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# AVIATION WEEK

## & SPACE TECHNOLOGY

### DEFENDING UKRAINE

Lessons Learned, Battles Ahead

**AAM Veteran  
Failures Loom**

RICH MEDIA  
EXCLUSIVE



**China's Spy Balloon  
Campaign**

**Runway Incursions  
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2022 Winner

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### ON THE COVER

One year after Russia's invasion of Ukraine, Aviation Week has assembled a special report assessing Russia's missile stockpile, how Ukraine's industry and air force are faring and may rebuild, and more. Coverage begins on page 14. Chris McGrath/Getty Images photo of missiles and rockets fired by Russian forces and collected as evidence for war crimes investigations in Kharkiv, Ukraine.

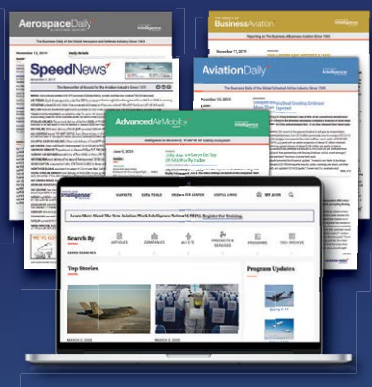
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## THE LONG RANGER

I would like to expand on a point in Jens Flottau's article on the Boeing 747's legacy (*Jan. 30-Feb. 12, p. 59*).

When it first appeared, the airplane's size and capacity were what grabbed the most attention. But over time, it was the 747's tremendous range that mattered most, and for that reason it really became the most successful airplane to serve Asia.

It entered service as the four Asian "tigers"—South Korea, Singapore, Taiwan and Hong Kong—were coming into their own. Japan already had announced itself to the U.S. in innovative electronics and auto exports, so there was a huge drive for business executives to reach Asia and for Asians to go abroad. The 747 made all that easy.

I remember traveling to Tokyo in 1993 and seeing Narita Airport dominated by 747 tails in every livery imaginable. "There's a billion dollars in '47s here," I thought, back when \$1 billion really meant something.

A Singapore Airlines official once commented that the government-owned carrier became so important to the island nation's economy

## BEHIND THE SCENES

Aviation Week's New York-based editorial production team celebrated the career of **Michael Hayes** (fourth from left), longtime proofreader for *AW&ST* and *Inside MRO*, who retired in December. Hayes worked at Aviation Week from 1996 to 1998 and again from 2012 to the end of 2022. She now is focusing full-time on making art and hopes to mount a show later this year.



## CHANGE THE FOCUS

Regarding "Debunking the 'Right Stuff' Myth" by P. Barry Butler (*Jan. 30-Feb. 12, p. 66*), the FAA medical certificate application for pilots requires a full written explanation for this checked-box condition: "Mental disorders of any sort; depression, anxiety, etc."

It is not "right stuff" bravado for pilots to be wary of checking that box; it is common sense. Once medically grounded by the FAA, pilots face an impersonal bureaucracy, legal problems and FAA doctors that must be satisfied for a return-to-flight status.

## BUSINESS BLUNDERS

Richard Aboulafia's excellent recent column highlighted what appears to be a systemic problem in contemporary business (*Dec. 26, 2022-Jan. 15, 2023, p. 8*): the number of companies 100 or more years old that have failed or fallen so far that they are almost unrecognizable. Boeing was the subject of Aboulafia's column, but Eastman Kodak, McDonnell Douglas, General Electric, at times Chrysler and others have suffered similar difficulties in the last several decades.

The "new" business model may increase the bottom line for shareholders, at least for awhile, but it sure tends to destroy storied companies.

*Tom Adair, Cocolalla, Idaho*

## WHERE IS THE WINDOW?

The whole KC-46 saga (*"How Boeing Will Fix the KC-46's Biggest Issues" Dec. 26, 2022-Jan. 15, 2023, p. 12*) begs the question: Why didn't Boeing put a window in it in the first place? It's worked for the KC-135 for half a century.

Simplification and adding lightness seem to be at odds with Boeing's current design philosophy. Maybe that is part of the problem.

*Todd Fredricks, Amesville, Ohio*

## CORRECTION

The issue dates in "Hydrogen Questions," "Staying Relevant" and "Life Support Testing" (*Jan. 30-Feb. 12, p. 6*) should have been Dec. 26, 2022-Jan. 15, 2023.



MICHAEL BRUNO/AW&ST

## BEHIND THE SCENES

"Looking to the Future" was the theme of Aviation Week Executive Editor **Graham Warwick**'s Feb. 7 address to the Pacific Northwest Aerospace Alliance's annual conference near Seattle. The event drew attendees from more than 350 aerospace companies and suppliers around the globe. Asked by the audience what could be the biggest technological breakthrough of 2023, Warwick said it might be the year hydrogen-fueled aircraft become a genuine alternative.

that in one year it accounted for a 2% increase in GDP. That was all because it was flying 747s.

When engine-makers expanded their high-bypass miracles enough to power big twins, especially the 777-300ER, the '47's days were numbered. Asian carriers and their U.S. and European competitors had a replacement with the same range, and its seats were easier to fill.

*Michael Mecham, Sonoma, California*

*Mecham was Aviation Week's Hong Kong bureau chief from 1993 to 1996. He retired from the magazine in 2013.*

"You're not alone" is certainly good advice for pilots struggling with their mental health, and the reduction of stigma is noteworthy as well. But until the FAA focuses on "serious" mental disorders, and not those "of any sort," the problem of health-care avoidance and withheld information will remain.

*Dan Biezad, San Luis Obispo, California*

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**Don Claussen** has become CEO of *ST Engineering*. He had been vice president for strategy, business development, product management and service delivery

at Intelsat General. Claussen was vice president and general manager of a portfolio division at L3Harris focused on satcom products and solutions.

**Tom Ballenger** has become vice president of the UAS group at *Berry Aviation*. He was director of the Aircraft Systems Integration branch at U.S. Army Special Operations Command (SOCOM) and completed an industry assignment at Bell Helicopter. He also has been deputy director of science and technology at SOCOM.

**Dan Satterfield** has been appointed chief financial officer of *StandardAero*. He succeeds Mike Scott, who is retiring. Satterfield was chief financial officer for Honeywell Aerospace's portfolio of products and services. He previously held senior executive financial leadership positions at Gates Corp., Eaton, Cooper Industries and Siemens.

**Lisa Atherton**, who was president and CEO of Textron Systems and had been executive vice president of the military business, has been named chief operating officer of the *Bell Textron* segment.

**Tom Hammor**, who most recently led Textron Aviation Defense, will succeed Atherton. Hammor previously held leadership roles in quality, manufacturing and customer service at General Electric.

**Brian Yutko** has been appointed CEO of *Wisk Aero*. He succeeds Gary Gysin, who has retired. Yutko was vice president and chief engineer of sustainability and future mobility at Boeing and had been chief technologist for Boeing NeXt. Previously he was senior vice president of programs at Aurora Flight Sciences.

**Robin Stamp** has become director of solutions engineering at *Velo3D*. He was a principal engineer at SpaceX.



**Thomas Arend** has become chief product officer at *Slingshot Aerospace*. He was vice president and head of products at Astra, where he was flight activities officer for its LV0007 mission on behalf of the U.S. Space Force.

**A.C. Charania** has been named NASA's chief technologist, serving as principal advisor to Administrator Bill Nelson on technology policy and programs. He succeeds Bhavya Lal, NASA associate administrator for technology, policy and strategy, who was acting chief technologist. Charania was vice president of product strategy at Reliable Robotics and had worked for Blue Origin and Virgin Galactic's



LauncherOne small-satellite launch vehicle program.

**Steve Berroth** has been appointed senior vice president and general manager for *Sierra Space's* Space Transportation sector. His experience includes advanced aircraft production and program management at Northrop Grumman, Triumph Group and Aerion. At Northrop, Berroth was program director for the Fire Scout MQ-8C.

**Gary Sinfield** has been named vice president for business development of *Nasmyth*. He managed global business development and key account management for Gardner Aerospace and TT Electronics.

**Brian Crowley** has been named vice president of engineering at *WiBotic*.

He was president and CEO of Alithion, Symbio and Bsquare, and has been an engineering executive at Applied Microsystems.

**Michael Eilts** has joined *Spire Global* as general manager of weather and Earth intelligence. He was co-founder, president and CEO of



Weather Decision Technologies. After it was acquired by DTN, Eilts was senior vice president of its Weather Business Unit.

**Phil Suglia** has been appointed vice president of modifications and completions at *Duncan Aviation's* facility in Provo, Utah. He was at Duncan's facility in Battle Creek, Michigan, where he was responsible for the company's regional managers throughout the world. And **Terry Stehlik**

has been named program manager for government and special programs at Duncan's facility in Lincoln, Nebraska. She was a government contracts manager and facility security officer.

**Etienne Cote** has been promoted to chief pilot for demonstration flight operations for *Bombardier* from demonstration pilot. He also worked within the Bombardier Safety Standdown.

USAF Lt. Gen.

(ret.) **Scott Howell**, former commander of the Joint Special Operations Command, has been appointed to the advisory board of *Joby Aviation*. Previously, he was vice commander of U.S. Special Operations Command.

**Leanne Caret** has joined the board of directors of *Raytheon Technologies*. She was CEO of Boeing Defense, Space & Security.

**Keith J. Masback** has been named an independent board member of *Cognitive Space*. He was president and CEO of the U.S. Geospatial Intelligence Foundation as well as director of the Source Operations Group at the National Geospatial-Intelligence Agency and director of intelligence, surveillance and reconnaissance integration for the U.S. Army. ☒



To submit information for the Who's Where column, send Word or attached text files (no PDFs) and photos to: [whoswhere@aviationweek.com](mailto:whoswhere@aviationweek.com) For additional information on companies and individuals listed in this column, please refer to the Aviation Week Intelligence Network at [AviationWeek.com/awin](http://AviationWeek.com/awin) For information on ordering, telephone U.S.: +1 (866) 857-0148 or +1 (515) 237-3682 outside the U.S.

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# FIRST TAKE

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Force Research Laboratory Off-Board Sensing Station program.

**The Indian Navy** completed the first launches and arrested recoveries onboard its new aircraft carrier INS Vikrant on Feb. 6.

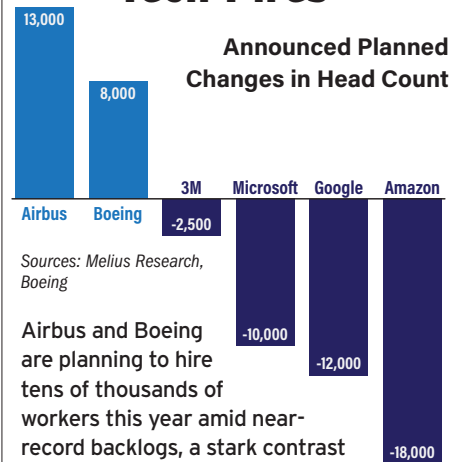
**France and Italy** are jointly purchasing nearly 700 MBDA Aster surface-to-air missiles to replenish stocks for ground-based and naval air defense.

**Hindustan Aeronautics Ltd.** has opened a helicopter factory in Tumakuru, northwest of Bangalore, initially to produce light utility helicopters.

**COMMERCIAL AIRCRAFT** **Mitsubishi Heavy Industries** finally pulled the plug on the SpaceJet and will not restart the paused development of the regional jet (page 13).

**Boeing marked** the completion of the 56-year-long 747 program with hand-

## Aerospace Hires, Tech Fires



Airbus and Boeing are planning to hire tens of thousands of workers this year amid near-record backlogs, a stark contrast to the tech sector, which is cutting large numbers of jobs. Boeing announced that it will cut 2,000 positions in finance and human resources, but that would be more than offset by plans to add thousands of jobs in engineering and manufacturing.

TURKISH AEROSPACE



### DEFENSE

**Turkish Aerospace** has completed the first engine runs on its indigenous Hurjet advanced jet trainer ahead of a first flight expected in March.

**General Atomics'** Gambit air-launched UAV has been selected for the U.S. Air

over of the final 747-8F to Atlas Air on Jan. 31.

**Boeing is to reactivate** a dormant assembly line and add a fourth to ramp up 737 MAX production to 50 a month.

**China has flown** a subscale model of a blended wing body concept for a future airliner carrying 300-330 passengers (page 57).

**UK regional carrier** Flybe ceased trading Jan. 28, and Norwegian low-cost carrier Flynor suspended flights and filed for bankruptcy Feb. 1 (page 50).

### TECHNOLOGY

**Regent, a U.S. startup** developing a regional wing-in-ground-effect seaglider, has secured investment from Japan Airlines.

**China's Aerofugia**, a subsidiary of car-maker Geely, has flown a prototype electric vertical-takeoff-and-landing (eVTOL) air taxi.

**Japanese eVTOL startup** SkyDrive is to establish business operations in South Carolina and pursue FAA certification.

**Leonardo has ditched** Honeywell's HTS900 turboshaft in favor of Safran's Arriel 2K for the AW09 light helicopter.

## VIEW FROM TOULOUSE

### Airbus, Qatar Smooth Things Over

Airbus and Qatar Airways have settled their dispute around surface degradation on the A350 fleet, paving the way for Airbus to return to a normal relationship with one of its most important customers.

The two companies said Feb. 1 that they have "reached an amicable and mutually agreeable settlement," adding that a repair project is now underway. They said they also would "discontinue their legal claims," and noted that the settlement was "not an admission of liability for either party."

While the details of the agreement are confidential, Airbus had offered to repair the affected Qatar Airways A350s, a program that is now part of the solution. Notably, Qatar Airways' orders for 23 more A350s and 50 A321neos are reinstated as well. Both orders had been canceled during the public legal battle.

Qatar Airways is expected to receive its next A350 this year, and the first A321neos are scheduled to arrive in 2026, three years later than originally planned. Airbus had canceled the A321neos after Qatar Airways refused to take more A350s on firm order, escalating the conflict. Instead, the airline ordered 25 Boeing 737-10s.

There were numerous attempts by business partners of both parties in the past year to achieve a settlement. Airbus was at risk of losing an important long-term customer, and Qatar Airways would have been reliant on Boeing, which has had program delays on the 787 and 777 programs, heavily affecting the airline's fleet plans.

## OBITUARY

**Robert R. Sandusky, Jr.**, chief engineer for the Northrop/McDonnell Douglas YF-23, died Jan. 11 in Virginia at age 83. Sandusky began his career at Boeing in 1965, where he worked on configuration design of its Model 908-909 contender for the U.S. Air Force Light Weight Fighter (LWF) program. He moved to Northrop in 1972, where he was involved in the YF-17 LWF prototype program before being promoted to manager of the advanced design department. There, he led design of the F-20 Tigershark. Sandusky then created a small carve-out from the Tacit Blue stealth technology demonstrator program to design Northrop's entry into the Air Force's Advanced Tactical Fighter program. This became the YF-23A.

A founding member of the Pioneers of Stealth, a group of people who worked on low-observable technology from its beginnings in the 1970s, Sandusky retired from Northrop Grumman in 1995 to become a professor at George Washington University at the NASA Langley Research Center in Virginia, where he taught aircraft design. Recognized for his love of "blank-sheet-of-paper" aircraft design, he was an avid flyer and teacher as well as a certified flight instructor. After retiring from teaching in 2003, he began a third career as president of Belcan's aerospace engineering services division. At the time of his death, Sandusky was chief engineer for commercial supersonic aircraft startup Exosonic.



BOB SEIDEMANN

## QUOTED

"EVERY INVESTMENT WE MAKE, WE DESTROY VALUE," HE TOLD EMPLOYEES, ADDING THAT FINANCIALLY, **"WE UNDERPERFORM EVERY KEY COMPETITOR OUT THERE."**



### —TUFAN ERGINBILGIC,

Rolls-Royce's new CEO, in a global address to staff that was first reported by the *Financial Times*. Erginbilgic also called the 117-year-old company a "burning platform."

## SPACE

**NASA's Mars Perseverance** rover has completed caching 10 samples of rock cores gathered from its Jezero Crater landing site.

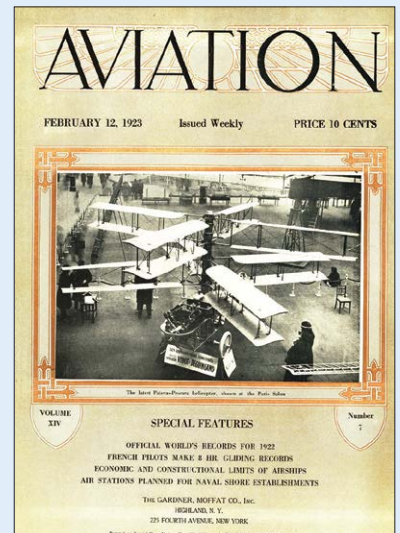
## AWARDED

**NASA's Double Asteroid** Redirection Test (DART) team has won the Space Foundation's 2023 Space Achievement Award. The DART spacecraft was slammed into the asteroid Dimorphos Sept. 26 to help assess whether such a technique could be used in the planetary defense of Earth. 🌌



## 100 YEARS AGO IN AVIATION WEEK

The rotorcraft industry's latest models will be on display at the HAI Heli-Expo show in Atlanta in March. One hundred years ago, another cutting-edge helicopter was showcased on our cover of Feb. 12, 1923. The Pateras-Pescara Model 3, brainchild of Argentinian rotorcraft pioneer Raul Pateras Pescara, featured two sets of powered, coaxial biplane rotors that contained 16 lifting surfaces. Our cover depicted it on display at the Paris Salon, the forerunner to the Paris Air Show. Six months later, the magazine reported "marked success" in Pateras' tests of the craft outside of Paris. "He is now practicing straight and circular horizontal flights, with a view to qualify for the 10,000 francs prize offered by the Aero Club of France," we wrote in our Aug. 27 edition. "Some noteworthy performances include a straight flight of 200 m [625 ft.] length, another of 460 m and a circular flight of 650 m circumference, with the machine landing in a circle of 10 m diameters from which it took off." Despite Pescara's efforts, limitations made the Model 3 helicopter impractical.



But his work paved the way for the more useful Focke-Wulf Fw 61 13 years later and the Sikorsky VS-300 in 1939.

Subscribers can access every issue of *Aviation Week* back to 1916 at: [archive.aviationweek.com](http://archive.aviationweek.com)







## UP FRONT SASH TUSA

### CHINA SOUTHERN AIRLINES'

Boeing 737 MAX flight on Jan. 13 was the first commercial operation of the type in China since the MAX was grounded in

March 2019 following the Lion Air and Ethiopian Airlines MAX crashes. Boeing had delivered 97 737 MAXs to Chinese carriers before March 2019, and 138 more MAXs built for them are sitting in the U.S.

Before the grounding and the COVID-19 pandemic, China was the single most important market for Boeing and Airbus jetliners. At the November 2018 Zhuhai Air Show, Boeing management said the company delivered 202 aircraft to China in 2017 and expected to exceed that in 2018. The company's stated deliveries (excluding those through leasing companies) were 161 and 192 aircraft for the two years, respectively (and a total of 1,000+ for 2011-18). China thus accounted for around one-quarter of total deliveries for Boeing and as much as one-third of the 737 program.

But this delivery rate collapsed in 2019 and has stayed low ever since: Boeing delivered a total of only 71 aircraft to China in the last four years.

## MAXed Out

Boeing's troubles in China run deep

It would be easy to attribute this decline purely to the pandemic—but that would be wrong. China's "zero-COVID" policy involved lockdowns and restraints on travel that endured longer than in any other region. But Chinese airlines did take delivery of new aircraft in 2018-22: 561 from Airbus and 90 jets from domestic manufacturer Comac (including the first C919).

Boeing's share in the Chinese market has fallen from more than 50% in 2019 to about 10%, putting it in the No. 3 position behind Airbus and Comac. Without pre-2019 levels of access and demand from China, Boeing's total addressable market is around one-fifth smaller for the 737 MAX and at least 10% smaller for widebodies.

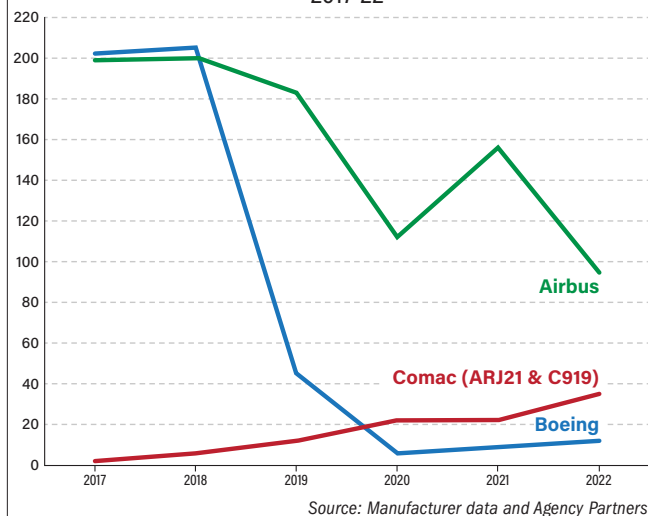
Aside from the relative weakness of the 737 MAX compared to the Airbus A320 family (and especially the A321neo), an even bigger problem is trade relations. Boeing is one of very few U.S. companies that has had a large positive trade balance with China. If Beijing is trying to exert leverage or retaliate over U.S. trade policy moves, Boeing is the obvious line of attack. Given the further deterioration of Sino-U.S. relations recently, especially regarding Chinese access to U.S. semiconductor technology, it is hard to feel optimistic about Boeing's return to its previous scale in China.

During the company's second-quarter 2022 earnings call, Boeing management referred to how the company was "de-risking" its Chinese exposure, including through remarketing undelivered 737 MAX aircraft previously intended for Chinese airlines. If carried

through, that should reduce the backlog of undelivered MAXs and generate much-needed cash. But a more important issue is securing new 737 MAX orders from Chinese carriers.

Here, the issue of Boeing's trade balance becomes a further negative. If China does as it has with every other manufactured capital good, the country increasingly will favor locally produced goods. In this regard, Boeing's 737 MAX completion center in Zhoushan does not cut it: Installation of seats, painting and handover work is low-value. Airbus' A320-family final assembly line in Tianjin has at least five times the labor content per aircraft.

Jet Deliveries to Chinese Airlines  
2017-22



A further twist comes from the recent certification of Comac's 150-seat C919 narrowbody, which is in production and should enter service with China Eastern Airlines in 2023.

Comac officials' recent statements that 150 C919s could be built annually by 2025 does not seem credible. No new airliner program has managed such a ramp-up, let alone in the current tight supply chain environment. But Comac's smaller ARJ21 achieved a record 33 deliveries in 2022, and we forecast it will reach 60 aircraft annually through the middle of the decade. It is realistic to think the more modern C919 could reach 100 deliveries annually in the second half of the decade. This suggests that imported 737 MAXs likely will take third place in a market that both Western manufacturers forecast at around 300 aircraft per year.

The implications for Boeing are that 737 production likely will peak at closer to 40 per month than the 50 per month of 2018. A (weak) No. 2 position would be near-structural versus Airbus. ☹

Aerospace and defense analyst Sash Tusa is a partner at Agency Partners. He is based in London.



# STAR PERFORMERS FLY E2

CONGRATULATIONS PORTER AIRLINES ON  
INTRODUCING THE E2 INTO COMMERCIAL SERVICE.

We're delighted to announce the Embraer E195-E2 aircraft that were delivered to Porter Airlines in January this year have now entered commercial service. The new-generation E2 with its superior cabin comfort and state-of-the-art connectivity will extend the airline's 'flying refined' service to dozens of new destinations and enhance its reputation for transforming the economy passenger experience. Porter's E2 fleet is based at Toronto Pearson International Airport and in the future will be deployed on business and leisure routes throughout North America, including to the west coast, Southern U.S., Mexico and the Caribbean.

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## INSIDE BUSINESS AVIATION

# WILLIAM GARVEY

### EMBRAER RECENTLY ANNOUNCED

a medevac option for its popular Phenom 300 light jet after the FAA and its European counterpart issued the necessary supplemental type certificates. The new configuration can include two stretchers, an incubator and additional medical equipment, and the airframer said the conversion from passenger to medevac service can be done in approximately 5 hr.

Developing alternate uses and thus expanding the customer base for an aircraft primarily intended for another role is a decades-old practice among airframe manufacturers. The Beech 18 began life in 1937 as an executive twin, but during World War II thousands were adapted by the Allies for use as navigation and gunnery trainers, photo reconnaissance platforms and even as light bombers, among other applications. A generation later, FedEx launched its overnight package delivery service with a fleet of Dassault Falcon 20 business jets converted into freighters. That worked out well.

Notably, business and private aircraft have been adapted for a wide variety of roles, including serving as high-altitude atmospheric research platforms, providing battlefield communications, making news and commercial videos, flying search-and-rescue missions and more. The most curious conversion I've witnessed was the transformation of Howard Hughes' private Boeing Stratoliner into an island-hopping houseboat. But that's another story.

Currently underway is a conversion that turns tradition on its head by reconfiguring grounded airliners into business jets. One program, as developed and conducted by Flying Colours, a major modification and maintenance outfit headquartered in Peterborough, Ontario, centers on the CRJ200.

An outgrowth of the Canadair Challenger 600, the Canadair Regional Jet was stretched 20 ft. and fitted with 50 seats, becoming a pioneering aircraft in the regional jet (RJ) revolution as fanjets supplanted smaller turboprop "commuters," beginning with the first CRJ delivery to Lufthansa in 1992. By the time Bombardier, which acquired Canadair, ended the model's production in 2006, more than 700 CRJ200s had been delivered.

Over time, however, broad economic concerns, regional pilots' migration to major carriers, fuel cost increases, the abandonment of service to smaller markets and then the onset of the pandemic, CRJ200s and other RJs were beginning to be placed into long-term storage—by the hundreds.

According to the Aviation Week Network's (AWN)

Fleet Discovery Civil, there were 188 CRJ200s in storage as of late January and the average age was 20.8 years. Regardless, Eric Gillespie, Flying Colours executive vice president, notes that the model's service life extends to 80,000 cycles and that the parked units tend to have 25,000-40,000 cycles logged, which means they have years of life remaining. That's especially true, he notes, when any are next placed in charter or corporate service, since those roles represent a fraction of the flight time and cycles demanded of an RJ.

The transformation process begins with the selection of a stored CRJ and negotiating with its owner—prices, according to AWN's Avitas, vary between \$1-1.6 million depending on age and condition—then moving it to Flying Colours outside Toronto or to its operation in St. Louis. After removing the seats, interior and unwanted equipment, the upgrade begins, along with any required or desired maintenance.

A CRJ200's interior is the same as that of Bombardier's large-cabin Global 6000 and thus able to accommodate a variety of configurations. These can range from a 16-seat corporate shuttle, to a split layout with a half-dozen business-class seats forward and 20 regular seats aft, or a low-

density VIP setup. Medevac, special missions and more are all potential configurations. Typically, the airframe is repainted as well, and long-range fuel tanks can be installed, if desired.

Gillespie says the process can take 4-8 months and cost \$2-8 million, depending on its complexity and choices of equipage. But when the project's done, the operator takes possession of a large-cabin, custom-designed business jet with years of service remaining. It comes with a two-year paint and installation warranty. In addition, parts and service are available worldwide. And all that for the price of less than a quarter of a new-production counterpart.

Flying Colours has delivered some 35 such conversions over the years. The company already has commitments for three more this year, and it hopes for two more by year-end. The goal is to continue at that pace, or better, going forward.

Meanwhile, Vista Global's XO shared service uses two refurbished CRJ200s outfitted with 16 and 18 "spacious captain's chairs," respectively, on flights between the New York area and South Florida. Pricing begins at \$1,500, and the initial response was so positive that it increased the schedule to up to four flights daily. But that, too, is a subject for another story. ☺

William Garvey was editor-in-chief of Business & Commercial Aviation from 2000 to 2020.

## Role Reversal

Unwanted regionals are finding welcome in new missions



FLYING COLOURS

# AIRLINE INTEL

## JENS FLOTTAU



**IN 1962, THE NIHON AIRCRAFT** Manufacturing Corp. YS-11 took off for its first flight. The 60-seat Rolls-Royce Dart-powered turboprop was the first

Japanese civil aircraft produced after World War II, and the hope was that it would be the first of many.

Some 53 years later, in 2015, what was then called the Mitsubishi Regional Jet (MRJ) made its first flight, eight years after the program was launched. But another eight years on, Mitsubishi Heavy Industries has finally ended the project, officially stating on Feb. 7 that it will not restart development of the aircraft.

The loss to Japanese industry and government is more than just the \$7 billion funneled into the ill-fated program. If there were ever a hope that one of the country's OEMs would return to commercial aircraft manufacturing, that has most likely vanished. It is inconceivable that Japan will attempt to develop a large commercial aircraft again in the coming decades.

The SpaceJet—as the MRJ has been called since 2019—was not necessarily bound to fail. In 2007, large regional jets were in high demand. While the Bombardier CRJ was unpopular with passengers, Embraer had just proved with its E-Jets that it was possible to bring a new aircraft design to the market successfully.

Of course, there was a major difference between Mitsubishi and Embraer. The Brazilian manufacturer slowly had built up its expertise in the design and integration of aircraft—the Bandeirante, Brasília and later the ERJ 145 represented all necessary steps that enabled the company eventually to build relatively large and complex aircraft such as the E-Jets and the E2 series, not to mention the KC-390 in its defense business.

Mitsubishi, one of the three Japanese “heavies” along with Kawasaki and Subaru (formerly Fuji), long has been part of the global commercial aircraft manufacturing scene as a major supplier to Boeing, but the Japanese aerospace industry has not had a continuous history of aircraft manufacturing since YS-11 production ceased in 1972.

Sure enough, Mitsubishi and its partners paid dearly for their lack of experience. Initially due for a first delivery in 2013, the aircraft was delayed six times. Numerous design flaws were discovered during development and even after the first flight, forcing highly expensive extra work and a restart of certification that resulted in multiyear delays. Over time, the project lost credibility.

And the market moved on. The idea of successfully

introducing an all-new large regional jet became unrealistic, particularly with environmental concerns gaining importance. Embraer is even struggling to find sufficient interest for a new turboprop of similar size, which would be much more fuel-efficient than the SpaceJet could ever be.

The SpaceJet's demise appears to be good news for Embraer, which remains the only internationally relevant maker of large regional jets, discounting Comac's ARJ21 and as Airbus' A220 moves into mainline fleets.

In theory, a monopoly is a comfortable position to be

in, but the big picture trends also must be a huge concern for Embraer and the long-term prospects of the E2. The aircraft has recently seen some solid sales, but overall it has not outgrown the E1's niche, which was Embraer's aim.

The shift to “rightsizing”—putting smaller aircraft on thin routes served by mainline jets—has to a large extent still not happened, even though the concept makes a lot of sense on paper. And there does not seem to be a growth story beyond refreshment of the

admittedly substantial fleets of E1s that will come up for replacement in 5-10 years.

Some of what hurt the SpaceJet affects Embraer as well. The industry appears to have woken up to the idea of tackling its environmental footprint, so research is going into new propulsion concepts rather than conventional designs. Meanwhile, the pilot shortage in the U.S. regional market and scope clauses are not going away.

Given the slow pace of sales in the early years of the E2 program, Embraer has suggested that it may have launched the aircraft too soon, with the E1 in-service fleets not yet up for replacement. While that is certainly true, Embraer is also lucky to have introduced the second generation when it did. These days, such a move would no longer be possible.

Some parallels can be drawn between the SpaceJet and the YS-11, too, even though the turboprop made it into revenue service, with 182 aircraft built. The launch customers for both aircraft were Japanese, and their international success largely depended on penetrating the U.S. domestic market.

Piedmont Airlines became the largest international operator of the YS-11, with 21 aircraft. SkyWest Airlines and Mesa Airlines had ordered 150 SpaceJets at one point. When Piedmont's enthusiasm for the aircraft remained a singular view, the YS-11's prospects deteriorated. As for the SpaceJet, even reaching that stage would have been a great success. 🍷

## Pulling the Plug

Mitsubishi ends the SpaceJet program



MITSUBISHI AIRCRAFT



# DO IT YOURSELF

- > WAR FUELS UKRAINIAN DEFENSE INDUSTRY BUILDUP
- > NEW 620-MI. LOITERING MUNITION MAY BE OPERATIONAL



A homegrown UAV industry has been emerging in Ukraine since fighting with Russia began in 2014.

UKROBORONEXPORT PHOTOS

**Steve Trimble** Washington

**M**oscow has not suffered a missile or air attack since World War II, but air defense systems started appearing around the Russian capital in early January. A city located less than 250 nm from the nearest enemy-held ground seemed finally wary of air attack from a relatively small, homegrown Ukrainian weapon designed explicitly to threaten them.

The sudden installations—including a Pantsir-S1 system atop the defense ministry's main building and an S-400 battery near a busy, northern metro train stop—did not seem provoked by any new threat provided by NATO to Ukraine. Despite increasingly urgent calls by Kyiv, NATO and other supporters have declined to send long-range missiles and fighters to Russia's adversary in the yearlong full-scale war.

Instead, the only imminent bombing threat against the Kremlin comes from

Ukraine's battered—yet resilient and inventive—defense industry. Since the latest invasion by Russia began on Feb. 24, 2022, at least three major Ukrainian Ukroboronprom facilities have been attacked. The Battle of Hostomel destroyed the Antonov An-225 Mriya, formerly the world's second-largest aircraft, within the first few days of the war. Ukroboronprom has closed other sites. But the private concern—ranked 79th on the Stockholm International Peace Research Institute's list of the

world's largest defense contractors—remains active, with manufacturing distributed to a network of smaller plants around the country.

An industry defined by Soviet-era manufacturers such as airlift specialist Antonov, turboprop manufacturers Motor Sich and Ivchenko-Progress, and guidance and control specialist Luch Design Bureau is evolving while under attack. Ukraine still depends on Western supplies of ammunition, artillery and support equipment, but the rising production of homebuilt systems is beginning to fill key gaps in capabilities and production volume.

In November, Ukroboronprom launched production of Russian-style, 152mm artillery shells, hoping to ramp up deliveries as Western stockpiles fall to critical levels. Turkey's Bayraktar TB2 made headlines last spring by supporting Ukrainian artillery strikes

during the first several weeks of the war, and Western-supplied drones continue flowing to Ukraine's front lines. But Ukrainian companies now are producing several types of small uncrewed aircraft systems (UAS), backfilling a type of modern military equipment that has proved short-lived on the front lines.

Ukrainian-sourced weapons still play a secondary role to Western-supplied equipment, but they are part of a critical, behind-the-scenes competition that could help decide the outcome of the war. Barry Pavel, vice president of the Rand Corp. think tank's National Security Research division, says winning the industrial competition is second only to military activity in determining the final result.

"The industrial battle is really important," Pavel says. "Can Ukraine's Western allies manufacture and supply Ukraine with what it needs faster than Russia can do [for] itself or by [importing] drones from the Iranians or other suppliers? So I think the industrial battle is second."

Most of the Ukrainian industry's contributions to the war effort have been overshadowed by the constant flow of foreign imports. But Ukrainian ingenuity startled the world on April 14 with the sinking of the Moskva, a Russian Navy cruiser and flagship of its Black Sea fleet. The weapon at the source of the downing is widely considered to be the Ukrainian-designed Neptune anti-ship missile, which Mikhail Khodarenok—a prominent Russian military analyst—had dismissed only three years earlier as a nonthreat to the Russian Navy.

Even as the Moskva sank, Ukraine's weapon designers had started working on a new capability with significantly greater range. On Oct. 17, Ukroboronprom announced on its Facebook page that development of a large new loitering munition soon would be completed. Russia has launched waves of similar Iranian-supplied Shahed-136 munitions at Ukraine's infrastructure since August. "We are finalizing the development," Ukroboronprom said.

An hour after the official announcement, the Come Back Alive foundation, which says it has raised over \$140 million to support the Ukrainian Armed Forces, confirmed its role as Ukroboronprom's financing partner for the new weapon.

Taras Chmut, the foundation's director, tweeted an ominous purpose for

the new weapon, using the Ukrainian slang term "bavovna," which translates literally as "cotton"—evoking the puff of white smoke created by an explosion. "Soon, there will be cotton in Moscow," he tweeted. The foundation said that it launched the "Cotton in Moscow" project in mid-August and that development had been fully funded within the first two months.

In late November, Ukroboronprom provided more details about the project in a lengthy press release. "It can operate at a range of 1,000 km [(620 mi.)] and under certain conditions up to 1,200 km," Ukroboronprom said. "Its payload is about 75 kg [(165 lb.)]. We accelerated the production of the first prototype as much as possible, tested it in the air and are preparing for the next stage—the demonstration of the capabilities of this complex to the leadership of the security and defense forces of our country."

A week later, in early December, two airfields located deep inside Russian territory—Dyagilevo and Engels—were struck by explosions (AW&ST Dec. 26, 2022-Jan. 15, 2023, p. 10). Photos on social media showed that a Tupolev Tu-95 bomber at Engels sustained heavy damage. The Russian Defense Ministry blamed the attacks on drones launched by Ukraine. Only two candidates in Ukraine's arsenal possess the range for such a mission: a modified version of the Soviet-era Tupolev Tu-141 reconnaissance drone or Ukrobo-

ronprom's recently disclosed weapon. On Feb. 6, a Ukrainian-launched Tu-141 carrying a 100-lb. bomb came within about 100 nm of central Moscow, but crashed in a forest in the Kaluga region.

In either case, the weapons evaded front-line defenses with deep-penetration flights. Neither of the weapons has fulfilled the goal of creating explosions in Moscow, but they do at least continue to display an impressive home-grown capability to surprise one of the world's largest militaries. Other examples include an attack on Russia's Black Sea fleet using underwater drones, the sinking of the Moskva with the Neptune missile and a sophisticated approach to information warfare.

