

# FLIGHT INTERNATIONAL



How Max cuts hurt Boeing backlog



## Feeling supersonic

Making throwaway aircraft affordable **p32**

Hydrogen switch for Fresson's Islander **p34**

Will Overture be in tune with demand? **p52**



**Big worries**  
We assess A380 outlook as last delivery looms **p14**



**Warning sign**  
Why NOTAM burden can baffle pilots **p22**



E499



GO BEYOND

PRATT & WHITNEY

**GTF**

THERE IS NO COMPARISON.  
NO EQUAL. THERE IS ONLY ONE.

**THE COMMERCIAL JET ENGINE  
IN A LEAGUE OF ITS OWN.**

Powered by an industry-first geared architecture – and more than 40 other groundbreaking innovations – the **Pratt & Whitney GTF™** is unlike any engine that's come before it.

EXPLORE THE FUTURE OF FLIGHT AT [PRATTWHITNEY.COM](https://prattwhitney.com)



Prospects receding

# Future dreaming

Once thought of as the future of air travel, the A380 is already heading into retirement, but aviation is keenly focused on the next big thing



Airbus

It has been a rapid rise and fall for the Airbus A380, which not so long ago was being hailed as the future of long-haul air travel.

The superjumbo would be, forecasts said, the perfect tool for airlines operating into mega-hubs such as Dubai that were beginning to spring up.

But the planners at Airbus failed to take into consideration the efficiency gains available from a new generation of widebody twinjets that allowed operators to open up previously uneconomical point-to-point routes.

While the A380 limped on with flagging sales – ultimately forcing Airbus to axe the programme – it was assumed that the in-service fleet would continue flying for decades to come.

Then Covid-19 intervened and airlines reassessed their attachment to the double-decker. Outside the fleets of a handful of operators – British Airways, Emirates and Qantas, for example – the A380 is unlikely to make much of a reappearance in the post-pandemic world.

What, then, is the future of air transport? Clearly, that depends

on who you ask. As we report elsewhere in this issue, there are those banking on supersonic speeds being the answer.

The likes of Aerion and Boom Supersonic view the ability to shave significant time from journeys as a unique selling point.

While projects are likely to be technologically feasible, to be able to sell these new aircraft in significant volumes their manufacturers will have to ensure that supersonic flight is not merely the domain of the ultra-rich.

Although it would be an enormous stretch to imagine an EasyJet-operated supersonic jet, they must be sufficiently cost-effective to appeal to an audience wider than a handful of niche operators.

Moreover, as aviation's environmental performance faces ever-closer scrutiny, those supersonic jets will have to be as green as possible to avoid any backlash.

Elsewhere, though, the prospect of a cleaner air transport industry is the *raison d'être* of other developments. For many of these, hydrogen is seen as the fuel that enables that sustainable future.

Hydrogen is not without its issues, of course, but nonetheless it appears more feasible as a power source for large transport aircraft than batteries do at present, even allowing for improving energy densities.

However, there are others who see hydrogen through a different filter. They argue that so-called sub-regional aircraft – the Britten-Norman Islander, among others – can be given fresh impetus if a fuel source can be found that is both cheap and non-polluting.

In theory, such aircraft could link towns or cities currently under-served by any mode of transport, or provide a more sustainable lifeline to island communities (who may also be able to produce their own hydrogen through use of two abundant natural resources: wind and waves).

At this early stage of development it is hard to say who will succeed, but what is clear is that aviation is on the cusp of a radical change where new technologies could prove more disruptive than ever the A380 was. ▶

**See p14, p52**

## In focus

How pandemic reversed decade of growth **6**

Mixed times for 737 Max **8**

Electric Beaver charges on **10**

Taiwan feels the pressure **12**

Demise of double-decker **14**

The learning power of PISA **18**

ICAO targets data overload **22**

Canada backs Airbus tanker **24**

US Army's FLRAA plans **25**

United sets diversity target **26**

Renewed authority at CAA **28**

Cost war of attrition **32**

Fresson takes new direction **34**

Airbus warms to cryogenics **36**

BA zeroes in on hydrogen **38**

Opinion: A powerful change **39**

View from the cockpit **41**

# 52



**Boom time** Virgin Galactic's delta-wing civil jet will be capable of Mach 3.0



Boom Supersonic

# 34



**Regulars** Comment **3** Best of the rest **42** Straight & Level **74** Letters **76** Jobs **81** Women in aviation **82**

**In depth**

**Open for business 46**

Covid-19 has buffeted private aviation more lightly than its commercial cousin

**Upping the pace 52**

Are we ready for the return of supersonic passenger services?

