

Issue

2

Tuesday
20 June 2023

FLIGHT DAILY NEWS

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PARIS AIR SHOW
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JUNE 19-25, 2023

HOW CAN THE SPEED OF
INNOVATION
MEET THE PACE OF
CHANGE?



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Continued on page 6



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Paris air stroll

French president Emmanuel Macron walked the show yesterday, getting personal tours of the best aircraft in the static park and brushing shoulders with the aviation industry's top brass, including Airbus head Guillaume Faury, marking the start of this year's edition. Macron, who arrived in a French navy Airbus Helicopters H160, showed his support for a sector that is in full recovery mode. The Paris air show organiser could not hold back: "With his presence, the grand spectacle of aviation and space innovation is officially under way!" Quite right.

IndiGo goes for it

Low-cost carrier's record-rebreaking order gets show off to a flying start

David Kaminski-Morrow & Mark Pilling

Indian low-cost carrier IndiGo set Paris alight yesterday with a blockbuster deal for 500 firm Airbus A320neo-family jets that will see it taking delivery of the type up to 2035.

Describing it "as a day I'll never forget", IndiGo chief executive

Pieter Elbers told a jam-packed media room: "No-one has ever [placed] an order of this magnitude," pointing out that the agreement is firm and there are "no options".

The deal, which had been well-flagged in the run-up to the show, set a record for the biggest single purchase agreement in the history of commercial aviation, says Airbus.

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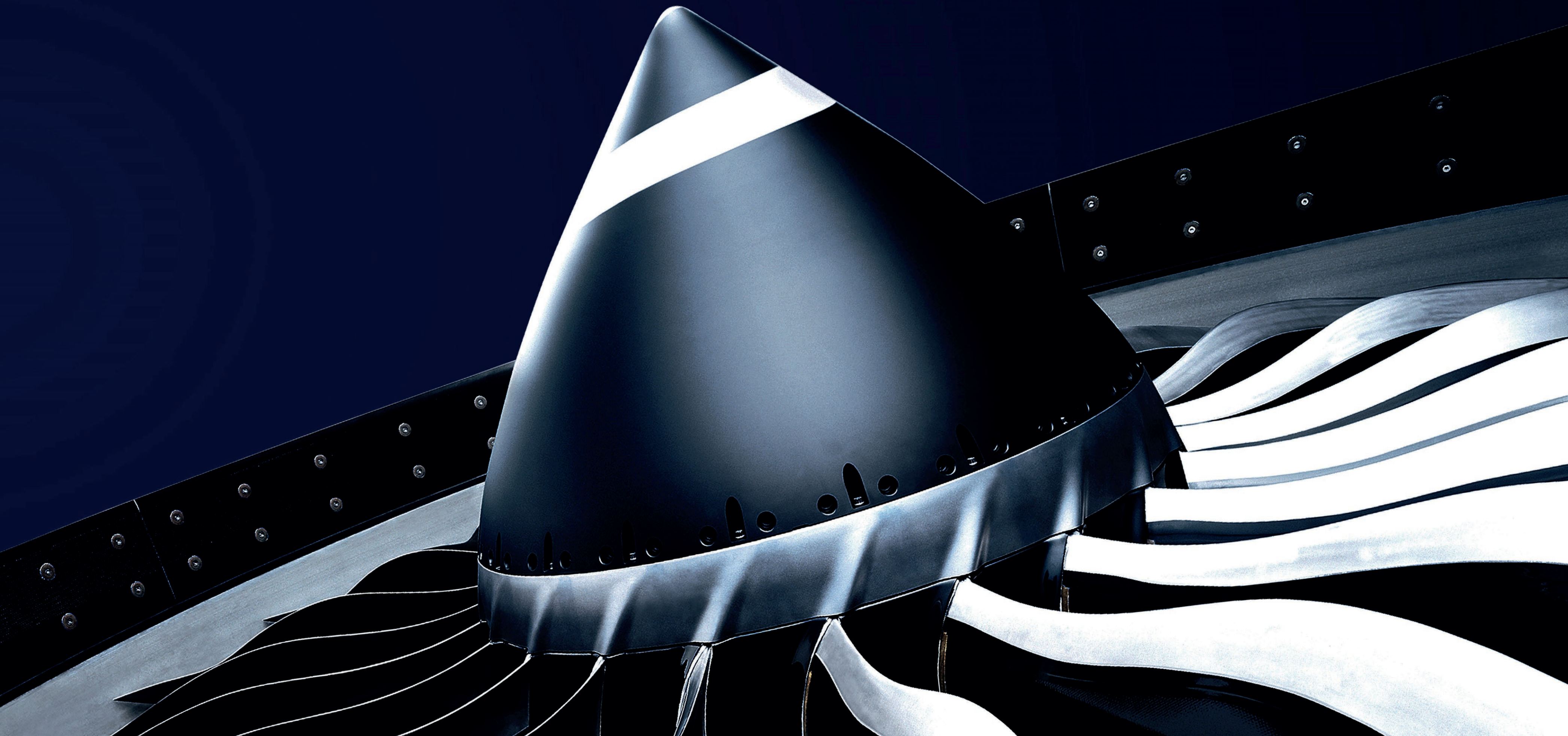
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Archer's Goldstein with Midnight model

Air taxi firms race for Olympic wins

Howard Hardee & Pilar Wolfsteller

Rival US air taxi developers Wisk Aero and Archer Aviation have zeroed in on a major international event to showcase their electric vertical take-off and landing (eVTOL) vehicles: the 2028 Olympic Games in Los Angeles.

Both Wisk chief executive Brian Yutko and Archer founder and chief executive Adam Goldstein said at the show yesterday that their competing eVTOL concepts – as well as the corresponding air traffic control infrastructure to keep the skies over the metropolitan area safe from collisions – will be ready for prime time in five years.

Yutko called the sporting event a “very interesting” potential date to show off the company’s vehicle, implying it could be ready for commercial operations earlier than previously thought. In the past he had stated that the company intends for its air taxis to clear

regulatory hurdles and enter service “this decade”.

Archer’s Goldstein, meanwhile, envisions “hundreds or thousands” of eVTOLs plying the skies above the US west coast city during the 2028 games.

Wisk and Archer’s Midnight are just two advanced air mobility (AAM) concepts that are competing for attention at this year’s Paris air show. China’s EHang, Germany’s Volocopter and Lilium, Airbus and Embraer-backed Eve have brought prototypes and



Yutko envisions hundreds of thousands of eVTOL aircraft in 2028

mock-ups of their aircraft and cabins, while dozens of other companies – both airframers and suppliers – are looking to get a piece of the eVTOL action.

The aviation revolution that these new small aircraft will precipitate, Goldstein says, will begin as soon as next year as Archer launches its flight-test campaign for its Midnight regulation-conforming aircraft.

The company will be moving to “a high cadence of operations”, going from “a couple of test flights a day

to thousands of test flights per month”, Goldstein said.

“2024 is a huge year for us as an industry, because we’re moving into the flight-test-for-credit [programme] with the Federal Aviation Administration,” he says. “So that means in Archer’s case, you’re going to see six-plus piloted conforming planes flying around Silicon Valley every day, multiple times a day, racking up thousands of flights over that year.”

“That all comes alive next year,” he says.

Archer’s Midnight is anticipated to be capable of flying distances up to 87nm (161km) but will be “optimised” for 17-43nm flights. It will fly at speeds up to 130kt (241km/h).

Archer recently hired former acting FAA Administrator Billy Nolen to help it navigate the aircraft’s lengthy and costly multi-step certification process, with the aim of certifying Midnight in 2024, and launching commercial operations in 2025.

Wisk, which became a wholly-owned Boeing company last month, presented

its production-conforming aircraft – the sixth generation of its air taxi – for the first time at the Paris air show.

It is designed to cruise at about 120kt (222kmh) with an 87nm (160km) range, and to carry four passengers.

Yutko says said the aircraft will be manufactured using carbonfibre composite components, often used on Boeing commercial aircraft.

“There are very practical ways that we benefit from technology and products that Boeing uses on their airplanes,” he says. “The 787 is one of the world’s largest and most successful composite airplanes. We can use the material systems from the 787 programme... to use directly on this aircraft.”

Yutko adds that Boeing, in turn, will benefit from Wisk’s research on autonomous flight, eventually “providing safety enhancements to large, piloted airplanes”.

The company had not yet announced a date for its certification programme “because we are doing something very novel and we do not feel it is appropriate to force regulators ourselves toward a date,” Yutko says. “We obviously have an internal planning date... As we get [further] down the road we will talk about specifics.”

Both companies say the new aircraft types will present massive benefits over today’s helicopters in terms of safety, reliability and maintenance costs, in addition to contributing to lower noise levels.

“It has literally orders of magnitude [fewer moving parts] than a helicopter,” Yutko says.

Despite their shared ambitions, the two northern Californian start-ups have been locked in an acrimonious lawsuit about intellectual property theft and patent violations. Wisk sued Archer in 2021, claiming Archer had engaged in “brazen theft” of trade secrets. It said outgoing employees – bound for Archer – stole design documents, which they then turned over to their new company.

Supernal signs up two key suppliers

Supernal has disclosed a pair of new manufacturing agreements with major aerospace companies that will allow it to scale production of its in-development electric vertical take-off and landing (eVTOL) aircraft.

The US-based company, a subsidiary of Hyundai

Motor Group, said at the show yesterday that it is partnering with Garbon Aerospace to mature component welding techniques.

Supernal says it is working with Garbon – a manufacturer of composite components for commercial and military aircraft – to develop a “novel manufacturing process”

called induction welding “that will enable the advanced air mobility industry to meet expected demand in the coming decades”.

The eVTOL developer is also partnering with GKN Aerospace to design and build “major aerostructures” and an electrical wiring system for the Supernal

aircraft. The companies will also work to mature “high-rate manufacturing technologies” to produce parts and assembly methods.

“Instead of focusing on ‘time to market’, Supernal is prioritising ‘time to scale,’” says chief executive Jaiwon Shin. “Our work with GKN Aerospace will lay the

foundation for producing eVTOL vehicles at scale and will be bolstered by Hyundai Motor Group’s high-tech manufacturing processes.”

Supernal says GKN will supply high-voltage electrical wiring systems for its full-scale technology demonstrator, which it plans to fly next year.



SkyDrive adds a seat

Alfred Chua

Japan-based advanced air mobility company SkyDrive has updated the specifications of its eponymous electric vertical take-off and landing (eVTOL) aircraft by adding an extra seat, and plans to have the programme certified by 2026.

Unveiling the changes at the show yesterday, SkyDrive founder and chief executive Tomohiro Fukuzawa

said the SkyDrive eVTOL can now carry two passengers and one pilot, with an increased maximum take-off weight of around 1,400kg (3,100lb), compared with 1,100kg in the older configuration.

“Our proprietary rotor dome design enables the aircraft to accommodate three people while keeping the aircraft compact,” SkyDrive adds.

Fukuzawa says the change in seating capacity – which comes on the back of user

feedback – is “unlikely” to affect certification efforts. SkyDrive aims to obtain Japan Civil Aviation Bureau (JCAB) certification by 2026, with US approval to follow soon after.

SkyDrive aims to clinch its airworthiness certificate by 2025, in time for the Osaka Expo held in the same year, where it expects to operate demonstration flights.

Fukuzawa discloses that the company has “over 100 pre-orders” from companies in Asia and the USA.

In a presentation at the show, SkyDrive lists Vietnam-based investment firm Pacific Group and USA’s Greenville Downtown airport among its customers.

The update comes as SkyDrive announces a partnership agreement with Japanese carmaker Suzuki. Under the agreement, SkyDrive will assemble its eVTOLs at a Suzuki factory.

Fukuzawa says details of the factory’s location have not been firmed up, but he hopes the facility will be

operational at the start of 2024.

Once fully up to speed the facility would be able to produce 100 aircraft annually, he adds.

SkyDrive, based in the city of Toyota, is among a growing list of advanced air mobility companies hoping to capture a slice of the Japanese market. Already three other developers – Volocopter, Vertical Aerospace and Joby Aviation – have applied to the JCAB for certification of their eVTOLs.

SkyDrive will now be able to carry two passengers

Medevac agency commits to 150 Volocopters

German air taxi developer Volocopter and ADAC Luftrettung, one of Germany’s largest air rescue organisations, have agreed to customise two VoloCity eVTOL aircraft for rescue services and add up to 150 more later, pending a successful test phase.

ADAC reserved the first two airframes in 2020.

“From the very beginning, we have been convinced that these aircraft can also shape and improve the rescue service of the future,” Frederic Bruder, chief executive of the German EMS operator said at the show yesterday.

“With higher ranges and operational speeds as well as significantly more payload of the next generation of eVTOLs, we can also put the benefits for emergency care into practice – and

fulfil our statutory mission to further develop the rescue service from the air with pioneering innovations,” he adds.

The first two VoloCity aircraft will enter a two-year test phase in the Idar-Oberstein and Dinkelsbuehl regions in western Germany once the airframe has received its type certificate from the European Union Aviation Safety Agency, anticipated in 2024. The testing programme is expected to begin later that year.

A pilot will dispatch an emergency physician to incident locations to supplement ADAC Luftrettung’s EMS rescue helicopters.

Following the testing period, the VoloCity aircraft could join the regular ADAC Luftrettung roster and up to 150 “additional eVTOLs will be considered for use



in future rescue missions”, Volocopter says.

Dirk Hoke, chief executive of Volocopter, adds, “There is no better way to start Vo-

locopter eVTOL operations in Germany than by saving lives.

“We have proven the emergency rescue use case

works in theory, now we are concentrating on the delivery and execution to start EMS operations in Germany in 2024,” he says.

Otter comeback



De Havilland Canada to resurrect DHC-6 300 after gap of 35 years

Jon Hemmerdinger

After a 35-year hiatus, De Havilland Canada is rebooting production of its DHC-6 Twin Otter 300, a move responding to customer demand for a lighter utility aircraft with more payload capability than Twin Otter Series 400s.

The Canadian manufacturer launched the new Twin Otter Classic 300-G variant at the show yesterday. The aircraft will have Garmin G1000 NXi avionics and a choice of Pratt & Whitney Canada PT6A-27 or 34 turboprops.

De Havilland has identified Jetcraft Commercial, a division of aircraft broker Jetcraft, as the launch customer for the variant, having signed an agreement to purchase 10 units. The airframer expects to deliver the first example in 2024.

It also announced that Indian operator flybig has signed a letter of interest to acquire 10 examples of the variant, alongside a purchase agreement for two Series 400 models.

De Havilland vice-president of corporate affairs Neil Sweeney says the company launched the Twin Otter 300-G after completing a review with customers.

"They're looking for improved avionics. They were looking for greater payload. They were looking for some flexibility in the engines," Sweeney says. "They wanted something that was lighter and had more ability to make them a profit."

"We've put into production... a more-usable, customer-friendly aircraft. It's more economical," he adds.

De Havilland stopped producing Twin Otter 300s, which it offered with PT6A-27s, in 1988. Production remained paused until Viking Air acquired the programme and launched the updated Series 400 variant in 2007.

It had been producing the Series 400 ever since, though that aircraft's future has recently become uncertain. In 2020, during the pandemic, Viking Air parent Longview Aviation Capital said it was pausing 400 production and conducting a customer review. Long-

view also shifted the Twin Otter from Viking to the De Havilland brand, which it also owns.

De Havilland's decision to reboot the Twin Otter 300 throws fresh momentum behind the programme.

The 300-G will weigh 136-181kg (300-400lb) less than other previous variants, allowing it to carry more payload, or to fly further with the same payload. Some of that weight saving

comes from the Garmin avionics, which are lighter than the Series 400's Honeywell package, says Sweeney.

The 300-G's maximum payload on a 100nm (185km) flight will be 1,972kg, compared with 1,842kg for a Twin Otter Series 400 operating the same mission.

"With the same rugged airframe, the lighter-weight DHC-6 Twin Otter Classic 300-G will deliver increased payload range and de-

creased operating costs for our customers," says De Havilland chief executive Brian Chafe.

Jetcraft Commercial president Raphael Haddad calls it "the best-in-class commuter aircraft solution".

Like other Twin Otters, the 300-G will be capable of carrying passengers or cargo, and De Havilland is offering it with floats and skis instead of traditional landing gear.



Chafe (left) and Haddad seal the deal at the show yesterday

Elbers: An unforgettable day



magnitude, you evaluate all options.

"This landmark agreement will bring the total of Airbus [aircraft] ordered by IndiGo to 1,330 aircraft. I think that speaks to the deep partnership we are having," he adds.

Between now and the end of the decade, IndiGo's constant acceptance of new A320neos will see it double in size and "this order helps us in long-term planning going forward", says Elbers.

The huge potential of the Indian market means "there is still plenty of room to grow domestically and even more so internationally", explains Elbers. Today the carrier operates 78 domestic and 32 international routes, and the share of overseas

routes will start to rise.

Faury is not concerned about the ability of the airframer to meet the demand, stating that the current supply chain problems are a "short-term challenge" compared with the timeframe of the IndiGo order.

"I don't see it as an issue," he says. "Here it is about the long term."

He adds that, while Airbus is looking to increase A320neo output to 75 aircraft per month, any notion of a further rise in production rate is "completely premature".

Faury was asked if he would consider manufacturing the A320neo in India. "I love this question," he says, describing how Airbus has been significantly expanding

its "value creation" around aircraft manufacturing, engineering and training in the country.

But the symbolic final assembly of the A320neo in India would be a step too far, with the system, and the associated complexity, of 10 final assembly lines for the A320 on the horizon being sufficient to reach rate 75, explains Faury.

And Airbus was not quite finished on day one of the show, with Saudi low-cost operator Flynas firming up an order for 30 Airbus A320neos, which will allow it to grow its international network.

Finally, Air Mauritius confirmed an order for three more Airbus A350s, all of which are the -900 variant.

Continued from page 1 aviation and the ambitions of IndiGo," says Elbers, who notes his airline is only 16 years old and expects to carry 100 million passengers

this year.

Asked if IndiGo considered splitting this mammoth order between Airbus and Boeing, Elbers notes: "If you place an order of this

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Collins Aerospace
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New Rafale standard helps France 'fight connected'

Air force and navy hail type's latest configuration, as operational testing continues

Craig Hoyle

The French military is hailing a major advance with its Rafale combat aircraft, with the Dassault-built type poised to employ a raft of new operational capabilities.

Approved in March for introduction to the fleet and now involved in an operational test and evaluation (OT&E) activity, the fighter's new F4.1 standard represents the first stage of a three-part enhancement process which will further bolster its capabilities by late this decade.

"With this F4 standard France and the Rafale enter a new era of collaborative air combat," says General Arvind Badrinath, head of combat aircraft and Rafale programme director for the nation's Armement General Directorate (DGA).

So far, several in-service aircraft have been brought up to the new standard from the currently operational F3R configuration, including air force B/C and navy M models.

"We modified six aircraft so that they could be used immediately on the [Charles de Gaulle] aircraft carrier and from air bases to test all the new enhancements in an operational environment," Badrinath says.

The update's key advance is around connectivity enhancements within a multi-aircraft formation of Rafales in support of air-to-air and air-to-ground tasks.

"Now we can share all kinds of information from the radar, all the sensors, electronic warfare [EW], and optronics," Badrinath says.

Updates to the Thales RBE2 radar support enhanced ground moving target indication and tracking functionality, while the aircraft's modified infrared search and track sensor provides longer-range passive detection of airborne threats.

F4.1-standard aircraft gain the ability to carry up to three Safran Electronics & Defence 1,000kg (2,200lb)



One of the two Rafales on display at the show

the tactics can be really enhanced now, using these additional features."

OT&E activities will run into 2024, while an initial operating capability standard will be cleared for use before the end of this year. This supports a French schedule to employ modified Rafale Ms operationally on the Charles de Gaulle.

He says early experience during the test campaign has led the military to adopt the motto 'Now fight connected'.

Two F4.1-standard Rafales are on display at the DGA's outside exhibit at the show. An air force example appears with two 1,000kg Hammers and the Talios pod, while a navy M is configured with a full load of eight air-to-air missiles; another enhancement made possible via the latest configuration.

Later this decade, additional functions will be introduced via the F4.2 and F4.3 updates, among them a Thales software-defined radio and satellite communications. Qualification activities on the upcoming standards will be finalised in early 2025 and early 2027.

"There has been an incremental approach since

the beginning of the Rafale programme," Badrinath says. "Each time there have been enhancements in all directions." He notes that the French armed forces provide feedback to the DGA every six months on potential future updates.

Badrinath describes the Rafale F4 as "a very effective aircraft, ready to realise any kind of mission. We have a product that is really ready for the next 10 to 15 years."

And he notes that for current and future international buyers of the multi-role type, "If you buy, you are part of the Rafale club", and able to benefit fully from France's investment in advanced technologies.

All F3R-configured Rafales - including those new examples to be delivered to the French air force this year - will be updated to the new mark by Dassault, the DGA or at a squadron level, with the task taking no more than one week for newly-produced examples.

Meanwhile, Paris is expected to within the coming weeks approve its next Military Planning Law, with the spending plan due to include a final batch of 42 Rafales for France.

Longer term, a future F5

operating standard will in the 2030s add the ability to carry MBDA's in-development fourth-generation nuclear missile - dubbed ASN4G, and the Future Cruise/Anti-Ship Weapon family, which is to succeed the current SCALP-EG and AM39 Exocet missiles.

The French air force operates its Rafale B/Cs along with two other Dassault-built combat types. Operations with the Mirage 2000-5 fighter are scheduled to conclude during 2029, while a recently approved mid-life upgrade for the ground-attack-rolled Mirage 2000D will see that type remain in use until 2035.

Meanwhile, the DGA will next year amend its current organisational structure to add the air force's Airbus Defence & Space A330 Phenix multi-role tanker/transports and navy's upgraded Dassault ATL-2 Atlantique maritime patrol aircraft within the combat aircraft portfolio.

The measure reflects ongoing steps to add expanded connectivity to the support platforms to work alongside the Rafale. "We can be even more effective, and have a global approach," Badrinath notes.

Greg Waldron

Czech aerospace company PBS has signed a memorandum of understanding (MoU) with Ukraine's Ivchenko-Progress to develop a new engine for unmanned vehicle applications.

The AI-PBS-350 engine is designed for use in cruise missiles, anti-ship missiles, and other unmanned systems. It produces 764lb (3.4kN) of thrust and weighs just 51kg (112lb).

A company brochure says it is optimised for "single-mission" UAV systems.

PBS says the AI-PBS-350 will be the most advanced engine of its kind, and that the company is now sharing technical details with potential customers.

The MoU was signed by PBS chief executive Milan Macholan and Igor Kravchenko from Ivchenko-Progress.