"I think, initially as a surprise is the incredibly innovative and adaptive way that Ukrainian forces have used modern technology," says Ruth Harris, director of the Defense and Security research group at Rand Europe. "I think this is a really good example of innovation in wartime that we need to look at."

In the past, any ingenuity displayed by Ukraine's defense industry has been limited by a chronic lack of resources. In November 2017, for example, Antonov, a Ukroboronprom subsidiary, unveiled the Horlytsya ("Turtle Dove"), a tactical UAS designed with 7-hr. endurance for spotting artillery targets. But Antonov canceled the project two years later, after the Ukrainian government ordered an initial batch of Turkish Bayraktar TB2s.



Russia's interior cities have been safe havens, but maybe not for the long term. Ukroboronexport has released photos of a long-range munition (left) with a publicized mission to attack Moscow. A panel on it (top) translates in the Ukrainian and Russian languages to "I will repay."



Antonov revealed plans to develop a larger armed Horlytsya-2 UAV in 2021 but has provided no updates on the project since.

Since fighting erupted in the Donbas and Crimea regions in 2014,

however, local companies in Ukraine have fielded several types of small UAS. The Ukrainian defense ministry has purchased several types in large numbers, including the Athlon Air A1-SM Furia, Spaitech Sparrow

and DeViro Leleka-100. UkrSpec-Systems, a company founded in 2014, has fielded the PD-1/-2 series of tactical UAS in the same performance category as the Horlytsya-1 and unveiled the catapult-launched

## How Ukraine Could Build a Future Fighter Fleet

- > A DETERRENCE-FOCUSED FIGHTER FLEET MAY BE VITAL FOR POSTWAR UKRAINE
- > LAYERED GROUND-BASED AIR DEFENSES ARE NEEDED TO PROTECT SKIES

**Tony Osborne** London

In the first days of the Russian invasion of Ukraine, it was difficult to imagine an outcome in which much of the country would not end up under Moscow's control. Ukraine's military was outgunned, its air force outranged, and the invaders equipped with technologically superior hardware.

A year on, however, thanks to Ukrainian boldness and bravery and significant amounts of Western-supplied weaponry, the defenders have managed not only to hold off Russian forces, but also to push them back, reclaiming territory taken by the Russians in the initial blitzkrieg-like push.

The cost has been enormous: Tens of thousands of military personnel and civilians have lost their lives, and Ukraine's economy and infrastructure are in ruins. Despite this, the country may yet repel the invaders, restore its pre-2014 borders in the east and even recover control of annexed Crimea.

Pushing Russian forces back into their own territory may not be enough to restore Ukraine's security fully, however. Kyiv may need to make significant investments in military equipment to keep the Russians at bay.

At the heart of those investments, experts say, should be a reconstituted air force equipped with modern Western combat aircraft and ground-based air defenses that could help deny Ukraine's skies to air and missile attacks.

How the country rebuilds its defense infrastructure could depend on what a potential victory would look like—could Ukraine repel the Russian invaders entirely, or would it end up agreeing to a cease-fire with disputed territory?

Ukraine's defense plans also may depend on the shape of its armed forces at the end of the conflict, as well as what happens politically: Who will dictate how funding will be spent—on rebuilding the military or the state?

Regardless, air force restoration should be a top priority, primarily to provide a solid deterrent against further Russian aggression, defense experts say.

"There is nothing to suggest that Russia will give up its territorial and political ambitions in Ukraine. . . . So, even if [Russia] loses on the ground, the Ukrainians will need to rebuild their military," Justin Bronk, the senior research fellow for airpower and technology in the military sciences



**The Netherlands says it would consider transferring surplus F-16s to Ukraine if requested, but the U.S. would have to approve it.**

team at the London-based Royal United Services Institute, tells Aviation Week. "There will be strong interest in the West in ensuring Russia is successfully deterred, so providing fighters to Ukraine would probably be part of that."

Ukraine's combat air force comprises four Soviet-era fighters: The Sukhoi Su-27 "Flanker" and Mikoyan (later Russian Aircraft Corp.) MiG-29 "Fulcrum" are both equipped largely for air defense, and the Sukhoi Su-24 "Fencer" and Su-25 "Frogfoot" are retained for ground-attack duties.

Limited funding in the years following Ukraine's independence from the former Soviet Union in 1991 has meant these fleets, many of which entered service in the 1980s, have had only a few upgrades since the Cold War ended.

Russia's inability to secure air superiority enabled the Ukrainian Air Force to keep flying. But Ukrainian combat aircraft were forced to operate at a low level and with high loss rates because they were overmatched and outnumbered by later-model Flankers such as the Su-30SM and Su-35S, as well as MiG-31s with more advanced radar systems and longer-range and more capable air-to-air missiles.

The rebuilt air force will need to replace Ukraine's Soviet-era aircraft urgently, in part, Bronk says, because most would no longer be considered suitable or safe for long-term peacetime flying. "The Russian-built aircraft will have used up a huge amount of fatigue on their airframes during the war," he notes.

Western fighter jets have been on the wish lists of Ukrainian commanders since the beginning of the conflict. However, so far Western leaders have been unwilling to transfer fighters, even denying deliveries of MiG-29s

TONY OSBORNE/AMST PHOTOS

Shark small UAS in October.

All of the companies will be competing for a fresh surge of investment in locally built, small UAS by the Ukrainian government. In mid-January, the defense industry announced a plan

to spend more \$500 million this year on indigenous UAS, seeking to replenish heavy losses of Ukrainian and foreign-supplied drones on the front lines.

"I think they've gone through a very significant evolution from a lot of the

do-it-yourself efforts in 2014-15 to a more streamlined approach, where commercial technologies are utilized on a massive scale," says Samuel Bendett, an advisor for the Center of Naval Analyses' Russian Studies Program. 🇺🇸

operated by Eastern European countries.

It was hoped the recent decision by several Western nations to transfer main battle tanks would provide momentum toward also delivering aircraft such as the Lockheed Martin F-16. But that has not been the case so far.

President Joe Biden on Jan. 30 responded with a firm "no" to a reporter's questions about whether U.S.-made combat aircraft would be sent, suggesting Washington still considers such a transfer a red line that could escalate the conflict.

After the war, the F-16 could form the backbone of a reconstituted Ukrainian Air Force, says Douglas Barrie, senior fellow for military aerospace at the International Institute of Strategic Studies.

"If you are moving your capability away from Soviet-era platforms, then the F-16 is not a bad place to start," he says. After all, numerous European countries operate the type, including neighboring Poland, which could support the development of a Ukrainian F-16 fleet.

A second, heavier type also may be needed, Bronk says. It could be an aircraft in the class of the twin-engine Boeing F-15, which offers more range and endurance to perform

Standoff air-to-surface weapons also may be needed to allow the Ukrainians to hold at-risk airfields and command-and-control facilities and keep the threat at bay, Barrie says. Filling such a request likely would prompt further deliberation about the level of long-range standoff weaponry Western governments would be comfortable selling to Ukraine. A cease-fire agreement, for example, could attempt to set limits on the kind of weaponry Ukraine could acquire—although Barrie says Kyiv should be wary of signing any such limiting agreements.

As a further deterrent, Ukraine may have to establish a layered and highly integrated ground-based air defense system, rather like the one being established to deal with Iranian-supplied one-way attack uncrewed aircraft systems and cruise missiles.

"Ukraine's air defenses will have to cover long, medium, short and point needs," Barrie says. "They will need to flush out the Russian systems and replace them with Western systems, rather like what the Polish are doing."

Poland is in the process of phasing out its Warsaw Pact-era air defenses in favor of U.S.- and European-supplied systems including the Raytheon Patriot and MBDA Common Anti-Air Modular Missile, as well as the locally developed Piorun man-portable surface-to-air missile.

Experience gained in fighting Russia illustrates the need for such systems—particularly the more advanced long-range systems—to be mobile and ready to move in the event of hostilities.

**Ukraine's Sukhoi Su-27s (pictured) and Russian Aircraft Corp. MiG-29s have worked hard in the air defense role, but both types would need urgent replacement in a postwar Ukraine.**

Delivering combat aircraft to Ukraine—whether in peacetime or during a conflict—would require considerable efforts by the nations supporting such transfers, as well as by Ukraine itself. Much would depend on the ground support, weapons packages and training being offered. Training during wartime takes valuable and experienced personnel away from the front line, potentially for months at a time. Pilots must learn not only how to fly an aircraft, but also how to fight with it effectively. Such training can take years in the West but is particularly important if the Ukrainians want to overcome the advanced platforms Russia has been fielding.

Before the aircraft arrive, Ukraine also may need to rebuild its airfield infrastructure. Unlike Ukraine's Russian-made fighters, Western aircraft—despite their sophistication—are less ruggedized for operations on austere airfields. They may be even less tolerant to operations from roads and highways, a tactic to which Ukraine has resorted to preserve its fighter operations during the conflict. 🇺🇸



longer defensive patrols. Longer legs are desirable for the Ukrainian Air Force, given the country's size.

Defensive counter-air would be the primary task of Ukraine's future combat aircraft, dealing with aircraft, cruise missiles and uncrewed aircraft system threats. But the aircraft also may need to be equipped for the suppression and destruction of enemy air defenses (SEAD/DEAD) and should have an anti-ship capability as well—learning lessons from Russia's blockade of Ukrainian ports, which has damaged the country's ability to export grain.

If Russia continues to attack Ukraine, the SEAD/DEAD capability will be essential, as part of the country's airspace could be within the coverage of Russian layered ground-based air defenses.



# Sizing Up Russia's Cruise Missile Inventory

The Tu-95MS strategic bomber can carry six Kh-55 missiles in its bomb bay and eight larger Kh-101s on its underwing pylons.

The Kh-101 missile body has a flattened cross-section and faceted sides, a shape that combines the requirements of radar cross-section reduction and efficient bomb bay capacity. The wings are folded under the missile's body before launch and unfolded afterward. The Item 84 turbofan engine developed by NPO Saturn powers the missile.

The Kh-101's guidance system combines an SN-5040 strap-down inertial navigation system made by RPKB, an SN-99 satellite navigation receiver developed by KB NAVIS, a terrain contour-matching system that compares the signals of a Doppler speed sensor and radio altimeter with the map stored in the missile's memory, and an electro-optical Otblesk-U digital scene-matching area correlation system (DSMAC) made by Moscow's TsNIIAG institute.

The most important of these sensors is the Otblesk-U electro-optical system, as it ensures accuracy within several meters, a necessity for a missile with a conventional warhead. The DSMAC is also the most demanding to use, as it requires detailed images of the target area. Gathering and processing the data necessary for a mission demands an appropriate reconnaissance infrastructure and qualified personnel.

If the Western embargo on the supply of military and dual-use electronics had been completely successful, it would have blocked the production of advanced weapons in Russia. However, microelectronic components produced by companies based in the U.S.

and the Netherlands have been found in the Kh-101 missile. Enforcing such an embargo is not easy. The components are unsophisticated and widely available. Russia has been able to smuggle in the com-

> RUSSIA CONTINUES TO PRODUCE MORE OF THE RADUGA CRUISE MISSILES

> OLD, DISARMED KH-55 CRUISE MISSILES SERVE AS DECOY TARGETS

**Piotr Butowski** Gdansk, Poland

**R**ussia launched its invasion of Ukraine on Feb. 24, 2022, using Tupolev Tu-95MS and Tu-160 strategic bombers to attack airfields and air defense sites. One year later, Russia still does not control the air.

The aggressor targeted military equipment production and repair facilities, strategic fuel reserves and railway junctions, as well as transports of equipment for Ukrainian troops fighting in the east of the country, all with little gain.

The strikes against Ukraine's energy infrastructure that began in October have been more effective—and especially severe for the civilian population. Ukrainian cities continue to struggle with a lack of electricity, water and heat. From October through the end of 2022, Russia conducted nine massive strikes, firing dozens of long-range missiles of various types.

With minor exceptions, Russian strategic bombers are using Raduga Kh-101 air-launched cruise missiles to hit targets deep inside Ukraine. In addition to the bombers, Moscow is drawing on ship-launched 3M14 Kalibr cruise missiles as well as Iranian Shahed drones. Single strikes with Kh-22 missiles from Tu-22M3 medium bombers also are being carried out. There have been no attacks with Kinzhal missiles for a long time, although three Mikoyan MiG-31K/I aircraft were de-

ployed from October through December in neighboring Belarus and have flown from there periodically, forcing Ukraine to announce air alerts and send civilians to shelters.

The Kh-101 is a large missile, weighing up to 2,400 kg (5,291 lb.), with a body length of about 7.4 m (24 ft.) and a wingspan of 3.7 m. The missile can fly at an altitude of 50-6,000 m with a cruise speed of Mach 0.55 and maxi-

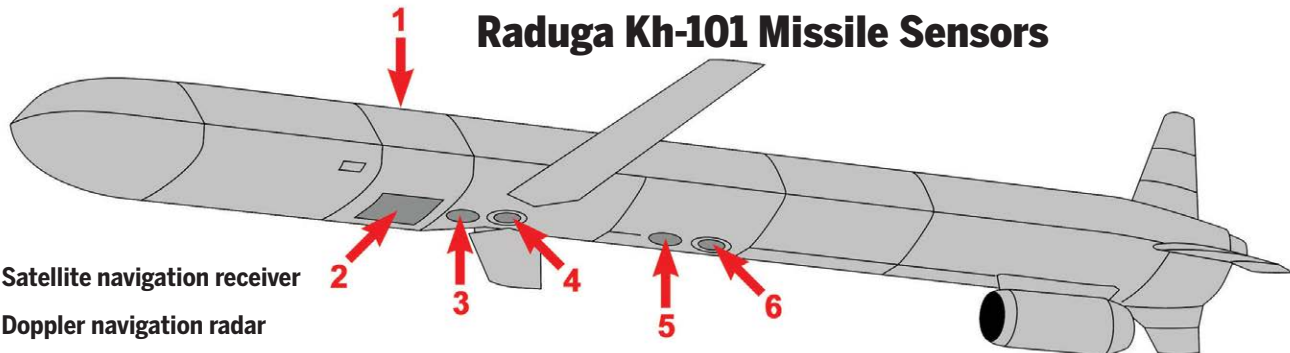


The numeric marking on this warhead found last March indicates that Russia is still making Kh-101 missiles.

mum speed of Mach 0.75, for a maximum distance of about 3,500 km (2,175 mi.). The missiles have been flying low over Ukraine, since the distance from where they are launched to Kyiv is just 1,000-1,500 km.

## Raduga Kh-101 Missile Sensors

- 1 | Satellite navigation receiver
- 2 | Doppler navigation radar
- 3 | Radio altimeter transmitter
- 4 | Electro-optical digital scene matching area correlation (DSMAC) sensor
- 5 | Radio altimeter receiver
- 6 | DSMAC illuminator



SOURCE: PIOTR BUTOWSKI

ponents using companies in third countries and so continues to produce the weapon.

But how many of the missiles remain in its inventory?

The best way to assess production volume is to analyze missile production codes, based on debris found in Ukraine. From the numbers printed on spent missiles, it appears that five batches totaling 100 missiles were produced last year, or about eight missiles per month. This means the rate of production did not change (or was even slightly accelerated) after the start of the war.

Russian bombers used the Kh-101 for the first time in combat on Nov. 17, 2015, in Syria. According to the Russian defense ministry, strategic bombers fired 48 Kh-101 missiles in four days of operations. After that initial flurry, the use of Kh-101s in Syria dropped off, with a total of about 80 missiles launched during hostilities in Syria.

Data about the number of Kh-101s fired in Ukraine has been difficult to pinpoint.

According to the Ukrainian defense ministry, Russia had fired 132 Kh-101s by Nov. 18, which may be an underestimation. The same communique mentions the use of 150 Kh-555 missiles—but that has not been independently confirmed. If all of these were Kh-101s, it would bring the total used by mid-November to 282. The Russians conducted another five cruise missile raids before year-end.

By those measures, Russia's stock of Kh-101s is likely close to exhaustion, an assessment supported by noting

that of every nine missiles launched last fall, as many as seven were produced that same year.

The Russians struck only twice this January, with fewer missiles than in last year's attacks. The first missile strike, on Jan. 14, was carried out, according to the Ukrainian defense ministry, with 28 long-range missiles, including Kh-101s, naval Kalibrs and five supersonic Kh-22s (one of which hit a residential building in Dnipro, killing at least 45 people).

Another strike, on Jan. 26, was made with a small number of missiles. The Ukrainian Air Force released images of one of the Kh-101s that crashed, revealing that it is a new version. The production code ends with the number 12007, marking it as the seventh missile of the 12th production batch. Since the 11th batch was in production in the fourth quarter of last year, it indicates that this missile was produced at the end of the year or the beginning of 2023.

Russia may be using other types of missiles as decoy targets. On Dec. 1, the Ukrainian defense ministry showed reporters the remains of a Kh-55 strategic cruise missile, which carried instead of a nuclear warhead a mockup of the same weight. Such missiles are usually used for air defense training. In Ukraine, the missile was used as a decoy, diverting air defenses away from combat missiles and increasing the chances of hitting the intended targets. In the following weeks, Kh-55 missile remnants, with the warheads removed, were found in Ukraine.

These were most likely missiles that Ukraine transferred to Russia in 1999-2000 when it liquidated its nuclear arsenal. The Ukrainians say the production codes on the Kh-55s were intentionally erased, making it impossible to identify them, which supports the notion that they were converted into dummy targets.

The Kh-55 cruise missile was pro-

duced in Kharkiv, Ukraine, from 1980 to 1987, after which production was moved to a plant in Kirov, Russia. After the dissolution of the Soviet Union in 1991, a large nuclear arsenal remained in Ukraine, including Kh-55 missiles and strategic bombers.

On Oct. 6, 1999, in Yalta, in the Ukrainian region of Crimea occupied by Russian forces since 2014, Ukraine agreed to hand over eight Tu-160 and three Tu-95MS bombers and 575 Kh-55 cruise missiles to Russia, in exchange for \$285 million deducted from the Ukrainian debt for Russian natural gas. Many of these Kh-55 missiles were converted into training versions when their service lives ended.

The circumstances around the Kh-555s are puzzling. The missiles are mentioned in Ukrainian defense ministry announcements but have not been shown in any of its illustrations.

The Kh-555 is a conversion of the Kh-55, which is used only with 200-kiloton TK-66 nuclear warheads, into a non-nuclear missile. Such modifications were made by the Russians in the 2000s, when the Kh-101 was not yet ready.

The conversion was complicated because the conventional warhead was much heavier and moved the missile's center of gravity. The accuracy of the nuclear Kh-55 is clearly insufficient for a non-nuclear missile. To compensate, the Kh-555 has a new guidance system similar to the one developed for the Kh-101.

It is unknown how many Kh-555s were converted into Kh-555s, but it probably was not more than a few dozen. There is no firm confirmation of the use of Kh-555s in Ukraine, despite its mention in Ukrainian announcements. Russia might have started converting old Kh-55s into Kh-555s again in 2022, but this also has not been confirmed. ☛



# Ukraine's Creative Mix of Air Defenses Proves Effective

- > RUSSIA STILL RELIES ON STANDOFF STRIKES AND IRANIAN DRONES
- > "STAGGERINGLY POSITIVE" SUCCESS PROVIDES A MODEL FOR FUTURE DEFENSES

**Brian Everstine** Washington

**U**kraine's ability to creatively employ effective air defenses thwarted Russia's attempts to gain superiority over its skies early in the invasion, and the airspace remained contested for almost a year thanks to a surge of surface-to-air missiles sent to Kyiv.

question will be . . . how long until the Russians decide that this is a kind of fruitless effort on their part?"

Russia's inability to conduct an effective suppression of Ukraine's air defense campaign in the opening salvos of the invasion perplexed many of those watching from abroad, espe-

kamikaze drones that are launched in waves at sites across Ukraine.

The international community has responded by donating with several systems ranging from short-range, man-portable air defenses to multiple high-end U.S.-made Raytheon Patriot systems. Raytheon-Kongsberg National Advanced Surface-to-Air Missile Systems from the U.S., Canada and Norway have shown to be extremely effective, if expensive, using Raytheon AIM-120 advanced medium-range air-to-air missiles to down incoming missiles and drones. International donors include: the Czech Republic, with Strela-2 and Strela10M systems; France, providing its Crotale air defense system; Germany, offering

Poland has redeployed Patriot missile batteries to Warsaw for military exercises close to one year after Russia's invasion of Ukraine. In January, Germany pledged to provide the U.S.-made air defense system to Ukraine.



Experts warn, however, that the West cannot grow complacent and this surge needs to continue or Ukraine soon will risk giving up control of its skies.

"If you look at the way the Ukrainians have created an air defense network of all sorts of different types of air defense, and you look at the success that they're having against not just cruise missiles but in particular against the UAV situation, it's really staggeringly positive," a senior U.S. military official says. "And so the

cially because of Moscow's expected ability to outmatch the much smaller Ukrainian Air Force with a much larger and more capable fleet. Despite having fewer, older air defenses, Ukrainian troops maneuvered and used deception to keep Russian aircraft under threat.

Russian jets since have largely remained outside Ukrainian airspace, firing standoff weapons from inside Russia's borders to target Ukrainian infrastructure. Additionally, Russia has relied heavily on imported Iranian

its IRIS-T and Gepard anti-aircraft guns; Slovakia, providing S-300s; and Spain, with its Spanish Hawk missile complexes. Along with American Avenger air defense systems, RIM-7 Sea Sparrows and Hawks are some of the publicly announced new systems surged to Ukraine.

In December, U.S. Air Force Chief of Staff Gen. Charles Q. Brown, Jr., said his service also donated low-cost threat emitters used for replicating surface-to-air missiles for American pilots in training to Ukraine, and the

technology is being used to confuse Russian pilots.

Kyiv has cobbled together its layered air defense in creative ways, such as modifying SA-11 Buk Soviet-era launchers to fire American RIM-7s. The Buk has shown to be the most effective, using transporter-erector launcher and radar vehicles as “pop-up threats” instead of as formed batteries to make Russian medium- and high-altitude operations “prohibitively dangerous,” the London-based Royal United Services Institute (RUSI) writes in a November report.

“With air defense, you can never consider one system in isolation,” says Laura Cooper, the U.S. deputy assistant defense secretary for Russia, Ukraine and Eurasia affairs. “It’s all about the layered air defense with multiple systems with different ranges applied over broad geographic territory, protecting key nodes.

“Buk is an important system at the short range,” she continues. “And the Ukrainians, I’m sure, will be masterful at employing this new missile on this

system that they are familiar with. But it’s only in concert with these other capabilities that the Ukrainians can continue to shoot down this withering attack by cruise missiles, Iranian-purchased drones and the other threats from the air.”

This amalgam of international and Soviet-era air defenses has been able to down the majority of incoming Iranian drones and about half of the cruise missiles, RUSI says. Ahead of an expected spring offensive by Russia, the flow of these systems cannot abate, especially that of man-portable air defenses and self-propelled anti-aircraft guns such as the Gepard.

“If Ukrainian [surface-to-air missiles] are allowed to run out of ammunition, then not only will Ukrainian infrastructure and other key target sets become dramatically more vulnerable to Russian missile strikes, but the Russian [Air Force] fixed-wing fleet would suddenly again be able to start penetrating deep into Ukrainian-controlled airspace at medium and high altitudes,” the RUSI report states.

In late January and early February, as attention shifted toward whether the U.S. and other nations would provide aircraft to Ukraine such as the Lockheed Martin F-16, American officials worked to keep the focus on air defenses. U.S. Defense Secretary Lloyd Austin said at the end of a Jan. 20 meeting of representatives from more than 50 nations in Germany on Ukraine aid that the focus is on air defense needs and armor. He added that the countries are working on synchronizing donations to ensure they are fully operational and sustained.

“Western military aid has quite rightly concentrated on equipping and supporting the Ukrainian ground forces until now,” the RUSI report says. “Ukraine has so far managed to hold its own in the air domain, largely using its own equipment. However, there is a real danger that this success leads to Western complacency about the threat that the [Russian Air Force] can still pose to Ukrainian forces, infrastructure and cities if given an opening.” 📧

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# Russian Airlines Fly Most Aircraft in Spite of Sanctions

> AIRLINE TRAFFIC RESULTS FALL BELOW EXPECTATIONS

> SPARE PARTS SUPPLY PRESENTS CHALLENGES, BUT MAJORITY OF AIRCRAFT CONTINUE TO FLY

## Aviation Week Network Staff

**R**ussia's air transport industry managed to survive almost a year in a new reality shaped by the war in Ukraine and sanctions that cut access to lucrative Western markets and modern aircraft technologies. The impact has not been as significant as expected because Russian airlines and the Kremlin are applying pandemic-inspired remedies to mitigate the fallout.

Russian airlines carried 95 million passengers last year, Transport Minister Vitaly Savelyev says. Demand was 15% lower than in 2021, when Russian air transport began recovering from the COVID-19 crisis. The numbers announced fell short of the government's goals; it had expected in mid-2022 that Russian airlines would carry a combined 100 million passengers on domestic and international routes.

The drop in traffic was due in part to the government's decision to keep 11 southern airports closed beginning in late February because of their proximity to the Ukraine combat zone, Savelyev says. Among those airports were Simferopol International Airport in Crimea (which served 6.8 million passengers in 2021), Krasnodar International Airport (5 million), Anapa International Airport and Rostov-on-Don Airport (2.9 million passengers each) as well as some smaller airports. These gateways could have added 19 million passengers to the total traffic, which would have exceeded the previous year's numbers, he points out.

But the lower numbers were not considered a failure. "I expected the air traffic would amount to only 80-85 million passengers, taking into account the closure of the airports and restriction for international services," Fyodor Borisov, a senior expert at the Institute of Transport Economics and Transport Policy Studies at Moscow-based HSE University, tells Aviation Week. He says

the government managed to avoid a greater traffic slump by introducing direct subsidies, which allowed carriers to adjust fares to support demand. "Taking into account inflation in Russia in 2022, the real price for air travel fell," Borisov says.

Savelyev confirms that the government allocated a record-breaking 174 billion rubles (\$2.44 billion) last year to the industry. This support included 100 billion rubles for domestic air services

tance as major international hubs. The largest of the Moscow trio, Sheremetyevo International Airport, recorded 28.4 million passengers last year, a 7% decline.

The other airports have not yet published annual results, but Russian media report that Domodedovo experienced the strongest drop in total traffic—15% to 21.2 million passengers—while Vnukovo lost about 9% and to 16.4 million passengers.

Russian airlines will have to look to the domestic market for new revenue. S7 Airlines reports that it increased its share on the Russian market to 17% by focusing on direct flights between Russian regions, avoiding the national capital. Its non-Moscow traffic grew 22% during the year to 5.8 million passengers. S7 also developed its two Siberian hubs, increasing traffic by 21% in Novosibirsk and 54% in Irkutsk.

Western sanctions have affected Aeroflot's Boeing 777 operations.



and 19.4 billion rubles to compensate for ticket refunds for canceled international flights. Another 2.9 billion rubles went to support freight services.

In fact, the direct impact of sanctions on the air transport industry was similar to that of the pandemic restrictions, when local carriers also lost most of their international routes. Western countries have banned Russian airlines from their airspace while many others do not allow Russian-operated aircraft with double registration.

"Those who planned to rely on the international services had to completely reorganize their activities," Borisov says, adding that most Russian airlines were not caught by surprise because they had started this process during the pandemic.

The country's largest gateways, Moscow's airports, lost their impor-

These efforts enabled privately owned S7 to outperform its major rival—government-controlled Aeroflot—and become the country's largest airline, at least in March and April. S7's total traffic declined a relatively low 10% in 2022 to 16 million passengers.

Aeroflot reports that it carried 20.5 million passengers (a decline of 4%) in 2022 for the main carrier and 40.7 million (-11%) as a group. It had to drop plans to hand over the domestic network to low-cost subsidiary Pobeda and fly to only the most profitable long-range international destinations from its traditional hub in Moscow.

Instead, the Aeroflot group is focused on developing regional bases across Russia to provide point-to-point domestic services. In 2022, it added Sochi and Mineralnye Vody in southern Russia to its non-capital

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bases in Krasnoyarsk in Siberia and St. Petersburg. Aeroflot also plans to use Khabarovsk or Vladivostok as a base in Russia's Far East and is looking to set up another base in the Volga River-Ural region.

The distinctions among the Aeroflot group's airlines will become less obvious. According to the new development strategy, the parent airline will offer only a high-level product. Rossiya will have the balanced one while Pobeda will work with the basic product.

Nevertheless, Aeroflot continued to reset its Western-made fleet for international operations. The carrier bought back 10 Boeing 777 and eight Airbus A330 widebodies from foreign lessors and withdrew them from foreign registers. CEO Sergey Alexandrovsky says the airline moved 89 of its 150 operational aircraft off double registration, allowing them to fly to available destinations outside Russia.

Russian airlines kept almost all their prewar fleets because the government forbade their return to foreign lessors. Savelyev said on Jan. 24

that Russian airlines now operate 1,164 passenger aircraft, 200 fewer than the number he cited in March 2022. The Kremlin forced the carriers to transfer all leased aircraft to the Russian register without the consent of their foreign owners and ordered the local regulator, the Federal Air Transport Agency, to deal with their continued airworthiness.

Maintenance costs have grown due to more complicated logistics after Western sanctions banned deliveries of aircraft spare parts to Russia. In an interview on Russian media at the end of 2022, Aeroflot CEO Alexandrovsky admitted that the sanctions had caused spare-parts costs and delivery times to increase and but said the airline had spares for 2-6 months, depending on the items.

The government expects the industry to increase production of fully Russian-made aircraft by 2030 to replace the aging Western-made fleets. The industry has been tasked with rolling out 142 Superjet-NEW regional jets, 270 Irkut MC-21-310RUS and 70

Tupolev Tu-214 narrowbody airliners as well as about 500 smaller passenger aircraft by then. Russia's largest private carriers—S7 and Ural Airlines—have expressed concern that most of the announced aircraft already have been contracted by Aeroflot.

The latter placed preliminary orders for 89 Superjets, 210 MC-21s and 40 Tu-214s. Alexandrovsky sees these orders as a guarantee for Aeroflot to have a working fleet, since it is unclear how long the Western-made jets can stay airborne. The group expects that in 2030, the Russian-made aircraft will constitute 70% of its fleet, which will grow to more than 500 airliners from 340.

The Kremlin also understands the uncertainty of the future, which might depend on the outcome of the Ukraine conflict. "We plan to carry over 101 million passengers in 2023," Transport Minister Savelyev promised President Vladimir Putin, but he added that the final result will depend on how long the airports in southern Russia remain closed. ☒



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# Blown Away

> JAPAN, TAIWAN AND U.S. TARGETED BY CHINESE SURVEILLANCE BALLOONS

> OPAQUE FABRIC POINTS TO POSSIBLE INNOVATION

FRANK MELLIERE

**Steve Trimble** Washington and **Guy Norris** Colorado Springs

**M**ore than two years before a U.S. Air Force F-22 shot down a Chinese spy balloon off the coast of South Carolina on Feb. 4, Zheng Zhenfeng, an employee for Taiwan's weather service, photographed a similar object floating high above Taipei, Taiwan, on Sept. 26, 2021.

Zheng's boss, Zheng Mingdian, is certain the two events are connected, revealing a perhaps yearslong, high-altitude spying campaign by the People's Liberation Army across the world using a new form of lighter-than-air technology.

"The high-altitude spying balloons in the news have been around a long time, and [my] weather-agency colleagues took [pictures of] them two years ago," Zheng Mingdian, executive director of Taiwan's weather service, wrote on Facebook on Feb. 4. "Before that, there were photo records elsewhere, too, for many years."

The bizarre five-day, 2,000-mi. journey across the U.S. of China's apparent spy balloon revealed three important new insights: A Raytheon AIM-9X Sidewinder-armed F-22 can

shoot down a floating object above 60,000 ft., U.S. officials believe Beijing has waged a yearslong aerial spying campaign with high-altitude balloons, and some experts think the Chinese vessel reveals a potential breakthrough of ultra-long-endurance, lighter-than-air technology.

The Lockheed Martin stealth fighter's capability to down a high-altitude balloon had never been tested or possibly even conceived, but the brazen violation of U.S. airspace prompted President Joe Biden on Feb. 1 to order a shoot-down attempt, White House officials say. Some criticized the decision to allow the balloon to cross the U.S. landmass, but military officials insisted the balloon's surveillance capabilities posed no threat to national security. Military analysts also gained ample time to study the alleged spy-craft's behavior and emissions, while the fighter-pilot community ran simulations to determine the best way to attack the unfamiliar target.

"I don't know that they've tested [the] AIM-9 at that altitude," says Gen. Glen VanHerck, the head of North

American Aerospace Defense Command. "I'm not aware of any engagements against a high-altitude balloon such as this."

The F-22 from the 27th Fighter Sqdn. did not act alone on Feb. 4. Another F-22 flew armed and ready as backup in case the first shot missed. A high-altitude balloon—even a 200-ft.-tall balloon—presents a challenging

**A photo of the Chinese balloon over Modoc, Illinois, on Feb. 3 reveals potentially breakthrough design features for ultra-long-endurance, lighter-than-air systems.**

target for a heat-seeking missile, with a dim thermal signature and a helium gas void within the envelope. The F-22 appeared to aim instead for a 70-100-ft.-long (20-30-m) horizontal truss dangling from a single line beneath the balloon—VanHerck compared its length to an Embraer ERJ135 or ERJ145. Ground-based civilian photography revealed that the structure carried 16 solar panel arrays and three inboard stations or pods.

The heat generated by the electronic systems appeared to be enough to provide a targeting lock for the imaging infrared seeker in the AIM-9X. The height of the target—60,000-65,000 ft.—still required the missile to ascend several thousand feet from a launch point at 58,000 ft., a senior defense official says. The result was a perhaps unlikely first air-to-air kill against a balloon by the U.S. Air Force's premier fighter.

"I'm really incredibly proud of everybody that took part in this, but the F-22 was remarkable," VanHerck says.

Two U.S. Navy ships—the amphibious landing ship USS Carter Hall and the survey ship USNS Pathfinder—are mapping and collecting pieces of the debris from the balloon that now lie scattered over an approximately 1 mi. X 1-mi. box about 50 ft. below the surface roughly 6 mi. off the South Carolina coast.

In the age of hourly satellite overflights and relentless cyberattacks, an inflated surveillance system slowly drifting over Alaska, Canada and the continental U.S. appeared at first to stand as an unusual—inexplicable, even—one-off event. But the story quickly grew as reports emerged of similar balloon sightings around the world, including an ongoing balloon flight over South America, previous incidents in East Asia that

had gone unexplained and a newly discovered trail of previous balloon flights over U.S. territory, including Guam, Hawaii, Texas and Florida. Instead of a singular provocation, a pattern has developed of Chinese spy flights by slow-moving high-altitude balloons, which had gone apparently undetected by U.S. surveillance systems.

"I will tell you that we did not detect those threats, and that's a domain awareness gap that we have to figure out," VanHerck says.

Although the previous overflights above U.S. soil had been missed, the intelligence community kept track of China's spying balloon campaign in other parts of the world. Congress was briefed about the program in August, White House spokeswoman Karine Jean-Pierre said.

"There has been a program that has been in effect," Jean-Pierre added. "We have kept Congress abreast on that. But I don't have anything more to say or to share."

In fact, the evidence for such a spy effort has been available in the public domain for several years, but the shock of the U.S. overflight helped bring it back into focus. In addition to high-altitude balloon sightings over Taiwan in September 2021 and March 2022, Japanese government officials reopened reviews of similar publicly reported overflights of Japan in June 2020 and 2021.

When a similarly spherical white

balloon flew near Miyagi prefecture in northeast Japan in 2020, photos of the object showed a perhaps earlier version of the technology that entered the U.S. on Jan. 31. In that case, the dangling support truss supported 24 solar panel arrays, payloads and a crosswise boom. The latter appeared to include a set of outboard-mounted propellers. It was not clear if the propulsive devices were being used to steer the balloon or the structure housing the payload.

By contrast, images of the latest balloon captured by photographers on the ground with telephoto zoom lenses appear to show a major evolution in the design of the payload module, including one-third fewer solar panels, three inboard payload modules and no clear evidence of any propellers.

Such long-distance visual evidence contrasted with remarks by John Kirby, the National Security Council spokesman. "It had propellers," Kirby says. "It had a rudder, if you will, to allow it to change direction." Civilian photos provided no signs of a rudder aboard the balloon, and it is not clear how such a control surface would help steer a spherical, slow-speed object. Kirby also may have been speaking metaphorically about a rudder.

In any case, members in the high-altitude balloon community have identified potentially significant technology advances exhibited by the Chinese vessel.

The few examples of ultra-long-

distance, high-altitude balloons, such as Google's canceled Loon project, share a few common traits: a pumpkin-shaped, superpressure envelope, internal ballonnet and translucent fabric.

The final item in that list is essential for regulating the temperature—and therefore pressure—inside the helium envelope. A translucent fabric allows most light to pass through the balloon without heating the helium gas inside.

But the Chinese balloon appeared to use an opaque fabric over a pumpkin-shaped helium envelope. If confirmed, China's program may have been the first successful design to use a helium envelope covered by a fabric that reflects the Sun's energy rather than letting it pass through, says Dan Bowen, a former balloon systems engineer at Project Loon. The result suggests a breakthrough by creating a more efficient system to regulate temperature without adding too much structural weight.

"I'm sure the rest of the world will quickly investigate this," Bowen says in an analysis released on Stratospheric Balloon Science, his YouTube channel.