**Upwardly mobile 58**

The prospect of eVTOL aircraft carrying passengers above crowded cities is drawing near

**In pole position 62**

Can the F1 factor give start-up Vertical Aerospace an edge?

**Sustainable strategy 65**

The business aviation sector is embracing alternative fuels

**King Lear's long reign 70**

Looking back at Learjet's six decades of style, speed and sexiness





# How Covid-19 pandemic reversed decade of growth

The collapse in demand for air travel caused by crisis has inevitably hit the orderbooks of Airbus and Boeing

AirTeamImages

**Jon Hemmerdinger** Tampa  
**David Kaminski-Morrow** London

**A**nalysis of the big two airframers' backlog data over the year since the onset of the air transport crisis shows overall orders declined during the period - an extraordinary contrast to their strong annual performances over the previous decade.

Airbus's total orders fell by 83, to 20,315, while Boeing - which spent until November last year also wrestling with the grounding of the 737 Max - saw its total orders fall by around 800 aircraft.

It is tricky to make a perfect like-for-like comparison between the two manufacturers due to differences in the way they present their order and delivery data on a monthly basis. For Boeing we have instead relied on its stock market filings, the most recent of which provides only approximate totals. It also only includes figures for its in-production aircraft, leading to an overall order total lower than that of its rival, even though it has been in existence much longer.

But despite the differences in presentation, the impact of the pandemic is clear.

Airbus's order total had risen each year by an average of over 1,000 aircraft from the end of March 2011 to the end of March 2020, the point at which the pandemic started to generate serious disruption to international air travel.

But its latest backlog data shows that in the subsequent 12 months, to the end of March 2021, order activity not only stopped its upward surge but actually reversed, with the overall order total slipping from 20,398 to 20,315.

## Reduced demand

This reduction of 83 aircraft resulted from 210 cancellations being only being partly offset by 127 additional orders.

Total long-haul aircraft orders were down by 26 - comprising 17 A350s and nine A330s - while those for short-haul jets fell by 57.

But the performance of individual models in the short-haul range varied. The A321neo, which has proven a popular variant, increased its net total by 46 aircraft - possibly aided by upward conversions

# 20,315

Total orders for Airbus - a drop of 83 since March 2020: 210 cancellations partly offset by 127 new orders

from the A320neo, whose order level fell by 98.

The A220-300 also generated a small net gain in orders over the 12-month period.

Analysis of the main cancellations shows 88 are attributed to Scandinavian budget carrier Norwegian, 17 to lessor BOC Aviation, 10 to each of AirAsia X and Gulf Air, and six for Turkish Airlines, while another 56 were classified as undisclosed.

Chinese operators and lessors had a strong presence among customers whose orders increased over the year.

Eleven Chinese carriers - among them Air China, China Eastern Airlines, China Southern Airlines, Qingdao Airlines, Shenzhen Airlines and Sichuan Airlines - plus lessors Bocomm, CMB Leasing and ICBC Leasing, are all listed with higher order figures.



Robust cargo demand has driven continued interest in 747-8F

The airframer has been managing the impact of the pandemic by cutting its production rates and working to negotiate deferred deliveries to customers – and chief executive Guillaume Faury has pointed out that the company has experienced only a “low number” of cancellations.

Airbus’s total order figure of 20,315 at the end of March 2021 was just over double the level of 10,061 recorded 10 years earlier in March 2011.

Meanwhile, on the other side of the Atlantic, Boeing’s total aircraft orders tumbled by roughly 800 jets over the last 12 months.

The backlog losses reflect a pile of cancellations only partly offset by far fewer orders.

At the end of March, Boeing’s total orders stood at about 17,000 aircraft, including 4,054 in its backlog. That is down from the 17,835 total orders, including 5,049 in the backlog, that Boeing held at the end of March 2020, company data shows.

### Uncompleted sales

The decline over the past 12 months reflects the removal of firm orders for about 1,200 jets, including 670 cancellations and another 550 aircraft that Boeing shifted from its backlog into an accounting bucket reserved for sales that it suspects will not close.

