has launched its third call for proposals, with a total value of €950 million (\$1.03 billion) including €380 million of EU funding. While EU-based organizations are expected to apply, associated countries that are home to potential candidates also are feeling the effect of geopolitical changes, which may strengthen the new dual

civil-military focus.

Krein expects proposals from entities in Canada, Norway, the UK and Ukraine in particular. Norway has a frontier with Russia, the UK increasingly shares views with the EU about European defense, and Ukraine has fought Russia's full-scale invasion for three years. In Canada, doubts are emerging about the country's dependence on U.S.-made weapons (page 16).

The broader issue of sovereignty may benefit from decarbonization. Increased use of additive manufacturing for complex aircraft parts brings big weight reductions, Safran CEO Olivier Andries noted. Another virtue of the process is that it requires markedly less metal with which to start compared with a more conventional machining process. The improved buy-to-fly ratio means less metal must be imported, Andries added. ☛

AIRBUS HELICOPTERS



Built under the Clean Sky 2 program, the Racer has become an example of dual civil-military demonstrator.

nomic growth—into a program. Among the areas for action, the Compass announces a joint road map for decarbonization and competitiveness. The EC has promised to implement an Affordable Energy Action Plan.

Also part of the road map, the Clean Industrial Deal (CID) sets out a competitiveness-driven approach to decarbonization aimed at securing the EU as an attractive location for manufacturing. The CID, presented in late February, focuses on energy-intensive industries and clean technology and identifies business drivers to help industry succeed: lowering energy costs, boosting demand for clean products and financing the clean transition.

"Red tape is a weak point," Damien Caze, France's director general of civil aviation, said at the Clean Aviation Annual Forum held March 18-19 here. "Bureaucratic rules make competition

TECH TAKE

By **Graham Warwick**

For the latest, go to [AVIATIONWEEK.COM](https://www.aviationweek.com)

Sikorsky Flies Rotor Blown Wing

Sikorsky has completed the first series of flight tests with its Rotor Blown Wing prototype uncrewed aircraft, including full transitions between vertical hover and forward cruise.



Sikorsky's Rotor Blown Wing is a hybrid-electric, fully autonomous flying wing uncrewed aircraft.

Weighing 115 lb., with a 10.3-ft. wing-span, the all-composite Rotor Blown Wing (RBW) is a flying-wing aircraft that takes off and lands vertically in a tailsitter configuration and flies autonomously using Sikorsky's Matrix autonomy system. While the production version is intended to be hybrid-electric, the prototype is powered by batteries, with electric motors driving a pair of semi-articulated rotors.

During the flights tests in January at Webster Field in Virginia, the RBW prototype flew at its design speed of about 80 kt. and performed dozens of transitions, says Igor Cherepinsky, director of Sikorsky Innovations, the company's rapid prototyping organization.

Wind tunnel tests were conducted in parallel using a full-scale model to provide further validation of the control laws by measuring the performance against data from test flights.

Cherepinsky says the purpose of the trials was to demonstrate transition between hover and cruise while validating the autonomy, control laws and flight physics. He describes the prototype as providing a stepping-stone to scale to larger aircraft eventually.

The aircraft was designed to have low-speed flight characteristics and handling qualities similar to those of a heli-

copter, Cherepinsky says. As a blown-wing concept, airflow from the rotors interacts with the wing and helps to prevent stalls and generate added lift during takeoff.

"We did a whole bunch of maneuvering, we expanded the envelope, we flew to almost 2g and have now done close to 100 transitions," Cherepinsky tells Aviation Week. "The physics are holding, the control laws are working, and the aircraft performed quite well. So with that base set, we can actually accelerate now to bigger vehicles."

Sikorsky envisions the RBW as a suitable platform for a variety of mission types including intelligence, surveillance and reconnaissance; firefighting; and cargo. The configuration could be scaled to accommodate several hundred pounds of payload. The company says the test data also indicate the aircraft can operate safely from pitching ship decks and unprepared ground even at larger scales.

"We have several contracts with the [U.S. Defense Department], and we've had discussions with a couple of civil operators, and there is a lot of interest in this product," Cherepinsky says.