The most advanced ultra-long-endurance, high-altitude balloons seldom use propellers for directional control. Instead, such aircraft pump regular air into an internal ballonnet envelope to descend or release the air to climb, Bowen says. Altitude adjustments are made to find wind currents moving in other directions. The system



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provides a limited capability for directional control.

U.S. researchers have worked on similar technology with the Strat-OAWL (stratospheric optical autocovariance wind lidar), which Ball Aerospace flew on DARPA's Adaptable Lighter-Than-Air (ALTA) balloon in 2019. ALTA was aimed at demonstrating a high-altitude, lighter-than-air vehicle capable of windborne navigation over extended ranges and, according to DARPA, could navigate without independent propulsion by changing altitudes in excess of 75,000 ft.

A key element of ALTA was development of a Winds Aloft Sensor, which in the case of the DARPA proj-

ect could send real-time stratospheric wind measurements back to the ground. The Ball Strat-OAWL system, which dates back as far as 2004 to proof-of-concept hardware efforts, is designed to measure winds from aerosol backscatter at the 355-nanometer or 532-nanometer wavelengths.

Meanwhile, the debris recovery effort also may help answer questions about the capabilities of the Chinese balloon's alleged surveillance payload. The decision to allow the balloon to cross the U.S. before shooting it down was based on a military assessment that the onboard sensors provided no threat, Kirby says.

"The time that we had to study this

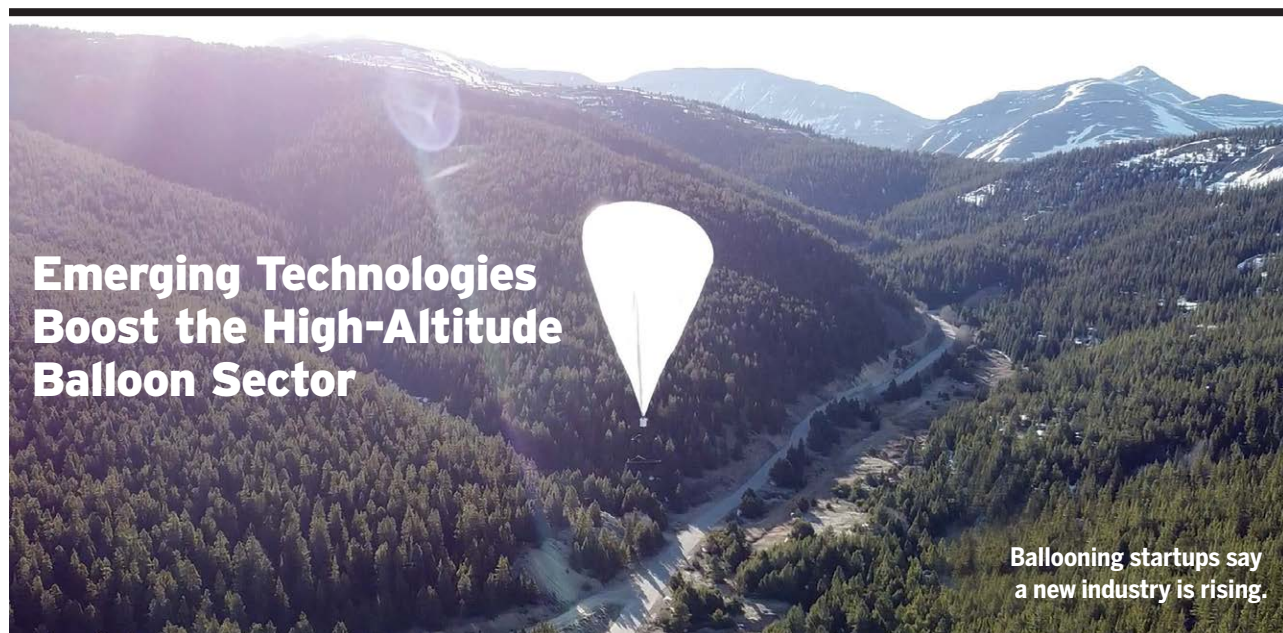
balloon over the course of a few days last week we believe was important and will give us a lot more clarity not only on the capabilities that these balloons have, but what China's trying to do with them," he says. ☼

**Check 6** *Aviation Week's defense and technology editors discuss China's spy balloon program:*

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URBAN SKY

## > MACHINE LEARNING IMPROVES HIGH-ALTITUDE NAVIGATION

## > LIGHTWEIGHT TECH MAKES FOR SMALLER, MORE USEFUL BALLOONS

**Garrett Reim** Los Angeles

**S**ince 1783, when the Montgolfier brothers of France sent a sheep, a duck and a rooster aloft in their hot air balloon, humans have used the lighter-than-air devices to carry all sorts of payloads. Yet the type mostly drifted into obscurity with the dawn of aircraft in the 20th century. That is, until China allegedly sent a 200-ft.-tall balloon, dangling spy equipment the size of a small airliner, floating over the U.S., including above a field of ballistic nuclear missile silos in Montana.

The incident, which took place between Jan. 28 and Feb. 4, has put balloons back into the public consciousness. It also comes when new technologies are enabling balloons to play a possibly greater role in aviation again.

Modern high-altitude balloons, like the variety China released into the jet stream en route to the U.S., typically rely on helium to rise and the wind to carry them to their destinations. Operators raise or lower the altitude of a balloon to catch winds moving

in different directions at different elevations.

Knowing where to find the right wind in the stratosphere can be difficult. But improvements in computing in recent years are allowing balloons to be more useful for remote-sensing operations.

Alphabet's Project Loon, an effort to broadcast the internet from on high that launched in 2011 and shut down in 2021, is credited widely with advancing stratospheric balloon navigation. With more than 1 million flight hours of data, the company used deep reinforcement learning, a machine-learning technique that enables a platform to learn by trial and error, to develop an autonomous navigation system.

"Loon was instrumental in showing

the world what was possible with controlled stratospheric balloon flight and really brought the idea of altitude control for balloon navigation into a well-known space,” says Jared Leidich, co-founder and chief technology officer of remote-sensing balloon startup Urban Sky, who notes Alphabet did not invent the technology. “I think we have yet to see the outcome of them open-sourcing so much information about their systems.”

Leidich, who served as the space-suit lead on the Stratospheric Explorer program, the 2014 world record skydive from a balloon platform that reached 136,000 ft., says the use of two additional emerging technologies is changing the ballooning industry: miniaturization of electromechanical and optical systems, and new zero-porosity thin films and fabrics for balloon skins.

“Prior to the modern age of ballooning—the last 5-10 years—useful optical and electromechanical systems weighed dozens of pounds, and the lightest thin films were both relatively heavy and fragile,” he says.

That made for big and heavy balloon systems that had to be launched from fixed infrastructure, limiting where they could survey, Leidich says.

“But sometime over the last decade or so, everything came together,” he says. “Real targeting could be achieved with smaller, lower-cost mobile-launch balloons that ensure overflight of the balloon above precise target areas simply by being able to launch closer to the target area and at a reasonable cost.”

In addition to Urban Sky, startups such as World View and Near Space Labs tell their customers—and their investors—that high-altitude balloons provide a cheaper and better way to survey the Earth than satellites or aircraft.

Balloons fly closer to the Earth, allowing for higher-resolution data collection; Near Space Labs says its visible light image resolution is 10 cm (4 in.) per pixel, for instance. The cost of launching a balloon is also far cheaper than rocket-launching a satellite—Urban Sky says its prices start at \$5/km<sup>2</sup> per tasking. And balloons can loiter over a site instead of rapidly passing over it, as do low-Earth-orbit satellites. World View says its balloons can loiter over an area of interest for up to 45 days.

Balloons can carry a variety of sen-

sors, including electro-optical, infrared, radar, hyperspectral and thermal equipment. Sensor data can be used for asset monitoring, pipeline and utility line inspection, wildfire and storm tracking, climate change research, and agricultural and maritime monitoring, among other purposes.

World View, which plans to go public soon via a \$350 million merger with a special-purpose acquisition company, also has partnered with Sierra Nevada Corp. to integrate military payloads by including intelligence, surveillance and reconnaissance equipment, electronic-warfare sensors, communication net-

works and cyberintelligence devices into its balloons.

However, with the fast-growing space economy, including the Earth-observation sector, projected to reach \$1 trillion in value by 2030, it remains to be seen how much the balloon industry can expand.

“When balloons are usable anywhere, anytime and able to carry out tasks that face the Earth, space or the atmosphere, we believe they will finally find their place in the aerospace ecosystem with usefulness on par with satellites, leading to a robust and valuable stratospheric economy,” Leidich says. ☛

## BAE Systems Is Confident of Striker II Fighter Helmet Sales

- STRIKER II IS A BASELINE FOR TEMPEST PILOT-AIRCRAFT INTERFACE
- U.S. FUTURE VERTICAL LIFT PROGRAM SHOWING INTEREST IN ACTIVE INCEPTORS

Angus Batey Rochester, England



BAE SYSTEMS

**C**omplexity is a given in aerospace and defense. It is a condition that applies not just to the industry's products but also to its business operations. BAE Systems' electronic systems site here offers a case study.

The facility produces advanced avionics products, including the Striker fighter helmets and the company's active inceptors, and its staff performs extensive physical and electromag-

**Apprentices wear BAE's Striker II helmet in the simulation suite at the company's Rochester facility.**

netic qualification testing. On-site specialization in aircraft optics stretches back to a gunsight for the Spitfire that includes cockpit-mounted and head-up and helmet-mounted display (HMD) systems, each among the leading capabilities of their respective eras.



But that history also brings challenges. The site—originally built in the 1930s—needs a comprehensive refresh. Last April, outline planning permission was secured for a multimillion-pound, decade-long redevelopment, so pressure to bring in new business is increasing. And while the company is not yet ready to make an announcement, there are hints it may be about to secure a first customer for the Striker II.

The Rochester team has been carrying out further development of the advanced HMD since launching the system at the Farnborough Airshow in 2014. The product draws on both the Striker I, which is in operation on the Eurofighter Typhoon and Saab Gripen platforms, and work the company did toward a canceled alternative HMD system for the Lockheed Martin F-35.

Since launch, color has been added to the original green-screen visor display. It also has a video-in-image capability and audio cueing to aid the pilot in assessing a target's relative position to the platform. The Striker II is providing a baseline on which BAE intends to build the pilot-aircraft interface for its Tempest program, but the company cannot afford for the system to be a purely developmental project.

"Obviously, without production contracts, it isn't sustainable," says Nigel Kidd, BAE Systems director of head-mounted displays. "I can't talk on behalf of our customers, but I have a very high level of confidence that situation is changing."

Kidd says the company has collaborated with the Royal Air Force (RAF) on the Striker II's ongoing development and that 41 Sqn., the RAF's Typhoon test and evaluation unit, has flown the system. Feedback from them and other potential end users is being folded into a specification that will go through qualification and enter production. The company expects to be able to announce a customer this year.

"One of the things we can do here, because of what we've done on programs all the way back to the basic cueing system on the Jaguar, is [absorb] lots of lessons learned in terms of not just how you design and manufacture, but how the thing gets used and supported," Kidd adds. "We've already taken a number of low-technology-readiness things that we could not put into a product and qualify today and proven them within a Striker

architecture. The kind of product we would produce for a sixth-gen platform will look different to Striker, but we are absolutely using all of that knowledge and buildup capability to inform our next product."

The Rochester site staff also is able to take technologies developed for military use and repurpose them for



**An inceptor system for the Typhoon is ready for electromagnetic compatibility testing in one of the Faraday Center's anechoic chambers.**

civil platforms. The active inceptors the company developed in part for the F-35, which are on Embraer's KC-390 and Sikorsky's CH-53K, are part of the Active Parallel Actuator System (APAS) mission system that Boeing has included on the MH-47G Block II Chinooks it is building for the U.S. Army's Special Operations Aviation Command. The inceptors flew on a Boeing AH-64 Apache in 2015, and BAE is pitching the technology for other upgrade programs.

The product was also chosen by Gulfstream for the G500 and G600 business jets, implying a sizable potential market. Addressing that market is challenging, though.

"There's a lot of interest, both in the commercial world and in some military programs as well," says Adam Taylor, capability director for the company's active inceptors business. "Commercial air transport is one ap-

plication on the commercial side; there's some military programs, rotary wing in particular because the workload of helicopters is so high."

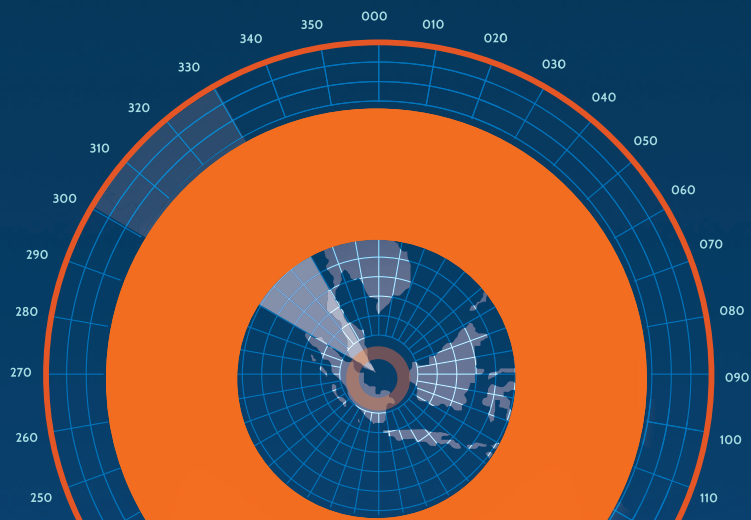
In theory, the technology is retrofittable, with the unit containing the stick a straight swap for passive inceptors. But to make full use of the system's capabilities—which include delivering tactile cues to the pilot through the stick—significant changes to the flight-control system would be required, meaning it is generally adopted during a platform's design phase.

As a relatively expensive system with nontrivial power requirements, it is unlikely to be of interest to the advanced air mobility sector, ruling out the one part of today's aerospace business with many new platforms under development. For now, Gulfstream is keeping Rochester's production lines busy, but new orders would be welcome.

"The U.S. Future Vertical Lift [program] has an interest in the technology, but it's difficult to work out what's going to happen because they have competing OEMs," Taylor says. "But it's almost like a seesaw, because if all these FVL platforms get built, there's less money for upgrading legacy aircraft. We're trying to position ourselves for both."

All these programs are aided by the on-site component and system test facility. This is housed in the Faraday Test Center, one of only two buildings on the site—adjacent to Rochester Airport—that will not be demolished during the proposed redevelopment. The center comprises adjacent environmental and electromagnetic compatibility testing facilities, and some of its capabilities—such as explosive decompression testing—are hard to find elsewhere. BAE markets the center to other companies: This not only adds to the bottom line but aids with recruitment and retention of the specialist skilled staff.

"We test air-data computers, helmets and head-up displays, but also ovens, fridges, microwaves, coffee makers—anything you would need to qualify for use in flight," says Paul Davison, manager of the center. "It's a really diverse range of products, which makes it interesting for the guys. They learn the different specs of different products, and they take that knowledge into whichever jobs they do next. It's a continual learning experience." ☛



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# STRIKING POWER

- > AVALON AIRSHOW IS EXPECTED TO SHOWCASE POST-AUKUS AUSTRALIAN DEFENSE PUSH
- > ONGOING REVIEW IS SET TO ANSWER LINGERING POLICY QUESTIONS

**Steve Trimble** Washington

**A** sweeping pact signed in April 2021 bound Australia, the UK and the U.S. into a trilateral security cooperative, committing the AUKUS partners to a new level of technological and industrial partnership.

As the first Avalon Airshow in a geopolitically dizzying four-year period gets set to start on Feb. 28 in Geelong, Australia, a new government in Canberra is finalizing the details of how the new alliance could reshape Australia's military buildup amid growing regional competition with China.

The results of an ongoing Defense Security Review are expected to be released during or shortly after the air show, in March. The planned release by Prime Minister Anthony Albanese

should clarify the still murky details of Australia's planned acquisition of prized nuclear submarine technology from the U.S. and UK and perhaps other advanced technologies, including local contributions to a new class of hypersonic missiles.

The 2021 version of the air show would have celebrated the centennial of the Royal Australian Air Force, but it was canceled due to lockdown policies triggered by the COVID-19 pandemic. The long-awaited follow-up instead

should serve as an international stage for Australia's transforming security policy, confirming a swing toward U.S. sourcing for advanced weapons at the expense of continental Europe and a new focus on expanding defense industrial capacity at home.

Australia's shift to U.S. and home-grown weaponry has proceeded steadily during the last four years. At the last Avalon Airshow, the Boeing Airpower Teaming System was unveiled, and now the first three of 10 MQ-28 Ghost Bats ordered by the Australian military are in flight testing in Brisbane.

Almost two years after the AUKUS pact was signed, the previous Australian government revealed a new partnership to codevelop scramjet-powered missiles with the U.S. Air Force. The first prototypes of a Raytheon/Northrop Grumman Hypersonic Attack Cruise Missile are expected to be launched next year from a Royal Australian Air Force F/A-18 as part of the Southern Cross Integrated Flight Research Experiment.

Long-range weaponry will be showcased at this year's show, reflecting a strategic domestic priority. Since 2021,



### Australia's Boeing F/A-18A/Bs will be fully replaced this year by Lockheed Martin F-35As.

Australia has established a platform for industrial collaboration called the Australian Missile Corp. and a joint venture of two domestic companies—Electro Optic Systems and Nova Systems—to form the Sovereign Missile Alliance. Both entities are at the heart of a \$AU1 billion (\$705 million) investment by the Australian government to form the Guided Weapons and Explosive Ordnance Enterprise (GWEOE).

The government's plan is to leverage collaborations with foreign companies to build up domestic capacity to produce long-range missiles. Australia has selected Lockheed Martin and Raytheon as strategic partners for the GWEOE. A candidate to enter development is a concept for a surface-launched version of the AGM-158C Long-Range Anti-Ship Missile, which a partnership between Lockheed Martin Australia and Thales Australia has proposed as a mobile, land-based option for targeting ships up to hundreds of miles off the coast.

The Chinese People's Liberation Army has built military bases on reclaimed land in the South China Sea, which is part of what Australia calls its "near region." Last year, the People's Liberation Army Navy also sailed a Luyang-class destroyer through the Torres Strait, between the northern tip of Queensland and Papua New Guinea, demonstrating a show of force by a ship with the capability to fire 64 missiles across the Australian continent.

More than a decade ago, the Royal Australian Air Force operated a fleet of General Dynamics F-111 fighters, which would have posed a conventional deterrent capability against China's long-range weapon systems. Since their retirement, Australia has been searching for a response to China's military buildup in its local region. "Without striking range, we're simply adopting a defensive posture and absorbing pun-

## U.S. Industry Contributions to Australia's Fleets

**MQ-28A Ghost Bat** Boeing's Australian division is expected to finish designing and start manufacturing the second-generation version of the fighter-like, uncrewed aircraft system (UAS) this year. The first three prototypes have been in flight testing since the first model achieved its initial flight on Feb. 7, 2021. Another seven of the low-cost, "Loyal Wingman" UAS will be acquired by the Royal Australian Air Force (RAAF), raising the overall fleet to 10. All of the composite aircraft are being produced on an automated Boeing assembly line in Brisbane. The total budget for development and manufacturing is \$AU672 million (\$475 million).

**F-35A Lightning II** No. 75 Sqdn. started transitioning to the Lockheed Martin stealth fighter last year, becoming the last of three RAAF operational and one conversion unit to fly F-35As. A full operational capability milestone is on track to be achieved in December, with all 72 Lightning IIs delivered since 2014. The activation of No. 75 Sqdn. also will establish an F-35 presence in the Northern Territory at RAAF Base Tindal, with the other Lightning II units remaining at RAAF Base Williamtown in New South Wales. The Australian Defense Department's focus is shifting to improving the country's ability to support F-35s in the region, with reprogramming, weapons warehousing and depot repair capacity expanding.

**MC-55 Peregrine** Ground support systems were due to be installed at RAAF Base Edinburgh in late 2022, but the timing of the first arrival of four new Gulfstream G550 special mission aircraft has never been revealed. The U.S. Air Force's secretive Big Safari cell is continuing to modify the four MC-55s acquired by the RAAF in Greenville, Texas, but the mission systems onboard also remain a closely held secret. The MC-55 is configured with a canoe fairing under the forward fuselage, a satellite communications farm on top of the fuselage and a bulbous antenna housing atop the vertical stabilizer. The RAAF has operated an electronic warfare variant of the AP-3C, but the MC-55 is billed as a new capability for long-range intelligence, surveillance and reconnaissance.

**P-8A Poseidon** The last two of 14 maritime patrol aircraft derived from the Boeing 737 are due for delivery imminently. The latter order reflects an Australian government decision in late 2020 to top off a previous order of 12 P-8As, with the full dozen delivered to RAAF Base Edinburgh by 2019. The RAAF plans to equip the P-8A fleet with the AGM-158C Long-Range Anti-Ship Missile and it named the patrol aircraft as a candidate platform to air-launch the scramjet-powered Hypersonic Attack Cruise Missile still in development.

**MQ-4C Triton** The fate of the procurement of the RAAF's first high-altitude uncrewed aircraft system hinges on the outcome of the Defense Security Review. The first of three MQ-4C Tritons on order by Australia was unveiled last September in Palmdale, California, with a scheduled aircraft delivery to RAAF Base Tindal in mid-2024. By mid-2026, the RAAF expects to be able to operate a single, continuous patrol capability north of Australia with the three aircraft. A second orbit of three aircraft, plus a spare, also could be acquired, pending the outcome of the review.

**C-130J Hercules** Australia's latest fleet decision is to buy up to 24 Lockheed Martin C-130J-30 airlifters, replacing and doubling a fleet of 12 Hercules acquired in 1999. The announcement in November did not provide a timeline for aircraft delivery, but the selection under Project Air 7404 Phase 1 will be forwarded for government approval this year.

**AH-64E Apache** Boeing's attack helicopter is slated to arrive in Australia in 2025. The Australian Army's selection of the AH-64E in 2021 came as a surprise. The Defense Department had released no tender to replace a fleet of 25 Eurocopter Tigers, which were demonstrating improving availability after a disappointing start. But the Tigers are planned be replaced by 29 Apaches starting in the third quarter of 2023, completing a nearly complete pivot by Australia from European to U.S. military aircraft.

**UH-60 Black Hawk** NHIndustries' loss is Sikorsky's gain. In December 2021, the Australian Army gave up on attempts to improve the maintenance and reduce the cost of operating the MRH90. The Morrison government instead opened discussions with the U.S. government to buy up to 40 UH-60M Black Hawk utility helicopters. The Royal Australian Navy already operates the MH-60R Seahawk, with a second batch of 12 awarded last May. 🇺🇸



**Australia will collaborate with the U.S. on hypersonic cruise missiles, leveraging a decade-long partnership on the HyFly research program.**

AUSTRALIAN DEFENSE DEPARTMENT PHOTOS



ishment,” Marcus Hellyer and Andrew Nicholls write in a research paper published last November by the Australian Strategic Policy Institute (ASPI). Hellyer is an ASPI senior analyst and Nicholls is a former senior advisor to Australian defense ministers.

About 23% of Australia’s \$AU48.7 billion defense budget in fiscal 2022 was allocated to procurement, with the biggest programs including new fleets of 72 Lockheed Martin F-35As, nine Hunter-class (Type 26) frigates, 14 Boeing P-8As and 211 Boxer armored fighting vehicles.

Despite those investments, Australia may still lack a sufficient long-range strike capability for at least a decade. The Hunter-class frigates are not planned to enter service until at least 2033, and all 32 missile cells aboard may be needed for air defense. Even with a single inflight refueling and relying on internal weapons, the F-35A lacks the range to strike targets in the South China Sea from Australia. Hellyer and Nicholls’ analysis indicates that any nuclear-powered submarines purchased under the terms of the AUKUS pact will not arrive until the 2040s, raising the question of how Australia should cope with a striking-range gap in the interim.

The ongoing Defense Security Review, which is being led by Stephen Smith and Angus Houston, is reportedly considering the acquisition of Northrop Grumman B-21 Raiders within the next decade.

The 56-page ASPI report recommends as “worthy of further examination” an estimated \$AU25-28 billion proposal to buy 12 stealth bombers,

enough to stand up one squadron on Australian soil.

The authors acknowledge that spending the equivalent of roughly half of Australia’s annual defense budget on a dozen aircraft is provocative. They concede there may be solutions other than an Australian-owned fleet of stealth bombers. But a B-21 acquisition remains intriguing in Canberra.

“Things that were previously inconceivable are now happening, so we shouldn’t dismiss the B-21 out of hand,” Hellyer and Nicholls write. “Our recommendation is that the Australian

a Lockheed-Dynetics team. But the ASPI analysts concluded that the LRHW’s reported \$40 million price per unit renders it more expensive than a penetrating bomber using cheaper munitions during a long air campaign against an advanced adversary. In fact, Australia’s B-21 squadron could be purchased for about the same price as 425 LRHW missiles.

Another option reviewed by the report is loading Lockheed Martin C-130Js with palletized munitions. But firing a load of 24 Joint Air-to-Surface Stand-off Missile-Extended Range missiles worth about \$40 million combined is also unsustainable, even if tactical airlifters can be spared from their primary mission in order to strike distant targets during a conflict.

More creatively, the authors consider the advantages of a theoretical, twin-engine version of Boeing’s locally built MQ-28 Ghost Bat with the ability to carry 12-16 GBU-39 Small-Diameter Bombs or 2-4 standoff cruise missiles.

“The question is: When will this kind of capability be mature? If it’s feasible by the end of this decade, then it’s an option that warrants further consideration and potentially accelerated investment,” Hellyer and Nicholls write.

Ultimately, the report highlights the practical economic challenge created by any approach to providing a long-



**More than 12 years after the retirement of the F-111, Australia is considering new options for the long-range strike mission.**

government should engage with the U.S. government to gain access to the information on the B-21 program so they can make an informed decision on its viability for Australia.”

The authors also consider ground-launched missiles, such as the U.S. Army’s Long-Range Hypersonic Weapon (LRHW), a two-stage missile with a hypersonic glide vehicle developed by

range strike capability, particularly for a country with a total military budget at less than 5% of annual spending by the U.S. Defense Department. This fiscal reality drove the authors to concede that there may be a better option for Australia than buying B-21s.

“There is potentially a way for Australia to have its cake and eat it too: by hosting USAF B-21s,” they note. 🍪

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## MAINTENANCE CHECK

# Airline Maintenance Costs Rising

**A**nnual results recently released by U.S. airlines show maintenance expenses grew in 2022 for the “Big Three” carriers.

American Airlines spent \$2.68 billion on maintenance, material and repairs, which is 35.6% higher than in 2021. That number was \$2.38 billion in 2019.

United Airlines spent \$2.15 billion in 2022, which was 20% more than the previous year. This compares to \$1.79 billion in 2019.



DELTA AIR LINES

Delta Air Lines spent \$1.98 billion on maintenance in 2022, compared with \$1.40 billion in 2021 and \$1.75 billion in 2019.

They all logged double-digit increases that can be attributed to increased flying year-over-year, but the broader market constraints—supply chain disruptions and labor shortages—which impact MRO capacity and turnarounds, most likely were factors as well.

Ken Herbert, an RBC Capital Markets analyst, expects airline MRO costs to keep climbing in 2023 for three reasons:

- Airlines have not reached their ideal fleets yet because both Airbus and Boeing are still ramping up narrow-body aircraft production. In short, deliveries are slow. This means older



*“Pricing should continue to be a headline for airlines.”*

equipment continues to fly, which usually means more maintenance expense.

- “Material pricing was up more than 7% in the fourth quarter 2022, and the pricing should continue to be a headline for airlines,” Herbert writes.

- Supply chain disruptions are prompting airlines to buy more inventory as a safeguard and are lengthening turnaround times at MROs.

Since expenses on one side equal sales on the other, the MRO market should continue to be strong this year—especially as recession concerns recede and travel in the Asia-Pacific region rebounds.

On the commercial aftermarket supplier side, revenues jumped 26% in 2022 compared with the previous year and were 102% of 2019 revenue levels, according to

Jefferies analysts. This indicates that the aftermarket, at least for publicly traded companies, has reached pre-pandemic levels.

Jefferies estimates that aftermarket revenues will grow 15% this year. While less than the 26% figure in 2022, it is still a healthy margin.

One wild card is parts pricing. How much will OEMs raise prices? While Aviation Week forecasts that aircraft owners will retire about 650 commercial aircraft this year, will those lead to part-outs and more used serviceable material?

—Lee Ann Shay

Access InsideMRO Online  
Go to: [AviationWeek.com/AWST](https://www.AviationWeek.com/AWST)





## Highlights

### Canadian MRO Enters Bankruptcy

Canadian MRO Springer Aerospace has begun restructuring proceedings following pandemic-related financial woes. It is now seeking potential buyers for its assets and business operations, which are based in Echo Bay, Ontario.

In court documents from Springer Aerospace's Companies' Creditors Arrangement Act application, filed in late November 2022, the company attributes its adverse financial situation to COVID-19 impacts on the industry, and "unusually high rates of employee turnover and operational inefficiencies from a rapid expansion of the business that was undertaken just prior to the COVID-19 shutdowns." Its pre-pandemic expansion in 2020 included growth in its operations and services, as well as construction of a new hangar. The documents note that the company's outstanding debt was \$C5.74 million (\$4.25 million) as of the summer of 2022.

Under the restructuring proceedings, Springer Aerospace has received approval for a sale and investment solicitation process (SISP) for its assets and business operations. The SISP will be used to seek opportunities for a sale, restructuring, recapitalization or other form of reorganization of its assets and operations.

### Lufthansa Technik To Expand in Shannon

As part of plans to grow its maintenance operations in Ireland, Lufthansa Technik Turbine Shannon (LTTS) has announced additions to the site's capacity, capabilities and workforce.

The Shannon-based company plans to add 22,000 ft.<sup>2</sup> of capacity with a new facility to house expanded repair services and manufacturing capabilities on CFM International CFM56 and International Aero Engines (IAE) V2500 engines, as well as new-generation engines such as the Leap and Pratt & Whitney geared turbofan.

LTTS has operated in the mid-west region of Ireland since 1992 and specializes in the repair of components for both high-pressure and low-pressure turbines for CFM, IAE and GE-manufactured engines.

Operations at the new facility are expected to begin in the first quarter of 2023. The move is expected to result in the creation of 25 technical jobs.




The new Lufthansa Technik Turbine Shannon facility will feature expanded engine capabilities and additional staff.

### Asia Digital Engineering Opens Johor Facility

Asia Digital Engineering (ADE), the engineering arm of AirAsia parent Capital A, has opened a new hangar in Johor Bahru, Malaysia and is offering its MRO services to third-party clients.

Situated at Johor Bahru Senai International Airport, the 5,000-m<sup>2</sup> (54,000-ft.<sup>2</sup>) hangar will provide services including component support, line maintenance and base maintenance primarily for the Airbus A320 and A330 aircraft types the AirAsia Group operates.

Capital A says the new hangar will be used to expand ADE's aircraft engineering presence in the region. ADE CEO Mahesh Kumar says part of the expansion road map includes establishing a training school for aviation professionals and aerospace engineering students. ADE also plans to extend its expertise to additional aircraft types. 

## Contracts

**AeroCheck MRO** won a **Breeze Airways** contract to provide Embraer 190 and Airbus A220 aircraft-on-ground (AOG) services and line servicing at Phoenix.

**Ametek MRO AEM** was selected by **ASL Aviation Holdings** for Boeing 737 landing gear maintenance and exchange services.

**AvAir** completed an agreement with **Sanad Group** to create a global component exchange pool with over 6,000 OEM-tagged line replaceable units (LRU) for Boeing, Airbus and Embraer aircraft.

**Collins Aerospace** extended its Dispatch flight-hour avionics support agreement with **China Southern Airlines** for Boeing 787s.

**Embraer** was selected by **Vortex Aircraft Services** to provide its Beacon maintenance coordination platform for faster AOG return to service.

**EPCOR** was selected by **Akasa Air** to provide Leap LRU and GTCP131-9B auxiliary power unit (APU) support for its Boeing 737-8s.

**Iberia Maintenance** won a multiyear **RwandAir** contract to provide CFM56-7B/-7BE maintenance for its Boeing 737NGs.

**Lufthansa Technik** received a six-year **Air France** contract to provide HGT1700 APU maintenance for its Airbus A350s.

**Safran Helicopter Engines** was awarded a **Yellowhead Helicopters** contract to maintain 21 Arriels out of Mirabel, Quebec.

**SR Technics** was selected by **SereneAir** of Pakistan to provide CFM56-7B maintenance in support of four Boeing 737-800s.

**ST Engineering** secured CFM56-7B maintenance contracts from two airlines in Asia for work in Singapore and Xiamen, China.

Contract Source: SpeedNews



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# Better Guidance

An industry working group has recommended that the FAA consolidate its disparate guidance for repair station certification and oversight into a single source.

Creating a single “acceptable means of compliance” (AMC) document is the top recommendation among several made to the FAA in a final report prepared by the Aviation

with creating a draft AMC. The group began the process as part of its original work but did not complete the draft within its allotted time frame.

“The AMC creates a transparent method of imparting information to applicants, certificate holders, agency personnel and the public,” the working group says in its report. “It includes the language of the regulation, its scope or intent, an acceptable means of compliance for the applicant or certificate holder, how the agency handles the data it collects or is required to review, and additional explanations or background to help aid compliance, certification, and oversight.”

The group also recommends that the FAA fine-tune the SAS data collection process, differentiating between “compliance elements” and “risk indicators.” The former should “directly” link to the “plain language of an applicable regulation” and be relied upon for showing compliance for issuing certificates.

Risk indicators “are those that may—depending upon the amount, type, scope, and complexity of work performed and the certificate holder’s size—show a need to increase the agency’s oversight,” the working group says. These, it adds, should only be used “during surveillance planning.”

The group also recommends new training for FAA inspectors and industry stakeholders that supports the AMC, including lessons on “the history, intent, and expected results for the certification and oversight of repair stations.” The group asked for a follow-up tasking to help develop the training.

“By creating training based solely on the history and plain language of the current rules, the agency can ensure showings and findings of compliance and the agency’s oversight remain directly aligned with the plain language of all regulations . . . applicable to repair stations,” the group says in its report. “Making the training available to applicants, certificate holders and agency personnel will enhance the certification process by ensuring all interested parties are well-informed on the regulatory requirements. Knowledgeable applicants and certificate holders will be able to efficiently show compliance. Additionally, agency personnel will have the tools to make compliance findings based upon the history, intent and expected results of the regulations.”

Working group membership includes representatives from about 20 aircraft, engine and component manufacturers, as well as dedicated repair stations, labor groups and industry associations. Sarah MacLeod, Aeronautical Repair Station Association executive director, and Ric Peri, Aircraft Electronics Association vice president of Government and Industry Affairs, serve as the Part 145 working group’s co-chairs. ☒

—Sean Broderick

**A working group concludes that the FAA’s repair station guidance needs a revamp.**



SEAN BRODERICK/AV&ST

Rulemaking Advisory Committee (ARAC) Part 145 working group and delivered in late 2022. The FAA confirmed in a Jan. 8, 2023, letter that it officially received the report—a formal step in the ARAC process.

“The FAA will keep ARAC apprised of the FAA’s efforts to address recommendations,” the agency responded in a letter to the group confirming receipt of the report.

The working group’s task, assigned in 2017, was to review all guidance related to certifying and overseeing FAA Part 145-approved repair stations. The review covered FAA internal documentation including orders and notices, as well as advisory circulars (AC) prepared for industry. It also examined data collection tools (DCT) used in the FAA’s safety assurance system (SAS), designed to help the agency identify potential safety risks and tailor audits and other surveillance activity accordingly.

Among the review’s conclusions: The AC and internal notice process, launched formally in 1962, has created a set of compliance information that often conflicts with the regulations.

“Internal orders diverge significantly from the plain language of the regulation,” the final report states. “The rules are performance-based, while the guidance is prescriptive.”

The DCTs are following a similar path, the group found. The tools “are being used as the de facto standard for certification and surveillance even though only [20%] cite a regulation,” the report states.

The working group asked the FAA to formally task it

## ARSA UPDATE

# Feeling the Squeeze

THE WHEELS OF GOVERNMENT MOVE SLOWLY, SO MAKING aviation policy better demands persistence. ARSA's efforts to press regulators for reasonable interpretations of the law may last months or even years.

A case in point is the association's eight-year campaign to facilitate U.S. industry compliance with parts-documentation requirements imposed by the FAA and the European Union Aviation Safety Agency (EASA) under the U.S.-EU

once again squeezed on one side by the European documentation rules for EU PAHs (which are required to issue EASA Form 1) and absence of a Form 8130-3 requirement for new parts in the FAA system.

Those interested in the specifics of the MAG fight can review the complete story at [arsa.org/mag](http://arsa.org/mag). The ongoing collaboration among entities representing, dependent on or supportive of U.S. repair stations—a collection of interest

groups covering all corners of the aviation community—is instructive. Should you take the time to read the chronicle of “the MAG mess,” you’ll see systematic and determined efforts to do the following on a regular basis:

- 1 Identify problems quickly, and thoroughly research the history and legal basis of the agency's position.
- 2 Create space to correct errors, consider practical implications and find solutions.
- 3 Build coalitions of interest with allies to add weight to the industry's cause.
- 4 Offer solutions or corrective action to the agencies based on the plain language of the rules (including international agreements and the regulatory systems of each civil aviation authority).
- 5 Push the issue on multiple fronts (including in the media and on Capitol Hill) while responding to agency correspondence in a timely manner.