"The agreement aims to establish a framework for commercial development, and production co-operation on the new AI-PBS-350 turbojet, which will be a joint product of PBS and Ivchenko Progress and will be available to customers from mid-2023," says the Czech firm.



Shaking on it: Igor Kravchenko and Macholan (right)

PBS to Progress new powerplant for UAVs

"The agreement also includes an extended co-operation agreement to identify new joint commercial and development projects in

the aerospace, defence, and energy industries."

Vadym Omelchenko, Ukraine's ambassador to France, says that Russia's invasion of Ukraine had a

major impact on all Ukrainian companies, but that Ivchenko-Progress has been able to continue its work with the strong backing of the government in Kyiv.

Sitting pretty

Vietjet will furnish its future fleet of 200 Boeing 737 Max 8-200s with Safran's Z200 seat, with deliveries to start in 2024.

The economy-class seats are designed for use aboard aircraft serving short- and medium-haul routes, and are 1kg (2.2lb) lighter than previous-generation seats, which Safran says will help reduce fuel costs and carbon emissions.

The seats include a holder for personal electronic devices and USB ports for charging. The commitment involves the delivery of about 24,000 economy-class seats.

"The selection of the latest-generation Z200 seat affirms Vietjet's commitment to modernising our fleet by investing in the core details of the aircraft's cabin interior to ensure passengers' utmost comfort and convenience," says airline chief executive Dinh Viet Phung.

The 737 Max 8-200 is a high-density version of the Max 8. The carrier ordered 100 in 2016 and another 100 in 2019.

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Boeing and GE open debate on open-fan

Jon Hemmerdinger

Boeing and GE Aerospace remain slightly at odds about the actual fuel-efficiency gains possible with CFM International's in-development open-fan engine.

GE insists the powerplant will burn 20% less fuel than current engines.

But Boeing Commercial Airplanes chief executive Stan Deal doubts that GE's open-fan design, when actually installed on the wings of a future aircraft, will hit the 20% target.

The disagreement came to light in recent days in Paris. GE has been heavily promoting its open-fan engine concept, which CFM International is developing under its Revolutionary Innovation for Sustainable Engines (RISE) demonstrator



programme. GE and Safran Aircraft Engines jointly own CFM.

Deal says GE's 20% target is based on an standalone

than installed," Deal says. "There is always a knock-down effect to get to pure fuel burn."

He declines to specify Boeing's efficiency estimate for CFM's open-fan concept but makes clear the company has not picked an engine design for its future aircraft.

"We haven't selected an engine," Deal says. "RISE is an option. Conventional engines continue... as another option."

Deal says Boeing is pursuing various technologies that, taken together, could help its next aircraft be 20% more fuel efficient, including, a truss-braced wing and greater use of composite materials.

Boeing is widely expected to bring its next aircraft, a 737 replacement, to market in the 2030s.

GE vice-president of engineering Mohamed Ali (pictured), however, insists

engine, not a powerplant integrated on to an aircraft.

"They are reporting numbers uninstalled. Every engine runs better uninstalled

CFM's open-fan engine will be capable of hitting the 20% target even when installed. Such engines allow for significantly wider fans and, hence, greater bypass ratios, without the drag and weight penalties imposed by nacelles.

"When we talk about 20% improvement, it's actually including the installed conditions," Ali says. "That is compared to today's fleet... All of our models are actually indicating that."

But Ali also specifies that reaching the goal will require improvements to how open-fan powerplants are installed on an aircraft.

"Part of the technologies that need to be matured and improved [are]... the installation in the most-efficient way," he says. "That's one of the key aspects [to] it actually working."

GE has placed a huge bet on RISE, positioning the open-rotor concept as its prime offering for the next generation narrowbody jets.

"We need this. The industry does... and this planet does," he says. "We need that level of fuel burn improvements... It's going to be a shame to leave [that] fuel burn improvement on the table."

Raytheon's real cool kit for F-35

Raytheon has conducted laboratory tests on a new electrical and cooling system for the Lockheed Martin F-35 fighter, which the company says can more than double the capacity of the current Honeywell power and thermal management system (PTMS).

Raytheon subsidiary Collins Aerospace is developing the Enhanced Power and Cooling System (EPACS), which Collins says is intended to support the planned Block 4 suite of upgrades to the F-35.

Collins' president of power and controls Henry Brooks says, based on initial test results, EPACS will provide more than twice the cooling capacity of the Honeywell system.

"This development can really carry improvements for the F-35," Brooks says. "That is expected to sup-

port the cooling needs for the remainder of the F-35 life cycle."

The F-35 PTMS works in tandem with the jet's single Pratt & Whitney F135 engine. Siphoning bleed air from the engine, the PTMS provides electrical power and cooling to the fighter's radar and advanced sensor package.

However, as capability improvements have been made to those systems, the onboard power and cooling requirements have grown in kind. That requires diverting additional bleed air to the PTMS, reducing engine performance and accelerating degradation.

"[The F135 is] operating beyond two times the specification of what it was originally operating at," says Jill Abertelli, P&W president of military engines.

While the F-35 can still

function under those conditions, the extra wear and tear has already cost the Pentagon \$38 billion in maintenance costs, according to a recent audit.

The cooling problem will soon become even worse, as Lockheed and the Pentagon prepare to launch the Block 4 series of upgrades – a modernisation package of some 50 improvements that will further expand the F-35's power and cooling needs.

"All of that requires a different level of level of cooling than we've seen before," Brooks notes.

While the Pentagon is yet to establish a formal programme for a next-generation F-35 PTMS, Collins and Raytheon are positioning the EPACS as the successor to the current Honeywell system. P&W is also developing an engine core

upgrade to the F135 that the company says will, in the short-term, address the cooling and engine degradation issue ahead of the Block 4 rollout.



Company claims system will double type's current cooling capacity

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ZeroAvia aims for CRJs

Howard Hardee

Powertrain developer ZeroAvia is targeting its hydrogen-electric technology at regional jets, having identified "clear applications" for Bombardier CRJ-series aircraft.

ZeroAvia said at the show yesterday that the CRJ700 could feasibly be retrofitted with its ZA 2000RJ powertrain, "confirming maximum take-off weight, centre of gravity and structural allowances".

A technical study conducted alongside MHIRJ – a subsidiary of Mitsubishi Heavy Industries and the owner of the CRJ programme – also found that

CRJ550s and CRJ900s are likely candidates for hydrogen-electric retrofitting.

The analysis suggests a hydrogen-electric CRJ could support up to 60 passengers with a range of 560nm (1,040km), which would cover 80% of regional jet flights, the company says. A standard CRJ700 can carry up to 78 people in an all-economy layout on routes of up to 2,000nm, depending on the exact variant.

Val Miftakhov, chief executive of ZeroAvia, tells FlightGlobal that his company's technology has the potential to revitalise regional air travel, saying the lower price of hydrogen fuel and reduced maintenance costs could provide operators with a "significant cost advantage".

"The system would drastically reduce operating costs

by virtue of hydrogen fuel use and reduced maintenance costs, creating opportunities for new routes, as well as more flights on existing routes to match or increase passenger volumes," ZeroAvia says.

Retrofitting the existing fleet of turboprops and regional jets with quieter hydrogen powerplants could also make regional air travel more appealing to the public, Miftakhov says, as "noise is one of the main objections" among residents who live near regional airports.

ZeroAvia in May took delivery of an Alaska Airlines De Havilland Canada Dash 8-400 turboprop, which will be retrofitted with a hydrogen-electric propulsion system; flight tests will begin next year.



Pope and Parent mark the deal at the show

CAE debuts CBTA for Boeing

Boeing and CAE have partnered on a new pilot training programme that will allow customers to access Boeing's competency-based training and assessment (CBTA) curriculum – an innovative flight instruction regimen that uses digitally advanced tools and customised data.

With the agreement, CAE will be the first to offer the CBTA curriculum, and becomes a Boeing authorised training provider, the Montreal-based company said at the show yesterday.

The shift to CBTA focuses on developing and evaluating skills, knowledge and behaviours essential for commercial pilots to operate safely and efficiently, CAE says.

"Boeing and CAE are working together to en-

hance aviation safety and this agreement gives more pilots access to the technology and curriculum through which they acquire the skills and knowledge for peak performance on the flight deck," says Marc Parent, CAE's chief executive.

The training programme will be launched at CAE's locations in India, and will soon be available in all of CAE's 70 training centres worldwide, he adds.

"This partnership expands our competency-based flight training capacity to better meet the needs of our customers worldwide," says Stephanie Pope, chief executive of Boeing Global Services.

Boeing and CAE already work closely in both commercial and defence aviation programmes.



Company says CRJ700 could be retrofitted with its powertrain

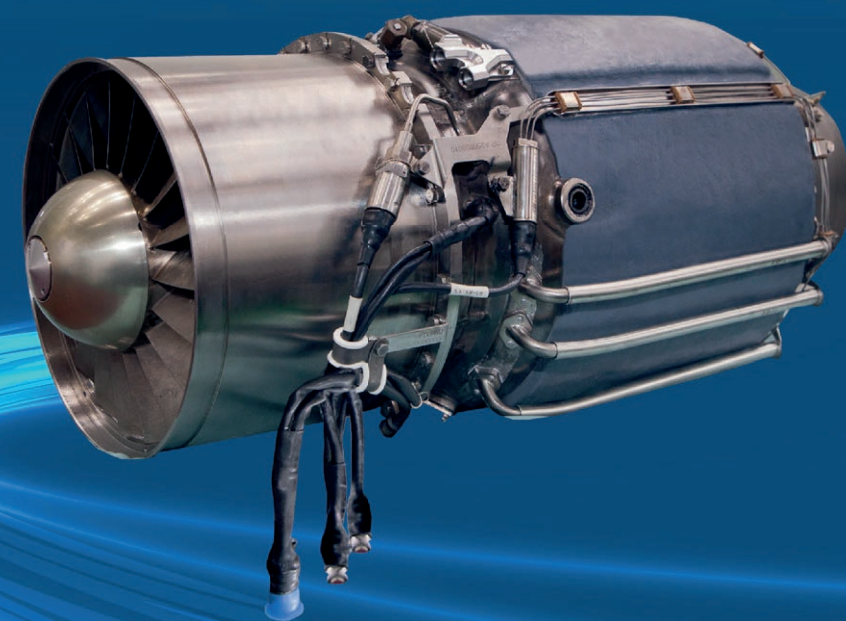


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Elit'Avia adds to Aura order

Dominic Perry

Private Aviation specialist Elit'Avia has added another eight aircraft to its existing 20-unit order for Aura Aero's hybrid-electric Electric Regional Aircraft (ERA).

To be configured in a VIP layout with eight to nine seats, the additional eight aircraft will join Elit'Avia's US fleet, says Michel Coulomb, chief executive.

The Maltese firm in May announced an expansion into the USA, acquiring Newburgh, New York-based Pioneer Business Services.

"In line with our business model and development plan to reduce our greenhouse gas emissions, this is the direction we have decided to take and go with another eight aircraft," he says. Elit'Avia signed an initial letter of intent for 20 aircraft in September last year.

It hopes to turn around half of the total into firm orders "within two to three



Aura Aero president Caussade (left) and Elit'Avia's Coulomb celebrate expanded deal



wire-equipped ERA as a future trainer aircraft for military pilots: "They have to go on a modern aircraft before they go on something like the A400M."

Special forces support missions could also benefit from a "more quiet, more modern, more reliable aircraft", he argues.

Caussade hopes to finalise the ERA's supply chain by year-end as it move towards a 2026 first flight. Service entry is envisaged "before 2030".

At present, Safran is supporting development of the type's hybrid-electric powertrain but there is no decision yet on whether the French company will supply the production aircraft, says chief technical officer Gwenola Robert.

With the latest agreement Aura Aero's backlog now stretches to 338 aircraft, around 25% of which is accounted for by the business aviation segment.

The company is confident of adding another 30 aircraft to its orderbook by the end of the show.

months", adds Coulomb. Jeremy Caussade, president and chief engineer of the Toulouse-headquartered firm, says it has identified

three main markets for the ERA: commuter shuttles, cargo and VIP. In the latter case, he sees an opportunity to "match decarbonisa-

tion and doing business". "We have to work together to make it happen," he adds. In addition, Caussade sees potential to use the fly-by-

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Magnix's Dash to repower industry

Dominic Perry

Electric motor manufacturer Magnix will later this year begin the conversion of a De Havilland Dash 7 to run on battery power as part of a NASA-backed project.

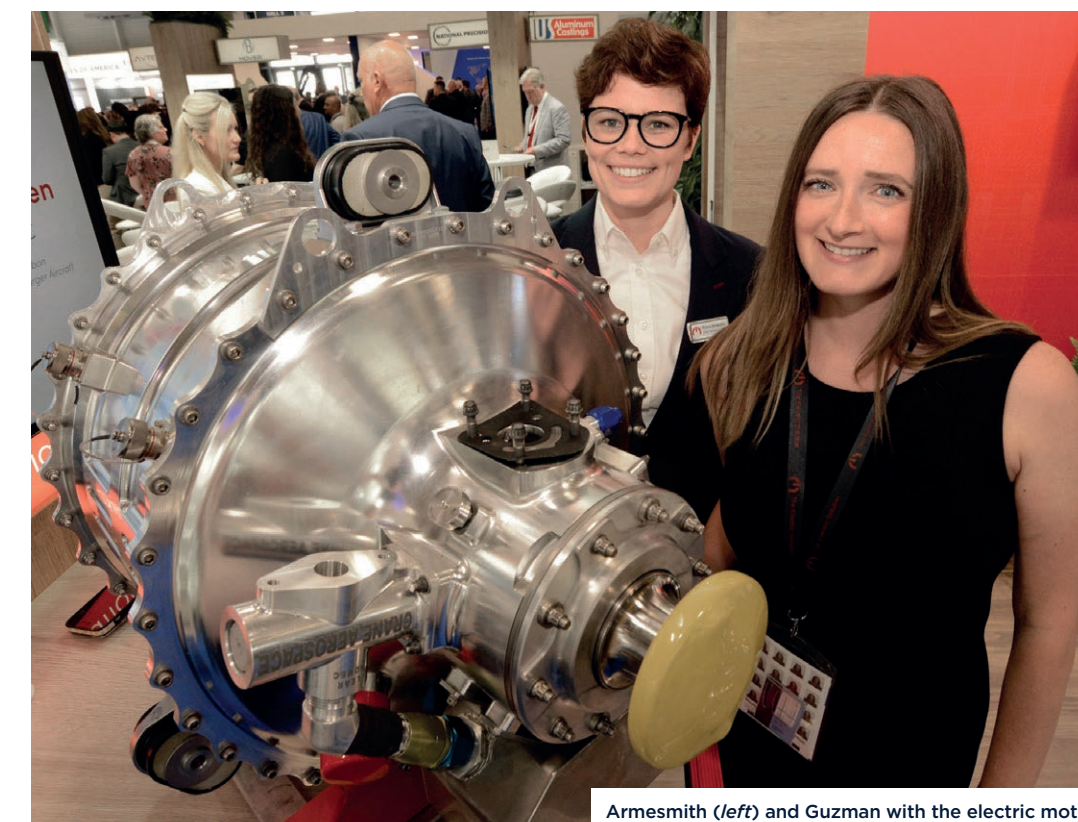
Magnix intends to fly the converted turboprop (C-FJHQ) in 2025, leading to "quite an extended flight-test campaign", says Mindy Guzman, vice-president of manufacturing at the US firm.

Under the Electrified Powertrain Flight Demonstration (EPFD) project, Magnix will replace two of the Dash 7's four Pratt & Whitney Canada PT6A engines with its Magni650 electric motors and two 450kW/h battery packs.

The aircraft has been acquired from Canadian regional carrier Air Tindi, which serves remote communities in the country's Northwest Territories.

Air Tindi will also assist with cold-weather testing of the electric propulsion system, says Magnix chief technical officer Riona Armesmith.

Conversion of the aircraft will begin later this summer, says Guzman, following a



Armesmith (left) and Guzman with the electric motor

strip-out of the cabin and initial baseline flights.

NASA's NEAT electric aircraft test facility in Sandusky, Ohio will also be used to test the Magni650 motors.

Best known for its motors, Magnix has also recently

begun to design the electric storage system as well; the EPFD aircraft is the first application of the entire powertrain, notes Guzman.

Armesmith says being in charge of the whole system enables Magnix to drive efficiencies through integrat-

ing the components "really tightly".

"We can offer something to the market that's a better overall solution," she says.

Magnix was driven to design its own battery packs after dealing with a range of third-party solutions. "We

found that a lot of the battery suppliers didn't really understand aerospace and how to integrate them onto the aircraft," she says. "It just makes sense for us."

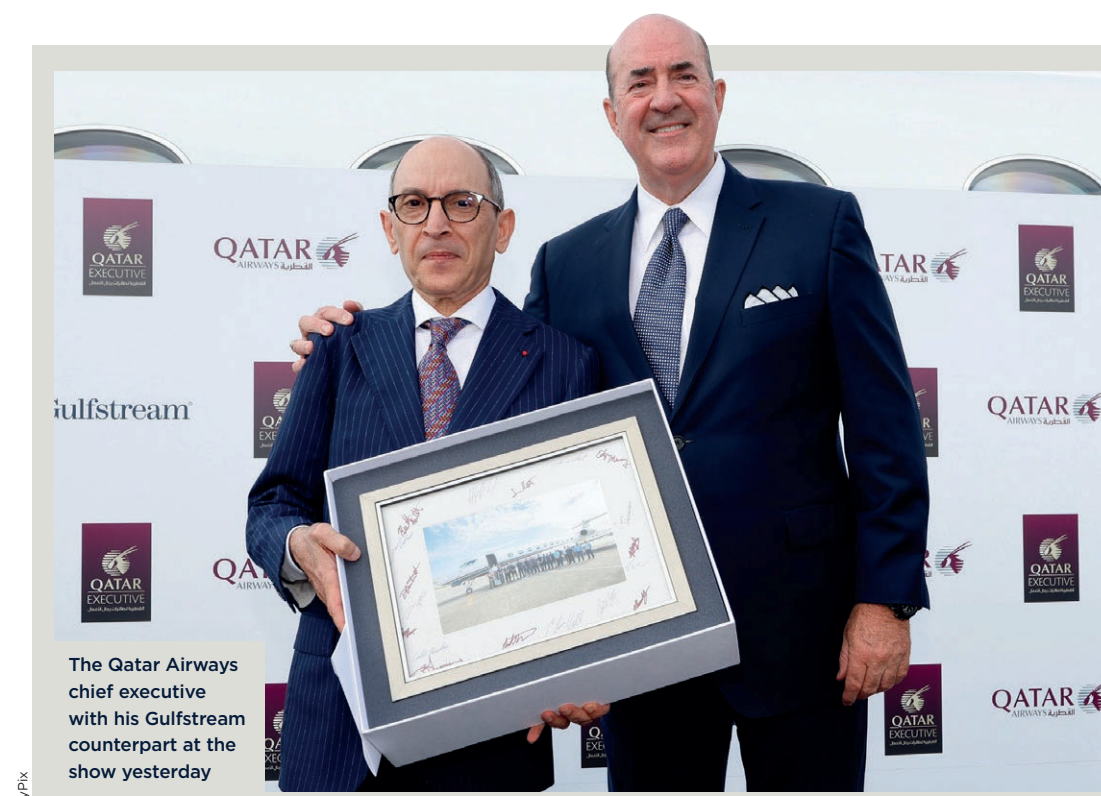
Magnix continues to evaluate different cell suppliers to ensure claimed performance matches real-world testing.

Meanwhile, Magnix continues to track towards US Federal Aviation Administration certification for the Magni650 in late 2025 or early 2026. A pre-certification version of the motor is already flying aboard Universal Hydrogen's converted Dash 8-300.

A first application for the motor will be for an undisclosed customer aboard a Cessna Grand Caravan conversion. "That is the first configuration we are designing for," says Guzman.

Italian airframer Tecnam recently announced it was pausing development of its all-electric P-Volt on concerns that battery technology was developing too slowly to guarantee a "viable" product.

But Armesmith says this is not Magnix's experience with the technology. "We can't agree with that [viewpoint] because we are flying aircraft and seeing totally different results."



The Qatar Airways chief executive with his Gulfstream counterpart at the show yesterday

The G700 is gamechanger, says Al Baker

Qatar Airways chief executive Akbar Al Baker says the Gulfstream G700 on display at the Paris air show will be a "gamechanger" for his group's corporate jet arm Qatar Executive.

"We are pleased to be the first carrier to offer this innovative aircraft to our loyal Qatar Executive customers," Al Baker told media and guests, before touring the G700 with Gulfstream Aerospace president Mark Burns.

Al Baker says the first G700 will be delivered "later this year", the first of an order for 10 of the type, and join its existing fleet of 15 G650s. Of the G700, Burns says the "performance is beyond compare and even better than we anticipated". He adds that it set a world speed record on its journey from Gulfstream's Savannah headquarters, completing the trip in 7h and 19min, powered with a blend of sustainable aviation fuel.

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Boeing readies Max rate rise amid stabiliser snag

Jon Hemmerdinger

Boeing is nearing the latest production rate increase for the 737 Max, taking output to 38 aircraft per month, although its priority is to first address a horizontal stabiliser problem affecting some of the narrowbodies.

"It's pretty soon," Boeing Commercial Airplanes chief executive Stan Deal disclosed on the eve of the show, although he declined to specify the date.

The next rise will bring output from 31 to 38 737 Max jets monthly, adds Deal. "It's sooner rather than later."

Boeing has in the last year been working to increase 737 output in the face of widespread production, supply and labour challenges.

Then earlier this year the airframer disclosed that the horizontal stabiliser brackets on some jets were found to be defective, further complicating the programme and forcing the company to stop delivering some 737 Max 8s and 737NG-based maritime patrol aircraft. Deliveries of 737 Max 9s have continued, however.

The issue involves brackets supplied by Spirit Aero-Systems and has required Boeing to perform rework on an unspecified number of jets. But the manufacturer stresses that the problem does not present a safety concern for in-service aircraft.

Boeing and Airbus have been seeking to ramp production in response to



Manufacturer will take monthly output of the 737 to 38

heightened demand for new narrowbodies.

The US airframer hit the 31-per-month rate one year ago and says it remains on track to deliver 400-450 737s this year.

Last year, chief executive David Calhoun said engine shortages were the chief brake on higher rates of production.

But Deal now says supply chain "pinch points" are not specific to one part but rather "move around" and affect various components.

Boeing aims to have its 737 Max 7 certificated this year, followed by its Max 10 in 2024.

Meanwhile, Boeing is projecting slightly rosier demand for new aircraft over the next 20 years due to factors including expected

airline expansion in emerging markets and a looming wave of retirements.