Boeing partly offset those losses with new orders for 417 aircraft during the last year.

The backlog slide contrasts sharply with Boeing’s stream of sales successes in the decade preceding the March 2019 737 Max grounding. Total orders nearly doubled from 9,597 at the end of 2008, to 18,229 at the end of 2018, equating to an average annual gain of some 860 orders, regulatory filings show.

Meanwhile, Boeing continued ramping up production of the 737 Max, hitting a high of 52 jets monthly in 2018.

All that changed when an Ethiopian Airlines 737 Max crashed shortly after take-off in March 2019 – the second accident involving the type. The regulatory grounding that ensued would last 20 months, until November 2020.

Of the 1,200 jets removed from Boeing’s backlog over the past year, more than 1,000 were for 737 Max aircraft, data shows: about 640 cancellations and more than 400 negative accounting adjustments.

Customers across the spectrum have axed deals for the narrow-body over the last 12 months.

Major carriers like Air Canada, Copa Airlines, Virgin Australia and WestJet scrubbed orders. More recently, Turkish Airlines cancelled 50 Max orders, converting 40 of them into purchase options. Uncertainty about Norwegian’s future led Boeing to shift a portion of its 92 Max orders into the ASC-606 accounting category.

Lessors including AerCap, Air Lease, Aviation Capital Group, Avolon, BOC Aviation, CDB Aviation, GE Capital Aviation Services and SMBC Aviation Capital have also cancelled deals for the Max.

# 1,200

Jets removed from Boeing’s backlog over the past year – more than 1,000 of these represented by the 737 Max

Boeing’s widebody orders have also suffered amid a pandemic that has had an outsized impact on international long-haul travel.

Widebodies accounted for about 140 of the 1,200 aircraft erased from Boeing’s books since March 2020, data shows. Of those, about 30 are cancellations and the balance are accounting adjustments.

The company has, however, offset a large part of those losses with new orders.

Boeing’s net orders for the 767 increased by 36 aircraft over the last year, likewise, net 747 orders increased by five aircraft during the last 12 months. The gains on both programmes come amid comparatively strong demand for cargo jets.

The 777 programme slipped by 67 and the 787 declined by 47 aircraft across the same period, data shows.

The 787 has suffered the additional pressure of quality issues that became known in 2020 and which led Boeing to halt Dreamliner deliveries between November 2020 and March this year. ▀



Norwegian was responsible for 88 of Airbus’s cancellations

# Two steps forward, one step Max

Boeing's rehabilitation of its troubled narrowbody is gathering pace, but the process has not been without setbacks

Graham Dunn London

After a traumatic two years for Boeing and its 737 Max programme, some of the airframer's top customers have signed up for hundreds more of the narrowbodies, delivering key endorsements as the type returns to service.

Notably, Southwest Airlines' decision, disclosed on 29 March, to replace 737-700s with 100 737 Max 7s came after follow-on Max orders from key customers Ryanair and United Airlines.

But a further batch of Max order cancellations in March – including Turkish Airlines (50) and lessors CDB Aviation (16) and China Aircraft Leasing (26) – again highlights the faltering nature of the recovery for both the jet itself and the wider industry.

In all, Boeing took in 196 orders in March, offset by 156 cancellations – the vast majority for the Max.

And in another example of how the 737 Max's troubles are not yet completely behind it, Boeing in April recommended that some airlines remove a subset of the twinjet from service pending maintenance related to an unspecified back-up power control system (see below).