In addition to the RBW, Sikorsky Innovations is developing the larger HEX hybrid-electric tiltwing vertical-take-off-and-landing demonstrator. HEX combines a 1.2-megawatt turbogenerator developed by GE Aerospace with flight and motor controls developed under the Matrix autonomy program as well as Sikorsky-developed electric motors and power electronics.

Cherepinsky says the company has begun manufacture of a ground-based propulsion system testbed with which it plans to replicate hovers and low-speed maneuvers within 12-18 months. Following the testbed, the company plans to develop the HEX demonstrator, which is expected to be ready to fly in late 2027 or early 2028.

—Ben Goldstein
in Stratford, Connecticut

Straightline Orders First Hybrid Airship

UK-based Straightline Aviation has placed a \$50 million order for the first large cargo airship planned to be produced by AT² Aerospace, the company to which Lockheed Martin in 2023 spun off its hybrid airship intellectual property.

The first Z1 hybrid airship is planned to be delivered to Straightline in 2028 for initial deployments to Brazil, Alaska and northern Canada for cargo and humanitarian missions to remote locations. The airship can carry a 23.5-ton payload.



Straightline plans to base a fleet of Z1 hybrid cargo airships in the U.S. for operation around the world.

Founded in 2015 by the team behind Virgin Group's airship company, Straightline first tried to buy Lockheed's LMH-1 hybrid airship in 2016, when it signed a letter of intent for 12, which it planned to use to transport oil and gas company equipment to remote locations.

The deal was backed by financing from Hong Kong but collapsed when tariffs imposed on China by the first Trump administration raised costs and risks. Tariffs are also a threat this time around, but financing for the latest deal does not come from China, and Straightline plans to operate the airship from a U.S. base.

Lockheed spun off the intellectual property to AT² after failing to find a military or commercial market for its hybrid airship technology. The new company is led by Bob Boyd, who was program manager for hybrid airships at Lockheed's Skunk Works for 25 years before he joined the new company.

Straightline signed a letter of intent for three airships and an option for up to 12 with AT² when the company was formed in late 2023 and has now firmed up its first order. "The spin-out has taken time to bed down, but AT² is now in a position to go forward," Straightline CEO Mark Dorey says.

"There has never been any doubt about the market and customer demand," he says. "We can reengage with that customer base now that we have a delivery date in hand." Manufacture of the first Z1 is expected to take 18 months, followed by 18 months of testing to obtain FAA certification.

Straightline will own and operate the airship and has partners signed up in Alaska, Brazil and Canada. Missions in Alaska and Canada are to include carrying cargo, equipment and crew for

industries and communities in remote locations where the seasonal ice roads are at risk because of climate change.

In Brazil the Amazon River water level is at an all-time low, and many of the smaller tributary rivers that provide the only way of reaching remote communities have dried up. “We are having many discussions with governments and agencies for humanitarian missions and transporting mobile hospitals,” Dorey says.

ZeroAvia Raises Performance Bar for Fuel Cells

Hydrogen-electric propulsion developer ZeroAvia has demonstrated a low-temperature proton exchange membrane (PEM) fuel-cell system producing 150 kW net power with a system-level specific power exceeding 1 kW/kg, including the thermal management system.

Commercially available fuel-cell systems for road transport application typically have a specific power of around 0.6 kW/kg, the balance of plant

takeoff-and-landing vehicles as well as open new applications in the aerospace, marine and ground sectors. The SuperStack Flex design enables separation of the core systems for integration onto different airframes, overcoming space constraints, the startup says.

Using selective laser-sintering powder-bed additive manufacturing, ZeroAvia has been able to combine parts or functions into monolithic structures. The key parts in the balance of plant—anode, cathode and coolant manifolds; thermal management; humidification and air compression systems—have been reduced to fewer than 100 parts from more than 200, with 50% reductions in weight and volume.

ZeroAvia is developing low-temperature PEM fuel cells for its first product, the 600-kW ZA600 hydrogen-electric propulsion system, aiming for a specific power of 1.5 kW/kg. The company is also developing high-temperature PEM fuel cells for its 2-5-megawatt ZA2000 propulsion system, aiming for a specific power of 2-3 kW/kg. This compares with 6 kW/kg for a small turboshaft.