Released on 18 June, the airframer's 2023 Commercial Market Outlook estimates airlines globally will require 42,595 new jets through 2042 - 1,425 more than Boeing predicted in last year's 20-year forecast.

Boeing has added more narrowbody and widebody jets to its estimate but removed regional aircraft - reflecting a pilot shortage - and cargo jets.

Boeing vice-president of commercial marketing Darren Hulst describes the changes from last year as relatively minor.

"There is a tremendous amount of demand in the market", he says, noting the global airline industry has

largely recovered from the Covid-19 downturn, with the fleet now at 97% of its pre-pandemic size, and passenger capacity at 92%.

The outlook covers only demand for regional, narrowbody, widebody and cargo jets.

Of the 42,525 aircraft Boeing thinks airlines will need through 2042, 7,440 are widebodies - 210 more than in its previous 20-year outlook; Hulst cites strong recent demand for 787s in particular.

Narrowbody aircraft account for 32,420 of the total, up 1,540 units from last year's report.

Hulst points out that airlines have recently delayed retiring older jets because production and delivery of new aircraft have been

held up by supply chain and labour problems.

All those older aircraft will need replacement, Hulst says, adding that some 3,000 jets now flying have reached what Boeing considers retirement age.

The company also sees more demand for narrowbodies from airlines based in regions outside North America and Europe, such as Asia, Africa and the Middle East, where the air travel industry has more room to grow.

Troubles facing the regional airline sector also support increased demand for narrowbody jets, Hulst says, noting airlines having been paring back their operation of regional aircraft due to lack of pilots and spiking pay demands. In response, carriers have deployed larger narrowbody jets on routes previously served by regionals, he says.

Due to that trend, Boeing now anticipates airlines globally will need only 1,810 new regional aircraft over 20 years - 310 fewer than in last year's report.

Boeing also trimmed its 20-year demand forecast for new cargo aircraft to 925, down from 940 one year ago; Hulst says the cargo segment cooled recently following a boom early on in the pandemic.

"This year, things have taken a little bit of a breather," Hulst says of the air cargo sector.

Boeing now expects the global airline fleet will comprise 48,600 aircraft by 2042, up last year's prediction of 47,080 at the end of 2041.

SkyAlps to trial Tamarack winglets

Alfred Chua



Tamarack Aerospace is to modify a De Havilland Canada Dash 8-400 with its active winglet system over the next year, as part of a joint venture with Italian regional operator SkyAlps.

Under the agreement, SkyAlps will dedicate one Dash 8-400 turboprop to Tamarack for the eco-Smartwing modification.

The demonstrator is expected to be flying "in the next nine to 12 months", says Tamarack chief executive Nick Guida (pictured), paving the way for eventual certification, which Guida says should happen in about two years.

"After certification, the aircraft will enter service with SkyAlps... we will also get on the schedule with them to retrofit [the rest of their fleet]. We'll be taking orders from other airlines too," Guida adds.

SkyAlps chief executive Alex Spinato says the aircraft will be ferried to Tamarack's Sandpoint, Idaho headquarters for modification works. The operator currently has a fleet of four Dash 8-400s, and expects to have an operational fleet of 14 turboprops by mid-2024.

The Smartwing consists of a wing extension, composite winglet and an active load alleviation system Tamarack calls Atlas.

Separately, Guida says progress "is going well" on the development of its active winglet system for the Airbus A320. The company first disclosed its intention to bring its Smartwing system to the narrowbody jet - offering a potential fuel-burn reduction of up to 15% - in October 2022.

"We are working with many airlines now, it's going well... things are accelerating and I think in the next few months we will have an official launch," he says.

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Comac's back after C919 service debut

Chinese airframer Comac hopes to raise its profile among potential airline customers, as it makes its first international appearance since the Covid-19 pandemic at this year's Paris air show.

The Shanghai-based airframer has models of its ARJ21 regional jet as well as its C919 narrowbody on display. An accompanying

panel highlights details of the in-development long-range widebody, the CR929 which Comac is working with Russian airframer United Aircraft.

Comac says it intends to "undertake targeted market promotion activities... and forge connections with potential customers".

Comac's presence at the show comes less than a month after its C919 narrow-

body made its commercial debut with launch customer China Eastern Airlines.

The programme, which had been beset by years of delays, was certificated by Chinese regulators in 2022.

The airframer has commitments for more than 1,000 C919s, and 775 ARJ21s. More than 100 ARJ21s are in service, including with the country's three larg-

est operators Air China, China Eastern and China Southern Airlines, as well as Indonesian operator TransNusa Airlines.

Comac launched its ARJ21 freighter conversion programme in January after clinching certification, and has two customers for the type: YTO Cargo Airlines and Zhongyuan Airlines.

Looking for role for Aarok

French company Turgis & Gaillard has unveiled a developmental medium-altitude, long-endurance (MALE) unmanned air vehicle (UAV) named Aarok.

The company has discussed Aarok with its home nation's military and parapublic agencies, says Jean-Francois Ferlet, a military advisor to the company and a former French air force general.

Turgis & Gaillard will also discuss the programme with foreign delegations at this week's show.

Ferlet says the first flight is planned before the end of 2023, but with a pilot on board. The company will work with regulators to define the path towards unmanned flights. Should Aarok be adopted by a customer, initial operational capability could be attained by the end of 2025. Ferlet says

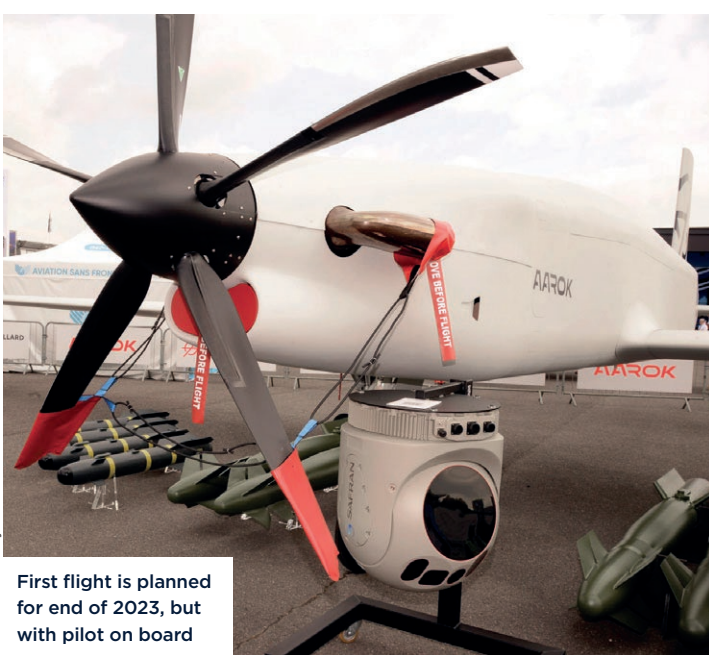
that the system will be comparable to the General Atomics Aeronautical Systems MQ-9 Reaper, which is already in service with France.

Aarok will be able to perform "multi-domain operations against peer competitors" and monitor large swathes of land and sea.

Ferlet says that while the UAV's 1,200hp (883kW) turboprop engine, landing gear, and other systems are off the shelf, the airframe is entirely new.

Payloads can include a Safran electro-optical/infrared sensor, synthetic aperture radar, signals intelligence, and electronic warfare systems.

An armed version is also envisaged, equipped with Safran's AASM Hammer guided munition and the Lockheed Martin AGM-114 Hellfire anti-tank missile.



First flight is planned for end of 2023, but with pilot on board



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US lawmakers: 'We're standing by Ukraine'

Jon Hemmerdinger

A US delegation of lawmakers is at the show stressing to European allies that the USA will stand firm in supporting Ukraine's defence against Russia, including with additional financial aid.

The members of Congress are also making clear that they view the USA's backing for Kyiv as reflecting its broader commitment to counter potential Chinese aggression against Taiwan.

"We are in it for the long haul," Democratic US Senator Joe Manchin says of the USA's support for Ukraine. "Being the superpower of the world, we are going to defend and support freedom [and] democracies anywhere in the world." Manchin, who represents West Virginia in the upper house, was among more than a dozen US Senate and House lawmakers at the show on 19 June - a group that Aerospace Industries Association chief executive Eric Fanning calls the



Manchin: We are going to defend and support freedom

largest-ever Congressional contingent to attend Paris. "What we see here is an opportunity for us to showcase the role that the United States is capable of playing, to demonstrate the

projection that we're able to provide a dangerous world," adds Kansas Republican Senator Jerry Moran. "This is a particularly important time for the United States to demonstrate its

support for the defence aspect of the show." Moran says the US delegation is taking that message directly to European leaders, noting that lawmakers plan to meet today

with French president Emmanuel Macron. "A role that we are playing is reassuring Europeans that the United States is in Ukraine - or assisting Ukraine - for the long term."

The administration of President Joe Biden has already provided tens of billions of dollars in support to Ukraine, including by supplying the country with advanced surface-to-air missiles and other military equipment.

Some US lawmakers say they support keeping those supply lines flowing with additional aid provided via future supplemental spending bills.

But the USA's commitment to Ukraine is provided with an eye to events on the other side of the world.

"I think this is an opportunity for us... to reiterate that the world has a lot at stake in what happens in the Taiwan Strait," says Moran. "What the West does in Ukraine is one of the greatest determining factors in how the rest of the world responds to the challenge in China."

No revamp plan for A380, Airbus tells Emirates

Airbus is unmoved by Emirates Airline president Sir Tim Clark's plea for a modernised version of the A380, insisting that its A350-1000 is a suitable successor as well as a strong candidate for Boeing 777-300ER replacement.

Emirates is the largest operator of A380s and Clark, undeterred by Airbus's cessation of A380 production, still believes a re-engined version would be highly efficient.

But Airbus is not considering aircraft larger than its A350-1000, said wide-body programme senior vice-president Florent Massou, in a pre-Paris air

show briefing, pointing out that even the proposed stretched 'A350-2000' is not being entertained.

"There is no -2000 study ongoing at the moment," he says. "That was done in the past in very specific conditions."

"Today we believe the -1000 is the right size, in particular to make sure the airlines operating the -900 can [increase capacity or] replace the 777-300ER."

He says the -1000 is "large enough" and the "perfect size" for the 777-300ER replacement wave ahead, adding that the Airbus twinjet has "more range and much better efficiency".

"This is the natural platform to take the lion's share of 777 replacement. This is where we see the market in the next few years."

Massou says Airbus is working closely with Emirates to ensure the A380 continues to fly with the Dubai-based carrier "for as long as possible".

"We'll deliver the A350-900 [to Emirates] next year with a brand new configuration and this will be an outstanding cabin and outstanding aircraft for Emirates," he says.

Airbus is continuing to tweak the A350 to enhance its performance,

introducing a wider interior - enabling 10-abreast economy-class cabins - and reworking the forward and aft door areas to expand crew working space.

Massou says the twinjet will benefit from weight-reduction efforts from 2026 - trimming 400kg from the -900 and 600kg from the -1000 - through the use of new materials and new assembly processes which are saving "grammes and kilogrammes, a bit everywhere on the aircraft".

Software improvements, he adds, enable new take-off configurations and better landing-gear retraction. Airbus commercial air-

craft head of marketing Stan Shparberg says the A350-1000 is the "flagship product" for the airframer, adding: "We believe it's got the right ratio of risk versus reward, the number of seats in premium and economy configuration."

He stresses his enthusiasm for the A380 as a passenger, but states: "Do we really need to close the gap to the A380? Do we need to have double-deckers flying out there?"

"I think the A350-1000 is very capable to take over from the A380s and 777-300ERs and be the aircraft of choice for a lot of our customers."



Emirates has long pushed for an updated version of the superjumbo

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Honeywell pumped up for 'staggering' SAF demand

Kerry Reals

Honeywell Aerospace is seeing "staggering" demand for sustainable aviation fuel (SAF) and expects to play a key role in scaling up production through technologies it has developed to support three alternative fuel pathways.

The company has sold 35 licences for its UOP Ecofining technology, which converts used cooking oil, waste fats and greases into SAF. If all of those licences result in SAF production facilities being built, "then we're talking about 2-4% of the jet fuel market that we can supply from those projects alone", Honeywell director of government relations Willie Coetzee tells *Flight Daily News*.

In addition to Ecofining, Honeywell recently introduced UOP eFining – a fuel processing technology that converts eMethanol, derived from combining carbon dioxide with green hydrogen, into e-fuels. US-based HIF Global has signed a commercial agreement to deploy eFining at its second e-fuel facility, which aims to make about 11,000 barrels of eSAF a day by 2030.

Coetzee says that Honeywell is "engaging with several players and projects both in the UK and Europe" about the potential deployment of its eFining technology on the other side of the Atlantic. If these discussions result in two to three European plants on a similar scale to HIF Global's planned US facility, "we are satisfying the target that we have for eSAF in Europe by 2030", says Coetzee.



Coetzee: feedstocks will become more limited

"By applying these large-scale technologies that we can and are able to do, we actually believe there's quite a good path towards getting to those targets," he adds. The European Union's ReFuelEU Aviation legislation includes a SAF blending mandate that will require a minimum SAF uplift at EU airports of 2% by 2025, 6% by 2030, 20% by 2035 and 70% by 2050. Of these amounts, 1.2% must be power-to-liquid e-fuels in 2030,

rising to 5% in 2035 and 35% by 2050. Coetzee acknowledges that the green hydrogen value chain "really needs to scale up in the next couple of years" in order for sufficient volumes of hydrogen generated using renewable energy to become available for the production of eSAF. However, he sees "positive movement" on the European side on enabling the green hydrogen industry to scale up.

"It would definitely be a constraint and I believe it's one of the bottlenecks that we need to look at, but there's a lot of momentum behind it," says Coetzee.

On the cost side, he notes that "anything where you use renewable feedstocks is going to be, initially at least, more expensive than your fossil alternative". However, as SAF production scales up he expects costs to come down.

Honeywell's renewable fuels portfolio also includes ethanol-to-jet technology, for which it has secured a partner in the USA. In addition, the company is investing in the forestry and agricultural waste fuel pathway, which Coetzee sees "playing a role in certain geographies". All of these different pathways will be required to help the aviation industry decarbonise, but limited biological feedstocks on the HEFA (hydrotreated esters and fatty acids) route mean that it will likely be eclipsed by other pathways in the future.

"Over the next decade or so, feedstocks will become more limited from the used cooking oil and waste fats and greases perspective, and then we'll start seeing alternative pathways overtaking that traditional pathway," says Coetzee.

Riyadh Air sets sights on Europe

Riyadh Air chief executive Tony Douglas (pictured) expects the ambitious start-up to be connecting the Saudi Arabian city to every major capital city in Europe as part of its aim to serve over 100 destinations by 2030.

The Saudi carrier will launch operations in 2025 and Douglas says it expects to start detailing network plans next year. "We will probably get to first quarter of next year, as we start getting closer to ticket window for the widebody, to explain what the network profile looks like," he says.

Douglas adds: "It's not going to be terribly difficult to work it out. In simple terms, it will probably be every major capital city in Europe, plus the obvious USA touchpoints – particularly on the eastern coast. We'll be talking about all the major capital cities in the far east, and then coming progressively back to the Middle East."

Douglas was speaking on the eve of the show, where the carrier has a Boeing 787-9 showing its livery for the first time on the static aircraft display. Riyadh Air already has an order for 39 Dreamliners and options on another 33. It is also negotiating a large narrow-

body aircraft order, though that will not be announced at Le Bourget.

"The reason why we went widebody first is in terms of connecting the Kingdom to the world, the biggest gaps are on those kinds of segments," says Douglas.

"The 787-9 deliveries start in 2025. We've got a delivery schedule with Boeing and the trick with this over the next two years is literally every week, every month... making sure they continue to deliver on all of those, because as we get them, they will be going straight into service."



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Ontic celebrates latest Triumph

Ontic is at Paris after a post-pandemic investment spree that has seen it add a former Triumph business in the UK, more than a dozen product lines, and capacity at its two US sites.

Chief executive Gareth Hall says the company, which licenses the intellectual property to manufacture and supply out-of-production components from the likes of Collins, GE Aerospace, Honeywell, Safran and Parker, will be hoping for opportunities to add to its portfolio this week.

Ontic says it had a "record-breaking" 2022. It took ownership of the former Triumph site in Staverton, Gloucestershire, near its Cheltenham, UK headquarters, at the end of the previous year. The acquisition gave it a portfolio of hydraulics components and a position on platforms including the Airbus A330, BAE Systems Hawk and Saab Gripen, as well as adding 100 employees.

The company also made "multi-million dollar investments" in its existing infrastructure, expanding its Creedmoor site in North Carolina, and creating more floor space at its Chatsworth facility near Los Angeles. During the year, it says it secured 13 exclusive licensing agreements.

Previous owner BBA Aviation – owner of the Signature Flight Support network of private aviation terminals – divested Ontic to private equity firm CVC for \$1.37 billion in 2019. Hall says the new owner has taken a "long-term approach, really allowing us to invest in opportunities when we see them, and add value to the business".



The C-130 is among the Lockheed Martin types used for firefighting

Lockheed takes the fight to fires

Ryan Finnerty

Lockheed Martin, the military airframer best known for advanced fighter aircraft such as the F-35 and F-22 Raptor, is applying its battlefield expertise to a different form of combat: the war against wildfire.

Climate projections indicate warmer years ahead for Earth, which will bring worsening droughts and more destructive fire seasons across parts of the globe. The challenge was particularly apparent during the opening week of June, when early summer blazes in Quebec blanketed major US cities in a haze of wildfire smoke.

Lockheed chief executive Jim Taiclet describes the hazard posed by such fires, including both the physical destruction and the environmental impacts of smoke,

as part of the 21st century security challenge companies like Lockheed are trying to address.

"The mission here is how can we help predict, detect and suppress wildfires much better than we ever could before, with what we have today?," he says.

Wildland firefighters from as far away as South Africa have flown to Canada to help combat those fires in Quebec. Lockheed now wants to take its experience enabling battlefield commanders and pilots to communicate and make decisions and apply similar tools to the hazardous work of fire crews.

"Just as soldiers or fighter pilots need information delivered quickly and accurately to engage threats, so do wildland fire commanders, analysts and suppression teams to make effective decisions as conditions change," says Amr Hussein, vice-presi-

dent of C4ISR programmes at Lockheed Martin.

Hussein, who notes that he lives in the USA's fire-prone state of Colorado, thinks tools Lockheed has developed for intelligence gathering and communications on the battlefield can be applied to detecting fires and deploying response resources.

"We're looking at how advanced technologies like artificial intelligence, machine learning and aerial planning decision aids can accelerate a crew's ability to analyse data from space, air and ground assets," Hussein says.

Lockheed's theory is that these technologies will provide "near real-time actionable intelligence" to fire bosses to help them make "faster, more informed decisions". Such efforts could include locating and mapping fires more quickly and developing prediction tools that can

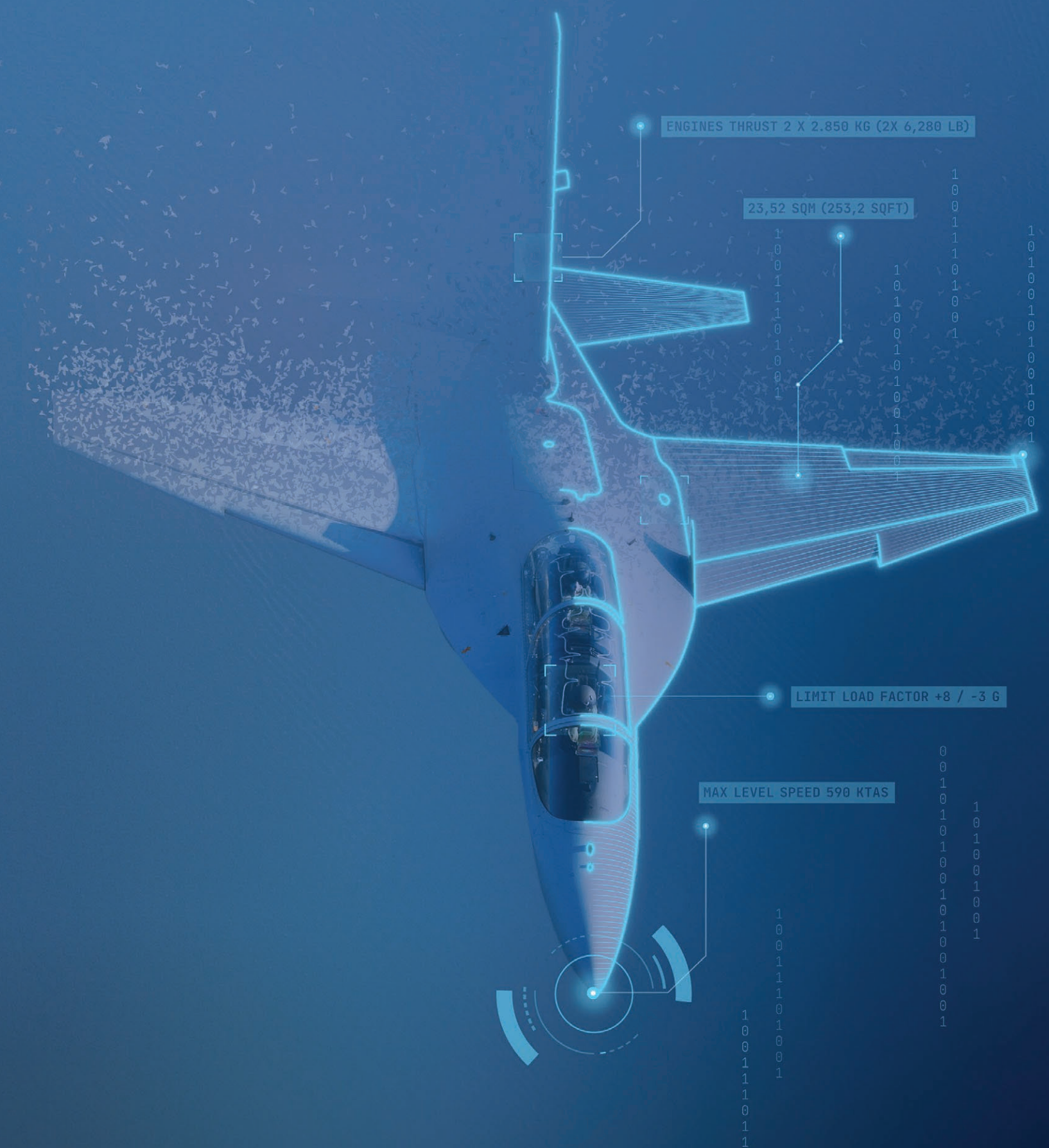
more accurately forecast a fire's behaviour and path.