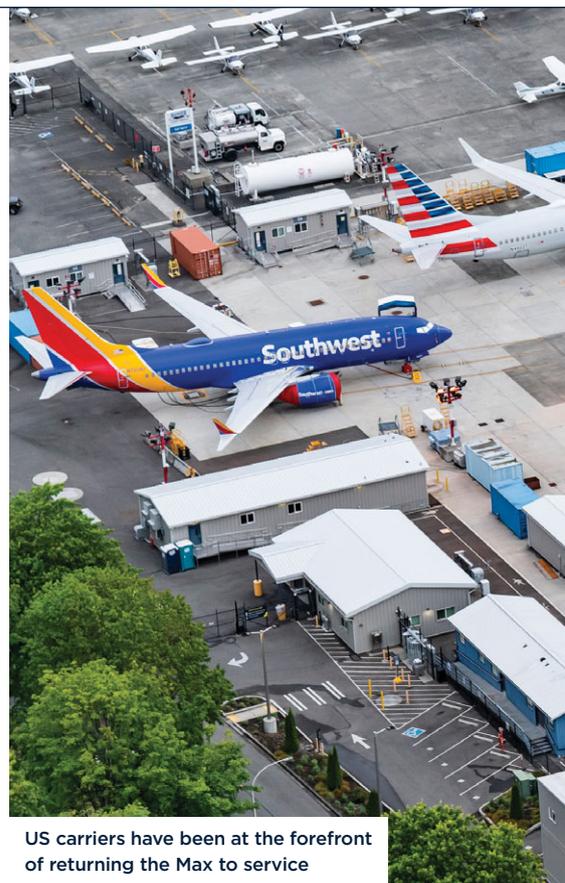
The news came as Boeing attempted to shift the narrative away from the jet's earlier woes, caused by a pair of fatal crashes.

## Gol followers

A string of airlines have now returned the Max to service, following Brazilian carrier Gol, which in December 2020 became the first operator to restore commercial flights with the type.

Globally, about 170 Max are back in the skies, with airlines holding another roughly 300 in storage, Cirium data shows.

While operators in North and Latin America have led the charge, European carriers too are returning the Max to service, after



US carriers have been at the forefront of returning the Max to service

regulators there, in late January, cleared the type. TUI Airlines became the first European carrier to restore Max service, in February, followed in March by Icelandair, Czech carrier Smartwings and LOT Polish Airlines.

Romanian budget carrier Blue Air, meanwhile, became a new Max customer at the start of April after taking delivery of the first of 10 of the type from Air Lease.

Ryanair too will shortly become a new Max operator in Europe,

## Deliveries stay steady, but fresh safety issue drives more jets into storage

Jon Hemmerdinger Tampa

Boeing has delivered almost 90 737 Max since US regulators lifted the type's grounding last November, putting the airframer on track reach its goal of delivering half those jets by year-end.

Production of the 737 Max continued during much of the period that the type was grounded, resulting in a total of around 450 undelivered aircraft by the time the US regulator re-certificated the narrowbody for its operational return.

In October 2020, the US airframer said the company aimed to deliver about half of those stored aircraft before the end of 2021, and the "majority" of the remainder in 2022.

The US Federal Aviation Administration lifted the grounding in November 2020, with other regulators following in subsequent months.

Boeing resumed 737 Max deliveries in December, handing over 27 of the jets that month. Another 62 have followed this year, up to 20 April.

Some of those aircraft might have rolled off Boeing's

production lines in recent months, but more than 80 examples completed first flight during the grounding period, making them part of the 450-strong inventory.

US carriers Alaska Airlines, American Airlines, Southwest Airlines and United Airlines have received the vast majority of recent Max deliveries – 67 jets, according to Cirium data.

Boeing has also, since late last year, delivered Max aircraft to airlines in Canada, Latin America and Europe, data shows.

But all the 89 Max that Boeing has delivered since December are



AirTeamImages

having been on the verge of taking its first Max when the aircraft was grounded in March 2019.

The Irish carrier expects to operate 16 737 Max 8-200s – a high-density variant of the Max 8 – by the peak summer travel season. That goal moved closer when the European regulator in early April approved the variant.

Ryanair chief executive Michael O'Leary has been a vocal proponent of the narrowbody: in December, shortly after the US Federal

**in storage with airline customers, Cirium shows.**

While many of those are parked owing to current low levels of demand, even where jets had been returned to service – for example, those aircraft operated by American, Southwest and United – a subsequent safety issue identified in early April related to a back-up power control unit has seen the aircraft pulled from flights for inspection and potential modification.

The problem relates to 737 Max that have been delivered recently, rather than those shipped before the grounding.

# 100

Order for 737 Max 7s placed by Southwest Airlines in March

Aviation Administration lifted the grounding, Ryanair firmed orders for 75 Max, bringing its total commitment to 210.

Boeing may have secured the Max's place with Ryanair, but the troubled state of the wider airline sector has raised uncertainty about its future with other European carriers.