- 6 Stay focused on the issue even after the government hopes you've moved on.

These steps have played out repeatedly regarding bilateral parts-documentation requirements, as they have with efforts to improve access to instructions for continued airworthiness, drug and alcohol testing requirements and countless others. The challenge for those in industry benefitting from these long-term fights is to recognize their importance, support the entities that undertake them, carry the message through their own interactions with the regulators and, of course, be persistent. ✈

*Christian A. Klein is the managing member of Obadal, Filler, MacLeod & Klein, overseeing the firm's policy advocacy practice. He represents trade associations as a registered federal lobbyist and provides strategic communications and legal counsel services to clients. He is executive vice president of the Aeronautical Repair Station Association.*

### ARSA's battle against problematic maintenance annex guidance changes demonstrates the need for persistence.

bilateral agreement (BASA). Each iteration of the maintenance annex guidance (MAG) issued pursuant to the BASA has included language regarding the use of FAA Form 8130-3 from the production approval holder (PAH) for new parts fitted during maintenance. In 2015, MAG Change 5 made the form mandatory. This caused considerable consternation for U.S. repair stations with EASA approval because FAA rules do not require U.S. PAHs to provide the form with new articles. Many older parts do not have dated documentation, rendering many new parts ineligible for installation in a dual-release workscope.

In 2016, the FAA accepted a solution proposed by ARSA that allowed repair stations to use their privileges under Part 43 to inspect new parts, document the inspection on an ARSA-designed form and issue FAA Form 8130-3 with a right-side signature. However, in 2022, after almost six years in use, the FAA bowed to EASA pressure and rescinded its acceptance of that process. As a result, repair stations are

THE BOLD BUREAU/ALAMY STOCK PHOTO





# Edging Up

The Latin American engine MRO market is forecast to grow slightly

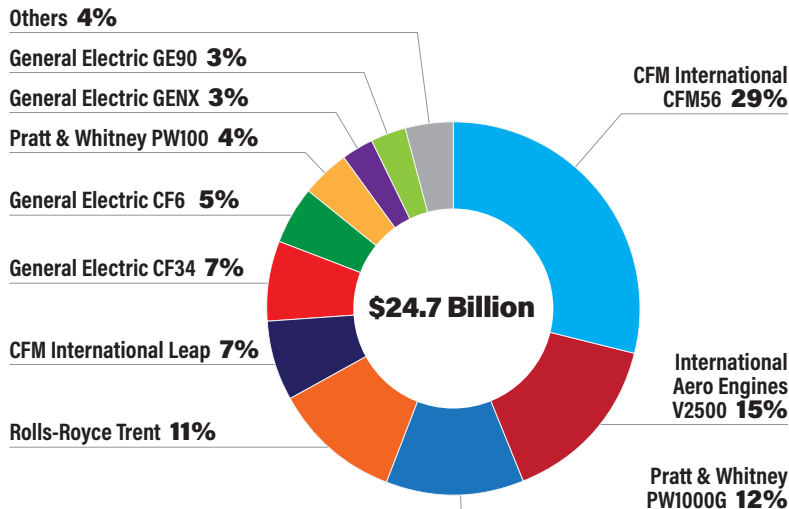
Christian Albertson

**A**viation Week's 2023 Commercial Fleet & MRO Forecast projects that Latin America will account for 5.3% of the worldwide engine MRO market after more than 7,900 engine service events through 2032, resulting in a modest 3.7% compound annual growth rate.

The Latin American engine fleet is forecast to grow to nearly 7,000 active engines in 2032 from just under 4,500 in 2023—a 55% increase. This fleet expansion and the commensurate utilization expected is projected to drive MRO spending up more than 3.7% over the 10-year period.

The forecast projects that the CFM International CFM56 will capture the majority of engine MRO expenditures, with 29.3% of the total Latin American engine market, followed by the International Aero Engines V2500 (14.6%) and Pratt & Whitney PW1000G (11.6%).

Latin America Engine MRO Demand  
(2023-32)



Source: Aviation Week Network 2023 Commercial Fleet & MRO Forecast

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# Aerolineas Argentinas

*Diego Georgiadis, the airline's technical director, talks with James Pozzi about what its aftermarket business looks for in MRO partners and why it aims to tap into specializations on certain aircraft and engine types to drive more third-party business.*

**How is the commercial aviation market recovering in Argentina since the outbreak of COVID-19 three years ago?**

The recovery in Latin America has been strong over the past year. Right now, we are at about 90% of activity in comparison to the pre-pandemic year of 2019. This is excellent, considering the recovery needed from the economic crisis for the industry brought on by COVID-19. Things are also looking positive for the airline. Domestic air travel activity is increasing faster than anticipated over the past two years, so recovering the fleet for this purpose was a complicated process at times. Overseas travel is also increasing.

In 2020, before the crisis, the company wanted to transform our technical division, and this is still the aim. Some of these transformations included selling our brand as an MRO around Latin America. [Another] key milestone was to discuss union arrangements with our mechanics. We signed a very important agreement with the mechanics union in December that will enable us to allow more flexibility while still working to industry standards.

**How has the maintenance team worked to help the airline reactivate its fleet?**

Our widebody fleet is composed of eight Airbus A330 aircraft, which we are looking to grow to 10 over the next few months. Over the past three years, it has mostly remained active, so there wasn't much need for our maintenance teams to do reactivation work on them. At the peak of COVID-19, several of these widebody aircraft were used for recovering passengers and transporting medical equipment for the vaccination process. Our Embraer fleet—22 of which we inherited from our merger with Austral in 2020—presented some challenges, as all of those aircraft with almost the same activity were grounded at the same time. When the COVID-19 crisis hit, which resulted in reduced technical operations for these aircraft, it was difficult to recover and get the necessary maintenance done. For example, structural inspections were due at a similar time on all the aircraft.



**Diego Georgiadis,  
technical director at  
Aerolineas Argentinas**

## About Aerolineas Argentinas

**HISTORY:** Aerolineas Argentinas was founded in 1949 by the country's government and commenced operations the following year. It went into private ownership in 1990, after being acquired by a consortium led by Spanish airline Iberia. The carrier has again been under the control of Argentina's government since 2008, after regaining ownership from its former Spanish consortium owners Grupo Marsans, which had purchased a majority stake in the carrier in 2001. Further organizational change occurred in late 2020, when Aerolineas Argentinas merged with its subsidiary airline Austral. The airline's MRO division, Aerolineas Argentinas Tecnica, has operated for more than 70 years and services the fleet of the Argentinian flag carrier along with third-party operators. The technical division of Aerolineas Argentinas employs some 2,300 people.

**FLEET:** Aerolineas Argentinas' fleet consists of eight Airbus A330-200s (expected to increase to 10 this year), eight Boeing 737-700s, 29 737-800s, seven 737 MAX-8s and 26 Embraer 190s. Delivery of two 737-800F aircraft is expected this year.

**CAPABILITIES:** Base maintenance up to D Checks, structural repairs of fuselage and composites, major and minor cabin modifications, line maintenance, continuing airworthiness management organization services and technical training. Aircraft serviced include the Airbus A330, Boeing 737NG and MAX aircraft and Embraer 190. Selected engine services are provided for CFM International CFM56-7B, General Electric CF34-10E and CF6 and Pratt & Whitney PW4000 models. The airline has about 20 components shops at its Buenos Aires sites.

**FACILITIES:** Aerolineas Argentinas' main bases, composed of eight maintenance hangars, are at two airports in Buenos Aires—four each at Ezeiza International Airport and Aeroparque Internacional Jorge Newbery. These facilities offer more than a dozen narrowbody and widebody maintenance bays between them. The airline also operates line stations across Argentina and the wider South America region, including Brazil, Chile, Colombia, Paraguay, Peru and Uruguay.

Three of these aircraft are still in storage, awaiting a maintenance slot because it has been a very slow recovery. Much of our maintenance is done by our technical teams in-house, but for this aircraft type we had to outsource four E190s last year and four more this year, as we don't yet have the required capability for that. The Boeing 737 fleet is different, as we changed our maintenance plans for that aircraft in 2019, which saw us manage the inspections and heavy checks in different phases. Almost all of those aircraft had returned to service by early 2022.

**What is your strategy for insourcing and outsourcing maintenance?**

For airframes, we try to keep most of it in-house, and the Embraer maintenance being outsourced was a unique situation

as we wanted to keep aircraft available for commercial use. We don't expect to send any other aircraft to third-party MROs this year, as those checks will be done in-house. Around 95% of our maintenance is done in-house, with the other 5% outsourced.

### **What does Aerolineas Argentinas look for in an MRO partner, and is it exploring new partnerships?**

Geographically, Argentina, and the South America region, is very far away from the rest of the world, so being in this location can impact logistics and lead times. So finding partners who can ensure short turnaround times is important. Of course, quality is a big driver when seeking our partners—this is a non-negotiable asset for us. Long-term relationships are also important, given the fluctuating economy of Argentina. We are seeking partners to work with in several areas, including improving our back shop and engine workshop capabilities. We are also analyzing the possibility of recovering our old test cell, which was previously used for JT8D engines powering MD-80 aircraft many years ago.



AEROLINEAS ARGENTINAS PHOTOS

**Aerolineas Argentinas operates two MRO facilities in Buenos Aires.**

We're trying to find a partner to potentially upgrade our test cell for current engine types. We have a good capability for CF34 and CFM56 engines, and upgrading the test cell could lead to improvements in our engine shop.

However, our location far away from regions such as North America, Europe and Asia-Pacific would mean challenges related to turnaround times and logistics costs. We need to assess whether this move would be economically viable. Also, we are speaking to an MRO provider about potentially partnering to set up a parts pooling location in Latin America.

We're also looking to grow airframe heavy maintenance for other airlines and grow our business as a third-party provider as we continue to grow our efficiency and develop business cases for our capabilities. This growth would target the Latin America region, where we see there is a need for more MRO providers.



**The airline plans to grow its business as a third-party maintenance provider.**

### **How has the MRO supply chain held up over the past few years, considering various global events and crises?**

Logistics costs are rising. In the supply chain, we share the same problems with other Latin American airlines. Together, we've discussed what OEMs can do to help us. From our side, in our procurement and materials management, we increased communication and permanently monitored the situation with our suppliers. We had to maintain and even increase our stock of certain component types, too. But overall, it's a tough environment right now. There are issues with logistics and distribution for parts from the U.S. to Latin America, and turnaround times are increasing. This has especially had an impact on our annual heavy maintenance plan. However, over time, these will ease, and I expect them to normalize by the middle of next year. One solution we've explored to ease some supply chain pressures is changing our policies toward [parts manufacturer approval (PMA)] parts. Aerolineas Argentinas has a restrictive policy toward PMA, but we are looking for more flexibility and a potential agreement between OEMs and PMA manufacturers. We've started to use PMA parts for our interiors work initially, and with approvals, we'd like to start using more PMAs in our fleet.

### **What technologies has Aerolineas Argentinas invested in for maintenance?**

We rolled out AMOS software across our operation four years ago to manage all of our technical operations. We are at about 80% usage of the system. Predictive and preventative maintenance are technologies we are very interested in utilizing. Using all of the tools we have available to do line maintenance differently is a goal of mine. This will first be used for the Embraer fleet, as this predictive maintenance could help overcome problems we have faced in the past few years. We have also introduced the Airbus Skywise platform across the entire fleet. The idea is to use this to help with fleet reliability. 🌐



# Cargo Momentum

A busy cargo conversion market continues to churn out new options



Henry Canada **Washington**

**T**he silver lining of aviation's COVID-19 cloud has been the boom in cargo and—for MRO shops—the related spike in cargo conversions. The pandemic has given rise to more options for converting aircraft to freighter configurations and a growing number of providers to perform these conversions.

The cargo boom has accelerated Airbus' expansion into a market once heavily dominated by Boeing. This has turned newer aircraft types into conversion candidates while sustaining conversions of older types, such as the Boeing 767 and 757.

Higher fuel prices and stronger pressures to reduce CO<sub>2</sub> emissions have tilted airlines toward newer, more efficient models, increasing the feed-stock for converting older types.

Because e-commerce has been such

an important part of the cargo surge, there is a greater incentive to move air cargo operations from hubs to smaller, outlying destinations, creating tasks best suited to narrowbodies or smaller regional aircraft. Consequently, conversion opportunities have exploded for ATR and Embraer aircraft as well as Bombardier CRJs and De Havilland Canada Dash 8s.

The cargo-hauling market is cooling as economic growth slows and wide-body belly space comes back, and

e-commerce giants such as Amazon are expanding more slowly. The International Air Transport Association reports cargo volume fell nearly 14% in both October and November 2022, compared with the same months in 2021.

But the conversion market has been permanently altered in the last several years, and it will offer shops, lessors and cargo carriers much greater flexibility in dealing with market shifts over the next decade. Conversion possibilities now include many different aircraft, various configurations for the most popular aircraft and a variety of combination and quick-change versions for a number of aircraft.

Most conversions take at least one month and sometimes many more, depending on aircraft size and the



In addition to a heavy focus on Boeing 737 conversions, AEI offers conversions for the MD-80 and Bombardier CRJ.

AEI

carried are sometimes used as well. An operator's business model dictates which payload metrics it uses. Range in nautical miles is influenced by weight actually carried—maximum range cannot be achieved with maximum weight.

Airframe OEMs almost always are involved with programs for their major conversion candidates, but independent shops or engineering companies often develop their own designs, which may boost capacity or emphasize features that some customers want. In any case, they expand the variety of conversion options and locations available. Customer orientation has been a strong focus of the conversion business for a long time and has increased in the last few years.

### WIDEBODIES

No new conversion can match the Boeing 747-400's enormous payload capacity of nearly 127 tons. The Bedek division of Israel Aerospace Industries (IAI) still offers the 747-400 conversion. However, Airbus, Elbe Flugzeugwerke (EFW) and ST Engineering, joined by partners around the world, have put together Airbus A330-200 and -300 conversion programs that can offer 61-63 tons. By September 2022, the EFW-ST Engineering venture had delivered 20 converted A330s; it has orders for 100 more. IAI also offers a 67-ton version of the A330-300.

Avensis Aviation received European Union Aviation Safety Agency certification for its Medius conversion modification for A330s in the summer of 2022, according to CEO Cristian Sutter. It is working on a similar conversion for Airbus A340s and different conversions for Airbus widebodies while exploring options for Boeing widebodies. Avensis conversions are done by multiple MRO partners in addition to shops contracted by customers. Sutter says Medius-converted A330-300s, which can carry up to 69 tons, are being operated by two customers.

Jonathan McDonald, manager of classic and cargo aircraft at aviation consultancy IBA, estimates that as 2022 ended, 21 A330s had been converted, two-thirds of which were -300s. Although few A330s have been converted so far, conversion programs for them have picked up strength in the last two years.

Going down a notch in size, IAI and partners in Mexico and Ethiopia offer Boeing 767 conversions with capacity of 50-64 tons, and several MROs in Asia also offer 767 conversions. Boeing has delivered more than 60 of its version, the 767-300BCF, at three active conversion sites. It has orders for more than 40 more.

Boeing's 767-300BCF was launched with All Nippon Airways in 2005, and first delivery occurred in June 2008.

complexity of work. Passenger interiors must be removed, floors strengthened and new fire-suppression systems installed. Barriers capable of resisting multiple G forces are usually installed between the cargo and cockpit, and additional doors must be cut—large doors for loading pallets or smaller ones for packages.

A host of other modifications, such as window plugs, are made according to specific conversion plans. Generally, modification companies try to minimize empty operating weight to maximize payloads. Payload and range are the most important characteristics of converted aircraft.

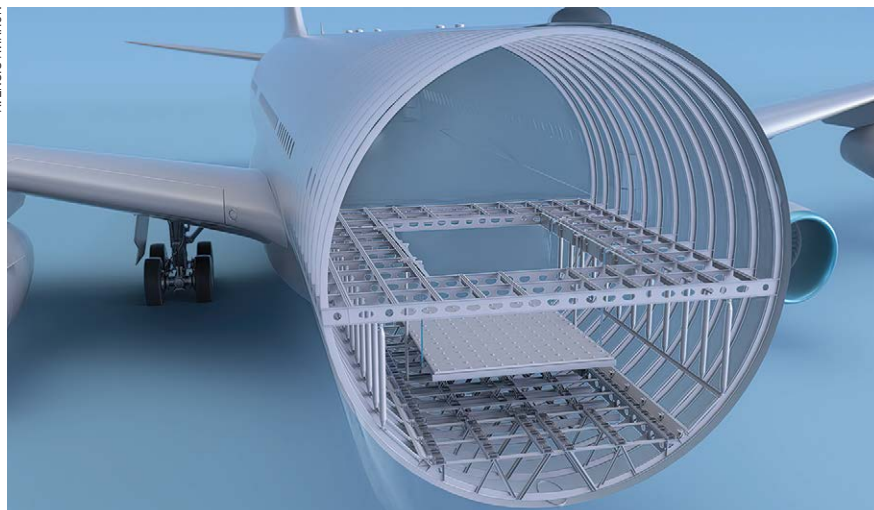
Payload is most commonly measured by weight, but volume in cubic feet or the number and type of pallets



Although Airbus A330 cargo conversions are relatively new, more than 20 have been completed.

EFW





**Following certification of its Airbus A330 cargo conversion, Avensis Aviation is targeting a similar program for A340s.**

Boeing argues that this is the world's most efficient medium widebody twin-engine converted freighter.

McDonald reports a total of 176 767-300 conversions through 2022, with nearly two-thirds of these 767-300ER BDSFs, the IAI version with extended range. Total 767-300 conversions have been numerous in recent years, with more than two dozen converted annually in 2021 and 2022.

Meanwhile, the race is on to handle much bigger payloads with converted Boeing 777s. A General Electric Aerospace-IAI joint venture hopes to deliver 110 tons with its 777-300ERSF. Two rival companies, the Kansas Modification Center (KMC) and Mammoth Freighters, are in litigation to offer 777 payloads in the 100-105-ton range.

David Dotzenroth, a former 777 pilot and original partner in the KMC business, says the program is taking a cautious approach by staying within OEM weight limits and putting the cargo door forward of the engines. He expects post-737 MAX FAA certification approaches to be very strict, yet the company hopes to have a converted aircraft on the ramp by the end of 2023, with certification and delivery in 2024.

## NARROWBODIES

The newest narrowbody conversions are Airbus types. ST Engineering-EFW has completed 12 Airbus A321-200 conversions and one A320, and it has orders for 90 A321s. Precision and C Cubed also convert A321-200s, which can carry 50% more payload

than the smaller A320. In all, 18 A321-200s have been converted, 11 in 2022 alone, McDonald says.

These A320-200 conversion programs are growing rapidly. HAECO Xiamen, currently working on two lines of 757-200 conversions, will shift all three of its lines to A321-200 conversions by the end of 2023, according to Zach Young, director of sales and marketing at Precision Aircraft Solutions, which is partnering with HAECO on the conversions. "The A321 conversion program is expected to be a 25-year program at least," he says. "We have five conversion sites with multiple lines each."

Converted Boeing 737 Classics and 737NGs have long served the cargo market. McDonald counts 141 737-300s converted—the great majority being 737-300SFs and the rest -300BDSFs, a type developed by IAI—and 187 737-400s, mostly -400SFs, with the rest IAI types. But for both -300s and -400s, recent conversions have been tapering off.

Pemco and Aeronautical Engineers Inc. (AEI) have been very active with these classic narrowbodies. Pemco offers a full 737-300 freighter, a quick-change version of the same type, a -400 freighter with 50% more payload than the -300, and a -400 combi with passenger space. However, Mike Andrews, director of cargo conversions at Pemco, expects its 737 Classic conversions to be finished by 2024 and future work to focus on 737NGs.

So far, eight 737-700BDSFs have

been converted by IAI. A total of 157 -800s have been converted; McDonald says conversions of this type have been increasing in recent years. IAI has performed 10 of these, but the vast majority are either -800BCFs, developed by Boeing but offered by shops around the world, or -800SFs, done by AEI.

Boeing recently delivered its 100th 737-800BCF, and it has active conversion lines at five sites. It plans to add 737-800BCF lines at KF Aerospace in 2023. The OEM stresses that 737-800BCFs have up to 20% lower fuel consumption and CO<sub>2</sub> emissions per unit of payload carried than the previous generation of narrowbodies.

Andrews' staff at Pemco has begun work on 737-700s and offers both full and several combi versions for this type.

AEI has begun converting 737-800s, too, and these types also can be converted in Central America, Canada, the UK and China. IAI works on both -700s and -800s, partnering with Mexicana on the former type.

The roomiest converted narrowbody is the Boeing 757: The converted 757-200 can carry 30-100% more payload than the A320 family and other Boeing narrowbodies. McDonald says more than 300 757-200s have been converted, with 10-12 done annually in recent years. Precision and several Chinese shops are active in this type. AerSale purchased two dozen 757-200s, confident there would be a market for the heavier Boeing jet.

Only AEI offers conversions on the lighter MD-80.

Boeing is focused on its active programs: the 737-800BCF and 767-300BCF. The company says decisions to launch a new program will be largely driven by customer needs and market demand.

## REGIONAL AIRCRAFT

For even thinner routes and lighter loads, a number of regional aircraft, both regional jets and turboprops, are being fitted for cargo operations.

ATR 42-300s and -500s, as well as 72-200s and -500s, can be converted, and 42-600s and 72-600s will be eligible in the near future, according to ATR Business Development Director Gilles Collaveri. Most ATR conversions are bulk freighters, while the rest have large doors for pallets. ATR also offers

CargoFlex, which provides extra cargo space in the front of cabin and can be installed quickly: The change between full passenger and passenger/cargo configurations can be done overnight.

About 150 ATR conversions have been done, and the pace has been picking up in the last five years. Seventeen were completed in 2021 and about the same number in 2022. Colaveri attributes the quickening pace to e-commerce's need for "the last airfreight leg."

AEI and Avmax are concentrating on Canadair Regional Jets, with the former offering a large cargo-door model that can handle eight pallets. Avmax is offering several versions of CRJ100s and -200s that can carry slightly more weight.

Embraer is offering significantly larger payloads on its conversions of E190s and E195s. The program kicked off in May 2022 with an agreement with Nordic Aviation Capital (NAC) for 10 conversions. NAC plans to place the first two E190P2Fs with

De Havilland Aircraft of Canada is offering several versions of its DHC-8-400s, which are struggling in passenger markets against competition from ATR. A quick-change package carrier and pallet model with a large cargo door will be modified at Ethiopian, which also is working on wide-body modification with IAL.

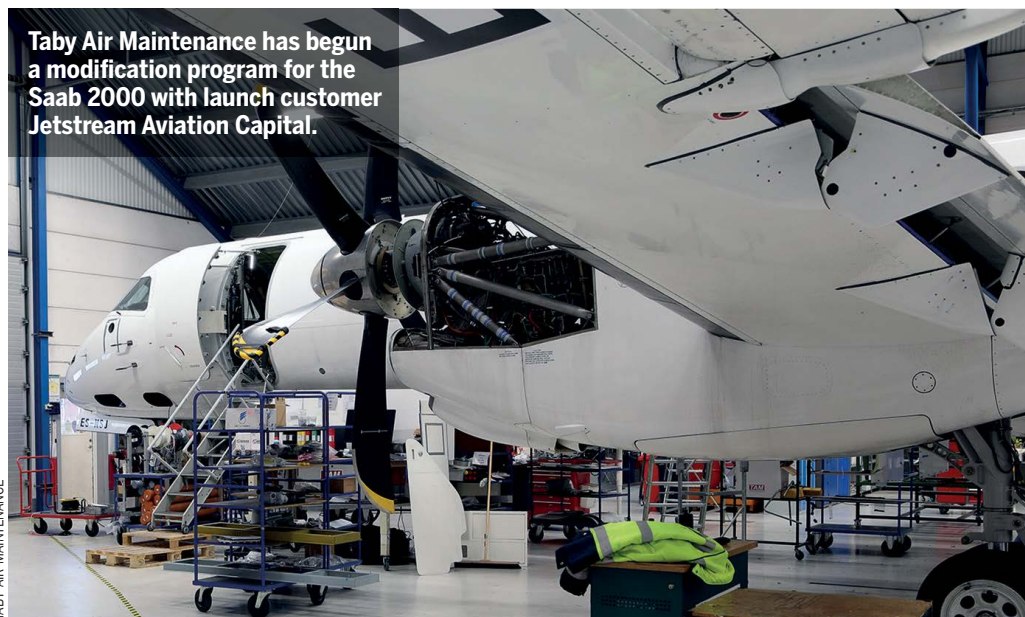
Sweden's Taby Air Maintenance has been busy modifying Saab 340As and 340Bs, and its partner C&L Aviation is converting 340Bs in the U.S. Taby has completed conversions of more than 30 340As, and it has begun a modification program for the larger Saab 2000 with launch customer Jet-

## Cargo Conversion Opportunities Expand

### Active and Planned Programs

Widebodies	Narrowbodies	Regional Aircraft
Airbus	Airbus	ATR
A330-200PTF	A320PTF	42BFC
A330-300PTF	A320-200CCF	72BFC
A330-300BDSF	A321PTF	42LCD
A330-300 Medius	A321-200CCF	72LCD
Boeing	A321-200PCF	42Flex
747-400BDSF	Boeing	72Flex
767-200BDSF	737-300F	Bombardier
767-300BDSF	737-300QC	CRJ200 LCD
767-300BCF	737-400FH	CRJ100 ER Package
777-300ERSF	737-400C	CRJ100 LR Package
777-200LRMF	737-700F	CRJ200 ER Package
777-300ERMF	737-700FC a	CRJ200 LR Package
777-300ERCF	737-700FC b	
	737-700FC c	Cessna
	737-700BDSF	SkyCourier
	737-800SF	SkyCourier Combi
	737-800BCF	Embraer
	737-800BDCF	190P2F
	757-200PCF	195P2F
	757-200PCC	De Havilland Canada
	757-200 AerSale	DHC-8-400 QC
	MD-80SF	DHC-8-400 PF
		DHC-8-400 F-LCD
		Saab
		340A
		340B
		2000

Sources: OEMs and MRO shops



Taby Air Maintenance has begun a modification program for the Saab 2000 with launch customer Jetstream Aviation Capital.

Astral Aviation from Kenya. Embraer also has signed a firm order for up to 10 conversions with another customer.

At the end of 2022, Embraer cut its first metal for a converted freighter, part of the main deck door. Deliveries are slated to start in 2024, and Embraer expects to ramp up capacity to 10-12 aircraft per year, each taking 3-4 months, with room for growth.

stream Aviation Capital. Rollout is expected in weeks.

The first conversion of a Saab 340A was completed in March 2007. For the next decade, 1-2 conversions were performed each year. "But over the last few years, the requests for cargo conversions have increased significantly," notes Taby spokesman Anders Annerfalk. Taby estimates that it will convert

between five and seven 340Bs in 2023.

Even business aircraft are getting into the cargo game, as Cessna offers a kit for converting its passenger-carrying turbo-prop into a SkyCourier freighter or combi. "Through the use of quick-release mechanisms and pins, two people can complete the conversions in ap-

proximately 1 hr," spokesman Whitney Watson says. "Operators can convert the aircraft in the field, provided a mechanic is available to sign off on the new configuration." Watson notes that a number of customers have ordered pure freighter and combi conversions.

Whatever the short-term prospects for cargo traffic, operators are still hungry for converted freighters. ☛



# Bringing It Home

**More airlines in the Middle East seek to insource maintenance as part of their recovery**

**James Pozzi** **London**

**S**ince the outbreak of COVID-19 three years ago, many sectors of the aviation industry have had to recalibrate both their day-to-day operations and long-term strategies. This is especially the case for airlines that are revisiting their long-term business models, including maintenance arrangements.

Cash-conscious carriers implemented short-term strategies such as deferring, renegotiating or even canceling scheduled maintenance. These costs have been reevaluated

airline-affiliated MRO providers in the region have sought to add further capabilities not only to support their airline operations but also to accommodate third-party customers. This includes Egyptair, which operates its Egyptair Maintenance & Engineering division from its main base in Cairo.

Yehia Zakaria, chairman and CEO of Egyptair Maintenance & Engineering, told *Inside MRO* in the summer of 2022 that he estimates third-party business accounts for almost 30% of its operating revenue, with plans to increase that to 40% soon. The airline MRO outsources around 50% of its engine maintenance requirements. Recent capability additions include light and heavy maintenance services as well as aircraft painting. Line maintenance capability additions include the Airbus A320neo, A350 and A380 with Pratt & Whitney engines.

Partly due to inflation, airline MRO costs also are escalating in the region. While airlines in the Middle East have not been affected by inflation to the same degree as in Europe, independent MRO providers and airline maintenance units are seeing price increases in the market related to the tight aftermarket supply chain.

“For parts and materials cost, there is a noticeable increase in price and lack of availability in the market,” says Shaune du Plessis, director of maintenance operations at Bahrain-based cargo airline Texel Air. He identifies one issue specific to his experience at the cargo carrier: “Lead times on repairs and overhauls have blown out, for example, on hydromechanical units for fuel on the CFM56-7B engines,” he says. “These are in short supply, with units taking 6-8 weeks to be ready now, with even the workshops struggling to get parts to repair from the OEM.” Du Plessis adds that prices have risen 50-70%, while lead times have increased by 50%.

Also seeing pricing pressures and supply chain constraints is Raghad Al Kaasamani, head of engineering at Kuwait-based Jazeera Airways. During the early part of the pandemic, the airline paused its long-term maintenance strategies and witnessed the impact on its maintenance and materials supply chain partners due to the shortage of labor, longer lead times related to parts repair and overhauls, and shortages of specific materials such as battery cells.

Since Russia’s invasion of Ukraine in February 2022, Jazeera Airways has faced further hurdles. “The Ukraine war added additional challenges to the availability of raw materials such as cabin parts, which are mainly made from polymers, in addition to other materials such as engine oil,” Al Kaasamani explains.

This year, he expects the ability of suppliers to support market demand will be a primary challenge. “This is in addition to logistics, as these sectors have not yet fully recovered since COVID, as demand has increased. But we are

**Some Middle Eastern carriers such as Texel Air are seeking to move more maintenance capabilities in-house.**



for the long term, particularly as airlines reactivate more of their fleets. While the expectation has been for carriers to outsource additional maintenance tasks, some have chosen to bring more services in-house, given the lingering supply chain problems resulting in longer turnaround times.

In the Middle East, even before the pandemic, airlines were bucking some Western trends by insourcing capabilities, mostly owing to the growth in domestic and cross-border travel in the region. The Middle East’s three large flag carriers—Emirates, Etihad Airways and Qatar Airways—typically work with a large network of partners and use their in-house affiliated MRO units to carry out most services while also growing as third-party MRO providers. Generally, all three carriers outsource engine overhauls.

Outside of the bubble of state-backed carriers, some

working on different contingency plans to absorb these challenges,” he says.

Despite these headwinds, Jazeera Airways is among the region’s airlines seeking to insource MRO services where appropriate. The low-cost carrier estimates that maintenance represents around 40% of its cost structure.

“Due to the increase of new aircraft system complexity and new technology, greater technical maintenance expertise is needed along with sophisticated and expensive test equipment that requires high investments and large maintenance facilities,” Al Kaasamani says. “Specific maintenance functions such as engine repair, overhaul or system component repair are a huge project and require a large investment.”

Jazeera operates 19 Airbus A320-family aircraft, including eight A320-200s and 11 A320neos, but it is planning to grow the fleet to 36 aircraft over the next four years. “Approximately 50% of our maintenance requirements are outsourced, while we insource the daily maintenance requirements up to light checks,” he says. Al Kaasamani notes that all the airline’s required heavy maintenance checks, repair and overhaul and off-wing engine maintenance are outsourced to third parties.

But Jazeera will seek to insource some maintenance services in a move driven by the airline’s fleet expansion plans. “We are carefully considering the services which we will bring in house to maintain safety and sustainability. For

2023, we are working to have our own battery shop as well as a wheels and brakes shop,” Al Kaasamani says.

For Texel Air, most maintenance on its relatively small fleet, which includes five Boeing 737 freighter variants, is performed in-house. The carrier chooses to outsource heavy structural inspections requiring specialized nondestructive testing techniques or if there is a high risk of major repairs being needed.

“We are trying to get to a position of almost all maintenance done in-house,” du Plessis says. “Currently, I would estimate that around 80% is being completed in-house by our own team. We are focusing on a progressive maintenance plan so that we can accommodate the airline within the ground times to accomplish maintenance tasks.

“The key for us is to control the workflow and quality of the product and utilize the [Maintenance Steering Group-3 document from ATA] to work around a flexible schedule by cutting tasks short if needed to accomplish a set amount of flying program,” he continues. The document is intended to help air carriers prioritize maintenance tasks.

When considering which MRO services could be beneficial to insource, du Plessis says Texel Air naturally has cost considerations but would prefer to bring work in house rather than use contractors and subcontractors on-site. “Some services, although handy to have in the long run, are a sunk cost if you are unable to utilize and maintain productivity in that department,” he adds. 📍

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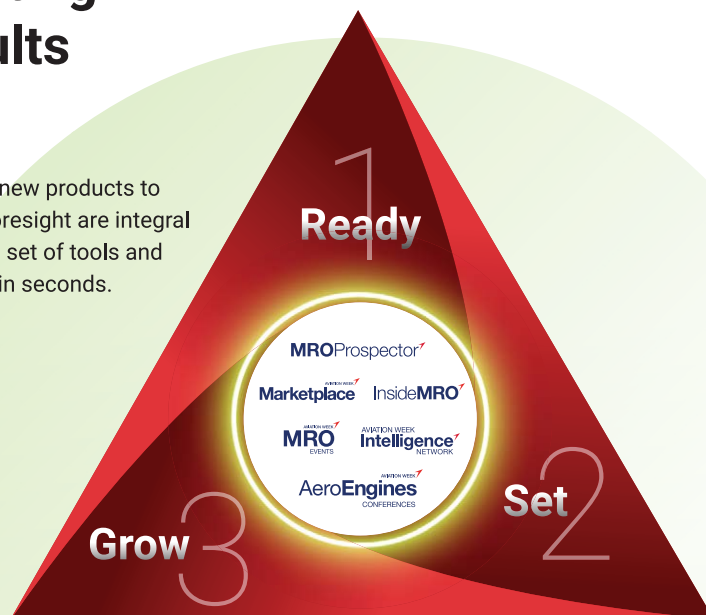
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# Widebody Refresh

EMIRATES



## Emirates navigates supply chain challenges as it upgrades Airbus A380 and Boeing 777 fleets

Prachi Patel **London**

**A**ircraft interior modification projects have been on the rise in past year as airlines recover from the pandemic downturn and work to enhance the passenger experience.

In early August 2022, Emirates launched a \$2 billion cabin upgrade project for 67 Airbus A380s and 53 Boeing 777s. The project, undertaken by the airline's Dubai-based Emirates Engineering division, is planned to run until April 2025 on a schedule of four aircraft per month undergoing retrofits. All of the A380s should be back in service by May 2024; the carrier aims to begin work on the Boeing 777-300ERs after that.

Technicians are slated to install 4,000 new premium-economy seats, more than 5,000 upgraded business-class seats and approximately 728 refurbished first-class suites. The airline also is replacing cabin carpets and stairs and refreshing cabin interior panels with new colors and designs.

Emirates looks for sustainable processes and materials for such projects and insists on both upcycling and re-

cycling. Ahmed Safa, divisional senior vice president of engineering at Emirates, says that for the widebody project, the carrier has worked out a process with its manufacturing partners to reuse existing parts and use materials that have a high score on the environmental index. The airline is choosing lighter-weight materials as well, to reduce carbon dioxide emissions.

To ensure the project could be executed safely and on time, Safa says the team conducted multiple trials, including time-motion studies on a spare A380 parked due to the pandemic. Additionally, the team conducted a thermal-motion study so it could understand the risk of weather conditions. Following the trials and studies, Emirates was able to start the project with risk factors minimized.

Furthermore, to optimize turnaround time and cost effectiveness, the company transferred skill sets and knowledge bases to Dubai and built temporary workshops to expedite the execution of the project, Safa explains.

Emirates finished the cabin upgrade

on the first of the 120 aircraft—an A380—in January. However, due to supply chain issues, it took much longer than the company expected.

“The biggest issue we have faced and continue to face is the material supply chain and the quality of the finished products,” Safa says. “We are working with our partners to resolve the issue. They have stepped up to the requirements and injected a lot of additional procedural improvements, processes and all necessary inputs that will bring back the turnaround time to the initial 20 days.”

**Emirates is upgrading its widebodies' premium-economy (pictured), business-class and first-class sections.**

The other main challenge faced by technicians during the retrofit of the first A380 was the amount of work that had to be completed in a short time. The process of refurbishing the aircraft and returning it to service in 20 days was not a small feat for Emirates. Safa notes that while the airline had laminated panels, walls, dividers, features and other cabin monuments without removing them on previous projects, it had not done so to this degree of intensity.

“The technicians completed the task without compromising on quality and managed to exceed expectations by ensuring that none of the panels exhibited any bubbling during the first flight following the refurbishment,” he says.

Emirates has received positive customer feedback regarding the first retrofit, and the second aircraft undergoing renovation was expected to be ready by the end of January.

“[The refurbishment project] is going to cement and enhance our reputation as a leader,” Safa says. “Certainly, it is going to set a new standard for what the average public would expect from the airline, and it is probably going to prompt a lot of airlines to do more with their aircraft.”

The airline also plans to invest in other projects to enhance the passenger experience. “This is only Phase One,” Safa says. “In the next phase, we will probably be looking at the inflight entertainment system, brand-new seats in all classes and all the other features in the cabin as well.”