Hussein says this is a natural progression for Lockheed, which already produces aircraft used in fire suppression, including the C-130 Hercules tactical transport and S-70i Firehawk helicopter – a variant of subsidiary Sikorsky's venerable UH-60 Black Hawk.

Fighting large forest fires is a massive enterprise, often involving fleets of modified Boeing DC-10 and C-130 water bombers dropping chemical retardant or water on top of hot burning zones.

Smaller aircraft deploy paratrooper-style teams of firefighters called smoke jumpers into remote or hard to access fires. These parachute firefighters jump from a variety of platforms, according to the US Forest Service, including the de Havilland Canada DHC-6 Twin Otter, Short C-23 Sherpa, CASA C-212 Aviocar and Dornier 228.

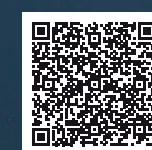
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Spirit AeroSystems strengthens defences

Ryan Finnerty

Spirit AeroSystems, the Wichita-headquartered manufacturer of fuselages, wing sections and other aircraft components, says it is steadily progressing toward its goal of expanding revenue from defence programmes.

Mark Miklos, senior vice-president of defence at Spirit, says the company expects 15% of its 2023 revenue to come from production of military equipment.

"Our pipeline is really becoming very well established," Miklos says in an interview ahead of the show.

The 15% figure represents substantial growth of Spirit's military business. As recently as 2020, the company derived more than 90% of its revenue from supplying commercial airframe components, according to Miklos.

Spirit has set a goal, by the end of this decade, for 40% of its revenue to come from defence sales, with another 40% coming from commercial aviation sales and 20% from aftermarket products and services. An internal realignment announced in 2021 aimed to enable that transformation.

Spirit now supplies parts for some of the highest-profile military aircraft in development or production, including Northrop Grumman's



Spirit supplies structures for some of the highest-profile military aircraft, including Sikorsky's CH-53K

B-21 stealth bomber, Sikorsky's CH-53K heavy-lift helicopter and Boeing KC-46's aerial tanker. Spirit was also named a supplier for Bell's V-280 tiltrotor, which the US Army selected to be its next-generation troop-carrying assault aircraft.

Miklos says his company's involvement in Bell's V-280 programme is indicative of how Spirit has achieved such rapid growth in its defence business. The company has adopted a design-build approach to military manufacturing, working with prime contractors to engineer Spirit's portion of aircraft.

"We believe our capabilities enable speed - to be able to scale next-generation programmes for our customers quicker than they would be able to do alone," Miklos says.

He notes Spirit designed and assembled the all-composite fuselage for the V-280 in under 22 months. To achieve such speed, Miklos says Spirit engineers are heavily involved with design work undertaken by its customers.

"We need to be a part of the development at an early stage," he notes. "That allows us to design for man-

ufacturability as early in the development as possible."

Spirit has long been a prime supplier of major components found on commercial passenger aircraft. It produces wing elements for Airbus A320s, A350s and previously A380s, and manufactures fuselage sections for numerous Boeing jets, including 767s, 777s and 787s.

But the 737 programme has long been most important to Spirit. The company makes 737 fuselages - work that accounted for about half Spirit's revenue prior to the 737 Max's 2019 ground-

ing. That share fell to 19% in 2021, prompting Spirit to realign its business that same year in a bid aimed at helping it expand into new markets, including defence.

Spirit is also using Paris to promote its development with NASA of advanced composite manufacturing technologies.

The company is performing the work under NASA's Hi-Rate Composite Aircraft Manufacturing (HiCAM) project, which seeks to solve challenges associated with high-rate manufacturing of composite fuselage structures.

The aerospace industry views such structures, which weigh less than metallic components, as a means to improve the efficiency of future aircraft. But making composite structures is expensive and technically challenging, especially at the high rates at which Airbus and Boeing are expected to produce their next narrowbodies.

"Spirit is leveraging extensive experience as a global leader in composite structures technology development and our commercial design-build production capabilities to take a leading role in NASA's HiCAM public-private partnership," says Spirit chief technology officer Sean Black.

Spirit will help "develop the next generation of composite primary airframe structures, which have the potential to help reduce aviation carbon emissions", he adds.

The HiCAM project's priorities include development of thermosets, thermoplastics and resin-infused components. Other companies to participate in HiCAM include Boeing, Collins Aerospace, Lockheed Martin and Northrop Grumman.

Getting it write



FlightGlobal journalists scooped two accolades at Sunday's 2023 Aerospace Media Awards, with Asia bureau chief Greg Waldron (right) named Aviation Reporter of the Year, and consulting editor Mark Pilling winning for Best Propulsion Submission. The ceremony takes place every year, alternating between Paris and Farnborough. Several other members of the FlightGlobal team were shortlisted.

Conflicts sparking boom in UAVs: Teal

US consultancy Teal Group predicts that the annual value of military unmanned air vehicles (UAVs) procured will grow to \$16.4 billion in 2032, up from \$12.1 billion in 2023.

In a forecast released on the eve of the show, Teal notes that unmanned aircraft are increasingly important in conflicts, ensuring that the UAV space will be one of the aerospace industry's most dynamic areas over the next decade. It predicts total spending over the 10-year period will top \$162 billion.

Whereas UAVs were once solely the preserve of major powers, they have played a



Sector remains dynamic area

"remarkable role" in large and small conflicts over the last decade. "The global military drone market remains dominated by the United States and Israel," says senior analyst Steve Zaloga. "But new players such as China and Turkey are challeng-

ing the United States in its traditional markets in the Mid-East. Their drones enjoy a price advantage and are sold without Washington's intrusive requirements."

The study also forecasts significant growth in the market for UAV payloads.

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Parker describes Paris as 'coming out party' for enlarged group following its \$8 billion transatlantic sloop for Meggitt

No brakes on growth

Kerry Reals

Parker Aerospace is looking forward to showcasing a range of next-generation technologies aimed at improving sustainability, during what will be its first major event as a combined entity following Parker-Hannifin's £6.3 billion (\$8 billion) acquisition of UK-based Meggitt last year.

"How nice it is to be together at our coming out party," says Parker Aerospace vice-president business development and global support Austin Major. "It's the first time we've properly introduced ourselves as one integrated solutions provider."

"When you look across from tip to tail, including the engines, we've got the right products and technologies that are flying today to really support the customers' products throughout the life cycle. We're incredibly thrilled to be able to present it together for the very first time."

To close the acquisition and satisfy competition concerns, Parker-Hannifin had to divest its aircraft wheels and brakes division, which was sold to aerospace firm Kaman, and agree to retain key operational capabilities in the UK as well as increase research and development expenditure in the country.

Major says that "we are absolutely supporting and, in many cases, are ahead of our commitments to the UK government, relative to the people, facilities, division names et cetera". While the sale of the wheels and brake division was "a big loss" for the Parker-Hannifin team, "Kaman is a great home for that business", he says, and "the bottom line is, we have a wheel and brake division now that's part of the Meggitt acquisition that we're happy with".

The process of combining the two companies' operations is proceeding smoothly and synergies are beginning to emerge.

"We're delighted at the combination and we've made really good progress on the integration activity to date," says Major. "I think we're ahead of schedule overall and we're really starting to see some synergies."

Parker Aerospace is bringing a combined portfolio of 13 key technologies to Paris, many of which are focused on making the aviation industry more sustainable. Among these are electric motor-operated pumps which, the company says, are lighter in weight and more energy-efficient than mechanically-operated systems.

"On the Parker legacy, our core



Major: 'Thrilled' to be presenting two businesses' product lines together for the first time

products are actuators, pumps and valves, and those used to be operated mechanically and not electrically. So we've had a lot of focus in the electrification area, primarily motors and controllers," explains Parker group vice-president technology and innovation Tracy Rice. "Over the last three years, we've been developing families of motors and controllers for these pumps, actuators and valves."

On the Meggitt side, the company developed an e-brake system for the Airbus A220, which integrates brake-by-wire technology with an electromechanical operating system.

"I think we're the only supplier out there that can offer the total, complete e-brake system including the wheels, tyres and brakes themselves, so we're really proud of that and that will be showcased," says Rice. "It's all about reducing carbon emissions and making the environment cleaner, so we'll [also] showcase some of the advanced composites we're working on that make aircraft lighter so they burn less fuel."

Parker is also developing a family of batteries which store energy and can be used to power an aircraft's systems before the auxiliary power

unit (APU) is switched on. The company's Tucson, Arizona facility is "funding several projects" in this area, says Rice, with a view to supporting large single-aisle aircraft and then smaller business jets.

"We're engaged with two manufacturers - Airbus is one and Gulfstream has also expressed interest," he says. The initial battery in this family is at technology readiness level (TRL) 4 or 5, he adds, meaning "it will probably be a year to a year-and-a-half at most for it to be ready to at least go on a development programme for a customer".

The company has also patented a new fire suppression agent known as Verdagent, which it is offering as a more environmentally-friendly alternative to halon.

"It's developed and certified, it's just a matter of working with one of the major OEMs and introducing it on an aircraft," says Rice. Verdagent is suitable for both widebody and single-aisle aircraft, although he thinks that "the first application will be a twin-aisle".

"We're ready, it's just a matter of how [the OEMs] can fit it into their retrofit or new aircraft programmes," he adds.

Another area of focus for Parker Aerospace is that of digital aircraft monitoring systems based on next-generation pressure sensors. The company says it has developed accurate, reliable sensors which provide health, system safety shutdown and over-pressure protection monitoring.

"I think with the sensor technology that Meggitt brings to Parker, we will make our systems and products smarter from a health-management standpoint," says Rice.

The company has been following developments in sustainable aviation fuel (SAF) and hydrogen as the aviation industry looks for ways to meet its commitment to achieve net-zero carbon emissions by 2050.

"We think SAFs will be first so we've been doing a lot of testing related to seals and compatibility with these new sustainable aviation fuels," says Rice. Parker is also working with Airbus on its ZEROe future hydrogen-powered aircraft programme, and announced plans earlier this year to develop an energy buffer (eBuffer) to support the ZEROe demonstrator.

"We have both new products that we're developing that touch hydrogen and other products like the energy buffer, which supports the new hydrogen-powered propulsion," says Rice.

"I think it's a longer-term solution but we're excited to support Airbus in their journey." ▶



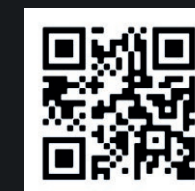
Meggitt developed an e-brake system for the A220

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David Shilliday, vice-president and general manager, urban air mobility & unmanned aerial systems at Honeywell Aerospace, explains how the sectors are becoming increasingly important for the group

Advancing air mobility

Q How do urban air mobility (UAM) and unmanned air systems (UAS) fit into Honeywell Aerospace's business, and what technologies do you offer or are you hoping to offer in this space? Who are you partnering with?

A Our work in this space is growing out of our existing technology building blocks from the legacy Honeywell aerospace business. It's a great opportunity to apply Honeywell technology in creative ways to meet the needs of new and emerging markets. There are also exciting opportunities in developing areas that currently don't exist within the aerospace industry today, including autonomy technology, detect and avoid, and ground control station.

Needs of the UAM/UAS market fit well with Honeywell's values of safety, precision, and reliability. Our offerings include avionics, electric propulsion, advanced cooling systems, actuation and others. We partnered with Denso on the development of electric motors for propulsion. Denso's legacy in the automotive market makes them a great fit for the scale, cost, and reliability this business demands. From a customer point of view, publicly announced OEM partners include Archer Aviation, Vertical Aerospace, Lilium, Supernal, and eAviation.

Q What is Honeywell's vision of UAM in the 2030s and beyond? What do you envisage being the main technical, regulatory and commercial challenges this nascent sector will have to overcome, and how will Honeywell help them do this?

A We have a north star in helping to advance the air mobility market in two ways: moving people and parcels. Our vision will enable door-to-door travel up to 100 miles away in 45 minutes or less for people, and expanding commerce and logistics offerings with same-day package delivery in urban areas using autonomous drone technology.

Primary challenges facing the industry are currently regulatory, though the amount of capital required is not insubstantial. There are unprecedented changes in the technology, mission and expectation for these new aircraft and regulators have the daunting challenge of setting frameworks to ensure this becomes an enduring change.

At Honeywell, we are leveraging existing relationships with regulators in several countries to establish and promote a set of agreed working practices that will form the basis of this industry for many years to come. On 18 July, we will be hosting the second annual Advanced Air Mobility Summit in Washington DC where we bring together stakeholders from across the ecosystem to drive positive industry change. We invite vehicle OEMs, lawmakers, regulatory bodies, and system suppliers to discuss the regulatory landscape.

Over the past few years, a lot of this work has moved from imaginative paper designs to flying aircraft. The technology challenges are appreciated, but those are not insurmountable hurdles, and many of our customers have a clear path to market in the next two or three years.

As this segment evolves, there can be many OEMs who can be successful in this space, and we're



pleased to be working with several of them. We predict that by the end of the decade, last mile delivery by autonomous drone and a ride in a flying taxi will not just be possible, it will be readily available and something business and public users will come to expect.

Q Unmanned air systems have made their mark in a number of conflicts since the start of the century, but what is their potential in the commercial market? Again, what are the hurdles that Honeywell will help the industry surmount?

A We recognize opportunities in the cargo and defence markets, which have in many cases provided a proving ground for these technologies. These markets

allow OEMs and operators to verify the performance of autonomous technology. Elements such as radar, navigation, and detect and avoid sensors will be proved long before they are utilized on commercial applications with humans onboard. Piloted air taxi flight will be how the passenger-carrying vehicles enter into service, though to scale and drive profitability, when safe, autonomous functionality will be brought to this space as well.

A major hurdle to ubiquitous autonomous operations is a capable navigation and sensor suite, and, as a business that is famous for developing safe technologies used across the globe, Honeywell has decades of proven experience and technology and is now focused on advanced detect and avoid offerings.

Q Honeywell has dabbled with being a platform company in these segments. Do you see the company's role these days as being an agnostic supplier/partner to platform developers?

A Yes. Our mission is to make the OEMs and the industry successful. That can be by supplying products as well as supporting regulatory or technical discussions more broadly across the industry. We recognize that the best place to leverage the unique capabilities we bring to this market is to do that as a system provider. By being able to provide integrated systems for these new vehicles, we can become a supplier of choice for our current and emerging customers, being easy to work with, reducing schedules and technical risk, and bringing our legacy experience in certification to these new players.

Q What are you showing or focusing on this week at Paris in the UAM/UAS arena?

A We will be talking extensively with existing and prospective customers about avionics offerings that can evolve from piloted missions to simplified vehicle operations to autonomy, reliable, power-dense electric propulsion systems, state-of-the-art flight control and actuation systems, and advanced green cooling systems for cabins, cockpits, and batteries that can provide passenger comfort and extend battery life. We will also continue our thought leadership during advanced air mobility panels, discussing the impact of UAM/ UAS advancements, technology and business challenges. ▶



Honeywell says needs of UAM sector align with its values of safety, precision, and reliability

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Forget appealing to the air travel elite with luxury washrooms and in-flight entertainment. Those inspecting the upmarket corporate jets at Paris this week are interested in rather different mission capabilities

Something special

Dassault says its fighter and Falcon aircraft represent its 'dual skillset'



Murdo Morrison

At private aviation shows such as EBACE and NBAA, the manufacturers of the grandest business jets tout the qualities of their aircraft to the rich, powerful and famous – and those who cater for them. The emphasis is on cabin size and comfort, range, and speed, as well as the glamour of the brand itself.

At Paris, the approach of Bombardier, Dassault and Gulfstream will be rather different. This week the potential customers casting their eye over the goods on display are not captains of industry, fractional ownership operators, or celebrities and their representatives, but militaries, ministries and government agencies.

All three manufacturers deliver a significant proportion of their aircraft – as much as 10% – in special mission configurations, ranging from surveillance and maritime patrol to medical evacuation, meteorological survey and head of state transport.

While they have all been at the game for decades, the arrival of latest generation platforms, such as the Bombardier Global 8000, Gulfstream G800 and Dassault Falcon 10X, have given the OEMs new impetus in a market where volumes might be modest and competition tight, but

margins are high.

All three claim that the performance characteristics as well as the cabin dimensions and environment of their high-end jets make them more suited for the exacting requirements of many special mission roles than either converted passenger airliners or small regional turboprops.

Bombardier last year established a new business division at its Wichita, Kansas campus branded as Bombardier Defense, with the main intention of promoting its Challenger and Global families to potential government customers, or

prime contractor partners.

Bombardier had long had a defence operation, supporting the Canadian military and even inheriting an unmanned surveillance helicopter programme, the CL-227, when it acquired Canadair in the 1990s. However, until 2016 the activity sat as part of its amphibious firefighting aircraft division.

When the latter was sold to De Havilland Canada that year as part of a massive divestment programme of non-core businesses, the company wanted to signal its intention that the government and military market was still important,

says Steve Patrick, vice-president of Bombardier Defense.

“Our CEO has made it clear that defence is a strategic priority that he wants to triple in size,” says Patrick. “We felt that establishing a defence brand speaks to that and clearly identifies to primes and governments that we consider ourselves a player in the defence domain.”

A sign of Bombardier’s commitment to the sector is its attempt to push the Ottawa government into initiating a competition for the procurement of a new Royal Canadian Air Force maritime patrol aircraft to replace the RCAF’s anti-submarine warfare fleet of 15 Lockheed Martin P-3 Orions.

The Montreal-based manufacturer is proposing a militarised version of its Global 6500, partnering with the Canadian subsidiary of General Dynamics, a mission systems specialist. This despite, earlier this year, Ottawa saying that only the rival Boeing P-8 Poseidon is compatible with its requirements.

Patrick, however, remains hopeful. “The government have said the P-8 is the only currently available solution that meets their requirements. It is true that the P-8 is available today, but they are not asking for an aircraft today,” he says. He says that Bombardier and



Medevac is one of the key special missions for business aircraft

Bombardier



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General Dynamics could have a solution ready long before the aircraft is due to go into service in 2031. "We believe there should be a choice," he says. "We are saying you should run a competition and we would like to be in that."

Meanwhile, as part of a deal secured before the establishment of Bombardier Defense, the unit late last year began modifying the first of three Global 6000s as signals intelligence gathering aircraft for the German air force, in a programme managed by Lufthansa Technik and sensor maker Hensoldt.

Patrick cites the German contract as an example of the division's "global" perspective. Although the business is headquartered in Wichita, "we are by no means US-centric", he says. "In fact, there are opportunities on every continent that we are pursuing."

Some 500 Bombardiers operate as special mission aircraft, although many are out-of-production Learjets in medevac configuration. However, other roles include adversary air training, head of state transport and coastal protection, says Patrick.

He insists Bombardier is flexible when it comes to fronting procurement bids or working with partners. "I can be the prime, a one-stop shop, or do the majority of the work if someone else is priming," he says. "We can even provide data if a customer is determined to do the work in-house."

Gulfstream has nearly 60 years of "DNA" in the defence market, asserts Leda Chong, senior vice-president of government programmes and sales. "We design, build and support business jets, but we have been adapting them for government and special mission for a very long time," she says.

The Savannah-based manufacturer has delivered more than 200 special mission aircraft to support governments and militaries in around 40 countries. One of its recent declared deliveries, in April 2021, was a G550 modified as a surveillance aircraft for the Israeli Air Force, a long-time customer.

The platforms are perfect for roles such as these, maintains Chong. "They have specific performance characteristics that allow higher altitudes, speed, and endurance.



A concept of the Global 6500 variant Bombardier wants to pitch for Canada's maritime patrol aircraft requirement

They have the ability to bring a capability to theatre quickly and leave quickly."

Cabin environment - part of the luxury proposition to business users - is also key. "On a G700, the cabin altitude is 2,900ft, compared with close to 8,000ft on a commercial jet. That impacts physiology. The crew are always going to be less fatigued and able to do their jobs better," she says.

While Gulfstream is always open to working with local primes and partners, what "differentiates" the manufacturer is the expertise of its engineers, "a subset of whom are focused on special mission adaptations", she says. "When you have that resource in-house it really does make a difference."

France's Dassault has the direct advantage perhaps over its rivals in the government market in that it is as much a defence as a business aviation manufacturer, thanks to its long history of making fighter aircraft. It makes much play of the fact that the same engineers

develop Rafale and Falcon jets.

"[They] are the perfect illustration of Dassault Aviation's dual skillset: our civil aircraft benefit from the cutting-edge technologies developed for our fighter jets, which in turn benefit from the industrial processes set up for the highly competitive production of Falcon jets," it says.

The Paris-based company says that special mission Falcons represent around 10% of the in-service fleet. Its notable programmes have included the Atlantique 2 maritime patrol aircraft - an update of the 1960s-era Breguet Atlantique - as well as variants of the Falcon 20/200 and the Falcon 50M.

One of Dassault's latest offerings is the Falcon 2000 Maritime Multi-Role Aircraft (MRA), which the Japanese Coast Guard selected in 2015. The manufacturer delivered the final example from an order of six to Tokyo in 2021.

Its most important customer, unsurprisingly, is the French government, which in 2020

commissioned seven Albatros aircraft - derived from the MRA and based on the Falcon 2000LXS - for its AVSIMAR programme. Deliveries are due to begin in 2025, and the plan is to eventually acquire 12 aircraft.

Dassault is also pitching the still uncertificated Falcon 10X for a future French maritime patrol need, although Paris and Berlin in 2018 agreed on a joint project to replace their Atlantique 2 and Lockheed P-3C Orion fleets. There is some uncertainty over that pact now.

Another Dassault type, the Falcon 8X is the platform for three signals intelligence aircraft the French government commissioned under its Archange requirement, in which Thales is also participating. That aircraft is expected to enter service with the air force in 2025.

So what are the prospects for high-end business jets in the very niche arena of military and other special mission requirements? For Bombardier's Patrick, the only way is up, because of the clear advantages they offer over turboprops and larger airliner platforms.

"We all know that we landed on the Moon with less computer power than you have on your smartphone," he says. "The same trend in technology is true in defence. You used to need an airliner to carry all the equipment required for the mission. Now it fits inside a Global."

At the same time, today's security needs dictate that surveillance and other special mission aircraft need to fly higher, faster and for longer to perform their role while staying clear of danger. That is not something that turboprops can do, suggests Patrick.

All three manufacturers will be showcasing their kit and capabilities at Paris and meeting potential customers, though Bombardier has no aircraft on display. The vibe may be very different to Geneva and Las Vegas, but the trio of OEMs will be hoping to impress government and military representatives from around the world.



Gulfstream says it has nearly 60 years of DNA in the defence market

Two and a half years after declaring its 2035 service-entry target for a hydrogen-powered aircraft, how much progress has Airbus made, and is it still confident of hitting its objective?