Chief among those is Norwegian which, prior to the grounding, operated 18 of the jets – more than any other European airline. But Norwegian has since embarked on a major restructuring, ditching long-haul operations. It does not plan to use Max aircraft as part of its initial operational ramp-up and has not commented on plans beyond the summer.

Last year, the carrier said it was cancelling 92 Max orders. Boeing has not actually removed those from its books but has shifted an undisclosed number into a special accounting bucket – known as ASC-606 – that is reserved for sales over which there is significant uncertainty.

Neither has there been apparent movement by two European customers to firm Max order commitments made during the grounding. Those orders include Air Astana's deal to acquire 30 Max for its low-cost unit, FlyArystan, and IAG's headline-stealing letter of intent, revealed during the 2019 Paris air show, to buy 200 Max.

Recovery has also been slower in the Asia-Pacific region, home to more than 20 Max operators before the grounding.

In late February, Australia became the first country in the region to lift the Max's grounding. Days later, New Zealand followed suit, though it stopped short of a blanket approval.

### Next steps

While no Australian carrier currently operates 737 Max, two foreign carriers – Singapore Airlines (SIA) unit SilkAir and Fiji Airways – had previously flown the type into the country. Fiji lifted its grounding in early April.

Though Singapore authorities have not cleared the Max for commercial flights, SIA is preparing for the type's return. The carrier – which has been integrating regional unit SilkAir into its mainline operation – in March began shuttling its six 737 Max back home from storage in Australia, as a cabin retrofit programme gets under way for the type.

Crucially, the Max remains grounded in China, which was the first country to ban flights of the narrowbody. China's civil aviation regulator has said that it has been discussing with Boeing a plan to restore 737 Max services, but has not presented a timeline for any such move.

China is a huge market for the single-aisle: at the time of the Max grounding, 12 Chinese operators had nearly 100 of the jets in service, with another 200 orders, Cirium data shows.

Aside from China, two other notable hold-outs in Asia are India and Indonesia, although the former has now permitted overflights with the type. Globally, more than 160 out of 195 civil aviation regulators have opened their airspace to the Max, Boeing says.

*Additional reporting by Alfred Chua in Singapore and Jon Hemmerdinger in Tampa*

# Electric Beaver charges ahead

Partners Harbour Air and Magnix team up with Swiss battery developer H55 to advance DHC-2 electrification programme

**Jon Hemmerdinger** Tampa

Swiss battery company H55 has been recruited by Harbour Air and Magnix in an effort to develop and certify an all-electric De Havilland Canada DHC-2 Beaver seaplane.

The project is already well under way, with Harbour Air, a Canadian commuter airline based near Vancouver, having flown a demonstrator all-electric Beaver for the first time in late 2019. That aircraft is powered by Magnix's Magni500 electric propulsion system.

Now, Harbour Air and Magnix, which has offices in Seattle, have enlisted H55 – a spin-off from the Solar Impulse project – to provide a battery system and other technologies for their electric Beaver.

The trio intend to “certify the world’s first electric Beaver commuter airplane through a supplemental type certificate programme”, they said on 20 April.

“The companies will collaborate together with Transport Canada to certify the installation of the Magnix electric propulsion unit and the H55 enhanced battery system, transforming Harbour Air’s seaplanes into an all-electric commercial fleet.”

It is currently unclear whether the addition of H55 to the team means changes to the demonstrator’s systems or configuration and the development timeline. The companies did not respond to a request for more information.

In January 2020, Harbour Air chief executive Greg McDougall said he hoped to certify the electric Beaver within two years, possibly less. But he suggested it might need more advanced batteries to be commercially viable.

H55 was launched in 2017 by a three-person team that includes Andre Borschberg, who, along with Bertrand Piccard, helped found Solar Impulse, the organisation behind the solar-powered aircraft project. Borschberg is H55’s executive chairman.



Demonstrator made its first flight near Vancouver in December 2019

Harbour Air/EPA-EFE/Shutterstock

“We have been attracted by Harbour Air and Magnix’s vision, pioneering spirit and commitment to make aviation clean,” Borschberg says. “The path to electric aviation is complicated. But, at the same time, by joining forces our combined experience will lead to quicker certification.”

H55 has developed a “single-engine battery pack system” designed to power small aircraft. The pack has energy capacity of 50kWh, produces 67hp (100kW) of maximum power, has 90min endurance and can be charged in 1h, the company says.