# *It's Time for a Cargo Conversion*



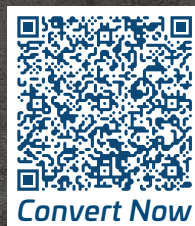
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# Scaling Breeze

*Tom Doxey, formerly United Airlines' senior vice president of technical operations and chief financial officer of operations, became president of Breeze Airways in June 2022. He spoke with Lee Ann Shay about fleet expansion and flying charters.*



## What's your outlook for the North American low-cost carrier and ultra-low-cost carrier market, especially if JetBlue Airways' acquisition of Spirit Airlines goes through?

We've seen the larger carriers continue to reduce the capacity they have allocated to smaller and midsize airports

focused on those large cities; they fly large, dense airplanes and are competing directly with others. For the overwhelming majority of our markets today, we are the only airline that flies nonstop between those two cities. We also provide first-class seats on the Airbus A220—and we have a section within the economy cabin that

## How is the existing fleet operating?

We have 10 A220s and 15 Embraer E-Jets and are getting good performance out of them. We're using the A220s for a lot of cross-country flying. Typically, the airplane would have an additional segment in its day—so think of it as starting in Hartford [in Connecticut] and going to a place like Pittsburgh or Cincinnati, and then continuing on to a place like San Francisco and then back. That's the type of routing a typical A220 would do on a given day. That's a higher utilization for our most efficient airplanes.

We have seen great fuel-burn performance, and our guests and team members really love it, too. That airplane has big windows, big bins, LED lighting and it's quiet. The pilots really enjoy flying it as well. We have 70 more A220s on firm order, plus another 40 options. We're basically getting one per month.

We use the E-Jets in two ways. We have 10 E190s and use them primarily for charters, but that's not how it started out. Initially, we were flying them on scheduled service, but as fuel prices rose and as the charter opportunity presented itself, we shifted that fleet to charter to primarily fly college sports teams. For this season of men's and women's basketball, we will be the largest charter operator for that sport, in our first year of operation. We have multiyear agreements with schools such as Brigham Young University, Florida, Nebraska, Notre Dame and Tulane. We also fly a bunch of other schools on a smaller scale. The other five aircraft that are in the fleet, the E195s, we use for shorter-haul scheduled service, such as Charleston to Norfolk, Virginia.

## Are you flying the Embraer 190 under Part 135?

No, it's all under the same [Part 121] certificate.



Breeze operates 10 Airbus A220s and has 70 more on firm order.

while they focus on the larger ones. That's a great thing for us because it opens up opportunity. What they primarily had been flying into those airports were 50- and 70-ish-seat airplanes, in and out of a hub, two to four flights a day. Unless you wanted to go to that hub, you had to connect in that busy airport, which took time. We are flying nonstop to places where people want to go, such as Tampa, Orlando and Jacksonville in Florida; Savannah, Georgia; Charleston, South Carolina; Las Vegas and Los Angeles. It's an opportunity that has been moving toward us and I think will continue to move toward Breeze.

We're unique, even compared to some of the other low-cost and ultra-low-cost carriers because they are

has more legroom. We've got comfortable airplanes providing nonstop service at nice fares.

## Are you concerned about inflationary pressures and a potential market slowdown?

I don't see inflationary pressures having a significant impact on leisure demand, which is what we mostly serve. The inflationary pressures are more about us as a management team making sure that we can properly manage the business—so: what is it going to cost us to buy spare parts, for example? We are focused on managing costs, but I don't see it impacting demand a lot—at least we're not seeing any indications of that.

## What is Breeze doing to prepare for receipt of one A220 per month?

We've got a great operations team, for one, and we know the importance of having a good operation, so it's a big part of how we spend our days, ensuring that we have the infrastructure in place. To be able to grow by one airplane per month, we've got to make sure we've got technicians in place. We have to have pilot training in a good spot. We have a training center here in Salt Lake City, near the airport, where we have a couple of flight simulators.

As we grow, that will continue to grow. A lot of it is about making sure you have the people, the right parts in the right place and the structure that enables growth. David's [Neeleman] history has been really helpful for us, because he's been so successful with the other airlines he's launched. We have a lot of people who want to be a part of our team and what we're doing—there's a lot of excitement around it.

For example, we have a pilot who retired as a Boeing 777 captain from Delta who took early retirement during the [early part of the] pandemic. There are many like her who have chosen Breeze to be the airline that they go to for the last three years before they turn 65. On the technician side, we have ex-military folks who are really excited about coming into commercial aviation after retiring from the military, and Breeze is a destination for them. Some of our bases, such as Charleston and Norfolk, have a large military presence, and people don't want to move. We have opportunities for them to stay in those locations—not something that most other airlines offer.

## What maintenance are you doing in-house?

We do line maintenance in-house, and we primarily utilize the OEM partners for the heavier maintenance and for the components and engine type maintenance.

We contract with GE for the engines on the E-Jets and Pratt & Whitney for the A220 engines. We just started doing C checks on the E-Jets and have been using Embraer for those.

## United Airlines' and Breeze's operations are very different, but are there any similarities between the two tech ops?

Tech ops is usually the first place I stop when visiting our bases. At Norfolk, the first thing I do is visit the parts room and talk with the people in our warehouse and to our technicians, and then I go everywhere else. We have very talented people here at Breeze, but that was also the case at United. The difference is just the scope. United had 13,000 in the tech ops organization scattered around the world and focused in the hubs. Breeze has about 1,200 people in the entire airline, and we perform line maintenance only. In both, the people are the best part of it. 🛩️

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# Reinforcing a One-Stop Shop

Iberia Maintenance's engine MRO division preps for the challenging aftermarket landscape

James Pozzi **Madrid**

Three years after the outbreak of COVID-19, the pandemic's effects on the commercial aftermarket are lingering. Airlines have sought to streamline maintenance costs, most notably expensive engine MRO commitments, to cope with the crisis. That has resulted in a sharp downturn in scheduled maintenance demand, and

Group (IAG) parent company—Iberia, British Airways, Aer Lingus and low-cost carrier Vueling—with the remainder coming from non-IAG airlines and leasing customers.

During the early part of the pandemic, Iberia was able to retain all its staff and continued work at its facility located close to Adolfo Suarez Madrid-

saw customer confidence increase in the market, and this was reflected in a growing number of engine shop visits," she said.

Merino estimates that Iberia Maintenance is inducting three times the number of engines as it was before the pandemic, with demand in the International Aero Engines V2500 aftermarket particularly strong. She expects these inductions to rise in 2023. "Now, at the end of the year, we have a much bigger engine pipeline ahead of us, and we will have to decide which inductions we are going to do, taking into consideration the capacity and the pipeline," she noted.

While the upturn in engine workscopes is positive for MRO providers like Iberia, Merino expects that change could be permanent in overall workscope volumes themselves, given the post-COVID-19 alterations in operator maintenance strategies. "I don't think the workscopes will ever recover to pre-pandemic levels because operators have found a new way of saving money and a new way of operating the engines without spending those large amounts of money," she said.

The airfreight segment spike has buoyed the aftermarket in the past few years for the Rolls-Royce RB211 engine, which powers several wide-body Boeing aircraft types mostly flown by cargo operators. While Iberia is aware of this demand and plans to keep some staffing and capacity for RB211 operators, it will do so in smaller volumes. Merino anticipates that the number of labor-intensive RB211s in its shop will decrease, requiring a shift in staffing to the V2500 while still keeping enough technicians available for the first wave of Pratt & Whitney PW1000G (GTF) engines.

Iberia Maintenance joined the aftermarket network for the GTF in October after receiving its license from Pratt & Whitney. Technical staff are receiving familiarization training for the GTF; that will lead to a full 16-week training program. The first inductions, of IAG-operated aircraft engines, are expected this year, and Iberia's on-site test cell will be correlated for the GTF in April 2023.

Multimillion-euro investments also were made in tooling and machinery at the site for both the GTF and Leap



Iberia's on-site test cell will be correlated for the GTF in April 2023.

while the aftermarket's prospects are improving, the recovery has been sluggish, with activity still well below pre-pandemic levels.

Engine MRO has been among the most heavily affected segments as expensive and labor-intensive engine overhauls and restorations were placed on hold. Spanish MRO provider Iberia Maintenance decided early in the pandemic to double down on engine maintenance offerings by adding more capabilities and investing in its Madrid engine shop. A quarter of the airline-affiliated MRO's work stems from the carriers of its International Airlines

Barajas Airport, but activity was reduced vastly compared with the pre-COVID-19 period. "We really reinvented ourselves in everything—not only in production, but in our proposals and how we offer services to customers," Eylo Gonzalez Merino, engine shop director at Iberia Maintenance, told *Inside MRO* at the Madrid engine shop in early December 2022.

Reflecting on the previous 12 months, Merino says momentum picked up as the year progressed. "The beginning of 2022 was tough because we were still seeing part of the decrease in inductions, but throughout the year we

engines. Some of these investments include a high-speed grinder and other machinery, which cost around €7 million (\$7.5 million), and building of all-new cleaning areas. Iberia Maintenance plans to ramp up Leap services once GTF capabilities are operational, performing smaller checks initially before moving into full overhauls for both engine families.

Despite the company's focus on new-generation engines, demand related to the narrowbody stalwarts is projected to continue throughout the decade. High worksopes are anticipated for CFM56 and V2500 engines, with inductions yet to peak for either family. However, given the uncertain and inflationary economic environment in Europe, Iberia Maintenance is exploring ways of reducing costs for these programs. Strategies include growing its stock of used serviceable material for both engine types. The primary focus is on investing in new part-repair capabilities for the narrowbody engines to target costs and turnaround times.

Merino said Iberia Maintenance likely will hire more staff gradually to service the ramp-up of engines. The company, which currently employs around 600 people in its engine division, plans to acquire skilled technicians through its collaborations with schools and partnerships in Madrid and to utilize its apprenticeship programs. Training takes about two years and involves some theoretical but mostly practical instruction, with trainee technicians learning to disassemble and reassemble a Rolls Trent 500 engine.

MRO demand patterns have shifted in the last year or so, but so has the way in which operators manage maintenance needs. David Alejandro Fernandez de Pedro, Iberia Maintenance's engine services transformation and support manager, sees a trend of airlines seeking more maintenance flexibility from MRO specialists than ever before for engine repair arrangements. The general preference is for fixed-cost arrangements over time-and-material ones, he says, partly because fixed-cost deals allow for better cost control. "Each engine operator will have a different strategy of when they will want to deliver it or how much they want to



**Iberia employs around 600 staff at its engine shop in Madrid.**

use it, and when factoring in particular worksopes, the operator wants to have budgeting costs under control," he said.

The economics driving maintenance costs are proving challenging across Europe, in part due to inflationary pressures. While inflation in Spain fell to 5.50% in December from the double digits of the previous summer, Merino pointed out the overall price escalation in the commercial aftermarket and cited price hikes by OEM vendors.

"Everything is increasing in price" she said, adding that while Spain remains less affected than other European countries in terms of energy supply, it remains vigilant about any further price escalations in 2023. "We are moving from one difficult situation with COVID to a second difficult situation with inflation escalations, gas and electricity increases," Merino added.

Initiatives such as installing solar panels on the roof of its Madrid engine shop have been rolled out to achieve more energy self-sufficiency. This approach extends to repairing engine parts, as Merino said the company strives to repair as many as it can rather than bringing in new components.

Other efficiency efforts include further digitalization, with a scheduled move across enterprise resource systems from a SAP system to a Ramco one. This will lead to a 100% paperless operation, with technicians equipped with tablets for accessing digital records. "We are trying to digitalize how

we work with customers because this ultimately saves time and any potential misinformation or miscommunication," Fernandez said.

One challenge over which Iberia Maintenance has less control is disruption of the global MRO supply chain, which has dogged the aftermarket recently and is expected to continue to do so in 2023. Merino pinpoints several causes of these disruptions, including the supply of new material, which has suffered partly due to a shortage of raw materials and a lack of capacity from manufacturers. "We are seeing the same with the repair vendors," Merino noted.

"The pandemic [has] had a very high impact on every company, and many of them have had to decrease their capacities to adapt," she said. "Increasing these capacities back is difficult for them."

Merino cited factors such as large numbers of people leaving the aerospace industry over the past three years, the length of time needed to train staff on technical repairs and even the way companies planned for the recovery, so repairs are taking longer than expected.

While the aftermarket supply chain is proving frustrating for Iberia Maintenance, Merino said the MRO provider it had planned for the eventual recovery, and so far it is fulfilling all its planned turnaround times. "That's why we are aiming to internalize all the repairs that we can," she said. ☛



# Living Large

Widebody operators are rethinking operational and replacement cycles for large engines

Alex Derber **London**

**L**ife-cycle cost management of widebody engines may have slipped down the list of priorities for many operators in recent years. Long-haul travel was the airline traffic segment hardest hit by the COVID-19 pandemic and has proven the slowest to recover amid different levels of travel restrictions around the world and the uncertain future for business travel.

However, with China lifting entry restrictions and popular tourist destinations reopening, capacity is coming back into the long-haul market, bringing a renewed focus on widebody engine costs as delayed maintenance work comes due and powerplants are returned from storage.

With this recovery, lessor Avolon sees a renewal in midlife widebodies—the segment in which values plummeted most dramatically early in the pandemic—as international markets reopen and new-build aircraft delivery delays persist. It predicts current-generation Airbus A330 lease rates will rise 35% this year. For the airlines operating them, this will require deliberation over

worksopes and other maintenance planning for workhorse engines such as the Rolls-Royce Trent 700, General Electric CF6-80 and Pratt & Whitney PW4000—some of which were earmarked for retirement two years ago.

Meanwhile, operators of new-generation powerplants such as the Rolls Trent XWB and 7000 and GE's GENx must plan for the life cycle of engines that have no successors in development, meaning reconsideration of the operational and replacement cycles of large engines.

Woven into these long-term strategies must be smart maintenance planning and parts provisioning, as engine support costs form the biggest element of any airline's maintenance expenses.

"Generally, the objective is to continuously keep the engine total life-cycle cost front and center and make choices that optimize both cost of ownership and airline value creation, rather than looking only at short-term maintenance costs," says Michael Grootenboer, senior vice president of engine products for AFI KLM E&M.



## UNIQUE REQUIREMENTS

Cost planning for widebody engines requires operators to consider factors that may not always apply to smaller engines. The most obvious is the prevalence of full-service maintenance contracts, which are signed with engine manufacturers on most new large engine sales.

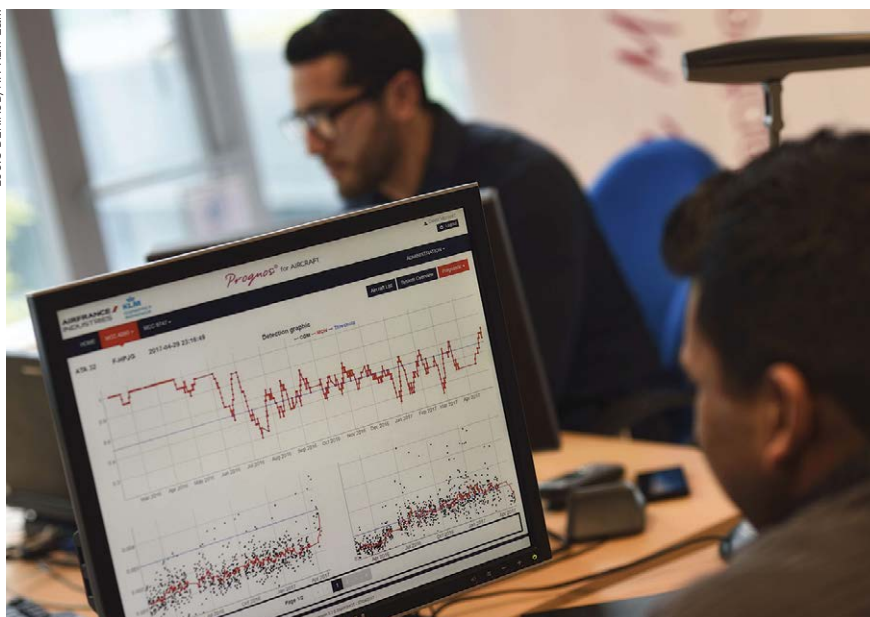
Charged on a dollar-per-flight-hour basis, these contracts vary in scope but aim to provide the same end result: predictable maintenance costs.

"Mainly, such contracts do cover the risk while providing predictable costs quite well," says Bernhard Scholz, Lufthansa Group's director of group engine management.

However, he adds that operators may face difficult decisions once the initial term of a full-service contract ends. "Depending on the MRO market diversity—which is zero for certain engine types—and on the engine maturity, getting a comprehensive MRO contract is challenging," Scholz says.

Even during the initial term, full-service contracts do not mean operators can leave responsibility for all cost planning at the door of the OEM or MRO provider. Operating patterns must be designed with maintenance in mind, and the use of expensive life-limited parts (LLP) must be monitored.

"No engine maintenance contract covers all risks and eventualities, and incremental coverage generally comes



Widebody engine predictive maintenance software is important to help avoid removals at airports distant from an airline's support infrastructure.

LOUIS DENAUD/AFI KLM E&M



LAURE LEMELLE/AFI KLM E&M

### Cost planning for newer engine types can be complicated by their lack of global fleet hours and reliability data.

at a premium,” Grootenboer says. “Even in the case of a comprehensive power-by-the-hour [flight-hour-based] type of agreement, time on wing continues to impact both the operational impact of engine removals and the timing of cash flows triggered by maintenance events in cases of restored rates. Use of cycles [the number of cycles used] on life-limited parts is generally also not covered in a power-by-the-hour contract.”

Widebody engine operators also must approach engine management differently than narrowbody operators, since their different operational profiles mean engine removals are more performance-driven than for narrowbody engines, which hinge more on life-limited part (LLP) limits.

“Generally, performance-driven removals are less predictable and therefore need a high expertise in the engine on-wing behavior as well as just-in-time logistics for spare engines,” Scholz notes.

One reason for this is the greater range of widebody aircraft and their engines, which makes for more complex logistics to ensure spare parts are accessible across different continents and at distant airports. This must include better predictive maintenance

to minimize component failures when the engine is outside an airline’s core maintenance support network.

Grootenboer agrees that widebody engine removals depend more on performance than on LLP limits. “Therefore, engine predictive maintenance has a greater impact on widebody life-cycle cost management than for narrowbody engines,” he says.

Accordingly, it makes sense to use life-cycle management tools that interact with predictive maintenance technology to ensure optimized operating and replacement cycles. Grootenboer says AFI KLM E&M’s Prognos predictive maintenance

system is the airline’s first line of defense against “unpredicted maintenance over-costs and airline operational burdens.”

However, it is easier to apply a data-driven approach to maintenance planning for older-generation engines than for newer ones, which do not have a long service history. This makes life-cycle management more difficult, as not enough hours have been accumulated on an engine type to predict points of failure in the future.

Nonetheless, experience with older engine types can inform life-cycle management for newer ones, Grootenboer says. “While new engine platforms may have limited maintenance data available, their technology generally builds on that of previous engine models,” he says. Grootenboer gives the example of the CFM Leap narrowbody engine inheriting technologies from the GENx widebody powerplant. “With Air France KLM’s extensive technical and operational experience in the maintenance and operation of a wide range of engine types, it is possible to extrapolate likely operational and maintenance behavior for new engines,” he says.

It also is vital to maintain a close relationship and ongoing dialog with engine OEMs to understand issues occurring elsewhere in the global engine fleet and keep abreast of their latest forecasts for wear and other potential issues.

Scholz notes that “design maturity is a key factor,” as is “how well an engine OEM is coming up with improved solutions or in-service support to cover operational and financial disadvantages.”

He also sees that airlines are increasingly opting for maintenance-cost guarantees with OEMs when ordering new engines.

### MAINTENANCE AND PARTS

“If an engine requires off-wing maintenance, the next step is smart workscope planning to ensure the optimal maintenance event of that individual engine is performed effectively and efficiently,” Grootenboer says.

The next step is provisioning the right material—a key consideration, given the ever-increasing price of parts. “On certain engines, we see that material costs since 2013 have almost doubled,” Scholz observes.

Raw material and energy-price inflation have fed into steep price increases for new engine parts, which means airlines and MRO providers should pursue alternatives to keep life-cycle costs down.

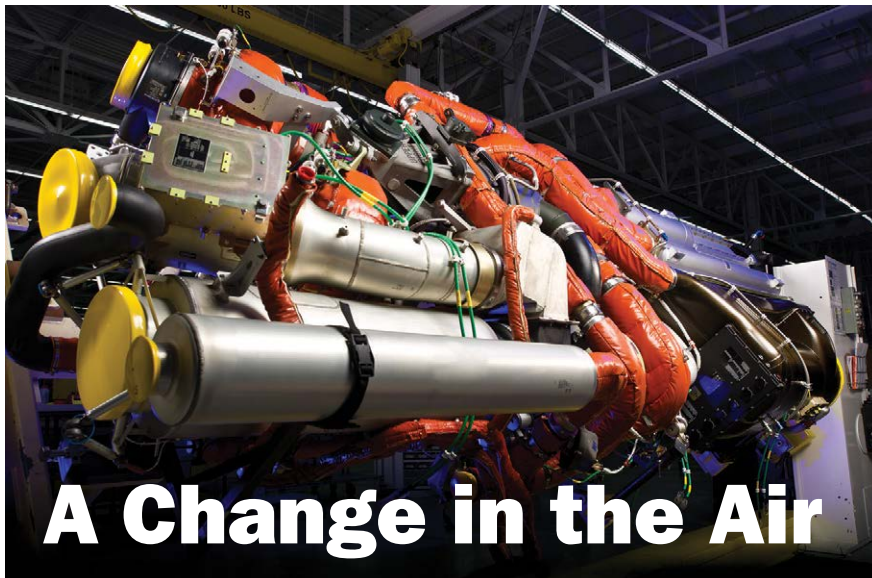
“To minimize the impact of new part purchases on the engine cost of ownership, AFI KLM E&M has a wide range of engine parts repair capabilities, to which we add continuously,” Grootenboer says. “Next, if parts are deemed unrepairable, we replace them where possible with used serviceable material.”

After a few quiet years for the used material market, due to the sharp decline in maintenance activity, supply is set to increase as more aircraft and engines are retired.

Avolon points out that retirements have remained “artificially low,” at about 300 annually since the beginning of the pandemic, versus 600 before it started. The lessor attributes this to booming cargo demand, a depressed used serviceable material market and an ongoing labor squeeze.

Avolon sees retirements accelerating this year as airlines and MRO providers race to restock parts inventories—pushing up demand for teardowns—and the fleet of old, stored aircraft is given its marching orders. The lessor estimates that 1,200 more aircraft older than 20 years are in storage now than before the pandemic. 🌐





# A Change in the Air

## Cabin air conditioning becomes greener, healthier and more reliable

**Paul Seidenman and David Spanovich San Francisco**

**A** new generation of cabin air conditioning systems is emerging, prompted by a focus on reliability, air quality and sustainability.

In the commercial jet world, air-cycle air conditioning systems are the standard. They depend on engine bleed air that is pumped into the cabin, once it has circulated through a highly complex system of components. The exception is the system on the Boeing 787, in which outside air is routed directly to cabin air compressors for pressurization, eliminating the use of engine bleed air.

Generally, the lowest-reliability components within air conditioning systems have a complex set of moving parts such as air-cycle machines, valves and actuators. At the same time, engine bleed air pre-coolers often have low reliability due to the extremely harsh conditions under which they function, explains David Yokota, senior director for air management systems at Honeywell Aerospace. He cites environmental contamination, wear and vibration as the primary causes of these component failures.

"Many mitigation strategies are employed to maximize on-wing reliability with zero maintenance, including filtration of contamination, material selections that minimize wear and specialty coatings to protect surfaces," Yokota

says. One example he cites is Honeywell's proprietary fifth-generation air bearings used within the OEM's latest air-cycle machines (ACM). "They provide unmatched wear-protection capability to extend ACM life while achieving high-temperature capability and high bearing load capacity," he notes.

Engine pre-coolers also are failure-prone due to the high temperature of the unconditioned engine bleed air and the vibration levels in the engine pylon, Yokota says. "As engine designs continue to evolve to higher pressure ratios, these interface conditions continue to increase," he says.

In fact, Yokota says Honeywell sees bleed-air-driven air conditioning systems diminishing over time. As engine bypass ratios increase, he says, so will the energy penalty. "Eliminating the bleed air system will not only save energy, but will also simplify the engine nacelle and wing designs by eliminating bleed ducting and over-heat-detection systems," he says. "This also opens the door to alternate forms of cooling such as vapor-cycle systems (VCS), which offer a significant power savings over bleed-driven air conditioning systems but require robust designs to prevent refrigerant leakage."

Honeywell is "investing to expand its VCS product line" to include prod-

ucts that cover the 50-80-kW cooling range, Yokota says, using the latest oil-free centrifugal compressors, environmentally friendly refrigerants and advanced electric power technologies.

**Collins Aerospace's environmental control system for the Boeing 787 draws fresh air directly into the cabin, eliminating engine bleed air.**

He says Honeywell is leading a work package with industry partners under the EU's Clean Aviation Joint Undertaking as well, focusing on thermal management technologies to enable highly efficient commercial aircraft designs. "One particular area of interest will be on more electric architectures, which will greatly reduce or eliminate engine bleed air consumption," Yokota explains.

Paul D'Orlando, director of business development for environmental and airframe control systems at Collins Aerospace, confirms that cabin air conditioning will be increasingly electric. Collins is the supplier of the 787's environmental control system (ECS), which D'Orlando stresses is still the only 100% fresh air ECS for a large commercial aircraft application.

"By replacing the traditional pneumatic engine-bleed-air control system with electric motor-driven compressors, the advantages for fuel efficiency are significant," he explains. "The ECS is the largest energy user on the aircraft besides propulsion. More than 3% of fuel burn on any given flight is used for air conditioning and cabin pressurization alone, so any reduction in bleed air consumption for the ECS can have a meaningful impact on fuel usage and, in turn, carbon emissions."

D'Orlando says Collins also continues working to reduce weight, complexity and parts counts. For example, he says the OEM has systems in service that incorporate composite parts. "Also, various assemblies have been integrated to reduce parts count," he says. "In addition, we are actively developing additively manufactured parts for future systems, which will open a range of benefits including reduced weight, parts count and improved thermal performance."

He notes that the company continues to develop new power and thermal management solutions for future

aircraft as well for upgrades to the current fleet. “By designing air management systems that are more efficient and use less engine bleed air, we can help improve engine performance and optimize fuel burn,” D’Orlando says.

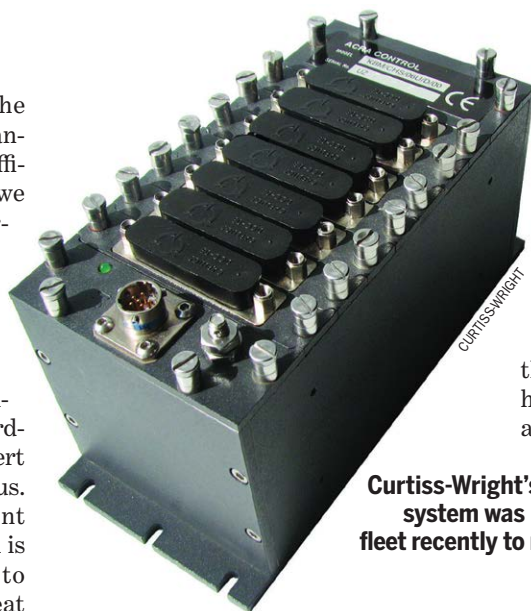
Typical design changes to cabin air conditioning systems focus on the positioning of control valves for temperature and flow control on the air-cycle machines, according to Holger Bammann, senior expert for air systems architecture at Airbus.

“Additional design enhancement targets fuel-saving potential, which is realized by smart control logics to minimize ram air drag for ECS heat exchangers and an optimized air supply just tailored for the amount of passengers actually in the cabin,” he says. “More disruptive technologies and designs are actually the subject of research and technology programs. However, these technologies are not yet available on Airbus aircraft.”

Asked about weight-reduction efforts, Bammann says they can be achieved by applying new materials and often by structural optimization—meaning better material distribution to where they are needed from a strength point of view. “Additionally lightweight materials (glass-fiber, carbon-fiber) are applied to minimize duct weight. For example, the A330neo uses thermoplastic ducts and particle-foam air outlets,” he explains.

While the OEMs continue to advance the engineering of cabin air conditioning, its system failure was high on the list of factors causing flight delays and cancellations at one airline, reports Patrick Quinn, product line manager for data acquisition products at Curtiss-Wright. To remedy that, the OEM installed its KAM-500 on more than 200 Boeing 737NGs flown by what he identified as “a major U.S. carrier.” He says this represented the first time the KAM-500 had an aircraft air conditioning system application.

The KAM-500 is a hardware product developed for flight-test data acquisition by ACRA Control, owned by Curtiss-Wright since 2011. The KAM-500 works in tandem with Das Studio, software proprietary to Curtiss-Wright. Specifically, the data acquisition comes from a mix of pressure and



**Curtiss-Wright's KAM-500 modular data acquisition system was installed on an airline's Boeing 737NG fleet recently to reduce flight delays and cancellations due to cabin air conditioning failures.**

temperature sensors strategically located throughout the aircraft that gather and interpret data regarding the air conditioning system maintenance status. Data is transmitted in real time over ARINC-429, using the Aircraft Communications, Addressing and Reporting System system resident on the aircraft.

“It was an off-shelf, predictive maintenance quick solution to what this airline wanted,” Quinn notes. “With KAM-500, the airline was receiving data they had not gotten before. As a result, air conditioning failures became one of the least problematic areas.”

With growing concerns about cabin air quality—recently due to the COVID-19 pandemic—airlines are showing more interest in assuring a pathogen-free cabin environment. For instance, Aviation Clean Air's (ACA) airborne air purification system is being adopted on a commercial airliner, according to Jonathan Saltman, a partner in the California-based company.

The ACA system incorporates a bipolar ionization component, which generates positive and negative ions using the aircraft's existing air, Saltman explains. The ions will be transferred via the airflow generated by the aircraft air distribution system to the cabin to neutralize and decontaminate cabin air and interior surfaces continuously.

Saltman says the ACA system is now offered by all business jet OEMs as either a standard installation or an option. Installation is accomplished under a supplemental type certificate (STC)—of which there are now more

than 60—available from ACA, aircraft OEMs and some MROs. In addition, installations or a retrofit of an entire aircraft family are permitted under an Approved Model List, which can be included in the body of an STC or as a separate document.

Last year, ACA added an STC for the Leonardo AW139—the first for a helicopter application. Saltman says an STC for the Sikorsky S-76 is ex-

pected this year. A ground-based version is also available.

“ACA is currently working with several airlines for fleet-wide installation of our airborne air purification system,” Saltman says, adding that “an announcement is forthcoming.”

In 2022, ACA rolled out what Saltman terms “lower-profile” equipment for the air purification product to enable easier installation on air conditioning systems with smaller ducting and reduced clearance, typically found on light jets and turboprops.

“Ongoing laboratory testing has continued to show the effectiveness of the system for all pathogens beyond COVID, including bacteria and viruses, as well as volatile organic compounds and mold spores,” Saltman says.

Mathieu St-Cyr, manager of sales engineering at Bombardier, reports that the OEM introduced Pur Air, a sophisticated air purification and circulation system, on its Global business jets to provide a clean cabin environment while optimizing engine bleed air extraction. He says Bombardier recently enhanced the Pur Air system on the Global 7500 and upcoming Global 8000 to filter out volatile organic compounds.

Honeywell's Yokota notes that the company is developing sensing technology to detect and isolate the sources of bleed air contamination. “Once the technology is mature and can be deployed, these sensor readings, combined with other air conditioning and aircraft parameters, can effectively identify the presence of bleed contamination and direct maintainers to potential sources of the contaminants,” he says. ☼



# Tearing It Up

Teardown and recycling specialists are adding new facilities, capabilities and projects

**Lindsay Bjerregaard** Chicago

## 1. Airframe Dismantling Services

**Company:** AerCap Materials

**Product:** AerCap broke into the teardown business in late 2021 by acquiring GE Capital Aviation Services, which included a parts business active in aircraft teardowns and part-outs. The new subsidiary, AerCap Materials, provides airframe dismantling services for a wide range of commercial and business aircraft. It dismantles aircraft from its facility at Greenwood-Leflore County Airport in Mississippi and recently opened a new distribution center in Memphis, Tennessee. AerCap Materials has dismantled more than 300 aircraft and stocks more than 15,000 unique parts. [marketplace.aviationweek.com/company/aercap-materials](https://marketplace.aviationweek.com/company/aercap-materials)



AERCAP MATERIALS

## 2. Upcycling Aircraft

**Company:** Ecube

**Product:** Ecube provides aircraft disassembly, demolition and recycling services in Castellon, Spain, and at its base in St. Athan, Wales. It opened its first U.S. teardown facility in October 2022 at Coolidge Municipal Airport, about midway between Phoenix and Tucson, Arizona. Ecube says the expansion to the U.S. enables it to cover almost 90% of the global aircraft market.



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JET AIRCRAFT SERVICES

In 2022, Ecube appointed a new CEO and a new vice president of sustainability and business development. As part of its sustainability commitment, it offers parted-out aircraft sections and components for upcycling in such areas as training, education and entertainment. [marketplace.aviationweek.com/company/ecube](https://marketplace.aviationweek.com/company/ecube)

## 3. Growing Engine Disassembly

**Company:** EirTrade Aviation

**Product:** EirTrade Aviation offers aircraft disassembly and recycling services for all commercial widebody, narrowbody, regional and private aircraft types from its teardown facility at Ireland West Airport. It added capability at its Dublin headquarters for on-site engine disassembly last year. While the facility focuses on CFM International engines, EirTrade is looking to expand capabilities to cover other engine platforms. EirTrade also offers a suite of integrated services, including maintenance, parking and storage and parts trading, which it says helps to maximize asset value for customers. [marketplace.aviationweek.com/company/eirtrade](https://marketplace.aviationweek.com/company/eirtrade)

## 4. Spanish Teardown Specialist

**Company:** Jet Aircraft Services

**Product:** Jet Aircraft Services (JAS) is an independent MRO with a teardown center at Ciudad Real Airport, near Madrid, which it says is a convenient hub for Europe and Africa. The company also offers aircraft storage and MRO services so aircraft can be maintained before disassembly. JAS has recycled more than 100 aircraft over the past five years, specializing in Airbus A330s and A340s, Boeing 737s and 757s and MD-80s. It tore down its first Boeing 777 in late 2022, just dismantled its 15th

A340 and recently started a program to dismantle three Boeing 717s. JAS will soon begin a new program to tear down eight A330s for full recycling.

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company/jet-aircraft-services](https://marketplace.aviationweek.com/company/jet-aircraft-services)

#### 5. Trent 700 Expertise

**Company:** Orange Aero

**Product:** Based in England, Orange Aero is a supplier of high-usage gas turbine engine components that also processes end-of-life aircraft engines to extract maximum value. Orange Aero focuses on dismantling Rolls-Royce engines, specializing in the Trent 700. It says this engine type is typically dominated by OEM support, so



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#### 6. Airbus Recycling Pro

**Company:** Vallair

**Product:** As a founding member of the Aircraft Fleet Recycling Association, Vallair specializes in teardown and recycling services for Airbus A320, A321 and A330-300 aircraft. It provides tear-downs from its main facility in Chateau-roux and its narrowbody facility in Montpellier, France. Vallair says it offers a "one-stop shop" service for tear-downs that includes repair capabilities, logistics, procurement and sales. It is currently tearing down two A320s formerly operated by Red Wings Airlines and is scheduled to tear down another two A320-family aircraft as well as two A330-300s this year.

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*Josh Abelson, founder of Aviation Business Strategies, provides fractional leadership and strategic advisory services.*

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# Fractional Approach

The answer to some aftermarket businesses' labor challenges could be fractional executives

**A** great deal has been written about labor challenges in aviation—much of it rightfully about pilots and mechanics—but another area, while less visible, is equally important to keeping the industry running.

Small-to-midsize businesses (SMB) are the heart and soul of the aviation aftermarket. They provide vital products and services that might otherwise fall through the cracks of a larger industry that counts safety and on-time performance as two of its most important benchmarks.

Building a small business may look easy, but it is far from it. It usually takes everything the business owner has and then some. So, when the SMB owner/leader runs into a problem or needs help solving major issues, or when they need to add skills to their team in finance, IT, sales, operations, engineering or human resources without breaking the bank, where do they turn?

Small businesses often do not have a team of industry veterans on which to lean. It can be especially “lonely at the top” for small business owners.

Enter the fractional executive. The aviation community is aware of the

term “fractional” as it relates to aircraft: You pay only for the flight hours you use, which provides tremendous flexibility at a fraction of the cost

**Fractional executives can lead or advise teams as well as lend their hands-on experience and network.**

of an entire aircraft. Now the term is being applied to staff, too. A fractional executive offers companies of any size a highly experienced resource at a fraction of what a full-time staff member would cost.

Unlike traditional consulting engagements, which typically focus

on a specific problem, timeline and fee, the fractional executive becomes part of the leadership team. They accept ownership and accountability for their deliverables. Fractional executives can lead or advise teams as well as lend their hands-on experience and network to the business owner.

An SMB owner recently described to me his rapidly expanding business as being in chaos. He wanted to move toward controlled growth. Everyone on his team was already doing all they could day in and day out. He needed someone with a strategic approach and no emotional attachment to dissect the business and make recommendations about where to focus resources and prioritize.

Finding someone whom the company could afford, who truly understood his lines of business and could be hands-on as needed, was a challenge. He was thrilled to learn of the fractional executive concept, which would allow him to have an experienced leader advising him and participating in the work at a price the business could afford.