Emission mission

Graham Dunn

Few could have accused Airbus of lacking ambition when in September 2020 it unveiled conceptual designs for a potential zero-emissions commercial aircraft and a 15-year horizon for its entry into service.

Notably, with all three clean-sheet concepts to be powered by hydrogen, it marked the most ambitious backing for the fuel amid the myriad of technologies that have emerged to help aviation deliver on its quest to reach net-zero by 2050.

Two and a half years on – or one-sixth of the way towards that 2035 service-entry target – Airbus head of research and technology, Mark Bentall, says the target has not moved.

“Our roadmaps have been on the 2035 timeframe and at the moment we don’t see any reason to change that,” he told FlightGlobal at the Sustainable Skies conference in Farnborough in April.

“Our constant search is to see if there are any show-stoppers, that is why we do technology research, and we are not finding any. So that is very encouraging.

“I’m not saying it’s easy,” he adds, acknowledging the scale of the task ahead. “But we are not trying to break the laws of physics with any of this. The fuel and the energy source are very well known, the handling characteristics are well known.”

But the challenge is not how to extract energy from hydrogen – be that through fuel cells or combustion – so much as how to incorporate it into a product: “That’s what we’ve got to try and crack, because that is what is going to turn into a reality. That means we have got to focus on the certification, the safety aspects, the airport aspects, the refueling aspects.

“All of those things are what turn a nice experimental set of technologies into something that is useable, and that provides the range, the seating capacity and the safety [required].”

If the scale of the challenge facing the industry is daunting and the potential role of hydrogen in aviation ground-breaking, the quest to make operations more efficient is in itself nothing new. And it remains a multi-faceted approach.

“From a technology point of view, we’ve always worked on reducing fuel burn,” Bentall says. “Maybe for different reasons in the past, but the techniques and technology have always been there from the very start of aviation.”

In his view, improvements to the propulsion system and wing are the “biggest drivers” to cutting fuel-burn and emissions. Here Airbus and partners are progressing a number of initiatives.

Bentall cites the airframer’s work with Rolls-Royce on its UltraFan engine demonstrator, which is designed to deliver a 10% fuel-burn



Airbus unveiled three clean-sheet design concepts for its zero-emissions aircraft it is targeting for 2035 service entry



Bentall: Not saying it’s easy

improvement over the Trent XWB powering the A350 widebody. The first engine to test is due to run ‘imminently’.

“This is a key technology. The engine guys know how to make more efficient engines and that’s where you end up with the UltraFan, which is great for widebodies.”

And in the narrowbody space, Airbus is working with CFM International to flight test the propulsion specialist’s RISE open-fan demonstrator later this decade aboard an A380 testbed. Crucial to that effort will be the integration of the engine and airframe.

“At the end of the day, the two have got to work together. There are trades going from a closed-fan to an open-fan [design] and so you’ve got to make sure those trades work in your favour,” he says.

Initial steps will see both parties perform design integration studies “and then we bring the two together and we try it in flight and see how it performs.

“The open-fan has been working on the ground and now it is coming

close to the next point to get it up in the sky.”

If the propulsion element is largely out of Airbus’s hands, the wing at least is a core area of expertise from which it can wring further improvements.

Last summer, the first full-size wing demonstrator developed and built under its multi-national Wing of Tomorrow programme was delivered, while through the ‘Extra Performance Wing’ initiative – one of a number of programmes run through its innovation arm Airbus UpNext – Airbus is evaluating several different technologies to validate aerodynamic performance improvements that could be applied to a future aircraft.

“The Wing of Tomorrow is looking at that future wing, what could it be and how do you make it? How do you manufacture it? We are at the higher end of the production numbers, so you’ve got to be able to produce at rate, you’ve got to make sure you are minimising waste,” Bentall explains.

“And on the efficiency side, you’ve got to look at what technologies can give me a high-performing wing. That is where the ‘X-wing’ is coming in so we can look at different techniques to make a higher-aspect-ratio wing.

“There are various different ways you can do it. So we are looking at the active adaptive, we are looking at the aero-elastic hinge, we are looking at some other technologies which we will now fly and see which ones work. We’ve tried those things in our windtunnel now, so the objective is clear.

“The portfolio of technologies, concepts and ideas is rich, and it is really trying to make sure we are getting the best combinations. Not all of them will make it. Every technology has to buy its way onto the aircraft,” says Bentall. ▀

Airbus acquired Citation VII business jet to support development work on its extra performance wing demonstrator initiative



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Two 737 Max crashes threw Boeing's safety culture into a harsh spotlight. The manufacturer insists it is repairing its reputation with a laser focus on internal processes – but it will take time

Lessons for a long journey

Pilar Wolfsteller

Almost half a decade after the first Boeing 737 Max crash, the US airframer says it continues implementing safety improvements designed to mitigate risks and catch issues before they become crises.

The US airframer presented its second chief aerospace safety officer report on 24 May, outlining its safety improvement efforts.

In this year's report Boeing touts more than 10 wide-ranging achievements from the past 12 months. These include use of new digital and analytic tools, communication improvements with customers, workshops, training programmes, increased employee engagement and a safety risk management evaluation with a major airline.

The Arlington, Virginia-based company established the position of "chief aerospace safety officer" in January 2021, after two 737 Max crashes – that of a Lion Air Max 8 off Indonesia in October 2018 and of an Ethiopian Airlines Max 8 in March 2019. The crashes killed almost 350 people and were attributed partly to assumptions Boeing made when designing, developing and evaluating the Max's Maneuvering Characteristics Augmentation System (MCAS), which activated erroneously during the two flights, putting both jets into dives from which the pilots could not recover.

Other accident factors, according to various crash reports, included pilot actions, maintenance issues and missteps by the Federal Aviation Administration and its oversight of Boeing engineers. Such issues prompted Boeing to assess its safety culture and processes.

Boeing in 2019 realigned its engineering structure so its 50,000 engineers now report up to Boeing's chief engineer, rather than within the company's individual siloed business units.

Leading the safety effort is chief aerospace safety officer Michael Delaney, who also holds a seat on the company's executive council. Delaney was previously Boeing vice-president of commercial engineering and vice-president of airplane development.

The Max crashes prompted Boeing to create a safety management system (SMS) – a formal organisation-wide safety framework designed to "inculcate" safety into Boeing's operation. The FAA approved the SMS in December 2021.



Boeing continues to address systemic failures such as those that led to two 737 Max crashes and the type's subsequent 20-month grounding

Delaney singles out Boeing's "global aerospace safety initiative", which involves embedding flight operations experts at aircraft operators to ensure those operators receive hands-on training in risk management and assessment. Lacey Pittman, vice-president of the initiative, says airlines have shown "resounding interest" in the programme.

"We have historically had the field service representatives... on the maintenance and engineering side embedded with the customers globally," she says. "We stepped back and said, what else could we provide in terms of support and working with the operators? We thought we could really balance that with a similar role on the flight operations side."

"Before we [deliver] a new airplane to an operator, we see if there are any gaps in either the flight operations or maintenance, [so] that we can help provide that safety support," she says. "When there's an operator getting a new fleet type, we send them out."

the global fleet might have gone largely unnoticed, says Delaney.

Leading the effort of bringing that data together is Boeing vice-president for aerospace safety analytics and safety experience Vishwa Uddanwadiker.

Uddanwadiker says the tools his team is developing, and the data they produce, must go beyond trying to prevent accidents before they happen.

"A lot of people think the mission is to find the needle in the haystack," he says. "I have a slightly different safety management systems view of that. If you're looking for a needle in a haystack, you've already made up your mind that the hazard is the needle."

"I'm looking for all sharp objects in the haystack," he says.

"There is a continued operational safety process which reports all unusual behaviors from the in-service fleet," he continues. "By aggregating data, we are looking for anomalies and any sort of uncertainties in the pattern."

With the data, Boeing hopes to further tighten its safety net and prevent systemic issues. But its transformation requires effort and time, and the company is "not there yet", Delaney says. "Hopefully we have people starting to see data and deviations from the norm, and then asking the question: Why is this deviation from the norm there?"

Addressing the significance of artificial intelligence in supporting safety processes, Delaney said he is still on the fence.

"It will be a tool," he says. "I'm guarded, personally. I haven't yet gotten into my head where all of a sudden there's going to be something that is going to significantly change the OEM space."

Use cases could start with human factors – pilot training or monitoring – and using data to solve ongoing aviation and aerospace challenges.

"It would be really great if we actually ever modernise the air traffic management system," he adds. "Think about airplanes communicating with airplanes."

However, companies will likely be reluctant to share the sensitive intellectual property needed to train the algorithms required for such sophisticated analysis, he adds.

Delaney calls Boeing's safety efforts a "journey". "We're not in a complete rebuild," he says. "We're building on a solid foundation and we're trying to figure out how... we go forward and also make sure we learn lessons from the last few years." ▶

The representatives are often retired airline pilots, with an average of 13,000h of flight time each, she adds. "They're really creating this bridge of communication... There is a two-way communication flow between the operator and us at Boeing."

In 2022, the company had "more than 60 engagements" with operators globally through these flight operations representatives, she adds.

"To my knowledge to date, nobody has said no," Delaney says. It is possible that future customers may turn down Boeing's assistance, which regulators do not mandate, at which time it will face the "hard decision" about whether to actually deliver aircraft to such customers, Delaney adds.

Part of Boeing's SMS involves collecting information and data from across the design, production and operation of its jets, including from airlines. Much data has historically been disparate and decentralised, meaning the extent to which safety issues that could be prevalent across

BARAK MX: the Vanguard in Air and Missile Defense

Advertorial



Credit: IAI

IAI's advanced air defense technologies have evolved to meet Israel's robust air and missile defense needs and are central to the country's multi-tiered air defense network.

IAI entered the field of air defense in the early years of the state of Israel with gunnery solutions and upgraded many systems to advanced configurations that included advanced sensors and C2, the upgrading of the Vulcan and Chaparral into slue-to-que systems; adding VSHORAD missile pods to the Vulcan; upgrading L70 guns into an advanced configuration and the upgrading the Shilka mobile air defense system.

In the 1980s IAI introduced the BARAK point defense missile systems protecting ships against anti-ship missiles. Since the early 2000s, IAI is focused on the development and fielding of the BARAK MX, a family of air defense systems designed to protect land and naval assets from all types of aerial threats. Since its 2016 operational debut, the combat-proven system has been adopted by seven countries for national Ground Based Air and Missile Defense (GBAD), naval air and missile defense, and wide-area air defense missions.

The name MX stands for the MIX of system elements for MAX performance and flexibility. Barak MX is designed to be loosely coupled to the radar and as such has been delivered to different customers with various radars based on their operational needs. This approach also allows for a simple upgrade of the system when new operational requirements emerge. One of the naval sensors of the system is the MFSTAR radar, an advanced multi-face digital phased array radar developed by IAI/ELTA. Apart from area search, target acquisition, and engagement, this radar

supports all other needs of the vessel.

The BARAK MX interceptors, uniquely designed as surface-to-air missiles, aren't limited by the size and weight restrictions associated with aircraft-carried missiles. They cover engagement ranges from 2 to 150 km and can efficiently target air-breathing targets (ABT) and Tactical.

The unique architecture allows BARAK MX remarkable speed and maneuverability to maximize the no-escape kill zone and probability of kill (Pk). The interceptors employ advanced large diameter active RF seekers providing optimal target detection and tracking in all weather and visibility conditions and allowing for large uncertainty handover errors enabling Launch on Remote (LOR) even with lower certainty air situation picture.

The BARAK MX's smart launcher is designed for autonomous operation, utilizing missile datalinks for early target pursuit initiation. This unique mode further enhances its capability and the overall system's efficiency, ensuring that each interceptor is focused on its designated target throughout the intercept. Leveraging LOR, BARAK MX synthesizes a unified sky picture based on multiple radars and sensors, delivering early warning intercept allocations to associated fire units, even when they are not associated with their own radar or battle management systems. Such coordination ensures optimal use of interceptors, eliminates 'double booking' of targets, and ensures all units remain armed to continue the mission.



Credit: IAI

Collins president Stephen Timm believes data analytics tools are key to the giant avionics-to-aerostructures provider delivering more value than the sum of the company's many parts

Making connections

Murdo Morrison

“Connected” is a word that pops up often in a conversation with Stephen Timm. The Collins Aerospace president lists the connected battlefield and connected ecosystem as two of his seven strategic initiatives – drivers to help Collins get better at targeting and combining its vast portfolio of technologies and capabilities to meet its commercial and military customers’ evolving needs.

Timm – who took over the top job at the Raytheon Technologies subsidiary in February 2020, just as the Raytheon merger with Collins’ former parent United Technologies was completing – has faced another connection challenge: pulling together the sprawling business, by creating a common culture among the 17 or so companies that have been absorbed by Collins in the past decade.

Since 2012, well known aerospace brands such as Arinc, B/E Aerospace, FlightAware, Goodrich and UTAS have all been subsumed into Rockwell Collins, or Collins Aerospace as the business became known after its purchase by United Technologies in 2018. It has given Collins Aerospace perhaps the most eclectic range of offerings in the industry.

From a business that had been largely an avionics and communications specialist, Collins has expanded to include product lines from nacelles and landing gear to airliner seating, and from auxiliary power units to aircraft tracking software. Turning the group into something stronger than the sum of its already impressive parts has been Timm’s number one mission.

To do that he has had to work at getting all the disparate elements of the business working together to improve not just their legacy products, but to devise ways of sharing expertise and creating value packages for the market that combine many of their technologies, harnessing the power of so-called big data along the way. Or, as Timm puts it, “using connectivity and analytics to create efficiencies”.

Timm’s connected battlefield and connected ecosystem strategic initiatives are core to this push. Collins defines the connected battlefield as “enabling JADC2 [joint all domain command and control] through seamless data sharing and autonomous, intelligent connectivity



Creating products and services that enable a connected battlefield is one of Timm’s seven strategic initiatives

that reduces decision-making timelines to machine speeds”.

The connected ecosystem, meanwhile, focuses on the larger, civil part of Collins’ business and entails “offering a comprehensive portfolio of enablement, digital and data solutions, and smart products to assist in the digital transformation of commercial aviation”. The 2020 acquisition of FlightAware was very much driven by this initiative.

“When you break it down, Collins is lots of different companies,” says Timm. “What I hear from investors over and over is ‘What are you doing with all these pieces?’ So our task is to recognise future trends that might benefit from capabilities from



Timm has led Collins Aerospace since just before its absorption into Raytheon Technologies in 2020

two or more of our businesses that we can combine to make a new product.”

By doing this, Collins, he asserts, is offering aerospace customers something unique. “In many ways, this has been a holy grail for the industry. We’ve had decades of companies working together, but no one has been able to take all these pieces and put them together with the horsepower that we have. It’s truly transformative,” he says.

Collins can combine the avionics that Rockwell Collins specialised in with connectivity from the former Arinc, and analytics provided by recent acquisition FlightAware. “Combined, this provides really powerful tools when it comes to flight profile optimisation,” says Timm. Another example is harnessing the thermoplastics know-how from aerostructures to create lighter seat frames.

To help harness these synergies, Timm has established a number of crucial internal processes and practices. Company-wide technical roadmaps “pull from different parts of the business”. He also makes sure that his senior management team gain experience around the organisation, perhaps challenging ingrained orthodoxies along the way. “I rotate my leaders a lot,” he says.

Each head of a business unit – aerostructures, avionics, interiors, mechanical systems, mission systems, and power & controls – also “owns” one of the seven strategic initiatives, which Timm established in 2020. These are autonomous

operations, cabin experience, connected battlespace, connected ecosystem, electrified aircraft, integrated solutions, and structural technologies.

“This means that each leader has to pull together people in a matrix way to satisfy a solution for a customer,” he says. All this has encouraged management to think more about Collins than the individual businesses they work in or came from, insists Timm. “When you used to hear ‘they’ a lot, that has turned to ‘we.’”

At Raytheon Technologies, a business realignment in July will see the two legacy Raytheon divisions combine, to sit alongside Collins and Pratt & Whitney. As part of the shake-up two former Raytheon activities – multi-domain command and control solutions, and air traffic management – will become part of Collins’ mission systems and connected aviation solutions business units, respectively.

Timm says he “loves Collins not being a pure play in defence or commercial” – traditionally military sales have comprised 30% to 40% of revenues. Although US export restrictions stop the transfer of most military technologies into commercial products, the reverse does not apply. “Our huge customer base on commercial means lower costs for our defence customers,” he says.

Both commercial and military customers aiming to connect with Collins this week can certainly expect to hear plenty of that word. ▶

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Although no longer in production, the age of the A380 is not over, with many grounded examples returning to service

Return of the giant



Even during the pandemic, Emirates' commitment to the superjumbo was never in doubt

Graham Dunn

It is 18 months since Airbus delivered its last A380 to by far the jet's biggest customer, Emirates, having three years earlier made the decision to pull the plug on the programme after 251 deliveries.

But while even at the depths of the pandemic Emirates' commitment to the A380 was never in doubt, it is the move by another UAE carrier to restore operations with the ultra-large jet which is more indicative of the recent upturn in airline interest in the type.

In December Etihad Airways said the "time is right" to bring some of its A380s back into service this summer. Etihad is bringing back four of its 10 A380s, initially deploying the aircraft on its Abu Dhabi-London Heathrow route.

While Etihad never completely ruled out the return of its A380s, it appeared one of the least likely operators to bring the widebody back into service after indefinitely grounding the type when the pandemic hit.

"We don't see them re-entering into our fleet planning unless the yield on the ticket price and the demand could ever make them financially viable. Now with the \$100 oil price that is unlikely to occur any time soon, if ever," then Etihad chief executive Tony Douglas told FlightGlobal in an interview in March last year.

"The A380 is an incredible product. It's something that all of us love from a travelling perspective. But the economics of it commercially don't work."

But fast forward to the end of 2022 and circumstances had changed sufficiently to earn the A380 a stay of execution with Etihad. And the Gulf carrier is not alone in doing so.

At the start of June German carrier Lufthansa carried out its first passenger service with an A380 in over three years after, deploying the type on its Munich-Boston service.

Like Etihad, Lufthansa had initially unlikely to operate the jet

again when in September 2020 it consigned its A380s to long-term storage – only to be reactivated in the event of an "unexpectedly rapid market recovery".

However having hinted that the ultra-large jet could be an answer to the carrier's capacity challenges during the post-pandemic ramp-up, Lufthansa group chief executive Carsten Spohr last summer confirmed its decision to bring three back into service for operation from its Munich base this June.

It has already since upped that number. Lufthansa is looking to bring back up to six of its A380s. It

will redeploy A380s on its Munich service to New York JFK from 4 July and to Los Angeles from 8 October. Lufthansa will follow this from the start of the winter season on 28 October, operating double-deckers on its Munich-Bangkok service for the first time. This will increase seat capacity by 75% over the A350s currently used and include eight seats in first class, 78 in business class and 52 in premium economy.

"The A380 is a wonderful example where customers and crew cannot wait, they are very happy," Spohr told FlightGlobal in March. "My controllers less so."

Lufthansa has eight A380s in total, having sold six out of the 14 it originally operated. What Etihad, Lufthansa and others probably were not counting on was that the recovery in travel demand would not only be stronger than most dared hope, but that it would be accompanied by such pressures on aircraft availability.

Supply chain challenges, exacerbated by the continued impact of Covid-19, the Ukraine crisis and China's lengthy following of a 'zero-Covid' strategy, mean aircraft capacity is at a premium this summer.

Indeed, Spohr has repeatedly suggested that capacity constraints will be a feature of the commercial air travel sector in the coming years. Among the key factors, global supply chain bottlenecks are causing "massive delays" to deliveries of new aircraft and spares for MRO work, Spohr says.

Airlines operating or with stored A380s (May 2023)

Airline	In service	In storage
Air France	0	5
ANA	2	1
Asiana Airlines	4	2
British Airways	12	0
Emirates Airline	90	31
Etihad Airways	0	10
Korean Air	5	5
Lufthansa	0	14
Qantas	7	3
Qatar Airways	8	2
Singapore Airlines	11	3
Thai Airways International	0	6
TOTAL	140	83

Source: Cirium Fleets data

Alongside the supply-demand dynamic, the cost side of the equation has also tipped a little in favour of the A380. Airlines made much of the improved operating economics of new-generation widebodies over the A380. However, fuel prices have relaxed. The barrel price of crude oil, which jumped well over the \$100 mark in the second quarter of last year, has sat significantly below that level for most of the past six months.

It meant that by the time Etihad's new chief executive Antonaldo Neves took the decision to restore the type, he was able to make the case that the post-pandemic recovery and rising demand has made the A380 "financially viable once more".

Etihad says the restoration of the A380s to service will free capacity to increase frequency on other routes and enable new destinations to be opened. Storage and MRO specialist Tarmac Aerosave redelivered the first of Etihad's A380s back to the airline in March. The aircraft had been stored and maintained at Tarmac's site in Teruel, Spain, before being shipped to the Gulf carrier after further maintenance work at its French facility in Tarbes. The carrier is set to operate its first revived A380 service between Abu Dhabi and London from July.

A third of the 15 airline customers which acquired the type and were operating the A380 when the pandemic hit have either withdrawn the type permanently or are yet to disclose their intent to return the type to service.

Charter operator HIFly only operated one of the type and by November 2020 had exited A380 operations.

Air France was arguably the most categoric in its decision. The airline had begun phasing out its 10 A380s even before the pandemic, under a plan to withdraw the type by the end of 2022. It, though, took the type out of service with immediate effect in May 2020, having grounded the widebodies in March.

Malaysia Airlines had been seeking a way out for its A380s long before the pandemic, having struggled to make the business case for the type. Its six A380s remain in storage and up for sale, with no signs of a reprieve. "The A380 is not in our network plan anymore," Malaysia Airlines chief executive Izham Ismail



Korean Air began returning A380s to service in 2022

told FlightGlobal last summer.

Thai Airways too has grounded its fleet. In November Thai Airways commercial chief Korakot Chatasingha told FlightGlobal that while the airline has not committed to a decision, it is looking at the "cost effectiveness" of such a move to help cope with a capacity shortfall. However, the Star Alliance carrier has not subsequently announced any plans for a return.

Ironically, China Southern Airlines, has been one of the few to operate A380s through the crisis. However the Chinese carrier a year ago said that it planned to axe the type by the end of 2022 and flew its last service with the type late last year.

Other Asian operators, though, have not lost their appetite for the widebody.