## Bristell fashion

H55 has integrated a battery system into a two-seat Bristell B23 Energic, which made its first flight in 2019. It aims to acquire European Union Aviation Safety Agency design and production certifications in 2021, and to gain a type certificate for its battery system by mid-2022.

H55 does not specify what system it is planning to develop for the Beaver, but it will have to be larger than that on the B23, due to the power requirements of the bigger aircraft.

“Magnix, Harbour Air and H55 will work on design optimisation for the electric propulsion unit, energy storage system and related aircraft systems based on ongoing flight testing,” the companies say.

Harbour Air sidelined one of its Beaver seaplanes several years ago for the project. The six-passenger aircraft’s Pratt & Whitney P-985 Wasp Junior piston engine was replaced with the 750hp Magni500.

The Magnix-powered Beaver made its first flight on 10 December 2019, lifting off from the Fraser River near Vancouver. That event was, according to Harbour, the first flight of an all-electric commercial aircraft.

The team has since conducted “additional flight tests to measure and collect data on cruise performance and take-off thrust efficiency, electro-magnetic interference, battery management software logic, noise levels and more”.

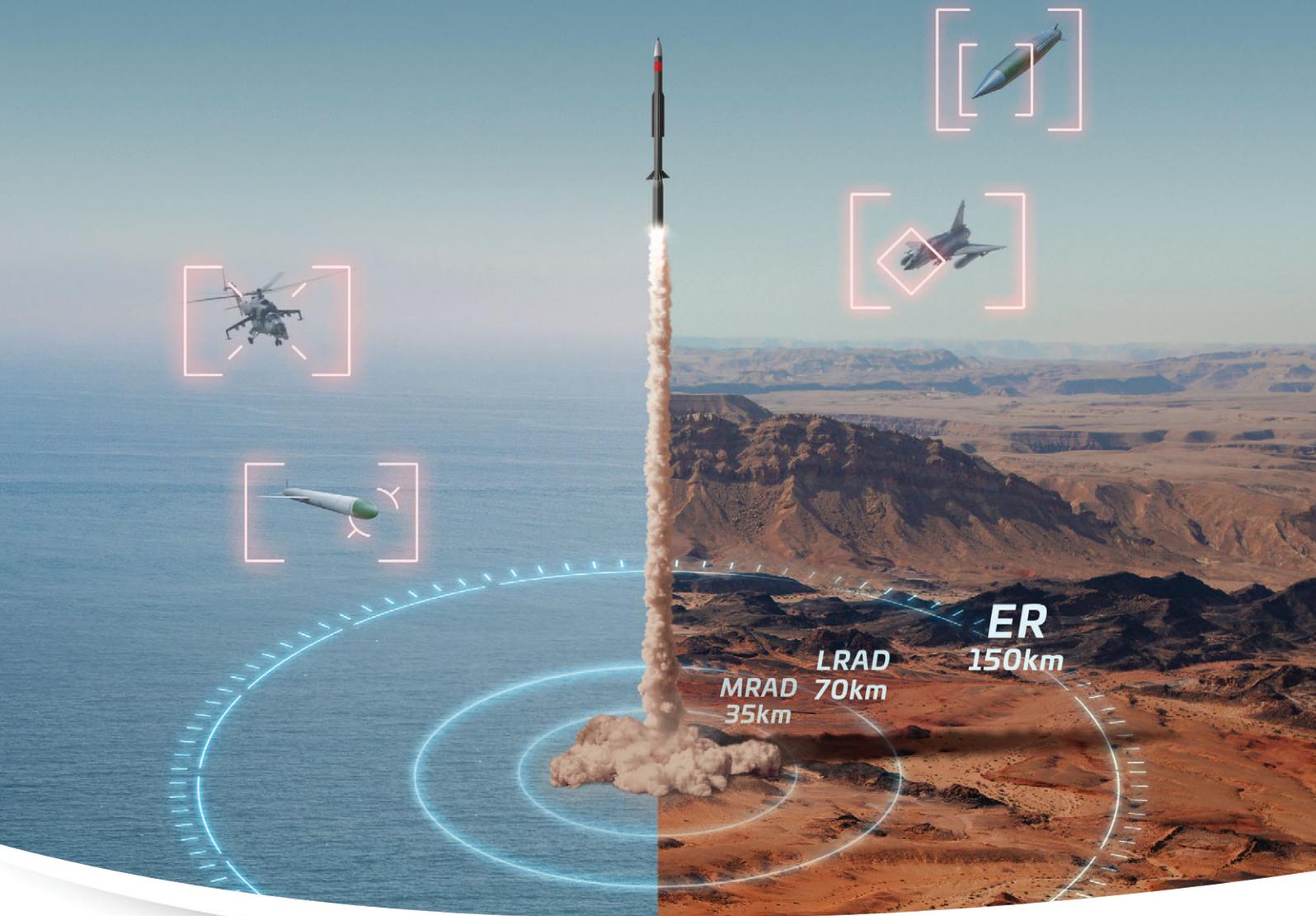
As configured early last year, the demonstrator Beaver carried lithium batteries with a power-to-weight ratio of about 135Wh/kg – a relatively low-power-density system, McDougall told FlightGlobal in January 2020.