Another business owner had a hiring problem. The company had tried various approaches with hit-or-miss success but needed a sustained campaign. The human resources team was appropriately sized to manage the day-to-day, including onboarding. However, it did not have experience recruiting in the new and highly competitive market. The team was not familiar with tools used by larger companies to engage with colleges/universities and transition members of the military. Instead of adding another full-time position, the company hired a fractional executive with the skills to do the job on a part-time basis.

Those are just a couple of the many scenarios in which a fractional executive can add tremendous value to an SMB owner.

This is an exciting new trend, and while it can be particularly appealing for SMB owners, many larger companies are taking advantage of it as well. ☺



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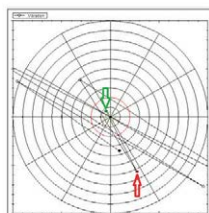
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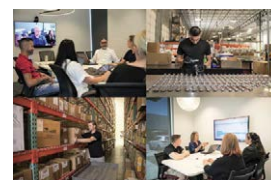
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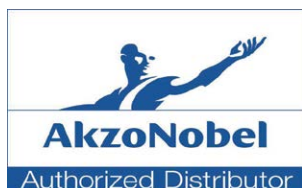
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# Will Japan Second-Guess the P-1 Maritime Patrol Aircraft?

> THE F-35 PER-UNIT PRICE DROPPED 37% FROM 2016 TO 2021

> JAPAN'S COAST GUARD IS OPERATING THE MQ-9B SEAGUARDIAN

## Asia-Pacific Staff

**T**he Kawasaki Heavy Industries P-1, one of the only two jet-powered maritime patrol aircraft in production globally, faces an uncertain future after the publication of Japan's Defense Buildup Program in December.

Extraordinary cost growth appears to be a factor that is putting Kawasaki Heavy Industries production at risk.

Hinting that the platform's acquisition will be cut, the defense document states: "For the Maritime Self-Defense Force, the number of fixed-wing patrol aircraft (P-1) acquisitions will be reviewed in conjunction with acquisition of a long-endurance uncrewed aircraft to enhance offshore surveillance capabilities over a wide area."

Meanwhile, the Japan Coast Guard has begun using the General Atomics Aeronautical Systems Inc. MQ-9B SeaGuardian, a possible partial replacement for the P-1. No development program for an indigenous uncrewed aircraft for maritime patrol is known.

At the end of last March, the naval force had 33 P-1s and 40 Lockheed P-3C Orions, which newer P-1s are set to replace. Since at least 2008, the intended total P-1 production has been 70 aircraft.

According to the Defense Buildup Program, Japan plans to buy 19 of the aircraft in 2023-27, suggesting that the assured total quantity is 52. More could be built in the following five-year planning period but not if the review of maritime patrol aircraft concludes otherwise.

Notably, this prospective cut is not a result of budget tightness: Japan intends to double its defense spending as a percentage of GDP by 2027.

Instead, the defense ministry and perhaps the navy have evidently decided that the P-1 offers poor value for the money. One reason must be cost overruns. According to an April 2022 finance ministry document, the acquisition cost for a P-1 was ¥19.1 billion (\$147 million at the current rate) in 2016 but then rose annually, reaching ¥22.6 billion in 2021, an increase of

18% from the 2016 figure, even though Japan's low-inflation economy experienced only a 2% rise in consumer prices during that time.

The finance ministry contrasted this with Japan's experience in buying Lockheed Martin F-35 Lightnings, the unit cost of which fell 37% in the same period.

The defense ministry's assessment of the program-wide P-1 life-cycle cost, published in 2021, is even more alarming. In 2008, the ministry estimated the figure at ¥2.29 trillion, covering devel-

Although the P-1 is often called an all-Japanese aircraft, using locally developed IHI Corp. F7-10 engines, imported components and parts comprise at least 40% of its cost. On average, they are about 50% more expensive than estimated in 2008, partly due to the weakness of the yen. The cost of Japanese parts has risen about 10%, according to a 2021 finance ministry analysis.

Another problem is that since the first P-1 delivery in 2013, some parts suppliers have discontinued production, particularly of electrical and electronic items. To cope with production discontinuations, the defense ministry secured ¥33.4 billion in 2021 for changes in design and for tooling.

Meanwhile, the navy is getting a close look at MQ-9s. Eight U.S. Air Force MQ-9A Reapers began operating from the navy's Kanoya air base in October. In the same month, the Japan Coast Guard began operating an



Japan plans to buy 19 Kawasaki Heavy Industries P-1 maritime patrol aircraft in 2023-27.

JAPANESE DEFENSE MINISTRY

opment, acquisition and operation of 70 aircraft. In its latest life-cycle cost estimates, made in 2021, the figure had jumped by 68% to ¥3.84 trillion.

The latest estimates assumed that each aircraft would be used for 23 years instead of 20, but the cost of operation, ¥1.97 trillion, was 81% higher than assessed in 2008. The cost of acquisition for 70 P-1s increased 74% to ¥1.56 trillion. The estimate for development was little changed at ¥310 billion.

The defense ministry says the aircraft are costing more because the latest units are more capable and reliable and also because greater quantities of spare parts must be bought at higher prices than originally expected.

MQ-9B SeaGuardian from the navy's Hachinohe air base facing the northern Pacific.

General Atomics says the MQ-9B burns 90% less fuel and requires 50% fewer people to operate than similarly configured crewed maritime patrol aircraft. In a U.S. Navy exercise in April 2021, an MQ-9A achieved the first high-altitude sonobuoy drop from an uncrewed aircraft. The company says the MQ-9 proved "its ability to detect, identify and track subsurface targets" during the exercise.

The defense ministry has not said when it expects to decide whether to change the maritime patrol acquisition program. ☐



# U.S. Air Force Tests New Tech To Thwart Drones in the Middle East

➤ NEW UNIT LOOKS TO UAS FOR AIR AWARENESS

➤ COUNTERMORTAR SYSTEMS AND RADARS TWEAKED FOR NEW ROLES

**Brian Everstine** Washington

**A**s three Iranian-made kamikaze drones attacked a U.S. and Syrian Democratic Forces outpost in Syria on Jan. 20, American troops launched three counter-drone systems that had been rushed to their base in the months before the attack, and they were able to use them to down two of the three Shaheds.

U.S. Central Command (Centcom), in explaining the incident, called the attacks unacceptable after they injured two partner troops. Centcom officials say forces in the region face these threats daily as drones from small quadcopters to much larger Shaheds have rapidly proliferated. To address this threat, the command is looking to industry for more new counter-UAS systems and new ways to integrate sensors from high-end integrated air and missile defense systems down to local commercial off-the-shelf drones.

“We have a lot of [integrated missile defense] capability in-theater, but the adversary is advancing very quickly, and we need to keep up through innovation,” says U.S. Air Force Lt. Gen. Gregory Guillot, Centcom’s deputy commander.

U.S. and partner forces in the region are taking multiple steps to improve their counter-UAS capabilities while also modernizing broader air defenses, using approaches more similar to tech startups than traditional military acquisition to speed up the process. U.S. Air Forces Central in October 2022 stood up a new unit focused on UAS, called Task Force 99, tasked with using commercial off-the-shelf drones to focus on three areas: imposing dilemmas on adversaries, improving air domain awareness and finding hard targets to speed up the targeting cycle, the unit’s commander, Lt. Col. Erin Brilla, says.

The task force follows the U.S. Navy’s similar unit, Task Force 59, which uses uncrewed ships and aircraft to increase maritime surveillance. Along the same lines, the U.S. Army established Task Force 39 to focus on ground surveillance. Brilla says the goal is to combine the three services for complete, 360-deg. awareness. The Air Force unit also has agreements with three undisclosed nations in the area to collaborate on UAS development.

In February, Air Forces Central plans to host industry officials for an innovation day specifically focused on air domain awareness (ADA) in the Middle East. The current ADA and counter-UAS mission relies on disparate systems that are not combined into one command-and-control system, which greatly limits its speed and effectiveness.

**U.S. forces are under increasing threat from Iranian kamikaze drones, such as this one displayed in 2017.**



JIM WATSON/AFP/GETTY IMAGES

“[Air Forces Central] requires an integrated, consolidated air picture which feeds a single application and is shareable among U.S. entities, allies and partners,” the command says.

In October, Centcom announced that it is creating a regional test facility in Saudi Arabia focused on countering new Iranian drone and missile threats. Modeled after the White Sands Missile Range in New Mexico, the new Red Sands Integrated Experimentation Center will test electronic warfare approaches such as directed energy, jamming and high-powered microwaves.

As these technologies mature, Centcom is considering other ways to adjust currently deployed weapons and sensors to improve their use against UAS. For example, the widely used Counter-Rocket, Artillery, Mortar (C-RAM) gun used to protect bases has been repurposed to serve a “valid role” against drones, Guillot says. Other radars are being tuned to track slower, smaller aircraft.

“You can’t look at this as a counter-UAS fight and as an integrated air missile defense fight. You’ve got to look at it holistically as an integrated air and missile defense fight,” says Army Maj. Gen. Sean Gainey, director of the Joint Counter-Small UAS Office. “So these [are] systems that may not have been put into theater to get after the counter-UAS fight we’re looking at.

“The way they’re doing it is with the integration in the layer approach, leveraging everything within a joint fight—whether it’s defensive counter-air capability, like . . . some of our air defense systems that were traditionally used for cruise missiles or aircraft or helicopters—putting these into the fight and then developing a set of counter-UAS capability,” Gainey adds.

Similar to fighter jet exercises in the U.S., Centcom has deployed “aggressors” to operate UAS and try to infiltrate U.S. bases to test their defenses, Guillot says. The red-air UAS are used to see if sensing layers, from fighter aircraft in the sky to radars on the base, can detect them and at times use live-fire weapons to “kill these drones to make sure that we don’t have any vulnerabilities,” he says.

While strong sensors already protect these bases, Guillot says he needs more to detect threats from farther away, allowing more time to find the right asset to shoot them down—such as the Raytheon-developed Coyote counter-UAS system that was used in the Jan. 20 incident—“so we’re not sending an F-16 to shoot down something that a Coyote could.” 🇺🇸



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# SpaceX Is Pressing for Starship Orbital Flight Test in March

> STARSHIP IS PART OF NASA'S ARTEMIS PROGRAM

> COMPANY'S FAA LAUNCH LICENSING IS PENDING

Irene Klotz Washington

**W**hen NASA's Space Launch System rocket lifted off for the Artemis program's first mission to the Moon, it became the most powerful booster to fly successfully. But that milestone, set less than three months ago, is about to be eclipsed.

SpaceX is nearing the debut launch of its Starship/Super Heavy space transportation system, a multipurpose vehicle intended to make interplanetary travel routine and affordable.

**A Starship upper stage and Super Heavy booster, standing nearly 400 ft. tall, were loaded with more than 10 million lb. of propellants for a Jan. 23 wet dress rehearsal for launch.**



SPACEX

The company plans to continue to operate its fleet of Falcon 9 and Falcon Heavy rockets for as long as its customers want. SpaceX in January marked the 200th Falcon flight since the booster's inaugural launch in June 2010, with a 99% mission success rate. It took SpaceX more than a decade to reach its first 100 launches. The next 100 flights took a little more than two years.

Along with continually refining the Falcon production, launch, recovery and refurbishment processes, SpaceX has been developing the fully reusable superheavy-lift Starship system. With 33 liquid-oxygen- and methane-fueled Raptor engines, the Starship's Super Heavy first stage is designed to generate nearly 15 million lb. of thrust at liftoff—roughly 86% more thrust than the 8.8 million lb. generated by the Space Launch System (SLS).

Following a tanking test of the Starship/Super Heavy launch system on Jan. 23 and pending a successful static

engine firing, SpaceX is targeting the first orbital flight test of its new vehicle for March. "This first one is really a test flight," SpaceX President Gwynne Shotwell says. "We can't separate the ship from the booster until we lift off. So this is truly a flight test. And the real goal is to not blow up the launchpad. That is success."

Both the booster stage and the orbital Starship are due to terminate their flights in water landings, a SpaceX 2021 filing application with the Federal Communications Commission (FCC) shows. The 230-ft.-tall Super Heavy is planned to perform a "partial" return after launch from SpaceX's Boca Chica, Texas, facility, landing approximately 20 mi. offshore in the Gulf of Mexico 8.25 min. after liftoff.

Meanwhile, the 164-ft.-tall, 30-ft.-dia. Starship upper stage is set to head into orbit on a trajectory that overflies the tip of Florida and the north coast of Cuba. The vehicle would then continue downrange until reaching the Pacific where, 1.5 hr. after launch, it would perform a powered descent and "soft ocean landing" at a location around 62 mi. off the northwest coast of the Hawaiian island of Kauai.

SpaceX "intends to collect as much data as possible during flight to quantify entry dynamics and better understand what the vehicle experiences in a flight regime that is extremely difficult to accurately predict or replicate computationally," it states in the FCC filing. "This data will anchor any changes in vehicle design or concept of operations after the first flight and build better models for us to use in our internal simulations."

The complete Starship/Super Heavy system, which is fully reusable, would be able to deliver about 220,000 lb. of payload into low-Earth orbit, more than twice the lift capacity of SpaceX's Falcon Heavy, SpaceX estimates. The Starship upper stage also could fly separately as a suborbital point-to-point transport. The system was selected by NASA in April 2021 to land astronauts on the Moon as part of the Artemis program under contracts worth more than \$4 billion.

While a Starship spacecraft has yet to reach orbit, SpaceX conducted five high-altitude flight tests with upper-stage prototypes between December 2020 and May 2021. The last vehicle, the full-size Starship SN15, landed after reaching an altitude of 6.2 mi.

SpaceX then turned its attention to developing the Super Heavy first stage. The company conducted a six-engine static fire on Sept. 8, a seven-engine static fire on Sept. 19, a 14-engine static fire on Nov. 14 and an 11-engine long-duration static fire on Nov. 29.

The Starship spacecraft Ship 24 and the Super Heavy Booster 7 were stacked for the first time in June. SpaceX completed a full wet dress rehearsal of the vehicle on Jan. 23, fueling Ship 24 and Booster 7 with more than 10 million lb. of liquid oxygen and liquid methane. A static fire of Super Heavy's 33 Raptor engines was expected on Feb. 9.

Also pending is authorization from the FAA's Office of Commercial Space Transportation for SpaceX to launch Starship into orbit. The company is required to implement more than 75 environmental mitigations to fly from Boca Chica.

"Some measures must be completed prior to launch, while others are designed to occur during post-launch activities or following a mishap event," the FAA writes in an email to Aviation Week.

"The FAA will make a license determination only after the agency is satisfied SpaceX meets all licensing, safety and other regulatory requirements," the agency writes. 🚀





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# Ariane 6, Vega Woes Drive European Launch Crisis

> CNES OFFICIALS RECOMMEND SPACE INDUSTRY REORGANIZATION

> ARIANE 6 TESTING IS WELL UNDERWAY

Thierry Dubois Paris

Europe learned about sovereign access to space the hard way. In 1974, the Symphonie-A telecommunications satellite, a Franco-German design, was placed into orbit by a U.S. launcher. The good news was the agreement with NASA; the not-so-good news was that it followed the failure of a program to build a European launcher for the same purpose, and the bad news was that the U.S. State Department prevented any commercial use of the Symphonie satellites.

At least there was a silver lining. The shock treatment triggered the development of the Ariane family of launchers, which have met Europe's needs, with assistance from the Vega since 2012.

In adapting their portfolio of launch services, European Space Agency (ESA) member states have closely followed market trends, which led to the start of the Ariane 6 and Vega C in 2014. Given Europe's track record and undisputed skills, the industry seemed to be on the right path.

Fast-forward to December 2022. Three unrelated sequences of events converged to send Europe's space launch activities into crisis mode: Ariane 6 development was slowed by the COVID-19 pandemic and a series of technical issues, leading to a three-year delay; the Vega and upgraded Vega C have undergone three failures since 2019 and have yet to return to flight; and launch provider Arianespace's cooperation agreement for the medium-lift Soyuz was terminated due to Russia's invasion of Ukraine.

After the last Ariane 5 launch in the middle of this year, Europe will no longer have guaranteed access to space. That will last for at least 2-3 years, until the Ariane 6 and Vega C cadences have ramped up.

The Ariane 6's woes are the most prominent. While testing is progressing, technical difficulties and strengthening competition are forcing a reorganization earlier than expected. European players agree that they have to reconsider their roles.

At the forefront of the discussions will be prime contractors ArianeGroup and Avio, launch provider Arianespace and ESA. The European Commission and national space agencies, such as France's CNES, are expected to have their say, too.

CNES Chairman and CEO Philippe Baptiste says the industry should reorganize in a more straightforward way,

especially by reconsidering the geographical-return rule. "The complexity in the current system is diluting responsibilities and preventing us from moving as fast as we could," he said Jan. 17 during the agency's annual press conference in Paris.

ESA's geo-return rule is also known as the rule for "fair geographical return" or "global balance." When a partner country's industry receives a work share, it should be proportional to that country's investment in the program, the rule implies. It has become controversial over the years, however, and Baptiste asserts that it is no longer adequate. He is concerned the arrangement is hindering efforts to operate a competitive launcher, although he admits that it has helped new players emerge.

"Arianespace's position [on the market of launch services] is being questioned," Baptiste added. "Several models are on the table that matter [and have] to be studied this year. It was one of the points at issue in the [recent] agreement between France, Germany and Italy."

Last November, Europe's three leading countries in space launchers issued a joint statement that set the stage

for further cooperation on the Ariane, Vega and micro-/mini-launcher programs in the usual ESA framework.

ESA Director General Josef Aschbacher is taking a nuanced stance. "It is clear we have to think about our future," he said Jan. 23 during ESA's annual press conference in Paris. "Our institutions will need some changes. . . . [However,] some say geo-return is the key to solving everything. We will address it, but it is not the reason for delays on Ariane 6."

Aschbacher sees the problem as technical and something that should be handled at the launcher and ground-segment development level as

well as the ESA level. Geo-return may interfere with the launcher's competitiveness, he said.

ESA should change its approach, focusing on major building blocks and acting as a customer, Aschbacher added. That may give industry a stronger role. "We have not gone the full way to giving industry the responsibility of leading the development," he said.

Meanwhile, despite technical glitches, the Ariane 6's final test campaign is well underway, ESA officials say. At Europe's spaceport in Kourou, French Guiana, a ground-test article of the launcher in its two-booster, medium-lift version is being linked to the ground infrastructure. Combined tests have started with electrical connections. In March, fluidic connections will follow. A first firing of the Vulcain 2.1 main engine is planned for May, before a longer one—to last 500 sec.—is slated for early June. An issue with the optopyro system, used in the stage-separation process, has yet to be solved, though.

Hot-firing tests of the full upper stage in nominal conditions were completed at the German aerospace center DLR's test center in Lampoldshausen, Germany. 🌐



After a successful inaugural launch, the upgraded Vega C failed during its first commercial flight.

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AVOLON

# 'We Believe in the Aircraft'

**Andy Cronin**, 43, took over as CEO of aircraft lessor Avolon last October from predecessor Domhnal Slattery after having been the company's chief financial officer since its founding in 2010. Avolon has risen quickly to the top of the leasing industry through acquisitions and direct orders. The company is now the second-largest lessor behind AerCap and an important voice in the industry. Cronin sat down in his Dublin office with Aviation Week Executive Editor for Commercial **Jens Flottau**.

**AW&ST: Airlines and lessors are complaining loudly about substantial delivery delays at both Airbus and Boeing. How exposed is Avolon?** Our delivery profile from OEMs is relatively modest this year. Our normal run rate would be to take about 1-1.5 aircraft on average per week. For 2023, we are looking at around half of that. We intentionally chose a very smooth ramp-up post-[pandemic] compared to the original plan. Boeing is reworking the [737] MAX skyline completely, but—putting that aside—the delays we are seeing at the manufacturers are creeping up to the three-, six- or nine-month time frame, not necessarily by multiple years.

**What drove that decision?** We have intentionally positioned the business now that we are longer on cash than we are on metal, because we see opportunities to do business with our airline clients for financing of new deliveries directly with them. Overall, the delivery volume [for the industry] is increasing by 50% to \$110 billion in 2023 from \$70 billion last year. That expansion, coupled with the volatility in the financial markets, presents us with an opportunity to deploy capital directly with the airlines and do financing of their orderbooks. We see 2023 as growing the sale-and-lease back chain faster.

**Some important fundamentals have changed: Interest rates are increasing, the U.S. dollar has appreciated and oil is not cheap. How is that affecting the business?**

Investment-grade borrowers are mostly back to a more normalized financing environment, but most airlines are not investment-grade and as a result have a more limited access to capital markets and debt financing. Availability of financing is definitely a driver. Also, the airline industry has lost around \$135 billion over the last three years. It is forecast to make a \$5 billion profit in 2023, put that against the capital requirement of \$110 billion. That's what creates

the demand for leasing and investment to actually fund the delivery of these new-technology aircraft.

**But higher interest rates and higher costs in general must be affecting industry growth.** I think it is affecting growth and it is going to affect the pricing point, but there is also so much demand for air travel because of COVID. There was a debate about whether Zoom or Teams would take over from business or personal travel for families reconnecting. But my view is that COVID has reinforced that a computer screen is 2D and you can't replicate the meeting in person. And remember, there were 2,400 aircraft that were simply not produced during the COVID period.

Even if the manufacturers deliver on their stated objectives, that still leaves an under-provision relative to the pre-COVID runway, particularly on the Boeing side. Overall, we feel comfortable that the supply/demand dynamic and consumer behavior are actually enough to outweigh those cost pressures. Also, oil has dropped about 25% from the middle of last year and that is obviously a huge input variable for the 2023 calculations.

**Airlines are currently benefiting from supply constraints on the yield side. Do you think there is a structural change in airline behavior that will stay?** I think these things tend to go in cycles. People come out of a massive downturn with a conservative mindset, but human nature tends to produce short memories. COVID lockdowns already feel like a very distant memory. In the race for market share, that's where discipline is lost. So actually the natural break on it is the manufacturers providing a rational level of supply—that's the overarching limitation on whether too many aircraft come in and whether airlines fight and cannibalize each other's yield levels.

The other structural change I see that will be important for the next few years is that there has been a huge shift

in cost base to variable costs from fixed for airlines. That leaves them much better prepared to dial capacity up and down. It is much easier to do that if you have had a recent experience of dialing down to almost zero and then building up one by one. That variable cost base tends to creep into the fixed cost base over time, but that takes a few years.

**You have predicted that Airbus and Boeing will be a year late in raising production. Do you question the rate increases per se?**

Yes, we think rate 75 is high. A level that is lower than that is probably more in balance with the long-term demand. As to whether and when they actually get there, let's see how the demand is looking by the time those decisions actually have to be made. Obviously, a couple of years here and there do not make a difference, you have to look ahead five or 10 years. Having said that, China currently only accounts for 5% of the manufacturers' backlog and it should be 20%. People have been saying for some time that China has effectively underordered. India [and they] have the capacity to take on quite a bit of that supply.

**How concerned are you about the loss of market share that Boeing has suffered?**

The entire industry would like to see two relatively equal manufacturers. That does not have to be 50-50, it could be 60-40. At 65-35 it starts to become a question and then at 70-30 that's even more of a question. So we would like to see more market share with Boeing, for sure. The reality is that will take some time. The Boeing team is very focused on the operational issues, [on] production. But they are also focused on establishing a footprint in the high-growth markets where, frankly, Airbus [has] a larger market share, whether that is China or India.

**Air India's planned order will be very important, right?**

Yes, very, very important for lots of different reasons. Our preference would be for Boeing to recover its market share to a minimum 60/40 level, but that is a couple of years away. Also, from our airlines' perspective, those that have committed to Airbus deliveries got far more over the past three years than our Boeing operators. That has distorted some of the airline market shares as well.

**Can Boeing recover with the MAX or do they have to launch something new quickly?**

I think they can recover with the MAX. We believe in the aircraft, but it will take time. I'm not actually sure that launching a new product would close the market share gap. That would be such a long time period for an entry into service. The Neos and MAXs were announced in 2011 and really it [was] 2021 and 2022 before there was any significant number of MAXs intended to be produced. It was a decade even for reengining. Plus, a new aircraft may actually curb the recovery of the MAX.

**How do you see widebody demand returning?**

We are seeing a sharp uptick in demand for widebodies. The China reopening will again further accelerate that. We expect a 35% increase in [Airbus] A330ceo rentals in 2023, off a low base admittedly. That is reflective of the trend that we see in the market.

**You have a lot of exposure in the A330neo. Are you confident the aircraft will ultimately be successful in spite of its slow start?**

We would have liked to see a faster take-up of the A330neo. We were a launch customer and then we acquired CIT [Aerospace], which was also a launch customer, so we were a double launch customer. We have now completed the placement of our entire A330neo fleet, with the exception of two aircraft. Really over the past six months we have seen a sharp uptick in operator interest coupled with investor appetite to buy.

From our perspective it is becoming more mainstream. [The] plan that this [would be] the logical replacement of the A330ceo is now really [taking] hold. We just did a large Malaysia Airlines deal. It is indicative of the refueling that is happening on the widebody side. The A330 is equivalent to a midsize narrowbody for China.

**Speaking of which, China is now opening up again.**

**What do you expect for the recovery?** They are actually in a not-dissimilar place of where we were a year ago in terms of letting a less harmful variant move through the country. The difference between China and the rest of the world is that they have actually been operating domestically in excess of pre-COVID levels for much of the last two years. So they don't have aircraft that were in significant long-term storage. They didn't furlough staff and kept the infrastructure operational.

When the lockdowns ended, it was like flipping a switch—almost back to full capacity in an [instant]. We expect reopening in China, and consequentially travel around Asia, to be much quicker. We have seen a very high level of activity over [the] Chinese New Year. The international network will take a bit of time to reestablish, but that will also be much quicker than what you have seen in the rest of the world.

**There have been a lot of new lessors in China, though not very recently. Is the boom over?**

We have definitely seen a cooling in the smaller-scale lessors, but not just from China, also from U.S. funds. A lot of that has cooled because it is harder for them to leverage their investment because of the volatility of capital markets. That plays to the established large-scale, investment-grade lessors. The gap is growing.

**But now Saudi Arabia has big plans with AviLease, which is intended to become a major global player.**

Will the Middle East prevail? They have certainly stated big ambitions. I think we have yet to see how their real commercial activity unfolds and how readily they are prepared to buy market share in the space. Have they got the substance, the means and the time horizon to develop a large-scale force in the industry? Of course, they do.

**Avolon has been indirectly affected by the disintegration of HNA Group, parent of Avolon shareholder Bohai Leasing. How do you see that playing out?**

Bohai is a stand-alone public company. We represent around 80% of their assets. HNA Group is now effectively owned and controlled by a trust, which ultimately will monetize its holdings in favor of the previous creditors. 🌐



# The FAA's Funding Conundrum

By David Grizzle

## COMMENTARY

### IN A DEC. 29, 2022, LETTER TO

Southwest Airlines CEO Robert Jordan, U.S. Transportation Secretary Pete Buttigieg wrote: "I recognize that Southwest's employees, from customer service agents to ground staff to flight crews, are working extremely hard, under trying circumstances, to help the airline return to normalcy. These front-line employees are not to blame for mistakes at the leadership level."

The same comment can be made about the hard-working FAA front-line and management employees regarding the collapse of its Notice to Air Missions (NOTAM) system on Jan. 11 that grounded all flights into and within the U.S. for several hours. This collapse was decades in the making.

The NOTAM system has been around since the 1980s. It provides up-to-the-moment updates to pilots of information that is generally found in other places but may not be current. For example, pilots have loose-leaf binders (now usually tablets) with documents describing airports where they may land. A NOTAM would be issued if a runway were out of service or if construction were affecting the normal use of the airstrip. Before pilots depart for an airport, they check for NOTAMs related to the destination as well as any alternate airport. The mere existence of a NOTAM system as opposed to a system of embedded updates in digital airport descriptions (like what is done when a newspaper article is updated today) indicates how far from state-of-the-art the system has become.

The NOTAM system has not been completely revamped since 1999. Plans have been underway to upgrade it—without fundamentally changing its structure—since 2016, when the FAA entered into a NOTAM modernization contract. Its completion date is uncertain, as are most technology refresh contracts. Because the FAA experiences unrelenting budget pressure, it is forced into a triage process in which it must decide not just which systems need to be updated, but also which ones will do the most damage if they go down because they are not updated. This means programs to bring on new technology tend to be very large because they are very overdue.

Because these programs are not mere incremental improvements and are long in coming about, there is more uncertainty about the requirements for them and how extensively the capability will have to be reengineered. Budget changes and government shutdowns add even more uncertainty. Cost and schedule overruns are common, and the most surprising aspect of the overruns is that people are surprised when they occur. Often, critical components of new systems are out of date when they are delivered.

The fiscal 2023 budget that provides funding until Sept. 30, 2023, became law on Dec. 29, 2022, and allocates

\$11.1 billion to fund the Air Traffic Organization (ATO), which operates the National Airspace System (of which the NOTAM system is a component) and the NextGen organization, which develops new air traffic control (ATC) technology. Critically, this is not a single lump of money handed over to the ATO to use as it sees fit. The money comes in many parcels, but the \$11.1 billion is divided between \$8.8 billion for operations and \$2.3 billion for facilities and equipment (F&E).

Funding for construction of airport control towers as well as the more technologically intensive en route and terminal approach facilities comes out of the F&E budget. F&E funds also go to systems development, such as the new NOTAM system.



FRAIN PADRO/ALAMY STOCK PHOTO



ROBERT K. CHIN/ALAMY STOCK PHOTO

## PERENNIAL UNDERFUNDING

Many of the FAA's most critical facilities are more than 50 years old. Operationally essential technologies are running on microprocessors manufactured 20 years ago, and ATC areas regularly are shut down because of staff shortages. These outcomes are not because the FAA is monumentally incompetent; they occur because the FAA is perennially and woefully underfunded and subjected to a budget process that reduces the utility of the funding the FAA does receive. The December travails of Southwest Airlines would be an everyday occurrence if its capital allocation process were as starved and unpredictable as the FAA's.

When Congress appropriates less funding for the FAA than is needed to run a fully staffed, safe and efficient operation, the FAA has some tools at its disposal, but they can make the situation even worse. Given a choice between safety and efficiency, the FAA always will choose safety, which means it will maximize the funds available for the operation. Because the FAA cannot on its own initiative move funds between its operations budget and the F&E budget, it keeps new systems running out of the F&E budget long after they are fully operational to preserve more funds in the safety-critical operations budget.

While that is definitely the right choice for the airspace system, following this practice causes funds to be reduced in the F&E budget that Congress and the Office of Management and Budget had expected would be available for systems development—such as a new NOTAM system.

Simply put, when Congress provides inadequate funding for the operation, the FAA protects the operation by tapping the F&E budget in a way Congress never intended. Through the process of keeping programs in development long after they are mature, the FAA has money to run a safe operation, but no money to fund

efficiency-producing new systems. This is what you have to do when you do not have enough money to make ends meet.

All this is made worse by the frequent or threatened shutdowns of the federal government. Every time a shutdown looms, the FAA is compelled to put its contractors on hold. Like preparing to take a power plant offline, a lot has to be done in preparation, even if the shutdown never occurs, and then the recovery also takes time and resources.

As a case in point, during the government shutdown of nonessential operations between Dec. 22, 2018, and Jan. 25, 2019, the FAA had to stop work on the massive project of updating the technology that controllers use to guide airplanes on approach or recently departed. The five-week shutdown cost the program months in delay and tens of millions of dollars in increased costs, which came out of the F&E budget and simply reduced the funding headroom for other new technology, such as replacement of the NOTAM system that failed.

Understanding the challenge the FAA faces is further complicated by the existence of the Airport and Airway Trust Fund, receives all of the ticket taxes we pay for our flights and the aviation fuel levies the airlines pay. The trust fund is little more than a ledger entry in the federal budget:

## "NEW FAA SYSTEMS DEVELOPMENT IS HELD UP BY CULTURE WAR DEBATES THAT HAVE NOTHING TO DO WITH COMMERCIAL AIRLINE TRAVEL."

Getting money out of it to fund FAA operations and system development takes an act of Congress—a budget appropriation. The FAA is not able to tap the trust fund apart from the detailed appropriation it receives from Congress.

Money that comes out of the trust fund is a part of the overall federal budget level that is so hotly debated and often held up because of congressional disputes that have nothing to do with the amount of money the government spends and certainly are not related to the amount of money the FAA needs to run the operation—or the amount of money that is deposited in the trust fund. It is not an exaggeration to say that new systems development such as a replacement NOTAM system is held up because of culture-war debates that have nothing to do with commercial airline travel.

The FAA's long-term inability to deliver a modern ATC system is not an insoluble problem.

There are solutions that will lessen the burdens under which the FAA must operate and bring the nation's critical ATC system closer to adequate, stable and predictable funding. But, as Buttigieg said about Southwest, it will require better performance at the leadership level of the U.S. Transportation Department. 🌐

*David Grizzle worked at the FAA from 2009 to 2013 as chief counsel, acting deputy administrator and chief operating officer.*

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# Spotlight on FAA Runway Safety Improvement

- > DELAYED HUMAN FACTORS REPORT TO WRAP UP THIS YEAR
- > SOME CREDIT AIRCRAFT TECHNOLOGY, BETTER PILOT TRAINING FOR GAINS

Sean Broderick Dallas

A pair of significant occurrences at U.S. airports are generating fresh scrutiny of the FAA's multiyear runway safety improvement efforts, which the agency's own data suggest are yielding mixed results.

Investigations of the two episodes are in early stages. In the first, at New York John F. Kennedy International Airport (JFK) on Jan. 13, an American Airlines Boeing 777 crossed an active runway that a Delta Air Lines Boeing 737 was using for departure, triggering the facility's Airport Surface Detection System—Model X (ASDE-X) ground surveillance safety net. The alert prompted air traffic controllers to warn the 737's crew, who aborted their takeoff. The NTSB's database has labeled the mishap as an accident.

In the second incident, on Feb. 4, a FedEx Boeing 767-300 freighter was cleared to conduct a Category III, or extremely low-visibility, instrument-guided approach to Austin-Bergstrom International Airport's Runway 18 Left. A Southwest Airlines Boeing 737-700 was cleared to depart on the same runway. Publicly available aircraft tracking data shows the 737 was not airborne before the 767 reached the runway threshold, forcing the FedEx crew to go around and fly over the Southwest narrowbody.

NTSB investigators plan to look at myriad issues in both probes. The Austin incident likely will include a review of FAA protocol for keeping the "critical areas" around instrument landing lateral and vertical guidance antennas clear of traffic, minimizing potential signal interference. FAA regulations are clear about when aircraft and vehicles must be kept out of the carefully defined areas. The guidance makes several exceptions, including one for departing aircraft. It does not, however, provide parameters for clearing departures in front of aircraft that are on declared instrument approaches.

At least one of the investigations will be hampered by not having cockpit voice recorder (CVR) data. CVRs, which FAA rules require to keep at least 2 hr. of data before they can overwrite their contents, were not pulled from either aircraft involved in the JFK accident, NTSB Chair Jennifer Homendy told U.S. lawmakers during a Feb. 7 hearing on aviation safety. The NTSB has not said whether CVR data from the Austin incident was preserved.

Beyond identifying the immediate issues that caused each mishap, the NTSB plans to determine why they occurred. Among the broad areas investigators are set to examine are pilot and air traffic controller human factors issues.

Findings from the investigations could contribute to a

long-delayed FAA report on runway safety human factors. The study, recommended by an industry call-to-action group convened by the FAA in 2015 in response to rising incursion numbers, was slated to be completed in 2018. But a number of delays have held it up, including a lack of dedicated funding, said a 2018 Transportation Department Inspector General report on the group's progress. The current schedule has the report wrapping up this year, according to the FAA's latest National Runway Safety Plan.

A dedicated surface-safety group aims to augment the agency's human factors and fatigue research to study runway safety events "from every perspective," the FAA plan says.

Runway safety risk-mitigation efforts in recent years have focused on several key areas, including installation of systems designed to detect potential incursions and landings on taxiways. One of the efforts is to install ASDE-X at 35 large airports—but Austin is not one of them. "We're going to take a look at that as part of our investigation," Homendy told lawmakers.

Another project identifies troublesome airport designs,

such as problematic taxiway intersections, linked to higher incursion rates. The Runway Incursion Mitigation (RIM) program has flagged more than 200 spots on airports of all sizes. A May 2022 RIM update found that 80% of incursions were at spots where work was done.

Despite such success, the overall number of incursions is not declining. The FAA counted 1,732 incursions in fiscal 2022, which ended Sept. 30—nearly matching figures for fiscal 2019, the last full year before the global traffic downturn.

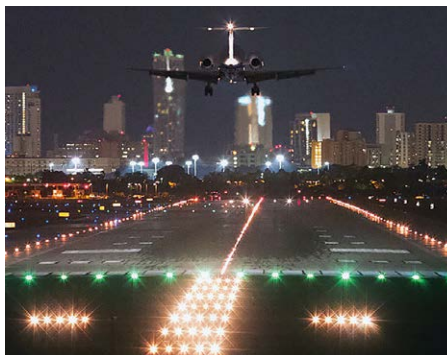
A deeper dive shows incursions at the 500 U.S. airports with control

towers increased every year in fiscal 2011-18, to 1,832 from 951. But the aggregate figures are only part of the story. The agency divides incursions into four severity levels. Categories A and B are the most significant. Category A "is a serious incident in which a collision was narrowly avoided," while Category B is when separation decreases "and there is a significant potential for collision," according to the agency's official definitions. Accidents are a separate category.