Korean Air returned the first of its A380s into service last year as international markets began to reopen in the region. Cirium fleets data shows it has so far returned

five of its 10 A380s. Korean's merger partner Asiana Airlines similarly began bringing back its A380s last summer in response to the demand ramp-up. Four of its six A380s are in service, according to Cirium data. Cirium fleet data shows Qantas now has seven A380s back in service. The Oneworld carrier, which relaunched A380 flights in April last year, initially brought back five of the jets into service. "These were key markets for Qantas before Covid-19, and given how well they have recovered, we expect travel demand on these routes to be strong enough for the A380," chief executive Alan Joyce said at the time.

It intends to bring its remaining three back into service by the end of this year - having retired two of its initial dozen A380s.

Singapore Airlines, launch customer for the jet in 2007, remains committed to the type. It was among the first airlines to restore A380 flights after the pandemic, initially on the London Heathrow route in November 2021. Cirium fleets data shows that it has double-decker jets back in operation and three more in storage.

Japanese carrier All Nippon Airways last summer brought back two of its A380s, deployed on its Tokyo Narita-Honolulu service. ANA had been the most recent new operator of the type, having taken delivery of the 520-seat jet in 2019.

When Lufthansa restores A380 flights, it will join British Airways as the only European operator of the jet. BA was the first European carrier to relaunch A380 flights in November 2021, as Covid restrictions on flights to the USA were eased. It has since returned all 12 of its widebodies.

BA's Gulf partner Qatar Airways has been one of the reluctant carriers to return the type to service. Chief executive Akbar Al Baker had

been a vocal critic of the efficiencies, both economic and environmental, of operating the A380 versus new-generation widebodies. However, Qatar Airways' own capacity was further crimped by the grounding of a portion of its A350s, prompting it to return the type to service in November 2021.

"We are so desperate for capacity to fuel the huge growth in passenger numbers the airline is facing in this period," Al Baker said last summer.

Cirium data shows eight of Qatar's 10 A380s are now back in service. Emirates of course remains the key A380 operator. Airline president Tim Clark has been steadfast throughout the crisis in believing demand will warrant the return of the double-decker. In March last year, as international markets reopened in earnest, Clark flagged a combination of "astronomical demand" and slot shortages at major airports as making the case for the type.

It has since brought back more than 90 - Cirium fleets data shows it has now 86 A380s in service and a further 35 in storage - and having outlined plans to resume flights with the type to destinations including Birmingham, Casablanca, Glasgow and Nice, it expects to have restored 90% of its pre-pandemic A380 network by the end of the summer.

Further underlining the importance of the type to Emirates' future, the Gulf carrier is retrofitting 67 of its ultra-large jets with a new interior. The first to these, which has been refurbished to include a 56-seat premium economy cabin, returned to service in January.

Overall, more than half the 233 A380s in service before Covid hit are back flying. Cirium fleets data shows that as of early May, before the planned service reintroductions by Etihad and Lufthansa, there were 132 A380s in service with airlines and carriers had a further 97 in storage. ■

Lufthansa is looking to bring back up to six of its A380s



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Amid growing confidence about the strength of the airline industry's recovery, carriers have been boosting their line-ups with aircraft variants and types that are fresh to their fleets

New kit on the block



oclephoto/Shutterstock

Porter heads west with E2s

Porter Airlines put its first Embraer E195-E2s into regular service in February this year.

Toronto-based Porter is using the E195-E2s for its North American expansion, having received its first examples in late 2022.

Porter says the Pratt & Whitney PW1900G-powered twinjets have 132-seat economy configurations.

By late May 2023, Porter had nine E195-E2s in service from a firm order for 50 of the type and purchase rights for 50 more.



China Eastern Airlines

C919 in commercial debut

Comac's C919 narrowbody entered commercial service with launch customer China Eastern Airlines in late May, with a service between Shanghai Hongqiao and Beijing Capital airports.

Comac, China Eastern, as well as Chinese regulators hailed the 'historic' milestone for the aircraft programme. Beijing hopes the C919 programme will be a serious competitor to Airbus' A320 family and Boeing's 737 narrowbody programmes. Although a Chinese programme, the C919 is entirely reliant on western systems, including its CFM International Leap-1C engines.



Jet2

Jet2 begins Airbus shift

Jet2's first Airbus A321neo entered service in early May, marking the beginning of its shift away from a Boeing-dominated fleet.

The CFM International Leap-1A-powered narrowbody debuted on the carrier's Manchester-Malaga route on 7 May.

The UK leisure carrier's order for the type in 2021 was a notable decision from what is a predominantly Boeing operator. Jet2 now has 97 A320neo-family deliveries outstanding.

Its fleet of just over 100 aircraft is currently dominated by Boeing 737-800s.



ATR

ORC readies for ATR launch

Japanese regional carrier Oriental Air Bridge (ORC) plans to put its first ATR 42-600 into service in July this year, having taken delivery of the aircraft in December 2022.

The 48-seat turboprop will operate on regional routes out of Nagasaki.

The carrier ordered the Pratt & Whitney Canada PW127-powered aircraft at the Farnborough air show last July.

Cirium fleets data indicates that ORC also has two De Havilland Canada Dash 8-200s and a single Airbus Helicopters AS365-N3+.



Airbus

Xiamen win for Airbus

SkyTeam carrier Xiamen Airlines took delivery of its first Airbus A321neo in February.

The CFM International Leap-1A-powered jet is leased from CMB Financial Leasing.

Cirium fleets data suggests that as of late May, the Chinese carrier had taken delivery of four more A321neos and had 18 on order. Xiamen Airlines also has outstanding orders for 25 A320neos.

Its Airbus orders in were seen as a coup for the airframer, given Xiamen Airlines had been a prolific Boeing operator.

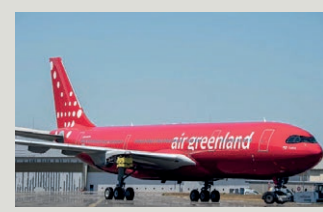


Boeing

Iraqi Airways takes Max

Iraqi Airways took delivery of a Boeing 737 Max 8 in early March, the first of the re-engined variant in the flag-carrier's fleet. Boeing lists 10 CFM International Leap-1B-powered 737 Max jets as having been directly ordered by Iraqi Airways in 2017.

Iraqi Airways is continuing to modernise its fleet, in accordance with a government programme, as it aims to secure the lifting of European restrictions on the airline. Iraqi Airways was preparing to take delivery of its first Boeing 787 in late May.



Airbus

A330neo Greenland mission

Air Greenland's Airbus A330-300 fully took over the operation of its service to Copenhagen in mid-February, following retirement of the carrier's A330-200. The airline took delivery of the Rolls-Royce Trent 7000-powered A330neo in December last year. Reports suggested the aircraft had been temporarily grounded in May, after sustaining damage at Copenhagen during a collision with another aircraft. Air Greenland is one of a handful of carriers to take the smaller A330neo variant.



RwandAir

RwandAir flies 737-800SF

RwandAir's first Boeing 737-800SF has underpinned the launch of a cargo partnership with Qatar Airways from its Kigali hub, which was announced in May.

RwandAir had received the freighter - its first - towards the end of 2022.

The CFM International CFM56-powered 737-800SF has been serving destinations including Johannesburg, Lagos, Lusaka, Brazzaville, Harare, Maputo, Entebbe, Nairobi and Sharjah in the UAE. The 737-800SF will play a key role in a joint cargo network with Qatar Airways.



Airbus

First A321neo at HK Express

HK Express took delivery of its first Airbus A321neo in late March this year, sporting the airline's new livery. The aircraft was the first of 16 A321neos the low-cost unit of Cathay Pacific Group has on order.

The narrowbodies are powered by CFM International Leap-1A engines, and seat 236 passengers. HK Express is an all-Airbus narrowbody operator, with 11 A321neos, five A320neos, as well as nine A320neos in service as of late May, according to Cirium fleets data.



Airbus

Azul doubles up on A350s

Brazilian operator Azul put its first Airbus A350-900 into service in mid-December last year, having taken delivery of the aircraft in September.

The Rolls-Royce Trent XWB-powered twinjet made its debut on the Sao Paulo-Orlando route. Replacing A330s in Azul's fleet, the A350s are configured with 334 seats.

The carrier had two A350s in service as of late May. Both are second-hand examples, leased from AerCap. They previously flew for Hong Kong Airlines.

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While its European rival is pursuing futuristic concepts exploring the use of hydrogen propulsion, US giant is taking a more progressive approach towards achieving emissions reduction

Burning issue

Howard Hardee

Thinking of innovative ways to cut fuel consumption and improve efficiency is nothing new for the aviation industry. Since the start of the jet age, commercial aircraft have become progressively more efficient in a continuum of fleet renewals and carbon dioxide emissions reductions, says Sheila Remes, vice-president of environmental sustainability for Boeing.

"It is innate in what we do," she says. "We have reduced the fuel burn every single generation. We have [now] reduced it by 70%. But getting to that last 30% is a really, really hard task when you consider how far we have come."



Airliners such as the 737 Max are up to 70% more efficient than previous generations

Urgent action
The matter is more urgent now. The aviation industry must supercharge its efficiency gains to meet its pledge to achieve net-zero carbon emissions by 2050, Chris Raymond, Boeing's chief sustainability officer, said during the airframer's first-ever Sustainable Aerospace Together Forum in Seattle, Washington on 17 May.

"We have come far, but we are also known as a hard-to-abate sector," Raymond says. "Now we have a new shared industry challenge of how to get to net zero."

Raymond was speaking to representatives from major aerospace stakeholders such as NASA, IATA, ICAO, the US Federal Aviation Administration (FAA) and the European Union Aviation Safety Agency, along with airline executives, bankers and energy sector representatives.

The gathering was Boeing's first effort to expand sustainable aviation discussions beyond individual meetings with "think tanks, energy companies, fuel producers" and airlines, Raymond tells FlightGlobal.

"This is our first time bringing a global audience together," Remes adds. "But we are really focusing on the four different sectors – policy, finance, energy and aviation – because all of these sectors have to come to terms with what we need to accomplish in order to scale decarbonisation solutions."

Boeing says the consensus solution is drastically scaling up production of sustainable aviation fuel (SAF), which is said to be sustainably derived and to have a smaller carbon footprint than conventional jet fuel. SAF is typically

biofuel but can be synthetic fuel derived from CO2 and hydrogen. Though propulsion systems powered by electricity and hydrogen fuel are showing early promise – particularly for regional and urban air mobility operations – SAF has emerged as the leading emissions-reduction strategy for airlines.

"When we look at all of the options that are available, the one that is clearly and evidently ready to be used by the industry is sustainable aviation fuel," Willie Walsh, director of IATA, told attendees to Boeing's forum.

Global concern
Juan Carlos Salazar, ICAO secretary general, adds that efforts to ramp up production of SAF must be

international. "It is clear that we need a significant early push on SAF all around the world, and that this is vital to get the sector to where we need to be by 2050," he says.

Salazar urged attendees to "not forget the potential of the developing world" and smaller markets to contribute to SAF production capacity. "I think we will find that SAF may come from many surprising places around the world," he says.

That idea was shared by Binyam Reja, who oversees a World Bank transportation decarbonisation programme.

"For many emerging economies, SAF represents a development agenda and job-creation agenda," he says. "They have a big quantity of feedstock they can leverage.



Sustainable fuel use is contributing towards emissions-reduction

We have estimated that if many of the countries we work in get into this space, that can create up to 14 million jobs just in the SAF production and feedstock space."

India, Kenya and South Africa are economies that are "positioning themselves in developing feedstock" and producing SAF in the decades ahead, Reja says.

Though most airlines' decarbonisation strategies rely heavily on SAF, significant challenges remain – including lack of available feedstock and land-use issues, which involve concern that land used to grow food crops will be converted to grow SAF crops, driving up food prices.

Currently, less than 0.1% of jet fuel burned globally is SAF, according to a March report from the US Government Accountability Office.

But production is scaling rapidly, Remes says. "Over the last two years, the amount of sustainable fuel has increased by over 200%," she says. "200% of a small number is still a small number, but what it tells you is that there is a transition happening."

SAF is produced from alternative hydrocarbon sources like grain, oil seeds, algae, fats, oils and greases, and agricultural and forestry residues. Engines burning SAF still emit carbon, but it is considered offset by carbon pulled out of the atmosphere by plants used to make the fuel. Depending on production methods, SAF is advertised as having 80% less life-cycle greenhouse gas emissions than fossil-based fuel.

But the actual benefits remain debatable.

"There is uncertainty on what the actual life-cycle emissions reductions from these fuels will be," said the FAA in a November 2021 report. "There are no mandatory governmental standards for calculating the environmental benefits or dis-benefits of SAF."

The FAA's report assumed SAF has net emissions reduction of "at least 50%" compared with conventional fuel. At 50%, the US aerospace industry's net emissions would be roughly the same in 2050 as in 2020, the report said.

Research is also under way to convert carbon removed from the atmosphere into a synthetic SAF, with United Airlines disclosing in March a \$15 million investment in carbon-capture technology firm Svante. Converting municipal waste into SAF is another possibility, though some argue that doing so

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It would release into the atmosphere carbon that would otherwise remain buried underground in landfills.

"Focusing on the next type of feedstock is important because there is a limit to [the availability] of fats, oils and greases," Remes says. "Essentially all the sustainable fuel that is produced now is from that feedstock."

Under current standards, approved SAF can be combined with conventional petroleum-based jet fuel in blends of up to 50%, but 100% SAF that works as a "drop-in" replacement for the most common jet fuels - Jet A and Jet A-1 - remains in development and unapproved.

A first step would be widespread use of half-and-half blends, Raymond says: "Just getting to the 50/50 blend would be incredible for the industry."

Some critics of the SAF-centric approach - such as Val Miftakhov, chief executive of hydrogen fuel-cell propulsion specialist ZeroAvia - say SAF is far from a perfect solution.

"Sustainable aviation fuels... do not eliminate carbon emissions in flight, nor do they significantly reduce other noxious and climate-warming emissions," Miftakhov said in prepared testimony during a 30 March Senate hearing about the feasibility of SAF and alternative propulsion systems.

"These non-CO2 emissions, as well as contrails, are known to have a multiplier effect on climate change."

Raymond says it is "too early to say" whether hydrogen- or electric-propulsion systems could be incorporated into Boeing's next clean-sheet narrowbody aircraft design, which chief executive David Calhoun says the company will bring to market in the mid-2030s.

Engineering challenges

But hydrogen brings with it significant engineering challenges - requiring aircraft to be substantially redesigned - and has lower volumetric energy density than fossil fuel. All-electric propulsion is widely seen as unsuitable for anything but small aircraft.

For those reasons, some analysts suspect Airbus's and Boeing's next narrowbodies will have largely traditional fuel-burning engines - though perhaps the powerplants could be open-fan designs, such as one under development via CFM International's RISE effort, or be



Critics point out that sustainable fuels do not eliminate emissions

augmented by electric systems, in a hybrid-electric architecture.

"Finding renewable energy alternatives with the same energy density and volumetric efficiency as fossil fuels is difficult," Raymond wrote in an op-ed article earlier this year. Advances in battery technology will allow for electric-powered short-haul flights in the near future, but batteries still weigh too much for long-haul routes.

"We are going to need sustainable aviation fuel, but that doesn't mean we are not spending [research and development funding] on electric and hydrogen," Raymond says, pointing to Boeing-backed electric air taxi developer Wisk.

"It means that we have taken a position that we are probably not going to achieve very much aviation carbon emissions reduction on a global scale [from hydrogen or electric propulsion] by 2050."

Despite recent landmark flights achieved by start-ups developing hybrid-electric propulsion technology - and Airbus's exploration of several conceptual hydrogen aircraft designs - Boeing remains sceptical of fuel cell-powered commercial flight.

There are a number of technical and logistical issues currently preventing hydrogen propulsion

from taking off, Raymond says. He cites NASA's experience with handling cryogenic fuel as a cautionary tale for the aviation sector; hydrogen fuel must be stored at extremely low temperatures -253°C (-423°F) - to retain its liquid state.

Rocket science

"We use it in rockets every day," he says. "Hydrogen is hard to work with and changes the properties of metal. It is hard to store. It leaks. These are all things that have to be solved if we really think we are going to run a scheduled commercial service on [hydrogen] with airplanes leaving 15 minutes after they arrive at a gate."

"Getting something into service and having it scale up to the point where it makes a big dent in the carbon emissions of aviation... we just don't see that coming from electric or hydrogen by 2050," he adds. "That doesn't mean we shouldn't be working on it, but we have been pretty straight on that, based on our analysis."

Some clean aviation players hope to change Boeing's mind on hydrogen-based propulsion, including Paul Eremenko, founder and chief executive of California-based start-up Universal Hydrogen.

Following first flight of his company's retrofitted De Havilland Canada Dash 8-300 on 2 March, Eremenko told FlightGlobal it aims for its hydrogen-electric hybrid propulsion system to be incorporated into next-generation narrowbody jet designs.

He believes rapidly developing and scaling hydrogen propulsion systems, which emit water vapour as exhaust, is the only realistic way of achieving zero emissions from aviation by 2050. He also says embracing SAF as a primary decarbonisation strategy could eventually stifle the industry, as reducing operations could become the only way to achieve emissions-reductions targets.

"Whether it is dinosaur kerosene or SAF, it is still a hydrocarbon that you are going to burn at 35,000 feet," he says. "If we end up with one or two hydrocarbon-burning narrowbodies

in the 2030s, I think there will be a curtailment of traffic volumes, and a curtailment of growth - and I think that would be really bad for the industry and the world."

"We are doing this to influence that late-2020s decision, because that is going to be at the heart and soul of the aviation sector for a while," he adds.

Airlines clearly view SAF as the clearest way forward - at least for large jets, and at least for now. They also have few other options, as fuel-burning turbofans will be flying for decades.

But some carriers say novel technologies might work for regional aircraft.

"We think about electric-hydrogen as sort of a real possibility for [regional operations] in the future," Diana Birkett Rakow, senior vice-president of public affairs and sustainability for Alaska Airlines, said during Boeing's forum.

The carrier recently delivered a Dash 8-400 to ZeroAvia, which intends to retrofit it with a hydrogen-electric propulsion system. The 76-seat turboprop is set to become the "world's largest zero-emissions aircraft", the companies say.

But that does not offer an immediate solution for Alaska's mainline operation. "Our mainline is all Boeing 737s, and that is going to be flying on jet fuel and SAF in the future," Birkett Rakow says.

That is an example of why Boeing is betting SAF will be the most-critical factor in helping the aviation sector take its next great carbon-reduction leap.

For that to happen, the industry must develop supporting technologies, energy sources and infrastructure. Currently, SAF is available for purchase at only a few airports around the world, but that is expected to change as global aviation pushes toward a cleaner future.

"It is an exciting time in this industry," Raymond says. "We are attracting venture capital, we are attracting engineers, we are attracting all this interest. Why? Because we have a big problem to solve." ▀



ZeroAvia will retrofit Alaska Airlines Dash 8-400 with hybrid propulsion

Alaska Airlines

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Alan Crawford, president, L3Harris Commercial Aviation, explains how the company is addressing the airline pilot shortage and the emerging advanced air mobility market

Q L3Harris is a diversified aerospace, defence and technology group. Where does it fit into the industry, what is its broad strategy, and how has the Covid recovery period been?

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Covid had a significant impact on our Commercial Aviation business, specifically pilot training. With borders closed and international travel severely restricted, airlines had to dramatically reduce the number of pilots, which had a knock-on effect to the training industry.

The good news is, now almost all restrictions have been lifted and demand for travel is booming again. Airlines have had to react quickly, bringing pilots back on the line and hiring new, low hours pilots. In fact, due to demand over the past six to 12 months we are at capacity for simulator training at our London Training Centre and have placed over 300 graduates from our Airline Academy with airlines across the globe.

Q What will L3Harris be focusing on in the second half of this year and into 2024?

A L3Harris will continue to build on our strong relationships with military and commercial customers, to discuss and advance strategic pursuits. As a global business we deliver unique capabilities across air, land, sea, space and cyber for military, security and commercial customers, worldwide.

Specifically, from a CAS perspective we will be looking to strengthen our position as a provider of end-to-end solutions across avionics, pilot training and data analytics for commercial aviation customers. We will also further conversations with prospective partners and customers as we position ourselves for the future of air travel by sharing L3Harris's capabilities within the advanced air mobility (AAM) arena.

Q In your area of responsibility, commercial aviation, what are

Creating safer skies



L3Harris's London training centre is at capacity again

the major industry-wide trends and what is L3Harris doing to address issues such as the flight crew shortage and the need to train pilots for emerging technologies such as eVTOL aircraft?

A The CAS business touches multiple aspects of commercial aviation, from avionics to pilot training to data analytics with the aim to provide integrated, end-to-end solutions that drive our mission

hours pilots. In fact, there's probably never been a better time to become a pilot in the USA, which is reflected by the number of pilot pathways to major airlines, via regional affiliates, on offer to students at L3Harris's Florida flight academy.

Airlines are increasing investment in their own training operations again with operators across Europe, Middle East, and South Asia purchasing flight training devices. These airlines are opting for a more diversified range of training tools, which has resulted in increasing orders for fixed based flight training devices (FTD) versus full-motion full flight simulators (FFS), offering airlines a cost-effective training solution without compromising on device quality.

L3Harris is also actively investing in technologies, avionics, pilot training and aftermarket services to cater for the ever-growing needs of the AAM marketplace. At the most advanced stage is the eVTOL training simulator that adopts the latest immersive technologies including mixed reality, motion and haptics, which combined with our simulation experience means we can deliver the same level of fidelity that we provide today through our FTD and FFS devices. At this stage our eVTOL simulator is more a proof of concept with the next step being to work with regulators and OEMs to devise and launch approved training programs for future AAM pilots. ▶

to create safer skies.

Post-Covid there has been a considerable increase in the demand for pilot training as airlines attempt to right-size their pilot staffing levels in line with the industry's recovery. The USA is already experiencing a pilot shortage and demand for new pilots has never been higher. Major and regional airlines are offering fast-track career pathways through to captaincy as well as sign-on bonuses and incentives to new, low-

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"The AMRAAM missile is arguably the most sophisticated air-to-air weapon in use today and for good reason. It has to be in order to address the complex threats we're seeing from our adversaries," said Paul Ferraro, president of Air Power for Raytheon, an RTX business.

Raytheon is driving new capability into the AMRAAM missile with the Form, Fit, Function Refresh – known as F3R –, which uses modeling to design, analyze, verify and validate the system. The F3R missiles – the AIM-120 D-3 and C-8 – feature modernized hardware, including 15 upgraded circuit

cards and advanced processors developed with model-based systems engineering.

The missile brings tremendous capability to counter both current and future threats and is postured to receive continuous advancements. The upgraded circuit cards also allow for Agile software upgrades for more rapid future improvements to the missile.