Regent Begins Seaglider Sea Trials

U.S. startup Regent has begun crewed sea trials of the first full-scale prototype of its Viceroy wing-in-ground-effect electric seaglider in Rhode Island’s Narragansett Bay.

With 12 electric propellers mounted on the leading edge of the 65-ft.-span wing, the Viceroy is designed to carry two crew and 12 passengers for 180 mi. at 180 mph, flying over water in ground effect at a height of approximately one wingspan to minimize drag.

Equipped with a boat hull, hydrofoil and wing, the seaglider will operate in three modes: transitioning from floating to foiling; then flying as it accelerates from the dock through the harbor and into open waters. The transition from float to foil and from foil to flight is enhanced by distributed blown-wing propulsion.

Christened the Paladin, the first prototype was crewed by Regent co-founder and Chief Technology Officer Mike Klincker and lead test captain Chris “Duff” Guarente on the March 6 initial low-speed sea trial.

In January, Regent broke ground on a manufacturing facility in North Kingstown, Rhode Island, which it expects to



Regent has begun sea trials with the full-scale prototype of its Viceroy 12-passenger electric seaglider.

begin producing seagliders in early 2026. The startup is seeking to certify the Viceroy with the U.S. Coast Guard as a maritime vessel.

—Ben Goldstein in Boston

Fuel Cell Put Through Flight Paces

A French team has tested the performance of a fuel cell in flight to validate the design of the modular hydrogen-electric propulsion system for a four-seat light aircraft planned by startup Blue Spirit Aero.

The 10-kW polymer electrolyte membrane (PEM) fuel cell with gaseous hydrogen storage was installed in a Cessna 206 under the Vhyper project, a collaboration between French research center CEA-Liten, Blue Spirit Aero (BSA) and fuel-cell developer Pragma Industries.

Over five flights from Moulins-Montbeugny Airport in central France, the fuel-cell system was tested at different attitudes, temperatures, vibrations and load factors up to 3g at altitudes up to 10,000 ft. to compare performance with that observed in the laboratory.

Previous flight tests of fuel cells were conducted at lower altitudes and load factors, the CEA says. Flights conducted in 2022 by Germany’s H2Fly using its HY4 hydrogen-electric propulsion testbed reached a then-record altitude of 7,000 ft.

BSA plans to build experience from the Vhyper project into development of its Dragonfly hydrogen-electric four-seater. This has 12 PEM fuel-cell modules mounted under the wing driving propellers on the leading edge to provide distributed electric propulsion.

Founded in 2020 and based in Toulouse, BSA is building a full-scale prototype of the Dragonfly, and it plans to begin flight testing this year. With a maximum takeoff weight of less than 3,550 lb., the aircraft is designed to fly more than 350 nm at speeds greater than 135 kt. ☯



ZeroAvia has used additive manufacturing to integrate fuel-cell components.

needed to enable the system to operate adding significant weight beyond that of the fuel-cell stack itself.

While ZeroAvia is developing hydrogen-electric propulsion systems for its own retrofit applications, the 150-kW configuration was demonstrated for an unidentified “major customer” as part of the startup’s plan to generate early revenues through component sales ahead of its own systems being certified.

The SuperStack Flex fuel-cell architecture is customizable and scalable from 100 to 600 kW, ZeroAvia says, and its “industry-leading” performance is designed to expand the system’s capabilities for uncrewed aircraft and vertical-

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Private Capital Is Essential to Defense

By Michael Sion

The chorus for change in defense acquisition grows louder each day. The new U.S. administration, key members of Congress, potential disruptors and incumbent prime contractors are all calling for improvements in how the nation develops and acquires military capability. However, these ideas and efforts likely will fall short without a critical ingredient: private, at-risk capital. This type of funding is essential to increase innovation, expand capacity and enhance productivity.

gram margins, inflexible business models and uncertain demand signals. Top contractor independent R&D budgets have not outpaced revenue since the end of the Cold War.

In other industries, private, at-risk capital plays an important role in advancing innovation and improving productivity. It is increasingly taking this role in the defense industry, too, given unmet customer needs and private capital's greater appetite for risk. SpaceX, for example, disrupted the national security launch market by dramati-

cally reducing cost per launch and time to market. Companies like Anduril Industries have raised significant capital, aiming to disrupt other segments of defense. Private capital inflows into the sector have grown markedly since 2019, according to Bain & Co. analysis (see chart).