And accidents are rare. An Aviation Week analysis of FAA data shows that the total number of A and B incursions rose every year from 2017 to 2022—to 18 from eight—but most involved general aviation operations. Looking at just Part 121 airline operations, the annual figure has fluctuated between three and five occurrences per year since 2016. Category A figures are even more positive: Airlines have reported just three in the last five years and none in 2022.

Whether the figures show a trend or an ancillary benefit is debatable. One former FAA engineer and commercial manufacturer test pilot with landing system and avionics development experience credits safer airport-area operations to "the steady march of improvements" in aircraft technology—everything from better traffic displays to advanced collision warning systems—as well as better pilot training.

"Truly fixing runway incursions, as well as other serious separation failures, requires a fundamental [air traffic system] architecture shift," the engineer tells Aviation Week. ☛



Data suggests the FAA has made progress in reducing serious runway incursions.

# U.S. Airlines Face a Vulnerable Aviation System in 2023

- > CARRIERS URGE MORE SUPPORT FOR THE FAA AFTER NOTAM FAILURE
- > DELTA, UNITED AND JETBLUE ARE ADJUSTING EXPECTATIONS TO A NEW OPERATIONAL REALITY

**Lori Ranson** Washington

**A** far-reaching technological failure at the FAA and Southwest Airlines' historic meltdown during the recent holiday season have put a spotlight on what one U.S. airline chief executive has aptly described as the fragile aviation system.

Delta Air Lines CEO Ed Bastian offered that assessment in December, before Southwest's operational chaos and the outage of the FAA's Notice to Air Missions (NOTAM) system on Jan. 11, which triggered a grounding of departures that lasted for hours.

But in reality, those were just the latest episodes of airlines battling internal and external constraints that continue to create headwinds to meeting the demand for air travel.

"In my opinion, 2022 was the most difficult operational year in our history and was capped off by a severe winter storm over the holidays," Bastian said during a recent earnings call with analysts and investors.

Bastian and other U.S. airline CEOs used the NOTAM outage as a rallying cry to push for more support for the FAA. The need to modernize the U.S. air traffic control system has been discussed for years, and the NOTAM failure provided a clear example of the challenges the agency faces in working with systems "that aren't as resilient as they need to be," Bastian noted.

"[They are] doing the very best they can with what they have, but we need to stand behind the FAA. And we need to take them off the kind of year-by-year funding it seems like they go through that's caught up in political negotiations and realize the importance of having a strong aviation infrastructure," Bastian said.

United Airlines CEO Scott Kirby echoed Bastian's comments in his company's first-quarter earnings call. "Many of us in aviation have been saying for a long time that the FAA needs more resources," he said.

Kirby noted that the FAA's budget, in real terms, is lower than it was 20

years ago, while the agency's workload is significantly higher.

The United CEO said huge resources have been dedicated to space launches, drones and thousands of individuals working on aircraft certification programs in the aftermath of the "[Boeing 737] MAX disaster." The agency "has been asked to do more, and they're doing it with less money," he said.

Another change United has instituted is to have roughly 25% more spare aircraft available than before the pandemic.

"One lesson learned during the pandemic recovery is that it is both economical and profit-maximizing to provide a cushion in our aircraft utilization," United Chief Financial Officer Gerald Laderman said during the earnings call. "Instead of pushing utilization to its theoretical limit, we are focused on protecting our reliable operation." He noted that such a focus minimizes delays and cancellations that would otherwise drive higher costs such as those for overtime and accommodations.

Other airlines also are approaching their operations this year with a certain level of caution. "I think we all in



But the FAA's challenges, which are significant, are just one of many factors causing fundamental changes to the U.S. aviation system. Kirby cited pilot constraints and supply chain bottlenecks as limiting airlines' ability to grow. Given those limiting factors, he said, the industry's capacity aspirations for 2023 are unachievable.

United has determined that it needs to "carry about 5% more pilots per block hour than pre-pandemic," Kirby said. Air traffic control challenges are also increasing airlines' taxi and en route flight times, he added.

"So the same number of block hours probably produces 4-5% fewer [available seat miles (ASM)]," Kirby said. "Put it together: You need 10% more pilots and 5% more aircraft to produce the same number of pre-pandemic ASMs."

the industry owe it to our customers to make sure we don't fly in excess of our capabilities," Delta's Bastian said.

JetBlue Airways also intends to be more conservative in its planning, President Joanna Geraghty said during a Jan. 26 earnings call. One step being taken is operating a higher percentage of out-and-back flights. "That's a really important part of how we plan the schedule, particularly with the airspace we fly into, so that if we do get into trouble we can cleanly cancel a flight," she said.

JetBlue's largest base, as measured by departing frequencies, is New York's John F. Kennedy International Airport, according to the Aviation Week Network's CAPA - Centre for Aviation. The New York airspace corridor is one of the busiest in the U.S.

The airline has introduced new



technology, too, “which enables us to repair canceled flights and broken crew pairings more quickly,” Geraghty said. “Which ultimately means we can recover faster and take advantage of the resources that we do have, without having those resources time-out or lose track of them.”

For United’s Kirby, the new reality is simple: “Our industry has been changed profoundly by the pandemic, and you can’t run your airline like it’s 2019 or you will fail.”

But Southwest, which was forced to cancel 16,700 flights during the December holiday period, is confident that sticking to its 2023 growth plans will fortify its operational reliability. The airline expects to increase its capacity 16-17% year-over-year in 2023 compared with its original growth

estimate of 15%. The increase is attributable to the high number of flights the carrier was forced to cancel at the end of last year.

CEO Robert Jordan said on an earnings call that almost all of Southwest’s planned capacity growth “is going into restoring the network. It’s going into existing city pairs, adding depth and breadth.”

That network restoration “should help fortify the operation with better itineraries, depth and reaccommodation options for customers, crews and aircraft,” Southwest Chief Operating Officer Andrew Watterson said on the same call.

Southwest is working to ensure that it can avoid another operational meltdown of the same magnitude. It has launched several internal initia-

tives and hired an outside firm to assess the event and recommend ways to prevent disruptions.

The carrier also is working to address what it calls a “functional gap” revealed in its crew scheduling software during the wave of cancellations, Watterson said. The large number of close-in cancellations disrupted the automation used for crew rescheduling. “When we lost the automation, there’s just not enough hours in the day for crew schedules to catch up manually,” he said.

Even as U.S. airlines adjust to new operating realities this year, Bastian remains optimistic about the long term. “I believe our industry will see tens of billions of dollars in incremental demand in the next few years coming out of the pandemic,” he said. ☛

## Avelo Bets on Flexible Strategy and Aims for Quick Fleet Growth

> THE ULTRA-LOW-COST CARRIER LOOKS FOR RICHES IN NICHES

> RETAINING PILOTS, GROWING REVENUE HAVE BEEN CHALLENGES

Chris Sloan Miami

**“R**apid” is an apt word for the breakneck ramp-up of startup Avelo Airlines, whose name was coined by the carrier to combine the roots of the Latin words for “route” and “speed.”

In just 18 months, the ultra-low-cost carrier has grown its fleet from two aircraft serving 11 cities from its single Burbank, California, base and has stretched its wings east of the Mississippi. It is operating three bases—soon to be five—with a fleet of 14 Boeing 737NGs and serving 34 destinations with point-to-point, out-and-back service. This is similar to Allegiant Air’s model, but in some ways different, too. Since its inaugural flight from Burbank to Santa Rosa, California, on April 28, 2021, Houston-based Avelo has hired more than 550 crewmembers and has carried more than 1.5 million passengers on about 12,000 flights.

Avelo co-founder and CEO Andrew Levy, an industry veteran who has been a chief financial officer at United Airlines and Allegiant, portrays Avelo as small but mighty. “There’s some

benefits to just scale when you’re small like we are,” he says. “Ten to 20 aircraft is really powerful because there’s very little overhead that’s required, but you get a lot more activity on that overhead. So that’s huge in terms of driving down your unit costs.”

Avelo does not plan to stay diminutive for long. “We’re going for 70-80% growth in 2023,” Levy adds. “There’s going to be a massive increase in routes between now and even the summer. By the end of this year, I bet you we’re close to maybe 50 cities and 100 routes.”

Instead of a one-size-fits-all approach—a la Allegiant—of connecting small airports with outbound traffic to a leisure destination, Avelo is opportunistically developing different strategies for each of its bases, often centered around an alternative airport.

“[Burbank was] the best thing we had going in 2022, without a doubt confounding the naysayers and skeptics,” the founder says. Avelo has built a brand awareness in the Los Angeles market, but most of its traffic originates from small, underserved spoke

cities without nonstop service such as Eugene, Oregon; Pasco, Washington; and Redding, California. Avelo also is pursuing non-base flying, such as connecting Santa Rosa in California’s wine country with Las Vegas and Palm Springs, California. There may be some growth there, with another 737 added to the Burbank base.

Avelo’s most high-profile base is at Tweed New Haven Airport in Connecticut, where another 737-800 is to be added. It is a small airport serving a large catchment area in Connecticut, New York, Rhode Island and Massachusetts. Back in 2020, the airport saw all of its commercial airline service cease due to complications from the COVID-19 pandemic. “New Haven is truly unique in many ways,” Levy says. “We feel it is going to be really good for us over time.”

Most of the 14 nonstop flights from Tweed serve destinations in Florida. Additional seasonal flights to Chicago Midway International Airport and Savannah, Georgia, are also in the mix, as Avelo aims to expand to 20 destinations from New Haven. The bulk of Tweed’s point-of-sale is for New England customers heading south. Six 737s based at the airport, including some higher-gauge 737-800s with short-field performance packages, enable non-weight-restricted departures to Florida from the short runway, which is due for expansion.

But last spring, the optimism about New Haven turned sour. “We were

clobbered by astronomical jet fuel prices,” Levy notes, attributing that to high state taxes and pipeline costs. “When you think about a stress test for a business, I don’t think a \$7-8 per gallon price of jet fuel would’ve ever even entered the imagination.”

Avelo’s third base, at Orlando, Florida, represents a departure in strategy. “Orlando reminds me of what we did at Allegiant, connecting Orlando nonstop to underserved markets like the Lansing and Kalamazoo [in Michigan] and Dayton [in Ohio], with most of the traffic being inbound.”

For its next phase at Orlando International Airport, the carrier envisions retaining exclusivity on most routes but skimming some traffic off the top of some routes flown by competing carriers such as Delta Air Lines, Frontier Airlines, Southwest Airlines and Spirit Airlines. Avelo intends to scale up to about 10 aircraft to support the base over the next five years. For now, Avelo’s only directly competitive route is to its new base at Raleigh, North Carolina.

The airline is expanding to another new base at Wilmington Airport in Delaware on Feb. 1, another location that has no existing commercial service. Frontier recently left the airport. “Nobody’s been able to really make Wilmington work before, but we’re approaching it in a way that’s just simply different and we expect that we’ll have a different outcome,” Levy says.

Wilmington shares similarities with New Haven in that it has a large local catchment area, which encompasses Delaware, southeast Pennsylvania (including Philadelphia), southern New Jersey and Baltimore.

Of all its planned bases, Raleigh is the outlier. Levy calls it an “experiment”—Avelo is serving Raleigh-Durham International Airport because no alternate airport is nearby. He notes that Raleigh has great demographics, a growing market, an optimal geographic location and the lowest fuel prices in the network. Four of the markets from which Avelo flies to Florida and New Haven have no competition, while three others do.

Avelo’s “fail fast and move on” strategy is demonstrated by its abandonment of seven locations since its launch. However, Levy points to the success of the Burbank base as proof that patience is important—a second-year maturity is kicking in, with fares

and schedule optimized and brand awareness emerging.

The discontinued use of 50-seat regional jets and the ongoing deterioration of regional connectivity are unlocking an upside in exactly the types of small markets Avelo serves. “[There are] infinitely more opportunities today than there were 15 years ago with a hub-overflying strategy. I expect that trend will continue,” Levy says. Consolidation in the ultra-low-cost carrier space could spur some competition as well. “If Spirit actually does get acquired, then that’ll create different opportunities. I’d call us an interested observer,” the CEO explains.

It has not all been smooth flying for Avelo. The recruiting of experienced talent that was more widely available, sometimes furloughed by other carriers,

was touted as an advantage early on but is now more of a challenge—and pricier. Recruiting and training pilots has not been the problem, but retaining them has. To stay competitive, Avelo has raised pilot hourly rates twice, with a third increase imminent.

Financially, Avelo is nearing completion of its third—and what Levy says he hopes is the final—round of raising private capital, accumulating a total of \$150 million. The carrier’s most recent financial reports to the U.S. Transportation Department revealed a loss of \$23.8 million on \$52.5 million in revenue in the first half of 2022. “While a -45% margin is nothing to be proud of, it dwarfs [in a good way] the -129% margin of Breeze in the same quarter,” reports airline industry news website Enliria.com

Neither the company nor the Transportation Department has released more current numbers. “We saw sig-

nificant improvement over the first half of the year,” says Jim Olson, head of communications at Avelo. Levy is bullish about the carrier’s finances, but admits Avelo is “still trying to get both the revenues higher and the costs lower to be able to get to a sustainable, profitable business.” He says the company was “solidly profitable” in December 2022 and expects it to be in the black for the full year of 2023. In December, Avelo achieved a system-wide record load factor of 84%, which Levy expects to exceed in the coming year.

Operationally, the ascent has not been as smooth as Avelo touts. Flight-Aware data reveals that an average of 24% of flights were delayed in the fourth quarter of 2022, by an average of 46 min.



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Levy concedes that the young carrier needs to improve its on-time game. The company’s customer friendly “soul of service” mantra is manifested in how it has recovered from service “irregular operation” disruptions and delays, he says. “We try to go above and beyond and make it right with our customers,” Levy says. “After a certain number of hours’ delay, we’ll give you an original form of payment and we’ll give you a credit for the inconvenience.” Avelo is at the top of the industry for flight completions and it has one of the lowest rates of bag mishandling, Levy says.

Going forward, the CEO projects confidence. “We’re doing exactly what we set out to do, which is to seek out different airports, offer service that isn’t offered, bring great convenience to our customers and low fares,” he says. “Our purpose is to inspire travel and we’re doing just that.”



# Upbeat LCCs Highlight Weaker Airlines' Struggles

➤ FLYR AND FLYBE SUSPEND FLIGHTS WITHIN DAYS OF EACH OTHER

➤ RYANAIR CEO FORESEES THE START OF A CONSOLIDATION WAVE

Helen Massy-Beresford Paris

Europe's low-cost carriers have been celebrating strong quarterly results, but their positive performance comes against a backdrop of two airline collapses in a matter of days—UK regional Flybe and Norwegian low-cost carrier Flyr—that highlight the very different fortunes within the sector.

Ryanair was the last of the three major European low-cost carriers (LCC) to report results. On Jan. 30, the airline expressed optimism, as budget carriers shrugged off the cost-of-living crisis and high oil prices, forecasting strong bookings ahead.



Ryanair CEO Michael O'Leary also has said a wave of consolidation is on the horizon. "We are definitely, post-COVID, entering a four- or five-year period of consolidation," he told Reuters on Feb. 1.

With a Lufthansa deal to buy a minority stake in ITA Airways finally moving forward and the aforementioned two airline collapses, it certainly seems that the consolidation wave of which O'Leary spoke is underway.

His comments came the same day that Flyr grounded flights and filed for bankruptcy. The company had launched service just over 18 months earlier in June 2021, operating a fleet of six Boeing 737 MAX 8s and six 737-800s to domestic and European destinations.

But a combination of the effects of COVID-19 and weak domestic demand were too much for the carrier, which struggled to navigate a backdrop of high oil prices and high inflation that has been making life difficult for all European airlines—and impossible for some.

Late last year, Flyr set out a plan to slash costs by furloughing half of its workforce and securing a wet-lease deal. But the wet-lease plan fell through after it failed to secure the necessary funding, and the company's efforts ultimately were not enough to save the airline.

Flyr's collapse came just days after that of Flybe, whose

latest incarnation—after an April 2022 relaunch—lasted less than a year. The UK regional airline went into administration on Jan. 28. The administrator of the carrier, which operated a fleet of eight De Havilland Canada Dash 8-400 aircraft, cited the late delivery of 17 aircraft needed for its schedule as one of the factors leading to its demise, severely compromising its capacity and ability to remain competitive.

At the opposite end of the European spectrum, the region's other LCCs are strong and growing stronger.

EasyJet highlighted strong booking trends and said it was on a path back to full-year profit when it reported quarterly results Jan. 25, with CEO Johan Lundgren citing "early indications of a strong Easter."

Wizz Air, issuing its own quarterly results the next day, said it was seeing continuing evidence of a solid fare environment, with the averages above 2019 and 2022 levels.

"We expect to see the load-factor gap continue to close versus 2019 in the coming quarters as our recent network investments start to mature," Wizz Air CEO Jozsef Varadi said. "As we reach the end of January, we are seeing booking volumes coming in ahead of 2022, which is in line with expectations. We remain optimistic."

Ryanair said it operated 112% of its pre-pandemic capacity in the first nine months of its fiscal 2023, which runs through March 2023, but the Dublin-based LCC does have one thing in common with Flybe: concerns over whether it will have enough aircraft capacity to keep up with its growth plans, albeit on a different scale.

The carrier posted a net profit of €211 million (\$226 million) for the three months through the end of December, highlighting growing market share in many markets and a "robust" demand outlook when it presented third-quarter results on Jan. 30.

But Ryanair once again noted the question mark over its 737 MAX deliveries.

The carrier received 11 new 737 MAX aircraft—which Ryanair dubs "Gamechangers" for their lower fuel consumption coupled with higher capacity—during the last three months of 2022, taking the total number of that type to 84 in a fleet of 523 aircraft. The budget carrier has announced over 230 new routes for its 2024 financial year, which runs from April 2023 to March 2024, making for a total of 2,450 routes with 3,200 daily flights.

O'Leary previously has expressed frustration at Boeing delivery delays, but the airline is now receiving MAXs. Ryanair is not planning to start retiring its older 737-800s until 2026, with current growth opportunities meaning it does not make sense to retire them yet, he told Aviation Week in a recent interview.

The company is basing its growth plan for fiscal 2024 on having 124 737 MAXs for the peak 2023 summer season. "Although there is a risk (despite recent Boeing production improvements) that some of our Gamechanger deliveries could slip," Ryanair said.

It may be frustrating that fleet growth cannot go faster, but Ryanair is in the camp of European airlines that seem to have put COVID-19 firmly behind them: posting strong market-share gains, including an increase in Italy to 40% from 26%; and confirming a recently raised profit outlook for its full financial year, which ends in March. If O'Leary's consolidation prediction turns out to be true, the gap between those strong performers and the weaker carriers may become even more evident in the coming months. 🌐



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# Improved Composites Inch Toward Large-Scale Production

> LIGHTER CONSTRUCTION MAY BENEFIT EXISTING NARROWBODIES

> LARGE AIRFRAME PARTS NEED TO BE CHARACTERIZED FOR REAL-LIFE CONDITIONS

**Thierry Dubois** Lyon

**T**hermoplastic composites have long been praised for their easier manufacturing and environmental benefits compared with thermoset types. However, those potential advancements have yet to materialize in the production of large aircraft components at high rates, due in part to the required investments in factory equipment.

The difference between thermoplastics and thermosets lies in the resin (the matrix) rather than the fibers (the reinforcement). When heated, a thermoplastic resin softens and melts; when cooled down, it can resolidify without losing its mechanical properties, making it recyclable. In addition, the components can be produced from offcuts and scrapped parts.



**Daher company KVE Composites of the Netherlands is a specialist in induction welding of thermoplastics.**

Thermoplastics have more features that favor sustainability. Thermoplastics can be welded, and using fewer rivets saves weight and helps aircraft efficiency. And their buy-to-fly ratio—the weight of the finished product compared with the raw material—is close to 1:1, compared to 5-10:1 with metal alloys. The material also is well-suited to high production rates because temperatures can be increased more rapidly when consolidating the thermoplastic laminates than with thermoset resin curing, reducing that process to a few minutes instead of hours.

The commercial aircraft industry's plans to ramp up production rates, along with increasing environmental pressures, make the conditions ripe for the thermoplastics era to commence. That could start, before the next generation of aircraft, with incremental improvements to existing single-aisles.

Against that favorable backdrop, Paris-based aerostructures specialist Daher intends to pitch its thermoplastic technologies to large OEMs. It has significant experience in small structural thermoplastic components—such as Airbus A400M floor panels—but has yet to expand into manufacturing large parts.

The company's know-how has progressed consistently in

recent years. Daher is close to serial production on a thermoplastic pedal for its TBM turboprop business aircraft. The part is more robust than its metal equivalent, says Chief Technology Officer Pascal Laguerre.

Another potential opportunity is that Airbus and Boeing are likely to extend the production lives of the A320neo and 737 MAX. Some metal parts could be replaced with composite ones, either thermosets or thermoplastics. "If we can bring new wing components by 2025-27, it will make economic sense," Laguerre says.

Daher was gearing up to receive Airbus' request for proposals for an A320 successor in 2024-25, and was prepared to answer with composites. But the supplier now expects Airbus' schedule to slip.

A structural torsion box—a subassembly of spars, ribs and skins—made of thermoplastics could be certified in 2025-27, Laguerre says. The spars, ribs and skins are welded together instead of riveted. "Over the next few weeks, torsion tests on a reduced-scale box will tell us whether the joins [can] withstand the effort we calculated," Laguerre says. "Then, we will move to full-scale trials." Typically, a torsion box is part of an empennage or a moving surface on the wing. Its first application may be on a Daher aircraft.

Ongoing assessments may help design engineers refine their digital modeling tools, Laguerre says. "Composite welding is a nascent technology," he adds. In 2019, Daher purchased KVE Composites, a Dutch specialist in induction welding of thermoplastics.

In addition to wing components, engine pylons could benefit from the improved composite material. The challenges lie in the large number of composite layers required—around 200, which translates into about 35 mm (1.4 in.) in thickness—and the necessary curvature, Laguerre points out. But the hoped-for result is worth the effort. The pylon's design would replace the need for titanium, an expensive material that thus far has been sourced largely from Russia.

Daher's new €7.5 million (\$8.1 million), 1,600-m<sup>2</sup> (17,000-ft.<sup>2</sup>) Shap'In TechCenter, near Nantes, France, brings together the company's full spectrum of aerostructures and composites expertise.

The facility features machining tools for high thicknesses, close to those needed on a pylon, Laguerre says. Daher also is studying ways to produce "net-shape" composite parts, which would not require post-cure machining. "Machining thick parts is aggressive for the cutter tools and is a long process—it is therefore costly," Laguerre notes.

Daher's CARAC TP program, which is to run through year-end, aims to characterize the behavior of various thermoplastic composites in an environment relevant to their future use. Large parts coping with strong loads face harsher real-life conditions than small parts carrying light loads.

Ribs may be immersed in fuel when located in a tank. Skins will encounter sunlight and high-altitude ozone. Some nacelle components may face temperatures of 150-300C (300-600F) if they are close to the engine and must be able to survive fire. Most airframe components may be in contact with deicing fluids.

In addition, the CARAC TP program staff is to study the various materials' suitability for production. Ideally, the material should retain its qualities under rapid heating to 400C, Laguerre says. Certification involves having both the material and production process approved before the part itself is certified. ☛

## Wisk Aero's Gary Gysin

Formed as a partnership in 2019 between Boeing and Kittyhawk, a startup founded by Google co-founder Larry Page in 2010, Wisk Aero is developing an uncrewed, four-seat electric vertical-takeoff-and-landing (eVTOL) air taxi. **Gysin** stepped down as CEO on Feb. 1, handing the top position to Brian Yutko. In his last official interview as Wisk CEO, Gysin talked with Aviation Week's AAM Report Managing Editor **Ben Goldstein** about the wave of failures he sees coming in the eVTOL development race. Excerpts follow.

**You've been pretty skeptical about the number of eVTOL startups that will achieve certification. Are you expecting to see failures in 2023?** There are going to be a lot of failures this year. Already, we've seen companies approaching us asking to be bought out because they're running out of money. When you consider the expense of building the aircraft, building out the infrastructure and the ecosystem and just how long that all takes—it's really about a \$2 billion funding journey. And even for the companies that went public, they're going to have to go raise money again, and the financial markets are tough, especially when so many investors are sitting on huge losses from the last year. I'm actually getting more jaded. I used to think there would be four or five eVTOL companies that make it; now I think it may be three or four that survive.

**What about 2024?** I actually think next year is going to be an even bigger year of failures. There are some companies that have enough funding to just barely get into 2024, but it's going to be very tough to make it to 2025. Besides the funding, you need the right team, you need to build the right aircraft, and you have to get it certified. It's really a decade-long journey to do all that. If you have a really strong business model and you've demonstrated progress in your development program, those are the kinds of companies that are going to have an easier time raising money. It's more the players that haven't demonstrated as much, that basically sold a dream to investors and now it's approaching proof time—are they actually going to execute, are they going to transition? I think it's going to be tough for them. Look, there are over 200 companies today that say they're



going to build an eVTOL, which is just crazy. So there is absolutely no chance that all of these companies are going to cross the finish line.

**You've stated before that you don't consider piloted eVTOL services as commercially viable. Can you elaborate?** We believe it's got to be autonomous. People will start with piloted versions, but it's hard to see how you can really make a sustainable business out of that when you consider the cost of having a pilot in the cockpit. It would have to be a premium type of service, which is not what we're after. So you can have a piloted vehicle and charge like a helicopter service, and you can make a profit, but that's a small market. Our goal is to have anybody [be able to] afford this, whether you're talking about college students or someone just entering the workforce. We've always been after Uber X-like pricing, which we don't think is possible unless we can get our costs down to around \$3 per passenger mile, and we just don't see any way to do that unless it's autonomous.

**But how realistic is it to expect regulators to sign off on autonomous passenger operations anytime soon?** No one ever thought SpaceX would beat all the traditional players in the commercial space market, but they set out to do something big and bold and take the hill, if you will—and they did it. That's how we view autonomy—and this is all going to be autonomous eventually. Boeing's interest in this is obviously for Wisk itself—but also their commercial aircraft, in time, will be autonomous. The technology already exists; just look at what's already happening in the military with large, autonomous drones flying every day. So the technology works, and it's just really about turning that into a commercial thing and bringing both the public and the regulatory authorities along on the journey.

**Why isn't Wisk pursuing orders like other eVTOL startups?** Look at most of these orders. They are extremely contingent orders, and they're mostly a financial play. These operators are getting warrants or they're getting stock or something like that. We will enter into the market for orders when they're real orders. And especially with the backing of Boeing and all the airline relationships they have, we feel we don't need to go chasing after press releases. When you're a public company and raising money, you have to continually try and demonstrate your relevance to investors. We're a private company, and we don't need to do that. We're just going to wait until the time is right and there is a market for solid, real orders. 🌟



# Startups Target Logistics Market With High-Capacity Uncrewed Aircraft



- PYKA'S PELICAN CARGO TO FLY IN THE UK
- MIGHTYFLY'S CENTO eVTOL ENTERS TESTING
- MOYA AERO EYES AGRICULTURAL MARKET

**Graham Warwick** Washington and **Garrett Reim** Los Angeles

**L**arge uncrewed cargo aircraft soon could be plying drone corridors over the southwest UK under an agreement between U.S. startup Pyka and operator Skyports Drone Services. The deal is part of a trend to accelerate the deployment of larger drones by beginning in regions where regulators have more flexibility to approve operations.

Pyka is one of a growing number of startups developing uncrewed cargo aircraft with substantially larger payloads and longer ranges than the small drones now being used to deliver medicines and other supplies. Skyports is a launch customer for Pyka's Pelican Cargo, an autonomous electric aircraft with a 400-lb. payload and range up to 200 mi.

The 1,320-lb.-gross-weight Cargo, which features a 38-ft. wingspan, made its first flight on Dec. 22 at Merced, California. The aircraft is a derivative of the Pelican Spray, an autonomous aerial-application electric aircraft that is spraying crops in Brazil, Costa Rica and Honduras.

Pyka joins startups such as Elroy Air and MightyFly in the U.S. and drone airline Dronamics in Europe, which see growing demand for larger uncrewed cargo aircraft to support e-commerce, provide humanitarian relief, improve health care in rural communities and connect remote areas.

FAA regulations have slowed the deployment of small drone deliveries in the U.S. and led companies such as Zipline to begin operations in Africa, where regulators have been more flexible in their approach. Pyka is taking a similar offshore-first approach to fielding its Pelican family.

UK-based drone operator Skyports plans to begin flying the Cargo early in the second quarter in Cornwall, England. This will include flights under Open Skies Cornwall, a project that has received £2.4 million (\$2.9 million) in UK

**Pyka's Pelican Cargo has a larger fuselage than the Spray and four electric propellers rather than three.**

government funding under the country's Future Flight Challenge. A second, undisclosed UK trials program is planned.

Open Skies Cornwall is building landing infrastructure, uncrewed traffic management sensor networks and establishing "Skyhighways"—drone flying corridors—in low-altitude airspace to support medical and commodity deliveries for partners including the UK's National Health Service, Royal Mail and Cornwall Council.

Pyka began flying the Pelican Spray in Latin America because it was easier to gain approval there for operations. The company has applied to the FAA for a Section 44807 exemption to Part 107 rules for drones, which would allow it to spray crops in the U.S. "We anticipate that in the next few months," says Volker Fabian, Pyka chief commercial officer.

The startup plans to apply for a similar exemption for cargo operations in the U.S. but is beginning in the UK, where Skyports expects to fly the aircraft under Specific Category rules for drones. These permit flights with heavier uncrewed aircraft when they have been granted an operational authorization from the regulator.

"We raised an application [with the UK Civil Aviation Authority] in October and anticipate a SORA-based [Specific Operations Risk Assessment] approval within the next six weeks," Fabian says.

"We've been focused on operations with smaller, high-value payloads," says Alex Brown, director of Skyports Drone Services. "The introduction of the Pelican Cargo brings new capabilities and means we can now fly significant

volumes of cargo long distances, connecting communities in remote areas.

“Importantly, we are doing this now—this isn’t future-gazing; it’s a ready-to-go service,” he adds. Pyka plans to work closely with Skyports on all cargo applications. This includes a launch operator in the Caribbean, where the regulator intends to base its approval on the UK process, Fabian says.

The two Pelican models are 80% common, but the Cargo has a larger fuselage and bigger battery and is designed to fly 150 mi. with its maximum 400-lb. payload. The Cargo has 66 ft.<sup>3</sup> of cargo volume with an upward-hinged nose and sliding cargo tray to facilitate loading and unloading.

MightyFly, meanwhile, began hover tests of its Cento hybrid-electric vertical-takeoff-and-landing (eVTOL) uncrewed cargo aircraft in December. The aircraft is designed for end-to-end delivery, from factory to warehouse or fulfillment center to retail store, with a payload capacity of 100 lb. and range up to 600 mi. Cargo is loaded and unloaded autonomously via conveyor belt to minimize human handling.

“Traditional express shipping services involving cargo aircraft rely heavily on ground transportation to connect the first, middle and last miles and to move goods to and from an airport,” says MightyFly CEO Manal Habib. The last mile is the most expensive and least efficient part of express delivery, she says, adding that the Cento “does not require an airport or ground transportation infrastructure, as it can transport goods from source to destination, generating time and cost savings.”

Compared with Elroy Air’s hybrid-electric Chaparral, which is designed to fly 300 lb. of cargo 300 mi., the Cento has a relatively light payload but a long range. “Many express delivery providers travel with the vehicle’s cargo capacity partially empty. This generates inefficien-

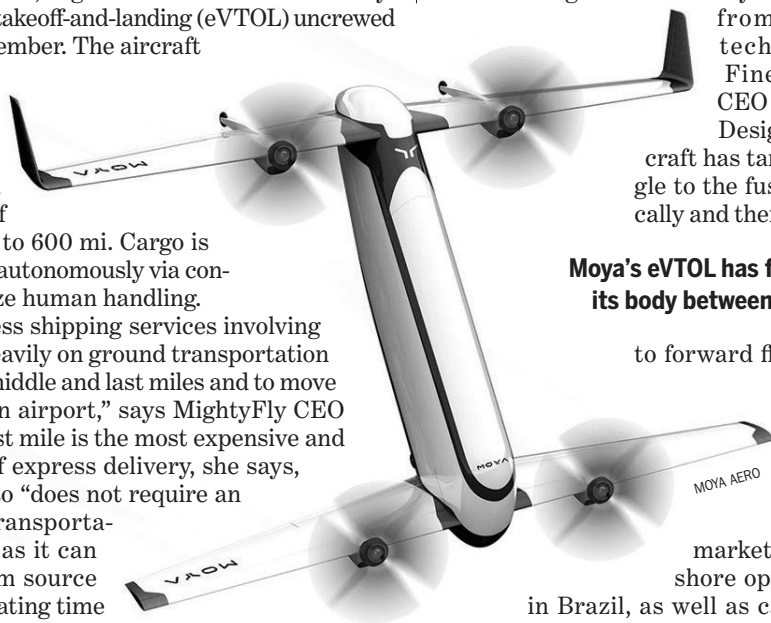
cies and high costs,” Habib says. “With 600 mi. of range and 100 lb. of cargo, MightyFly can provide express delivery services while operating with the aircraft fully loaded most of the time.”

In Brazil, startup Moya Aero is developing an uncrewed eVTOL aimed initially at crop spraying and cargo transport on large farms. The all-electric aircraft is designed to carry a 440-lb. payload 70 mi. Moya is building an 18-ft.-span demonstrator that it plans to fly in September. The production eVTOL will have a 23-ft. span and weigh 1,500 lb.

Based near Embraer in Sao Jose dos Campos, Moya was founded in 2020 as a spinoff from engineering services company ACS Aviation. The startup already has secured seed funding and in January received a \$2 million grant

from Brazilian government technology funding agency Finep, says co-founder and CEO Alexandre Zaramela.

Designed to be simple, the aircraft has tandem wings fixed at an angle to the fuselage so it takes off vertically and then tilts its body to transition



**Moya’s eVTOL has fixed angled wings and tilts its body between vertical and forward flight.**

to forward flight. The four fixed-pitch propellers provide propulsion in both vertical and forward flight. The batteries can be charged or swapped.

After the agricultural market, Moya plans to target off-shore operators, a major business in Brazil, as well as cargo transport to remote communities in regions such as the Amazon. There are no rules for Class 1 (above 330 lb.) UAVs in Brazil, so Moya is working with regulator ANAC to establish the certifications. The startup is looking for certification as well as venture funding in the U.S. and Europe, and it also has established an office in the U.S. ☒

**MightyFly’s hybrid-electric Cento has eight lift rotors and a pusher propeller on the rear fuselage.**





## Boeing Unveils New Military BWB Concept

> SHARPER NOSE SECTION AND FULLY INTEGRATED ENGINES ARE INCLUDED IN THE NEW DESIGN

> CARGO DOOR ADDS ELEVON IN UPPER SECTION

**Brian Everstine** and **Guy Norris** Washington

**A**s part of continuing efforts to position its long-researched blended wing body for a future military transport role, Boeing has unveiled a redefined scalable configuration for potential development as a tactical airlifter Lockheed C-130 replacement or a Boeing C-17-size strategic transport.

Revealed at the American Institute of Aeronautics and

the service said a BWB would drive “transformative changes,” as the design could increase aerodynamic efficiency by at least 30% over current tanker and mobility aircraft and enable greater fuel offload at range.

In June, the Defense Innovation Unit issued a solicitation kicking off the first phase of a program to develop the demonstrator, starting with \$56.9 million in funding for the Blended Wing Body Next-Generation Large Aircraft project. This phase includes selection of a digital concept, including an outer mold line, general arrangement, performance estimates, subsystems, life-cycle analysis and plans for testing.

The Air Force also is accelerating its plans for next-generation tankers and airlifters, issuing a new solicitation in December to shape budget planning beginning in fiscal 2024. The solicitation seeks aircraft with improved survivability, situational awareness, potential autonomous operations and new ways to maximize cargo volume.

“One of the things we’re doing this year is to take a look



**Boeing's new blended wing body concept was revealed at the AIAA SciTech forum on Jan. 24.**

Astronautics (AIAA) SciTech forum in Washington, the updated design includes a sharper forward fuselage and nose section, fully integrated engines and an all-new empennage with outward canted tail fins and lower-signature exhaust nozzle.

Developed by the Boeing Research and Technology unit working with the U.S. Air Force Research Laboratory under a Cooperative Research & Development Agreement (CRADA), the new-look configuration is a significant departure from the company's earlier blended wing body (BWB) concepts and could form the basis for an X-plane demonstrator proposal later this decade. While the company is not commenting directly on the design, further iterations are known to be under study as Boeing works toward a more refined configuration.

“Boeing continues its Blended Wing Body concept research activities with government customers to advance the state of the art in military transport aircraft design,” the company says in a statement. “Through successful structures, flight and wind tunnel testing, we are refining and improving our concept. The BWB-type vehicle could be developed in the next 10 to 15 years as a subsonic transport, with a focus on military transport vehicles.”

The concept comes as the Air Force is looking to fly a BWB prototype as part of a broader effort to cut back on fuel consumption. In a climate action plan released in October,

at the whole mobility equation,” Air Force Secretary Frank Kendall told Aviation Week in December. “One of the problems we’re confronting is the threat keeps trying to reach out to farther range to engage us. Now they’re out at ranges where we’ve got to worry about the survivability of tankers and transport aircraft . . . so we’re looking at that problem arc now, and we’re very wide-open aperture.”