Most recently, the business and the U.S. Air Force have completed a series of guided live-fire tests and the Functional configuration audit for the AIM-120 D-3.4

But, one of the most important aspects of successfully firing a missile has little to do with the missile at all. Striking a target first requires advanced radars and sensing technology.

One example of those advanced sensors is Raytheon's AESA radar PhantomStrike™ radar.

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The radar combines two RTX specialties – a gallium nitride-powered array and the compact high-reliability integrated receiver/exciter processor, or CHIRP – to match the capability of modern AESA radars. The upgrades provide capabilities including digital beam forming and steering, multimode functionality, and interleaved ground and air targeting.

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With a decade having passed since the first flight of its largest twinjet, Airbus is regaining production momentum after the pandemic ravaged demand for widebody capacity

The A350 story...



Singapore Airlines is currently the largest operator of the type, with 61 examples in use

...past and future

David Kaminski-Morrow

Airbus is promoting its family of commercial airliner products in traditional style at the Paris air show, with the event taking place almost 10 years to the day since its current best-selling widebody product – the A350 – performed its debut flight.

On 14 June 2013 – three days before that year's Le Bourget gathering started – the first prototype of the new-generation twinjet took to the air from Toulouse. The Rolls-Royce Trent XWB-powered A350-900 completed a roughly 4h test flight.

"If you think it looks beautiful on the ground you should see it flying," commented Airbus's then flight-test division president Fernando Alonso, who was one of six crew members aboard for the milestone sortie.

First impressions

"After the first few minutes it didn't feel like we were doing a first flight," said Airbus chief test pilot Peter

Chandler. "It felt like we were flying an aeroplane at the end of a test programme, it was so relaxed and so predictable."

Airbus's original concept for the A350 had emerged in 2004, after its belated realisation that Boeing's then-7E7 proposal – which would later become the 787 – was attracting substantial interest from customers in the 250-seat middle-market sector occupied by its A330.

The European airframer believed it would simply be able to refresh the A330-200 and -300 with the A350-800 and -900 – straight derivatives using lightweight materials and a version of the 7E7's engine – and press the aircraft into service in 2010, just behind its rival.

Airbus offered the original A350 with a non-bleedless GE Aerospace GEnx-72A1 powerplant as the launch engine. R-R would only confirm its own candidate – the Trent 1700, adapted from the Trent 1000 – nearly a year later.

With Airbus playing catch-up to Boeing, Qatar Airways lifted the A350's prospects significantly in

2005 with an agreement for 60 aircraft. This saw it become the largest customer for the new jet when it was formally launched later the same year with a total of 140 commitments.

Air Europa, TAM, US Airways and several leasing firms were among the other initial takers. Finnair, which signed for the A350 a couple of months after its launch, became the first operator to select Trent engines for the type.

The original 250-seat A350-800 and 300-seat -900 were pitched with respective ranges of 8,800nm (16,300km) and 7,500nm.

But high-profile customers had started indicating disquiet over the A350 proposal, sensing that the aircraft was little more than a warmed-over A330. Boeing was mercilessly mocking its rival's offering as such, with advertising pointing out that the 7E7 was all-new.

Acknowledging operators' and lessors' concerns that it needed a more impressive competitor to the 7E7, Airbus extensively reviewed the A350's design.

It opted for a more ambitious programme, comprising a completely new aircraft family that would feature a wider cabin. This would not only compete against the 787, but also take on the 777-300ER which, until then, had been unchallenged in the large twinjet sector.

Thinking big

Airbus retained the A350 designation, but underscored the increased cabin size of its new design by adding the 'XWB' branding, signifying the 'extra-wide body'. It planned to produce three versions: a baseline -900, along with the stretched -1000 and a -800 shrink.

Although GE had been the lead engine supplier on the previous A350 design, it was also the exclusive powerplant supplier for the 777-300ER, so Airbus eventually entered into its own sole-source agreement with R-R. The propulsion provider ditched the Trent 1700 in favour of a higher-thrust design, the Trent XWB.

Deliveries of the A350-900

THIS IS FORWARD THINKING



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A350-900 made its first flight just before the Paris air show in 2013



Barand Patrick/ABC/Shutterstock

It began in December 2014, with a first customer example handed over to Qatar Airways. The carrier launched revenue services with the type the following month on the Doha-Frankfurt route, employing it in a 283-seat, two-class configuration.

The baseline model's stretched-fuselage sibling, the A350-1000, made a 4h 18min first flight on 24 November 2016, powered by Trent XWB-97 engines. Deliveries of this variant commenced in February 2018, again with Qatar Airways leading the way in introducing the type, with a 327-seat layout.

According to its orders and deliveries data, Airbus had sold 967 A350s, and delivered 530 of these, by the end of April 2023. Its orders split includes 755 -900s (78%), 173 -1000s (18%) and 39 of the in-development A350F dedicated freighter (4%).

Cirium fleets data shows there were 480 of the type in commercial airline service as of 9 May, with the top five-ranked operators being Singapore Airlines (SIA/61), Cathay

Pacific (46), Qatar Airways (36), Delta Air Lines (25) and Air China (24). That total excludes a trio of -900s employed by the German air force in the head of state and VIP transport role.

Notably, OAG data shows that SIA used the A350-900 Ultra Long-Range model to perform the world's longest-range commercial flight last year, between New York JFK and Singapore – a recorded distance of 8,279km, with the aircraft in a reduced 161-seat layout. Qantas, meanwhile, plans to introduce the -1000 on nonstop ultra-long-haul routes between Australia's east coast and New York and the UK from 2025 via its Project Sunrise.

Some 411 -900s were in active use in early May, along with 69 -1000s, representing an 85% share for the baseline version.

Another 46 A350s were listed by Cirium as being in storage as of 9 May, including six previously flown by China's Hainan Airlines, and 17 Qatar Airways examples – all -900s – which are progressively being returned to use. Airbus and Qatar

Developmental A350F set to lift airframer's cargo prospects

Having secured a launch order for its A350F freighter from Air Lease in November 2021, Airbus is now progressing with development of the model, which will offer a 109t payload capacity.

To date, the company has announced commitments for a combined 39 A350Fs; one more than its delivered total of the lower-capacity A330-200F. Launched in 2007, the cargo variant of the previous-generation widebody twin is able to transport a load totalling only 64t.

Along with Air Lease (7), other takers for the A350F are: Air France-KLM Group (8, for operation by Air France Cargo and Martinair Cargo); CMA CGM (4); Etihad Airways (7); Silk Way West Airlines (2); and Singapore Airlines (7); along with an undisclosed customer (4).

The airframer on 3 May announced that it has "slightly adjusted" its industrial planning for the freighter, after achieving initial milestones. Chief executive Guillaume Faury confirmed during a first-quarter results call that the A350F's entry into service has shifted into 2026, describing this as a matter of a "few months" from the previous end-2025 timeframe.

Faury insists the slip does not amount to a "re-baselining" of the schedule, with the shift instead related to overall programme execution.

The first components for the freighter were recently produced at its Airbus Atlantic plant in Nantes. This work involved machining metal components for its reinforced centre wing-box.



Freighter variant, due to enter service in 2026, offers a 109t payload capacity

Airbus

Family planning: why Airbus shrank away from -800 variant

Airbus originally envisioned the A350 XWB as a three-member family, centred on the -900 variant, with a stretched -1000 as well as a smaller -800.

Simple shrinks generally tend to involve a weight penalty as a result of excess structure, but the airframer decided instead to optimise the -800 in order to reduce its weight, structurally modifying the twinjet and implementing changes to its landing-gear, wheels and brakes.



Smallest version was shelved due to poor customer demand

The aircraft would use derated Rolls-Royce Trent XWB engines and have a range of around 8,300nm (15,300km).

However, when Airbus started to concentrate on the -800's development, the rationale for the optimisation became less clear.

While the lighter structure offered reduced fuel burn, potential customers expressed concerns that the divergence in commonality would not be beneficial to them if they operated the -800 alongside other A350 variants.

Airbus chose not to pursue the improved economics of a reduced take-off weight in favour of simplifying the -800 as a straightforward shrink of the -900, allowing it to avoid the industrial complexity of optimisation.

The decision meant the airframer could instead accept the higher fuel burn and use the -800's structure to offer some 250nm of enhanced range, or a corresponding increase in payload.

But Airbus's decision to redesign the A350-1000 to compete more effectively with the Boeing 777-300ER, combined with the success of its A320-family Neo re-engining programme, resulted not only in a delay to the A350-800's development but also raised the possibility that the A330 could also be re-engined to help protect Airbus's position in the 250-seat sector.

Orders for the A350-800 peaked at about 180 aircraft in 2008 but subsequently declined as customers, including launch airline Qatar Airways, migrated to the -900.

The -800's failure to attract sufficient interest and Airbus's re-engining of the A330 for its -800 and -900 models – ironically, the foundation of the original pre-XWB A350 concept – ultimately led the airframer to abandon the smallest member of the A350 family.

When Airbus formally launched the A330neo programme, with Trent 7000 engines, on Bastille Day in 2014, it essentially consigned the A350-800 to the guillotine.

Airbus

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How Rolls-Royce engineered its XWB position of power

David Kaminski-Morrow

With the A350 XWB programme Airbus, for the first time, entered an exclusivity arrangement with an engine supplier – Rolls-Royce is the sole powerplant manufacturer for the type with its Trent XWB. But this exclusivity was only formalised relatively recently.

The Trent XWB is a three-shaft engine featuring a 22-blade fan of 3m (118in) diameter, an eight-stage intermediate compressor and a six-stage high-pressure compressor, with a 9.6:1 bypass ratio.

R-R's basic model, the Trent XWB-84 for the A350-900, has a thrust of 84,200lb (374kN), while derated versions are available down to 74,200lb for the XWB-75. The most powerful model, for the A350-1000, was originally a 93,000lb-thrust engine but was bumped to 97,000lb as the XWB-97 when Airbus undertook a redesign of the -1000 in 2011.

This redesign aimed to increase the aircraft's competitiveness with the Boeing 777-300ER, for which GE Aerospace's GE90 was the sole engine. As part of the modification, and the need for a higher-thrust engine, R-R was handed its own exclusivity on the -1000.

Airbus had intended an engine choice for the A350 XWB, having offered a GE GENx powerplant as well as the Trent 1700 for the A350's original iteration as a straight rival to the 787.

GE had been the lead engine on the earlier A350 concept, and customers who had ordered this aircraft with the GENx powerplant were interested in a GE option on the A350 XWB.

But GE was reluctant to provide an engine for the A350-1000, owing to the possibility of cannibalising its 777 position, and Airbus could not conclude an agreement for the smaller A350 XWB variants – which, at the time, included both the -900 and -800.

Absence of a GE option gave R-R de facto exclusivity on the A350 family, although blade-durability issues on certain Trent models plus emergence of GE's new GE9X engine for the 777X briefly raised the possibility of a rethink.

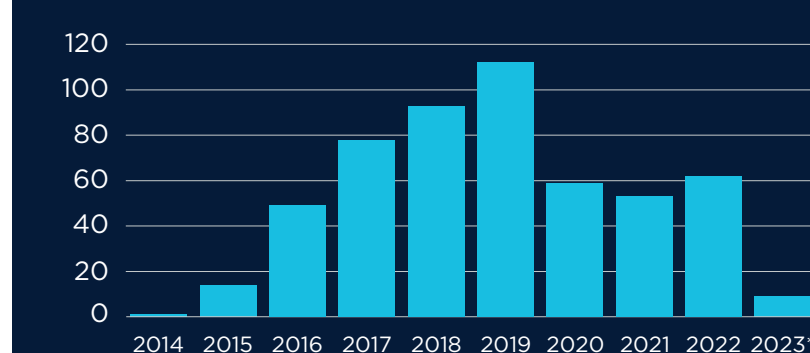
But Airbus and R-R quashed the idea in 2021, revealing a full Trent XWB exclusivity pact on all A350s to 2030, by which point R-R aims to have its new UltraFan engine available for consideration.

Meanwhile, service entry for an Enhanced Performance (EP) variant of the Trent XWB-84 selected by Singapore Airlines (SIA) in 2016 has slipped until the middle of the decade.

SIA had initially expected to field the update from late-2019, but now says it expects to "take delivery of the Trent XWB-84 EP engines from the first quarter of 2025". They will "be used mainly" on its fleet of A350-900 Ultra Long-Range aircraft, offering a projected 1% improvement in fuel consumption.

Additional reporting by Dominic Perry

A350 annual deliveries



Source: Airbus Note: *to end of April



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Airways announced on 1 February 2023 that they had "reached an amicable and mutually agreeable settlement in relation to their legal dispute over A350 surface degradation and the grounding of A350 aircraft".

Strong commitment

Cirium data shows that another 442 A350s are on order, although this total includes commitments from Aeroflot (11 -900s) and Iran Air (16 -1000s), which cannot receive the aircraft due to international sanctions imposed on Moscow and Tehran. Excluding those deals, Airbus's backlog stands at some 415 units.

By comparison, Boeing delivered 1,054 of its rival 787 by 30 April, when it cited a firm order backlog of another 533. Available in the -8, -9 and -10 models, the Dreamliner entered service with Japan Airlines in 2011.

This year has already delivered several boosts for the A350 programme. The first came as Air India in February announced plans for a massive fleet renewal activity, to include both Airbus and Boeing products, among them 34 A350-100s and six -900s. These have yet to be contracted, however.

Lufthansa in March ordered another five -900s, along with 10

-1000s, to further boost its fleet. Currently using only the smaller model, the German carrier will begin operations with the larger variant in 2026. Airbus also sold four A350F freighters to an undisclosed customer, and on 9 May announced that Philippine Airlines intends to take nine A350-1000s.

Following the start of A350 shipments in late 2014, when a single -900 was handed over, annual deliveries were on a steady upward curve until the Covid-19 pandemic hit air travel and widebody demand especially from March 2020 (see table).

From 112 A350s shipped in 2019, the number slumped to 59 in 2020 and then 53 in 2021, before recovering slightly to total 62 last year.

Just nine A350s - all -900s - were shipped in the first four months of this year: three to China Eastern Airlines, two for Starlux Airlines, and lone examples to Air China, Ethiopian Airlines, SIA and Turkish Airlines.

Speaking during a first-quarter results briefing on 3 May, Airbus chief executive Guillaume Faury said the A350 delivery situation will remain "weak" in the second quarter.

Deliveries of the twinjets will be backloaded to the latter half of the

A350 active commercial fleet

Operator	In service	Operator	In service
Aeroflot	5	Iberjet	2
Air Caraibes	6	ITA Airways	6
Air China	24	Japan Airlines	16
Air France	20	Lufthansa	21
Air Mauritius	4	Malaysia Airlines	6
Asiana Airlines	13	Philippine Airlines	1
Azul	2	Qatar Airways	36
British Airways	13	SAS	4
Cathay Pacific	46	Sichuan Airlines	5
China Airlines	14	Singapore Airlines	61
China Eastern Airlines	17	Starlux Airlines	3
China Southern Airlines	16	Thai Airways International	12
Delta Air Lines	25	Turkish Airlines	12
Ethiopian Airlines	20	Vietnam Airlines	13
Etihaad Airways	5	Virgin Atlantic	9
Fiji Airways	2	World2Fly	2
Finnair	17	TOTAL	480
French Bee	6		
Iberia	16		

Source: Cirium fleets data (as of 9 May 2023)
Note: excludes 3 VIP examples flown by the German air force

year "more than average", he says, due to supply chain factors including the late delivery of "high-end seats", rather than a lack of demand.

Airbus, which currently produces six A350s per month, is planning a gradual ramp-up of capacity to

return to triple-figure annual output. Its current goal is to achieve "rate 9" - nine deliveries per month - at the end of 2025. ▶

Additional reporting by Craig Hoyle

Cockpit delight

A sophisticated flightdeck with comprehensive automation gives crew a wealth of information and improves safety and efficiency - but still retains 'the joy of flying'

David Kaminski-Morrow

If there were any cynical concerns that the advanced automation on the Airbus A350 would reduce the pilot's job to little more than computer monitoring, British Airways director of flying Captain James Basnett does not share them.

"The joy of flying hasn't been lost," he told a Royal Aeronautical Society audience on 23 March, as he spoke about his impressions of the twinjet, stating that the aircraft's sophistication enables efficient performance while retaining the satisfaction of manual flight.

While entry-into-service with BA has been "very smooth", Basnett says the aircraft's electronic set-up for flight noticeably takes "twice as long" as that for the A320. The airline's reliance on paper in the cockpit has markedly declined in the last three or four years, he says, noting: "We're not quite there, but we're pretty well there."

The aircraft carries out detailed performance calculations, taking into account effects from individual system status and crosschecking figures with its expectations. Basnett says take-off weight limitations on the A350 are "very rare", even at hot-and-high airports such as Johannesburg, South Africa.

"It's probably true to say that, once you're away from the ground there's a sense of relief, because the set-up of the aircraft is time-consuming and critical," he says. "Once you're in the air, [the A350 is] a delight."

The primary flight displays contain "so much information", he says, with such features as vertical profile, terrain, and balance data, and are a "step up" from the A320. This requires a different approach to the traditional instrument 'T-scan' in earlier aircraft, he adds.

Once established in the cruise, the aircraft burns about 6t of fuel per hour. Basnett says the A350 provides flightcrew with information on contingency scenarios, with a 'what if' function - giving detailed data on single-engine descents, for example - enabling the pilots to engage in more interactive preparation. "The A350 has all these tools at your behest," he notes.

The crew can go into "minute detail" for approach planning, he says, and the A350 is a "really stable aircraft" in both cruise and descent. Load alleviation and flap controls are "constantly doing things which are completely outside the pilot", he adds - but although a lot of information is "need to know", the crew can call up systems pages to understand the jet's behaviour.

Basnett stresses the benefits of the A350's brake-to-vacate function, which constantly updates the automatic braking requirement according to the aircraft status and runway condition.

This gives the pilots "surety" in the runway exit after touchdown - sufficient to assist air traffic control with approach stream spacing - although he admits that it can be "unnerving" because, while autobraking usually begins immediately, brake-to-vacate optimises the deceleration timing, which means the brakes might not activate for a few seconds after landing.

BA has 13 A350-1000s, with 250 pilots assigned to the type. Basnett says the aircraft is one he "feels at home in", and argues that it is "completely futureproof", already prepared for the implementation of new independent approach patterns at airports.

He says Airbus has "nailed it in many ways" with the A350, adding that it "stands up well" compared with the Boeing 777. "It's a fantastic [aircraft]," he says.

"Pilots love flying it."



BA has 13 A350-1000s, with 250 pilots assigned to the type

Regional air transport could be the earliest beneficiary of disruptive forms of propulsion, if a new tranche of economical and environmentally friendly platforms make it to the market. But challenges remain



Electric connections

Howard Hardee

Companies seeking to re-envision regional flight could connect communities lacking air service and tap into a potentially lucrative market.

But that outcome remains far from a given, especially considering factors such as the need for highly expensive new airport infrastructure and far better batteries.

A recent report from management consultancy McKinsey estimates the market for regional air mobility (RAM) could reach as high as \$115 billion by 2035. But the report, released 31 May, also identifies challenges the sector must overcome before realising a renaissance of short-haul passenger flights.

"While there is excitement about the opportunity, there is also worry about, 'Can we actually get there?'" Robin Riedel, who co-leads the

McKinsey Center for Future Mobility and co-authored the study, tells FlightGlobal.

Whereas many electric vertical take-off and landing (eVTOL) start-ups are developing aircraft for flying up to four passengers from city centres to major airports, the separate RAM segment is focused on conventional short-haul routes between 150km (81nm) and 800km, using existing airports and developing aircraft capable of flying five to 50 passengers.

More than 50 RAM companies worldwide are "developing battery-electric, hybrid and hydrogen power trains; new and retrofitted aircraft designs; advanced avionics; operations and booking platforms; and other important enablers of the RAM ecosystem", McKinsey says.

For example, Australian advanced powerplant developer Dovetail Electric Aviation is working to electrify the existing fleet of regional turboprops. And California start-up

Xwing is developing technology it says will allow for autonomous aircraft - including types larger than turboprops - to safely integrate into national airspace.

The sector has attracted more than \$1 billion of investments. Proponents say embracing low- or no-emissions propulsion technologies such as electric and hydrogen-fuelled systems could revitalise regional air service, which is contracting amid an ongoing pilot shortage and an environment of high operating costs.

"Technology is getting to the point where [operators] can actually reduce costs, whether that is by novel propulsion, better designs of aircraft, autonomy or augmentation of flight crews," Riedel says.

But there are significant obstacles ahead, including the cost of new airport infrastructure to support electric charging and hydrogen fuelling, McKinsey warns: "A typical regional airport serving 200,000

passengers annually could require \$6 million in investment for charging or fuelling."

RAM's prospects also depend on "continuous technological advances" such as increased battery energy density, according to McKinsey.

"Battery energy density will need to at least double today's density for the RAM market to meet its full potential," the report says. "Similarly, hydrogen fuel cells are at an early stage of maturity and further advances will be critical to RAM's growth.... Hybrid power trains are nearer to commercialisation and will play an important role."

RAM companies see a relatively untapped market with thousands of small and mid-sized regional airports sitting underused across the USA. They also claim their aircraft have a clearer path to commercialisation than do eVTOLs, which face more-uncertain certification standards, unclear integration into existing air traffic management systems



and may require expensive new operating infrastructures.

US regional air mobility companies such as Eviation, which is developing an all-electric nine-seat commuter aircraft called Alice, tout that their aircraft do not require new standards for certification and air traffic control, or new airport infrastructure - unlike eVTOLs, which require "vertiports" for take-off and landing.

In many ways, Alice "is just an airplane that happens to be electric", says chief executive Greg Davis. "I think we found the sweet spot for electric aviation. It is a commuter-category plane, which means that we're going to certify it using existing standards and regulations."

Eviation has flown Alice - a clean-sheet, fixed-wing electric aircraft that looks the part of a commuter - but only once, in September 2022, and has not disclosed further flight-test operations in the roughly eight months since.

Based in Washington state, Eviation has said it intends to start certification test flights in 2025 and to start delivering Alice in 2027.

Powered by twin Magnix 700kW Magni650 motors, Alice is designed to fly at speeds up to 260kt (482km/h) and have about 250nm (463km) of range in visual flight conditions, with 30min of reserve range. Alice lends itself to the commuter model because its nine-seat capacity is the upper threshold for single-pilot operations.

"With the pilot shortage, the cost of pilots is high," Davis says. "And, of course, electricity is so much cheaper than jet fuel."

"You put those things together, and then you have an airplane that can fly from existing airports, through existing airspace, using existing regulations... I mean, it is just the clearest path for how we are going to do this," he says.