Private capital can serve as a catalyst in two important ways: Venture capital can fund startups developing new capabilities and seeking step-change improvements in cost and time to market; and private equity can help more mature companies increase manufacturing scale and production capacity, improve on-time delivery and reduce unit costs.

We expect private capital inflows to continue growing, as investors are increasing their focus on the aero-

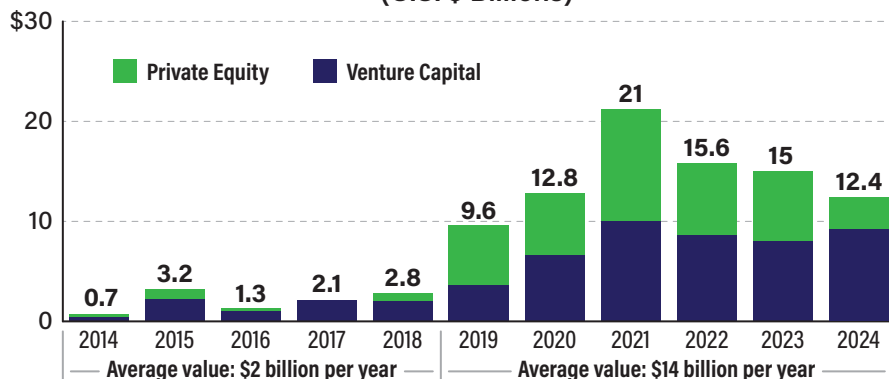
space and defense markets. In the past, generalist funds and limited partners have been wary of the sector, given the high barriers to entry, low unit volumes, high customer concentration and unique go-to-market costs of selling to governments. Their reticence is decreasing as they better understand the risks and as demand for private capital grows.

On the customer side, the Pentagon has shown considerable interest in buying from new entrants and commercial-focused companies, and the new administration seems inclined to continue that. Proposals like the Fostering Reform and Government Efficiency in Defense (Forged) Act and recommendations like those from the Defense Innovation Board would also reduce impediments faced by new entrants. The challenge is significant: The top 10 defense contractors' share of procurement and RDT&E spending has averaged more than 70% since fiscal 2020.

Faster, simpler acquisition processes and increased capital inflows would greatly enhance U.S. defense capabilities, especially in high-need areas, such as uncrewed systems, proliferated space satellites, command-and-control software and enabling technologies like artificial intelligence. Incumbent suppliers, seeking to defend their businesses, would likely respond by investing to meet customer needs better. The defense industrial base as a whole stands to benefit from greater and more focused investment. ☐

Michael Sion is a partner in Bain's Aerospace, Defense & Government Services and Private Equity practices.

Value of Disclosed Defense Deals Funded by Private Capital, 2014-24
(U.S. \$ Billions)



Sources: PitchBook, Dealogic and Bain & Co. analysis

Multiple efforts to improve acquisition practices and strengthen the industrial base have largely failed to stem rising unit costs. One of Augustine's Laws projected that by 2054, the entire U.S. defense budget would be enough to pay for just one tactical aircraft. Although Augustine wrote this in jest, the challenges facing the defense industry are more acute than ever. Efficiency, delivery schedules and capacity are inadequate. A 2024 report by the Government Accountability Office listed 26 of 31 major acquisition programs (80%) as delayed, over budget or both. For decades, investment levels have failed to keep pace with GDP growth or defense requirements.

Achieving step-change improvements requires billions of dollars of increased investment. But from where? Government R&D and procurement budgets are constrained and likely to remain so. Defense budgets have grown only modestly in real terms, while spending on procurement and research, development, test and evaluation (RDT&E) has gradually declined as a share of GDP since World War II. Outlays for RDT&E have barely rebounded since falling to 1% of federal spending in fiscal 2020. Of course, the U.S. Defense Department and Congress could better allocate funding toward the highest priorities for countering future threats. But history suggests that nimble shifts in spending in response to changing needs are unlikely.

Incumbent prime contractors are inclined to invest more but have been constrained by shareholder expectations, cost-plus contracting, low market volumes, capped pro-



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