Unlike the military airlifter BWB shown in recent years—derived from an earlier commercial transport concept with podded engines mounted externally on the upper fuselage—the new design incorporates embedded engines with large inlets mounted on either side of the forward lower fuselage. Studies into mitigating the potential secondary flow and fan distortion effects are continuing amid other configuration considerations, including possibly relocating the inlets to the upper fuselage.

The revised empennage retains the clamshell cargo door design previously shown by Boeing that incorporates an elevon in the upper section. The door-mounted elevon is one of the primary pitch control surfaces developed to shorten takeoff field length. However, the elevon also will likely be used to limit loads when the cargo door is open in flight for roles such as air dropping. When the door is closed, the design incorporates locking latches to ensure the elevon is effective for takeoff rotation and other maneuvers.

Unlike earlier versions, the trailing edge of the elevon is

angled to help partially reduce radar cross-section. Similarly, the outward canted tail fins and broader integrated engine exhaust nozzles also are designed to help reduce infrared signature. Despite the enclosed engine location, Boeing apparently is considering the use of medium- or even high-bypass-ratio turbofans, with the additional bypass providing mixing flow for further infrared suppression while the fins are positioned to shield the exhaust nozzles partially.

Cover panels for the main landing gear also are located in the side of the fuselage beneath the lower wing-body join. Boeing is thought to be looking at a four-wheel, high-flotation landing gear to ensure suitability for rough field operations.

The wingspan of the initial concept is about 130 ft., which would enable a full-scale version to maneuver and park on ramps designed for the 132-ft. span of the C-130.

The latest Boeing BWB design evolution follows a long track record of development that extends back to initial designs in the early 1990s by McDonnell Douglas prior to its merger with Boeing. NASA and Boeing also jointly evaluated the concept with the X-48 subscale demonstrator program that wrapped up in 2013. In 2015, Lockheed Martin unveiled studies of a T-tail hybrid wing body concept that combined the efficiency of the BWB with the practical aft cargo-ramp features of a conventional airlifter. 🚀

## *China Flies Subscale BWB Airliner Model*

**Graham Warwick** Washington

**CHINA'S NORTHWESTERN POLYTECHNICAL UNIVERSITY** has flown a subscale model of a 300-330-seat blended wing body (BWB) airliner concept, the BWB-300, designed in collaboration with commercial aircraft manufacturer Comac.

The 10.3%-scale model was flown autonomously from the UAV flight-test center at Jingbian in Shaanxi Province on Jan. 30. A team led by the university has been researching the BWB concept since the late 1990s, and development of the design began in 2017.

The low-speed model appears similar in size to the X-48B demonstrator, an 8.5%-scale model of a 450-seat BWB flown by Boeing and NASA in 2007, and is larger than the Maveric demonstrator, a subscale model of a 200-seat BWB airliner flown by Airbus in 2020.

Comac has previously flown subscale models of a blended-wing regional airliner, a truss-braced-wing narrowbody and a fuel-cell-powered aircraft as it explores next-generation aircraft configurations.

The BWB-300 has a deep, lifting fuselage similar to

that of the 200-seat SAX-40 BWB concept produced by a Massachusetts Institute of Technology-Cambridge University team in 2006 under the Silent Aircraft Initiative. Like Boeing's later BWB concepts, the design has two engines mounted on top of the body between twin vertical fins.

The concept has "spacious and comfortable" 16-abreast seating, which reduces forces on passengers in the outboard seats when the aircraft is turning, according to Northwestern Polytechnical University. Adding eight exits along the lower fuselage will allow all passengers to evacuate the aircraft within the 90 sec. required for certification.

The university says the Chinese team plans to focus next on structural design and noise reduction and development of concepts for electric- and hydrogen-powered BWBs with distributed propulsion. Under Airbus' ZEROe zero-emission aircraft initiative, the Maveric concept is a longer-term candidate for a hydrogen-powered airliner because of the large internal volume provided by a BWB design. 🚀

—With Chen Chuanren in Singapore

**The BWB-300 has a deep, cambered lifting fuselage.**





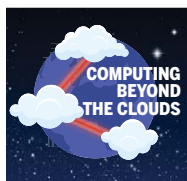
# EDGE COMPUTING



➤ BANDWIDTH ISSUES SPUR DEVELOPMENT OF GREATER COMPUTING CAPACITY IN SPACE

➤ DATA CENTER PIONEER SEES DIVERSE USES FOR ITS ARTIFICIAL INTELLIGENCE SOFTWARE IN SPACE

Garrett Reim Los Angeles



**AMAZON WEB SERVICES IS BEST** known for its data centers on Earth, but in recent years, the cloud-computing company has started investing off-world.

In fact, the Seattle-based subsidiary of Amazon.com, the giant e-commerce website, has the largest market share of cloud-computing services on terra firma, ahead of rivals such as Microsoft Azure and Google Cloud. It sees space as the next frontier for computing.

"We're sitting in this really interesting inflection point, where technology, including the cloud, I would offer, has really opened the aperture of what we can do in space in the future," says Clint Crosier, director of the Amazon Web Services (AWS) aerospace and satellite business.

The company envisions that by re-applying some of its cloud-computing applications, including artificial intelligence programs, to edge-computing processors in space, it can liberate satellites, spacecraft and space stations from bandwidth limitations and latency problems that come with radioing data back to Earth.

Edge computing is a model in which data processing and storage are conducted close to the point where the data is generated or needed, reducing bandwidth requirements and latency that come with sending information to far-away data centers.

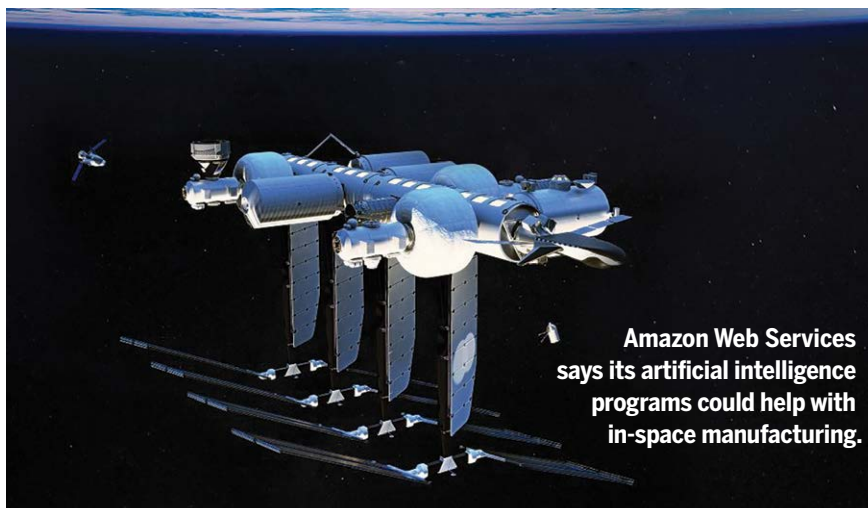
Increasingly, far more data is collected in space than can be downlinked back to the ground, meaning operators are unable to realize the full potential of their hardware in space. That problem is made worse when data sent back to Earth is unusable.

"In the imagery business, it's pretty standard that when

**The D-Orbit experiment tests Amazon Web Service's ability to filter out useless satellite images.**

you fill the buffer on the satellite and then download all that data, only 70% or 80% of that data will actually be usable," Crosier says, noting that in some satellite images clouds and smoke can obscure viewing the Earth. Wasting radio-frequency bandwidth on unusable images has financial and opportunity costs to satellite operators, he says.

"People always want more images than the buffer can hold. Every time you fill your buffer, you've told some other customer, 'I can't get your image in this cycle, but I'll try to get it in tomorrow,'" Crosier says.



**Amazon Web Services says its artificial intelligence programs could help with in-space manufacturing.**

To avoid bandwidth and latency problems, AWS is experimenting with providing computing at the edge—on the very spacecraft that collected the data in the first place. Last year, as part of a demonstration, the company processed images of Earth using machine learning software programs running on a computer hosted within D-Orbit's ION Satellite Carrier

LOGO: (CLOUDS) THEARTIST/GETTY IMAGES; (GLOBE) NADIA BORMOTOVA/GETTY IMAGES; (BACKGROUND) JOHN LUND/GETTY IMAGES

SCV004, an orbital transfer vehicle in low Earth orbit. AWS' machine learning software was used to automatically identify objects such as clouds and wildfire smoke, as well as buildings and ships.

"We looked at cloud cover, and we looked at other obscure onboard on the satellite using edge computing with [artificial intelligence and machine learning]," Crosier says. "When the edge-computing device determined that it was out of tolerance, it would do one of two things: It would either excise the clouds [from] the imagery and then just send you down the parts of the image that were usable; or, if that wasn't enough it would tell itself, 'this image is no good.' It would discard it, and then it would take the next image in the customer queue."

By cutting out pieces of images or ignoring entire images, AWS was able to reduce the amount of data the spacecraft sent back to Earth by 42%, Crosier says.

Back on Earth, AWS already provides cloud-computing services to the space industry—for example, to satellite companies such as HawkEye 360, a radio-frequency-sniffing satellite operator that used the Amazon SageMaker Auto-pilot program to build machine learning models for geolocating ships that may be illegally fishing, trafficking humans or smuggling goods.

AWS aims to provide some foundational capabilities and then work with partners and customers to create custom software and hardware. D-Orbit of Italy and Unibap of Sweden—whose computing system was used in the recent demonstration—are part of the AWS Partner Network, a group of qualified users and vendors of the company's cloud-computing services.

By keeping software consistent across terrestrial data centers and space-based edge computers, AWS aims to leverage the network's more than 20 million software developers, Crosier says.

"One value of running the same software at the edge as customers use in the cloud on Earth is that customers don't need both Earth-system software developers and satellite-specific software developers," he says.

Over the past three years, the company also has attempted to boost use of its software in the space sector by running its "Space Accelerator," a program to help startups use AWS products in space. To be sure, computing in space is not the same as on Earth. Unibap, whose SpaceCloud IX5 was used for the edge-computing experiment, says making a computer run reliably in space can be "really challenging," particularly because electromagnetic radiation, drastic temperature changes and the vacuum of space can wreak havoc.

"The secret recipe to make this happen is not one simple thing but a combination of many. It all starts with selecting radiation-tolerant components that are suitable for the environment while consuming as low power as possible," Unibap says. "In addition, you need to deal with the fact that the computer operation, regardless of chosen architecture, will be affected by single-event functional interrupts due to radiation and must be corrected and mitigated in run-time."

Not all environments in space will require special computers, however. Last year, AWS also sent its Snowcone solid-state-drive device, an edge computer designed for use on Earth, to the climate-controlled International Space Station (ISS). The off-the-shelf computer was qualified for space and launched as part of Axiom Space's Ax-1 mission,

the first all-private astronaut mission to the space station, for processing experiment data.

Typically, radioing experiment data from the ISS back to Earth can take up to 24 hr. But with the Snowcone device onboard, experiment data was able to be processed in 20-30 min., Crosier says. "Instead of running one experiment every 24 hr., you can essentially run an experiment every hour or two," he says.

Edge computing—and artificial intelligence—also could be used to automate in-space servicing, assembly and manufacturing, Crosier says. AWS is supporting Blue Origin and Sierra Space's Orbital Reef, an in-development commercial space station billed as a "mixed-use business park" for conducting research and manufacturing goods. AWS is working with Japanese space-robot manufacturer Gitai to monitor the health of its robots and record telemetry data from its robotic arms. Gitai aims to use its robots for in-space servicing, assembly and manufacturing, as well as lunar resource exploration and lunar base development (*AW&ST* Jan. 16-29, p. 60).

Ultimately, will AWS establish a parallel cloud-computing infrastructure in space? Will the company launch and operate orbiting data centers connected to each other, as well as other satellites, spacecraft and space stations, via a network of laser communications systems?

The question is "prescient," Crosier says. "You can hypothesize some of the things that we're talking to our customers about and some of the things we're thinking about," he says. "We don't have any announcements to make today." ☐

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# Avoiding Interference

> FAA'S PHASED 5G ROLLOUT SLATED TO HIT MAJOR MILESTONE JULY 1

> AIRCRAFT WITH AT-RISK AVIONICS FACE RESTRICTIONS



Airbus A220s need radio altimeter upgrades to fly in 5G environments.

TAD DENSON/AIRMODE INC./AIRBUS

Sean Broderick Washington

**A**n FAA proposal to codify an already agreed-upon plan that calls for commercial operators to upgrade radio altimeters to ensure aircraft can operate safely near new 5G C-band radio towers gives airlines an additional seven-month buffer to fortify their fleets. While some airlines are concerned that suppliers will not keep up with demand for needed equipment, the general consensus is that most affected operators will meet the proposed deadlines.

The FAA's draft airworthiness directive (AD), published Jan. 11, lays out new radio, or radar altimeter (radalt), standards—expressed as an “effective isotropic power spectral density curve” relative to an aircraft's height above ground and “received power from a 5G C-Band emitter”—for all U.S.-registered transport and commuter-category aircraft. Those types of aircraft that do not meet the standards, or “tolerance requirements,” either need a filter or an upgraded radalt, or they risk facing operational restrictions.

The proposed AD sets two deadlines. Most pressing is a June 30 date that requires all operators to meet the new tolerance requirements or face restrictions at 5G C-band mitigated airports (CMA). The CMAs are sites where wireless companies have agreed to mitigations, such as power reductions and specific antenna angles, to limit the chance of interference. For aircraft that do not meet the new

standards, restrictions include no instrument landing system (ILS) approaches, “automatic landing options,” and limitations on head-up display and enhanced flight vision system usage at specific airports, the AD states.

The second deadline calls for U.S. Part 121 operators, or scheduled airlines, to ensure their aircraft have radalts that meet the new requirements by Feb. 1, 2024. This provides a seven-month grace period that would permit U.S. operators to upgrade any laggards in their fleet while keeping them away from known C-band areas.

Meeting the first deadline will ensure operators are prepared to fly into the CMAs—183 airports as of late January—under the mitigations wireless companies agreed to put in place. But as more wireless companies roll out services around the U.S., the FAA will drop the airport-by-airport evaluations and consider all U.S. airspace as a 5G environment. The

second deadline reflects this reality.

While the proposed directive does not mandate retrofits for non-U.S. operators, the flight restrictions would apply universally. This creates a de facto mandate for all operators that use U.S. airspace.

The June 30 deadline aligns with a one-year voluntary extension of mitigations put in place by wireless providers AT&T and Verizon Wireless, two of more than 20 companies that plan to deploy midband 5G services. The one-year period was broken into quarters. At the end of each quarter, the companies activated new 5G towers and turned up the power on others that voluntarily were kept at lower outputs.

The FAA tailored a matching radalt upgrade schedule, ensuring the most vulnerable aircraft/radalt combinations were modified in advance of each quarterly 5G power-up.

Under the FAA's plan, the upgrades should cover all but a handful of air carrier aircraft in so-called Group 4. In other words, most aircraft would be safe to operate in a 5G midband environment by July 1.

“We’ve made it clear to all the stakeholders that we’re committed to holding this timeline,” an FAA spokesperson says. “The agency has been working closely with all stakeholders to identify and address supply chain issues that might threaten the schedule.”

The agency declined to discuss specific tactics it may use to help bridge any remaining compliance gaps, citing the directive's pending status and still unanswered questions about what, if any, issues will need addressing.

Several operators have told the FAA that supply chain bottlenecks will keep them from meeting the July deadline.

China Airlines told the agency it signed an agreement with an unnamed supplier in November 2022. On Jan. 11, the supplier reported that "due to [a] parts shortage," it cannot deliver needed equipment for the carrier's Boeing 777 and 747-400 freighters by the FAA's proposed deadlines.

"We can't control the supply chain issue," the carrier told the FAA in comments on the notice of proposed rulemaking, asking the agency to consider extending the deadlines or providing case-by-case alternate methods of compliance for affected aircraft.

SkyWest Airlines says it cannot equip its Embraer 175 and Bombardier CRJ fleets by late June, citing constraints on maintenance capacity

and suppliers' inability to provide filters fast enough.

"FiveG filters for SkyWest's CRJ fleet are projected to begin arriving no sooner than March 2023," the airline told the FAA. "This expected date only allows a brief four months to install the filters, which places an extreme burden on our maintenance personnel. Additionally, this scenario does not allow for any extenuating circumstances, namely a delay in 5G filter shipments or smaller than expected allotments."

The radalt upgrades present various levels of complexity for operators and suppliers. Adding a filter usually involves complex wiring and mounting—work that can lead to multiday downtimes for affected aircraft. Queue up enough at a given carrier, and the maintenance burden quickly grows. Repeat the process at multiple carriers, and suppliers are strained to meet parts demand.

Whether the agency will show leniency related to operators' constraints on maintenance capacity

remains to be seen. Technical problems affecting entire subfleets are more likely to get relief.

Three sources with knowledge of the issues say only a few radalt/aircraft combinations continue to pose problems. They include Airbus A380s and A220s as well as Boeing 777s with certain Thales altimeters. While none of the issues are seen as insurmountable, operators of several subfleets will not make the FAA's deadlines. Airbus has asked for more time for some A380s, two sources with knowledge of the request tell Aviation Week.

Among the challenges is the lack of a uniform approach. The aircraft and radalt manufacturers are working directly with affected operators and reporting progress to the FAA. Some operators report supply chain issues, while others do not. The International Air Transport Association (IATA) argues that a top-down strategy is more prudent.

"We urge the FAA to develop a project plan that includes milestones agreed to by all involved in the retrofit

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implementation,” the association wrote in a Feb. 2 letter to FAA acting Administrator Billy Nolen seen by Aviation Week. “In order to inform that plan, the FAA should request that aircraft and radio altimeter manufacturers provide written reports on the status of the retrofits of carrier aircraft,” including progress on needed retrofit instructions and the number of affected aircraft that need work.

“The FAA should use that information to develop a project plan that identifies realistic time frames agreed to by all parties as well as means by which to address barriers to success,” IATA added.

ensuring the time it takes electromagnetic waves to travel from the aircraft to the surface below and back. The data play a central role in low-visibility operations and support key automated functions, such as traffic alert and collision avoidance systems (TCAS), enhanced ground proximity warning systems and automatic braking.

Radalts use the radio spectrum’s 4.2-4.4-GHz frequency band. This is next to new 5G C-band or “midband” services licensed to use 3.7-3.98 GHz that began rolling out in the lower part of the band in early 2022.

Responding to concerns about possible radalt interference, the FAA put

Aerospace, Honeywell and Thales—studied their equipment to determine how susceptible it is to 5G interference. That work, combined with the FAA’s SIS efforts, gave the agency confidence it could put together a phased retrofit plan that would keep most aircraft operating safely as wireless companies slowly roll out their new services.

The slow 5G rollout also gave the FAA more time to quantify potential safety risks caused by signal interference. The agency has received about 420 reports of radalt “anomalies” since the 5G rollout began in January 2022. All but about 100 had nothing to do with 5G, the agency determined. As for the rest, “the FAA has excluded other potential causes for the anomaly but could not rule out 5G C-Band interference as the potential source” of interference.

Among those 100 reports were “various flight deck effects” including erroneous alerts from a terrain avoidance and warning system, TCAS and landing gear warning system as well as flight deck displays showing inaccurate radalt values. While spurious alerts and warnings may not be as severe as an ILS approach relying on incorrect altitude data, the trend raised alarms at the FAA.

“The erroneous warnings increase flight crew workload as they try to ascertain the validity of the warning,” the FAA says. “Repeated determinations that the warning occurred in error will lead to flight crew desensitization to warnings from these safety systems. In other words, as the flight crew becomes more desensitized to erroneous warnings, they are less likely to react to an accurate warning, negating the safety benefits of the warning altogether and likely leading to a catastrophic incident.”

The new standards replace airport-by-airport limits contained in Notices to Air Missions (NOTAM).

“Given 5G C-Band signals are not expected to be temporary and that 5G signals will cover the contiguous U.S., NOTAMs are no longer the best means of communicating the location of the 5G C-Band environment,” the FAA says. “In addition, given the information gleaned over the past year, the FAA is now able to identify the conditions under which radio altimeters can be relied on to perform their intended function in the presence of a 5G C-Band environment.”

JOE PRIES/AVIATION.NET



China Airlines says it cannot obtain the parts it needs to upgrade its 747-400 freighters before FAA's deadline.

Another concern is whether non-U.S. carriers will be able to comply with the deadlines. IATA repeatedly has warned that the push by U.S. operators to meet the deadlines—notably the February 2024 date that must be met to avoid grounding of any noncompliant aircraft—means suppliers could favor them over non-U.S. customers.

“At least one of the radalt manufacturers has publicly acknowledged what has long been recognized as a particular challenge for Part 129 [non-U.S.] carriers: Their priority is supplying the U.S. (Part 121) airlines,” IATA wrote in a November 2022 letter to the FAA. “We see no indication that this dynamic will change” before the deadlines.

The lack of a mandate that applies to non-U.S. operators could be another hindrance. Absent a specific non-U.S. carrier requirement with clear consequences, some airlines may struggle to obtain the resources needed for the upgrades.

In use for years, radalts determine an aircraft’s absolute altitude by mea-

suring the time it takes electromagnetic waves to travel from the aircraft to the surface below and back. The data play a central role in low-visibility operations and support key automated functions, such as traffic alert and collision avoidance systems (TCAS), enhanced ground proximity warning systems and automatic braking.

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# TECH TAKE

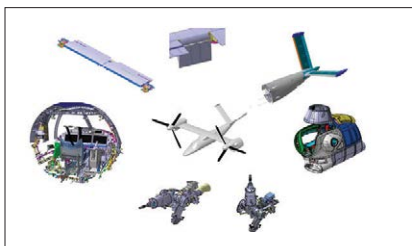
By **Graham Warwick**

For the latest, go to [AVIATIONWEEK.COM](http://AVIATIONWEEK.COM)

## Europe's Fast Rotorcraft Take Shape

Two major fast-rotorcraft flight demonstrator programs are running against the clock as Europe's Clean Sky 2 aeronautics public-private research partnership enters its final year of technical activity.

CLEAN SKY 2



### The Next-Generation Civil Tiltrotor demonstrator awaits wiring.

Both demonstrators—the Airbus-led Rapid and Cost-Effective Rotorcraft (RACER) compound helicopter and Leonardo Next-Generation Civil Tiltrotor (NGCTR)—are in final assembly and are planned to fly in the fourth quarter after delays caused by the COVID-19 pandemic and ongoing supply chain disruptions.

The NGCTR demonstrator is based on a Leonardo AW609 civil tiltrotor; structural assembly of the fuselage and installation of hydraulic lines have been completed at Leonardo Helicopters' plant in Samarate, near Milan. Wiring will be installed next, said Clive Scott, head of programs at Leonardo Helicopters.

The new wing, which is straight and simpler to manufacture than the AW609's forward-swept, dihedral wing is scheduled to be mated to the fuselage in March. The NGCTR design includes large flap-erons that deflect to reduce prop rotor download on the wing in the hover.

The new, lighter V-tail with its ruddervators is planned to be installed in May along with the avionics, landing gear and new propulsion system. Rather than tilting with the proprotors as on the AW609, the engines remain horizontal and only the proprotors tilt via a split gearbox.

"The fixed engine gives us the ability

to select engines in the market much more easily and also reduces the weight of the whole structure that we're moving as we convert from helicopter mode to airplane mode," Scott told the American Institute of Aeronautics and Astronautics SciTech Forum on Jan. 24.

The NGCTR demonstrator has a modular distributed flight control system with active inceptors for the single pilot. "Essentially, we're going from a very complex and centralized flight control system to an architecture that is more distributed, putting the redundancy management out where the actuators are and leaving the flight control computers to manage predominantly the flight-control laws," Scott said.

Functional testing on the demonstrator is scheduled to begin in July, and the aircraft is planned to move onto the flight line in August. The first run on the ramp is expected in September.

"First flight is expected before the end of this year," Scott said. "We then foresee approximately two years of flight testing to expand the envelope of the aircraft fully and validate those technologies in flight."

The RACER demonstrator also is scheduled to fly in the third quarter. The compound helicopter is in the final stages of assembly at Airbus Helicopters in Marignane, France, where the avionics were powered up for the first time at the end of 2022.

"In terms of assembly, we are now around 70%," RACER chief engineer Brice Makinadjian told the SciTech Forum on Jan. 25. "In March, we will finalize almost all the assembly of the aircraft with lateral gearbox and main gearbox mock-ups."

Because of delays, only 25% of gearbox testing has been completed. "We have missed a significant part of the testing of the main and lateral gearboxes," he said. "We will implement the lateral and main gearboxes for flight in the first six months of the year." The loss-of-oil tests on the lateral gearbox were to be completed by Jan. 27, he added, "which is an important step for us."

## Bye's Electric Trainer Advances

Bye Aerospace has received FAA approval for the means of compliance for Part 23 certification of its two-seat eFlyer 2 trainer, the first for an all-electric

light aircraft. Approval of the G-2 issue paper clears Bye to enter the certification testing phase.

Denver-based Bye applied for FAA Part 23 certification of the eFlyer 2 in April 2018 and secured approval of its G-1 certification basis in August 2020. The company downsized in mid-2022 to focus its financial resources on completing approval of the means of compliance.

Comprising 16 specific certification plans that cover all systems, subsystems and procedures, the G-2 is the first such approval in the general aviation industry and keeps the eFlyer 2 on track to be the first aircraft certified under Amendment 64 of Part 23 for a Level 1 normal-category aircraft, Bye says.



BYE AEROSPACE

### Composite wingspar testing is underway for the eFlyer 2.

"With this major milestone approved, Bye Aerospace is now poised to enter the testing and compliance demonstration phase of the certification, including the fabrication of eFlyer 2 Serial No. 001 and several production-conforming aircraft," CEO George Bye says.

Manufacture of the first eFlyer 2 is underway, but more capital is needed to build the second and third aircraft required for certification testing. Securing the G-2 is expected to help with fundraising, he says.

Next steps include finalizing the fault-hazard analysis and completing more conforming molds, tools and fixtures "along with area-specific test plans and testing—the wing spar, for example," Bye says. "We remain on course to have the world's first Part 23 Amendment 64 FAA-certified fixed-wing aircraft."

The first electric aircraft to be type-certified, the Pipistrel Velis Electro trainer, was approved in 2020 under the European Union Aviation Safety Agency's CS-LSA certification specifications for light sport aircraft. This is a level below Part 23, and equivalent FAA rules for LSAs do not allow electric propulsion.



Now owned by Textron eAviation, Slovenia-based Pipistrel is seeking to obtain U.S. certification of the Velis Electro under a planned FAA rulemaking package called Mosaic (for Modernization of Special Airworthiness Certificates) that is expected to update the LSA rules. Mosaic is delayed, and the FAA now expects to issue a notice of proposed rulemaking in August.

## Abu Dhabi Eyes SAF From Methanol

A consortium led by Abu Dhabi renewable-energy company Masdar plans to certify the production of sustainable aviation fuel (SAF) from methanol, adding another pathway to help scale up availability.

The initiative is one of several announced by Masdar, including an agreement to explore the export of green hydrogen from Abu Dhabi to the Netherlands for use in SAF production as well as a study into the production of SAF in the United Arab Emirates (UAE) using municipal solid waste (MSW).



**Abu Dhabi plans renewable energy projects for hydrogen production.**

Masdar established a green hydrogen business unit in December with the goal of achieving 100 gigawatts of renewable energy capacity and the production of 1 million metric tons of green hydrogen per year via electrolysis by 2030.

The company has teamed with TotalEnergies, Siemens Energy and Marubeni to certify SAF produced from methanol generated from the green hydrogen. The alcohol-to-jet (ATJ) synthetic paraffinic kerosene pathway is certified to produce SAF from alcohols, such as ethanol and isobutanol. The partners plan to widen the approval to include the methanol-to-jet (MTJ) pathway.

"Although the individual components

of the MTJ pathway are for the most part mature technologies, they have not yet been integrated for the purposes of making SAF, and this route is not yet certified," Masdar says, adding that the goal is "to get this novel pathway approved at the earliest."

Separately, Masdar has partnered with Abu Dhabi oil producer ADNOC, waste management company Tadweer, airline Etihad Airways and energy giant BP to conduct a joint feasibility study into producing SAF in the UAE using MSW and renewable hydrogen. If the result of the study is positive, the partners plan to build the region's first commercial-scale production plant in Abu Dhabi.

## Thermoplastic Fuselage for Clean Sky 2 Demo

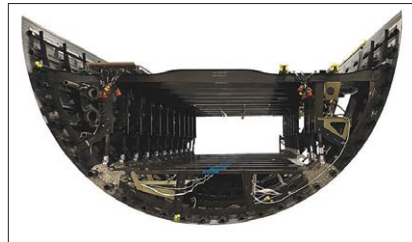
One of the largest thermoplastic composite aerostructures has been delivered by a team led by GKN Aerospace under Europe's Clean Sky 2 aeronautics research program. The structure forms the lower half of the Airbus-led Multi-Functional Fuselage Demonstrator (MFFD).

The MFFD project aims to demonstrate technologies for high-rate production of 60-100 aircraft per month while reducing total fuselage weight by 1 metric ton (2,200 lb.) and recurring cost by 20%, about €1 million (\$1.1 million) per fuselage. The demonstrator is an A320 fuselage section that is 8 m long and 4 m in diameter (26.2 X 13.1 ft.).

Under the project, more than 40 technologies are being demonstrated, including modular fuselage construction with upper and lower shells that are preequipped with integrated cabin elements then joined using thermoplastic welding, says York Roth, Airbus lead for the project.

Using thermoplastic composites allows structural components to be pressured outside the autoclave and joined using one of several welding techniques to eliminate fasteners and rivets and avoid dust and debris caused by drilling and chipping of composites.

The lower half of the MFFD was produced by GKN Fokker, Netherlands Aerospace Centre (NLR) and the Delft University of Technology's SAM/XL advanced manufacturing research cen-



GKN AEROSPACE

**More than 400 thermoplastic parts make up the demonstrator's lower half.**

ter. The aerostructure consists of more than 400 thermoplastic parts, thousands of spot welds and hundreds of meters of continuous welds.

The assembled structure has been delivered to the Fraunhofer IFAM bonding institute in Stade, Germany, where it will be joined to the upper fuselage produced by German Aerospace Center DLR. This will involve welding of two 8-m-long joins. One side will use an ultrasonic-welded overlap join, the other a laser-welded butt join. End frames will be joined using resistance welding, Roth told the American Institute of Aeronautics and Astronautics SciTech Forum in Washington in January.

GKN Fokker was responsible for assembly of the lower half, which consisted of skin and floor grid modules. The skin module features a single-piece skin produced by NLR using automatic fiber placement (AFP), 38 stringers made by using continuous compression molding and 208 injection-molded clips as well as frame subassemblies.

The floor grid module consists of passenger floor beam subassemblies with beams made by GKN using AFP. The floor grid was equipped with systems before installation in the skin module. The lower half of the fuselage demonstrator was assembled at SAM/XL using a 10 X 11 X 4-m ultrasonic welding robot.

Unlike the thermoset composites now used in aerostructures, thermoplastics can be reheated and recycled. The MFFD project staff has investigated this potential to reshape the composite, with lower-shell clips produced using recycled material.

The MFFD project also is looking at certification of thermoplastic aerostructures. "There are no showstoppers from the current perspective," Roth says. "And we don't see a major difference in maintenance as they are manufactured at much higher temperatures than operators will see." But repair of thermoplastics "is a new field that needs exploration," he says. ☛

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**VOL. 185, NO. 3 (ISSN 0005-2175)**

# Aerospace Calendar

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**Feb. 14-March 31**—RTCA Plenary Sessions/Committee Meetings. Virtual or various locations. See [rtca.org/content/upcoming-committee-meetings](http://rtca.org/content/upcoming-committee-meetings)

**Feb. 20-24**—International Defense Exhibition & Conference (IDEX 2023). Abu Dhabi National Exhibition Center. See [idexuae.ae](http://idexuae.ae)

**Feb. 21-23**—Spacecom 2023 (49th Space Congress). Orange County Convention Center. Orlando, Florida. See [spacecomexpo.com](http://spacecomexpo.com)

**Feb. 23-25**—2023 Women in Aviation International Conference. Long Beach Convention Center. Long Beach, California. See [wai.org/2023-conference](http://wai.org/2023-conference)

**Feb. 28-March 5**—Australian International Airshow (Avolon2023). Avalon Airport. Geelong, Australia. See [airshow.com.au/airshow2023](http://airshow.com.au/airshow2023)

**March 4-11**—2023 IEEE Aerospace Conference. Yellowstone Conference Center. Big Sky, Montana. See [aeroconf.org](http://aeroconf.org)

**March 6-8**—2023 Air Force Association Warfare Symposium. Gaylord Rockies. Aurora, Colorado. See [afa.org/events/2023-afa-warfare-symposium](http://afa.org/events/2023-afa-warfare-symposium)

**March 8-9**—Unmanned & Autonomous Systems Summit. The Sunset Room. National Harbor, Maryland. See [unmannedsystems.dsigroup.org](http://unmannedsystems.dsigroup.org)

**March 13-16**—Satellite 2023. Walter E. Washington Convention Center. Washington. See [satshow.com](http://satshow.com)

## Aviation Week Network Events

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**Feb. 22-23**—MRO Latin America. Buenos Aires, Argentina.

**March 1-2**—MRO Middle East. Dubai.

**March 16-17**—CAPA Airline Leader Summit. Budapest, Hungary.

**March 21-23**—Routes Americas 2023. Chicago.

**April 17-18**—A&D Raw Materials and Manufacturing. Atlanta.

**April 18-20**—MRO Americas. Atlanta.

**April 19-20**—Military Aviation Logistics & Maintenance Symposium. Atlanta.

**April 26-27**—CAPA Americas Aviation Summit. Ontario, California.

**May 9-11**—Routes Europe 2023. Lodz, Poland.

**May 17-18**—MRO Australasia. Brisbane, Australia.

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# Inspiring a New Generation of Leaders

By **Frank Slazer**

**A**s we begin a new cycle of divided government, the U.S. needs a clear signal of determination, unity and support for space leadership through a strong presidential budget request for NASA followed by bipartisan support in Congress.

The urgency is clear: China is aggressively pursuing its space programs, including a new space station, plans for a crewed lunar landing before 2030 and a new system of space law and space environment governance. As NASA Administrator Bill Nelson observed, China's actions on the Spratly Islands in the South China Sea indicate what the country could do with a leadership position in space.

But there is much more to winning this new space race than beating China or preventing U.S. space missions from slipping further. Decades of underinvestment in space exploration call into question America's ability to commit to long-term space endeavors, with worrying implications.

According to an October 2022 report by Research.com, 20.2 million students were enrolled in undergraduate programs in the U.S.—a decrease of about 800,000 from the previous year. While that is a drop of a little more than 2%, college enrollment in the physical sciences dropped by 7.6%. Worse still, even as our nation becomes more diverse, enrollment rates for African Americans dropped by 8.8%, Native Americans declined by 13% and Hispanics by 7.3%—populations already badly underrepresented in science, technology, engineering and mathematics (STEM) disciplines.

If this situation does not improve, the nation will struggle to replace retiring baby boomers in aerospace and other technical disciplines needed for the 21st century economy. STEM higher education and skilled trades are essential to the nation's future. The U.S. needs to inspire the new generation to pursue more of these careers, or the country risks falling behind international competitors and endangering national security.

Space as inspiration for students has worked before. The Apollo program inspired millions of baby boomers who could witness live coverage of astronauts on the lunar surface. While I followed that inspiration into a career in the aerospace industry, many of my fellow boomers went into IT, medicine or countless other technical professions. The revolutionary technologies developed in so many fields since the first Moon landings all benefited from the students inspired by our nation's space successes.

This is what Chinese students see now, with Chinese rovers on the Moon and Mars and Chinese astronauts doing spacewalks in Earth orbit.

Let's ensure the Artemis program will provide American students with that inspiration—it is sorely needed. And that is where a strong budget signal from the nation's leaders is absolutely vital.

The recent success of NASA's Artemis I mission is encouraging, but the first crewed mission will not launch for another two years, and the first crewed landing will happen in 2025 at the earliest. That said, NASA has a number of inspiring missions to anticipate in 2023, including the first crewed launch of Boeing's Starliner Commercial Crew vehicle to the International Space Station in April, the launch of the Psyche asteroid probe to a metal-rich asteroid in October and NASA's Commercial Lunar Payload Services program, which will send robotic landers to the lunar surface as precursors to crewed Artemis missions.

These missions and others already underway or being planned will enable new exploration missions and help generate a steady stream of STEM inspiration. Investment in Artemis and other exciting space missions will help to assure that the Artemis generation is ready to meet new challenges in space and on Earth.

That is why it is so important that President Joe Biden requests strong funding for NASA and our deep-space exploration programs. That is why it is so important that Congress provides funding with strong bipartisan support.

The U.S. is competing for influence in the developing world between its free-enterprise guarantee of liberty and personal freedom and a system directed by the centralized Chinese Communist Party. Strong NASA funding sends the signal that the U.S. is deeply committed—along with its partners in space—to winning this new space race and all the other vital scientific and technical challenges of the 21st century.

The scientists, engineers and technicians who will develop the capabilities needed to land a human on Mars are in U.S. elementary schools right now. Will the U.S. signal to them that the nation is serious about winning the future and they can have an exciting role in it? Or will the U.S. signal it is content for China or other nations to lead? 🚀

*Frank Slazer is the immediate past president and CEO of the Coalition for Deep Space Exploration. He retired Jan. 23.*



KEEMAN BARBER/NASA

**“THE SCIENTISTS, ENGINEERS AND TECHNICIANS WHO WILL DEVELOP THE CAPABILITIES NEEDED TO LAND A HUMAN ON MARS ARE IN U.S. ELEMENTARY SCHOOLS RIGHT NOW.”**

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