As eVTOL companies are rolling out Jetsons-type visions of air

taxis flying over major cities, other start-ups seeking to modify existing aircraft believe they have the edge in the race to reduce aviation emissions.

For example, propulsion system developer Ampaire has flown a Cessna Grand Caravan modified to run on a new hybrid-electric powerplant. It consists of a Red Aircraft piston engine, an electric motor and batteries supplied by Electric Power Systems - all replacing the Caravan's stock Pratt & Whitney Canada PT6 turboprop.

The company hopes to secure Federal Aviation Administration approval for the modification via a supplemental type certificate in 2024.

Kevin Noertker, co-founder and chief executive of Ampaire, says his company's hybrid-electric system serves as a half-step to fully electric regional aviation.

"The issue I see is that a lot of people try to take a full step with new technology - clean-sheet aircraft that have vertical take-off and landing or can land in the space of a parking lot, or require wild upgrades to the entire infrastructure of the country," he says. "It is very difficult to achieve anything new in aviation. How many Nobel Prizes do you need to gain along the path to commercialisation?"

Ampaire is taking a more modest approach, with Noertker hoping to "make a little dent on the world" by focusing on "one really important, hard problem". He views hybrid-electric propulsion as low-hanging fruit to help the aviation industry reach its emissions-reduction targets without the risks associated with developing novel aircraft.

"Upgrading existing airplane types is very efficient relative to a new airplane type," he says. Ampaire's Cessna "Eco" Grand Caravan burns about half as much fuel as conventional Caravans, providing immediate CO2 emission reductions

and cost savings, he says.

The start-up's longer-term goal is for Cessna parent Textron Aviation to offer Ampaire's hybrid-electric propulsion systems in aircraft right off the factory line. But Ampaire must prove the safety and reliability of its technology and establish a market before OEMs will take notice, Noertker acknowledges.

"The up-front cost of our system is less than the PT6 we're replacing, so this is an economically viable up-front purchase, [and has] better economics on operations," he says. "Now you can start to do some meaningful things with the market - you can either improve profitability of existing routes, open up new routes that have atrophied, or even drive additional feeder routes into [San Francisco] or [Los Angeles] or other major hubs."

Conventional aircraft retrofitted with hybrid-propulsion systems would use existing airports and not require new infrastructure, which Noertker views as potential pitfalls for all-electric and hydrogen aircraft.

"I'm worried that, whether it is the energy infrastructure, investment for megawatt charging... that the economics are going to be very challenging along the way for some of these peer solutions," he says.

Regional air mobility could benefit from increasingly congested highways, particularly in the USA but also globally, diminishing the convenience of driving as a regional transit option.

"In nearly 40% of US metro areas, traffic was worse in 2022 than pre-pandemic, and more than 200 major airports worldwide are capacity constrained, underscoring the unmet demand for transportation that avoids congested roads and major airports," McKinsey says.

Ultra-low-cost carriers are increasingly playing the role of regional airlines, with narrowbody operators filling some routes between secondary cities. "Although

air travel for trips between 150km and 800km has increased in recent years... much of this growth was driven by low-cost carriers using larger aircraft," McKinsey says.

But with larger aircraft come larger airports - and more hassle. Convenience is a top consideration for RAM companies, whose executives are aware that many potential customers would rather drive than take short-haul flights from major airports.

Some in the sector are looking to ride-sharing apps for inspiration as they attempt to create "end-to-end" journeys that smoothly link passengers' first and last miles, Riedel says. Regional air travel company Surf Air Mobility - another player seeking to electrify existing turboprops - is working to further develop its app-based booking platform, which allows passengers to book flights with third-party operators.

"The whole question of, 'How we make this easy to use, intuitive, seamless - or minimise the seams as much as we can?' is the big challenge that is going to make or break this industry," Riedel says.

He envisions a "terminal in a box that provides both digital and physical infrastructure to handle passengers" at regional airports. But matching the convenience of roadside ride-sharing apps will be challenging, he adds, as those services need not account for airport security checks and infrastructure.

"If you have to show up 20 minutes early and put your bags through something and go through security and take your shoes off - I am pretty sure most people would prefer to drive, even if it is a little bit longer," he says.

Much rides on creating a product that beats driving, Riedel says: "Can we as an industry figure out how to make this easy? There are thousands of airports available for this, but how do you really unlock them?"

The V2500 is 40 years old and – despite P&W's Geared Turbofan largely superseding it – the engine still provides propulsion for thousands of aircraft, including the in-production C-390

Jon Hemmerdinger

In March 1983, several aircraft engine manufacturers joined to form a company with the goal of offering a new turbofan for narrowbody airliners.

Forty years later, IAE International Aero Engines is still producing V2500s, including turbofans for Embraer's new C-390 military transport, and its maintenance shops are humming, supporting some 3,000 active V2500-powered Airbus A320ceo-family jets.

The company anticipates such aftermarket demand will not let up soon, saying airlines are leaning heavily on veteran V2500s amid new jet delivery delays and maintenance issues affecting newer engines.

"After 40 years, this programme is exactly where you would hope that a programme could be," says IAE's president Earl Exum (who has since moved to become chair of the IAE board). "We just went [service-entry] on a new aircraft in 2019... We are serving the cargo market and we are in the prime of our product life cycles in the commercial market."

Exum, also vice-president of mature commercial engines at IAE partner Pratt & Whitney (P&W), spoke ahead of 11 March, 40 years to the day after IAE's founding.

The company came together as a joint effort of Italy's Fiat, Japanese Aero Engines, Germany's MTU Aero Engines, P&W and Rolls-Royce. The three remaining partners include fan-section provider Japanese Aero, low-pressure turbine supplier MTU, and P&W, which produces high-pressure turbines and, through its Pratt & Whitney Aero Engines International subsidiary, high-pressure compressors.

IAE's big win came shortly after its founding with a deal to supply Airbus with V2500s – which now generate up to 33,000lb (147kN) of thrust – to power the in-development A320. Airbus also offered that jet with CFM International CFM56s.

The V2500 entered service in 1989 on an A320 operated by now-defunct Slovenia carrier Adria Airways. McDonnell Douglas also picked V2500s to power MD-90s, which entered service with Delta Air Lines in 1995.

IAE lost its place on the A320 programme when Airbus rolled out its A320neo-family of jets, which the airframer offers with CFM Leap-1As or P&W PW1100Gs.

But the engine firm scored another victory when Brazil's Embraer picked V2500s to power its C-390 military transport, which entered service in 2019 with Brazil's air force.

IAE has produced more than 7,800 V2500s, which have collectively logged more than 135 million flights and some 255 million engine flight hours, according to P&W. The vast majority of those engines were slung



Embraer chose the V2500 for its C-390 military transport

Powering on

on the wings of A320ceo-family jets. (P&W notes V2500s powered just 116 MD-90s, and Embraer has produced only a handful of C-390s.)

"The V2500 is a workhorse of the aviation industry, and has grown into one of the most-successful commercial aerospace programmes of all time," says Exum. "They are retiring at a relatively low rate."

P&W says V2500s still "power nearly 3,500 aircraft globally", with an average age of 12.8 years. About one-third of the engines have yet to undergo their first major maintenance overhauls, it adds.



The engine on an Airbus A321

Exum notes that V2500-powered A321s have recently proved popular as converted freighters – Elbe Flugzeugwerke and US specialist 321 Precision Conversions offer such conversions. He also says IAE is working to ensure V2500s can safely run on 100% sustainable aviation fuel.

Cirium fleets data shows the active fleet of V2500-powered jets closer to 3,000, including about 2,540 in-service and 440 stored jets, with an average age of 14 years. Those include three MD-90s and seven C-390s, with the balance being A320ceo-family aircraft, the data shows.

IAE now produces about 20 new V2500s annually, feeding Embraer's C-390 programme and supplying spares to Airbus operators, says Exum. He expects IAE will remain at the roughly 20-annual production rate for at least five years, though says production could bump higher if Embraer lands more C-390 sales. IAE's partners have extended their collaboration agreement until 2045.

Embraer launched the C-390 programme in 2009 with an order from Brazil, but sales have been modest. Brazil has trimmed its orders from 28 to 19, and already operates five of those, which have logged 8,000h of flight, at a completion rate exceeding 99%, Embraer says. Portugal ordered five of the aircraft, Hungary ordered two and the Netherlands has chosen to purchase – but not yet ordered – five.

Embraer has insisted C-390s have a promising future, saying geopolitical tension has driven fresh

demand for a modern replacement of decades-old military transports. Embraer also in 2022 partnered with US firm L3Harris to offer the "Agile Tanker" aerial refuelling variant to the US Air Force.

Exum also expects airlines will likely keep operating V2500-powered A320-family aircraft for years, citing the relative youth of the in-service fleet and noting ongoing maintenance issues affecting some newer-generation engines. Indeed, on 7 February, Spirit Airlines chief executive Ted Christie lamented that maintenance issues with PW1100Gs prompted Spirit to trim its 2023 capacity plan.

He also notes that Airbus and Boeing's deliveries of new jets have been "hard to pin down". Both manufacturers have failed to hit delivery targets amid supply chain troubles.

Such factors should lead airlines to continue operating V2500-powered Airbus jets well into the future, Exum says, calling the engine's performance "practically guaranteed" with 99.97% dispatch reliability. "Customers are going to sit on programmes they know."

That hefty in-service fleet requires "close to 800 shop visits" annually, generating strong aftermarket revenue for IAE's network of 17 maintenance, repair and overhaul facilities.

"That is where we make the money in this industry – when we do a shop visit. It's where the margins are," Exum says. "We are really, really pleased with where we are there."

Pat Wilson is commissioner for Georgia's Department of Economic Development. He outlines the state's contribution to the US aerospace sector, and why technology disruptors have been moving in

Q Why is it important for the State of Georgia to be at the Paris air show?

A As one of the country's top states for aerospace, according to the 2022 PwC outlook, Georgia serves as a model for aerospace innovation. It is home to more than 800 aerospace companies, and aerospace is Georgia's number one export – \$9.2 billion in 2022. It is also the state's second-largest manufacturing industry, contributing to a total economic impact of \$57.5 billion. In addition, Georgia is the fifth largest aerospace exporter in the USA.

Q Savannah is famously the headquarters of Gulfstream. What major aerospace companies are based in Georgia?

A Gulfstream is one of the largest aerospace manufacturers in the state and recently announced its fifth expansion since 2006. Other large major manufacturing operations include Lockheed Martin, Pratt & Whitney, Northrop Grumman, and Meggitt. There are 19,275 people working for aerospace manufacturing companies in Georgia and approximately 200,000 working in aerospace-related occupations.

Q What are you doing to encourage more companies to come to Georgia and, for those already here, to invest and grow?

A In Georgia, you'll find significant academic resources, R&D innovation, a AAA bond rating with a business-friendly ecosystem, as well as institutions created to establish a pipeline of workers.

Each year, in education, Georgia's 79 accredited colleges and universities award more than 155,000 degrees and certificates. The state is home to two of the nation's top 20 public universities – the University of Georgia and Georgia Tech, one of the leading producers of aerospace engineers. Middle Georgia State University is one of only nine institutions in the USA to offer degrees in aviation, ranging from a master's degree to



Savannah-based Gulfstream is a major employer in the state

Next-generation jobs in Georgia



In Georgia, 80% of US markets are less than two days away by land. Georgia also has the most extensive rail lines in the Southeast. Rail providers travel on 5,000 miles of track, moving nearly 200 million tonnes of cargo each year.

Q What are Georgia's other main industries, and what role does aerospace play in the wider economy?

A Aerospace is one of many growing advanced manufacturing sectors in Georgia. In November 2022, Archer Aviation, an aerospace company advancing sustainable urban air mobility, announced plans to invest \$118 million in a new state-of-the-art electric vertical take-off and landing aircraft (eVTOL) manufacturing facility. This is just one of nearly 40 e-mobility investments in the state since 2020. Recently automotive investments, specifically electric vehicles, have been a huge economic driver, with Rivian, Hyundai Motor Group, and Kia all announcing plans to manufacture EVs in Georgia. SK On is building battery manufacturing plants, and Ascend Elements and Aurubis are developing plants for battery recycling.

Georgia is leading the nation in attracting next-generation jobs. Companies looking to lower emissions and reduce the carbon footprint for themselves and their customers have invested over \$11.5 billion in Georgia since 2018. Qcells North America, an affiliate of Korean-based Hanwha, began solar panel production in northeast Georgia in 2019, and in March 2023, they announced an additional \$2 billion factory. Solar PV is the fastest-growing source of renewable energy in the state.

Keeping up with the latest computer-driven manufacturing robotics, as well as the software behind these systems, has resulted in the tremendous growth of Georgia's cybersecurity industry. Through the military's enormous investment in its new Cyber Command Center at Fort Gordon along with the state-owned Georgia Cybersecurity Training Center, Georgia has also welcomed an increase in cybersecurity companies and cyber-related talent. ▶

one-year certificates. These FAA-certified programmes focus on maintenance, flight training and air traffic control collegiate training.

These resources are complemented and can also be utilized by Georgia's military population, the fifth largest in the country. The skills, dedication and talent of 700,000 former service members and over 101,000 military retirees living in Georgia are valued here thanks to their immeasurable contributions.

Additionally, companies may qualify for Quick Start, the number one workforce development programme in the country, that offers customized training based on a company's specific manufacturing processes. The oldest programme of its kind, Quick Start has updated the skill sets of more than one million employees in 6,500 projects, and ensures that companies are operational on day one.

Research and innovation are also prevalent in our ecosystem. Gulfstream does all its R&D in Savannah. Research is the backbone of the Georgia Tech Guggenheim School of Aerospace Engineering, and The Delta Innovation Hub is the centerpiece of the University of Georgia's Innovation District. The Hangar, located in midtown Atlanta, serves as Delta's collaborative space for design ideation, rapid prototyping and innovation training. And Hermeus, a startup company from Atlanta, is developing commercial hypersonic aircraft.

The Georgia Center of Innovation aerospace team helps organisations with aerospace manufacturing, maintenance repair, overhaul, research, and education. The centre helps connect businesses to resources, including university researchers, business organisations, contract manufacturers, and many others.

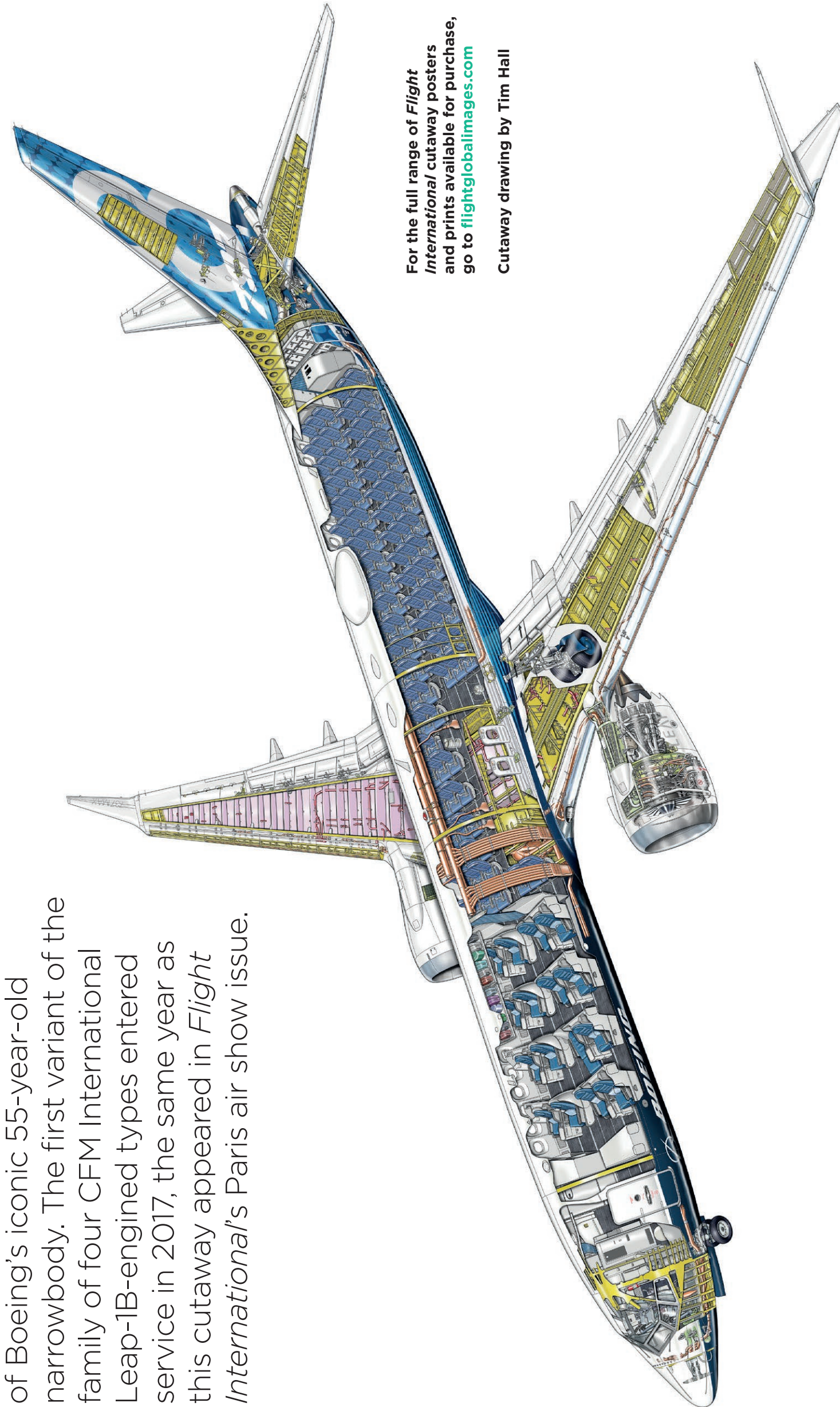
Q What role does Georgia's impressive transport infrastructure, including Atlanta as one of the country's biggest air hubs, play in attracting aerospace and other businesses to the state?

A Great infrastructure and connectivity are highly sought-after components, according to conversations with aerospace corporate executives. In addition to great incentives, Georgia is well positioned to offer the following: The state offers direct access to US and global markets from the busiest airport in the world, Hartsfield-Jackson Atlanta International Airport. This airport offers non-stop flights to 150 US cities and 50 countries. There are eight additional commercial airports for convenient air service throughout the state.

The deepwater terminals in Georgia's ports ensure the continuous flow of goods to and from global destinations. Providing a range of cargo diversity, these gateways move containers, cars and machinery, bulk and breakbulk cargo.

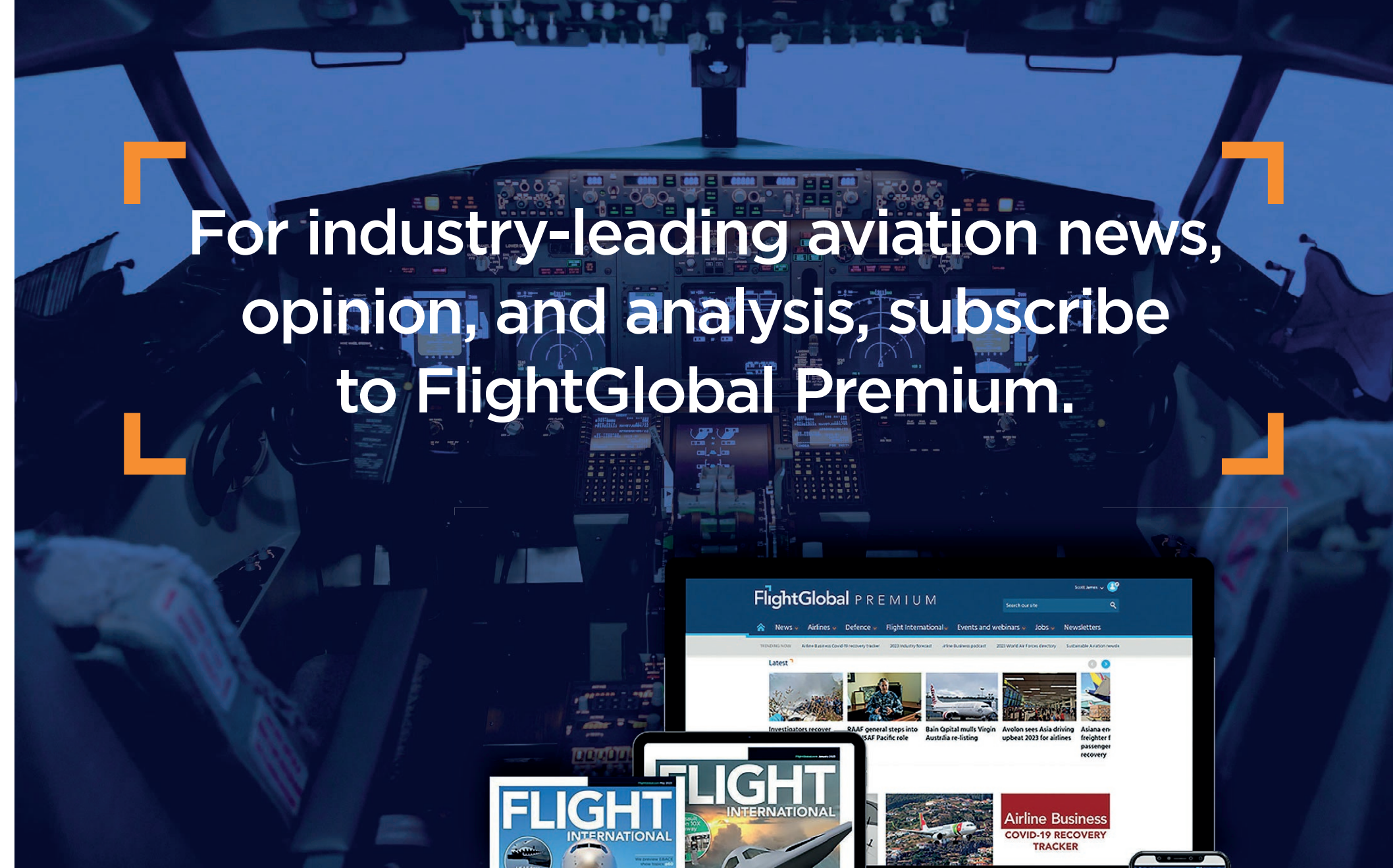
Boeing 737 Max-8

The Max is the fourth iteration of Boeing's iconic 55-year-old narrowbody. The first variant of the family of four CFM International Leap-1B-engined types entered service in 2017, the same year as this cutaway appeared in *Flight International's* Paris air show issue.



For the full range of *Flight International* cutaway posters and prints available for purchase, go to flightglobalimages.com

Cutaway drawing by Tim Hall



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