He said better lithium batteries could, as of that time, generate up to 235Wh/kg. But, he added, 400Wh/kg cells would likely be available by the time it starts commercial flights with an electric aircraft.

Magnix is involved in a separate project, alongside Spanish firm Dante Aeronautics, to install a Magni500 in a Cessna Caravan amphibian operated by Australia’s Sydney Seaplanes. ■

# BARAK MX

*Setting the Air Defense  
Standard in Every Arena*



## ***IAI's Barak MX - Multi-mission. Multi-target. Multi-range.***

- Combat proven
- Anti-Tactical Ballistic Missile (ATBM) capable
- Incorporating cutting-edge technologies
  - Wide aperture active seeker
  - Dual pulse motor for high energy end game maneuvering
  - Net centric
  - Advanced fully digital radar
- Single solution in both land and naval configurations
- Modular and expandable
- Simple integration with any legacy or new sensor / C2

[www.iai.co.il](http://www.iai.co.il) • [iai-mth-sms@iai.co.il](mailto:iai-mth-sms@iai.co.il)



# Taiwan feels the pressure



Greg Waldron Singapore

Fastaiwind/Shutterstock

Four J-10s were among group of 25 which neared island on 12 April

Taipei is accustomed to aerial incursions by Chinese military assets, but increased formations are now probing its defences

**Greg Waldron** Singapore

Incursions by Chinese military assets into Taiwan's air defence identification zone are nothing new, as Beijing continues its efforts to establish a new air power paradigm in the region.

Taipei recorded 380 such incidents in 2020: the highest number since 1996. But if that was a challenging year, the recent appearance of two large Chinese formations means 2021 looks set to surpass it.

Taiwan's defence ministry details every incursion, on Twitter, showing the People's Liberation Army Air Force and People's Liberation Army Navy aircraft involved, the course they flew, and the actions taken by its military. This invariably involves tasking a combat air patrol – generally with Lockheed Martin F-16s – issuing radio warnings, and having “missile systems deployed to monitor the activity”.

On 26 March, 20 Chinese combat aircraft flew a southeasterly course from the mainland, with several continuing well beyond Taiwan's southern tip before taking a north-easterly route, effectively bracketing the island.

The sortie involved four Xian H-6K bombers, 10 Shenyang J-16 and two Chengdu J-10 fighters, supported by a Shaanxi KJ-500 airborne early warning and control aircraft, two Shaanxi Y-8 anti-submarine warfare aircraft and a single Y-8 reconnaissance platform.

Beijing mounted an even bigger sortie on 12 April, with four H-6Ks, 14 J-16s, four J-10s, one KJ-500 and two anti-submarine Y-8s. However, this mission did not repeat the dogleg route around Taiwan's southern tip.

J Michael Cole, Taipei-based senior fellow with the Global Taiwan Institute in Washington DC, says that China rapidly increased sorties in January 2020, following the re-election of Taiwanese president Tsai Ing-wen.

“This isn't solely a reaction by Beijing to visits by senior US officials to Taiwan, but also a demonstration to domestic constituents that the Chinese Communist Party is doing something, and that it, not Taipei, gets to set the tone,” he says. “No doubt this stems in part out of frustration that Beijing's policy of ‘peaceful unification’ has been an abject failure.”

## Psychological warfare

He adds that the flights can be seen as a form of “psychological warfare”, calibrated to intimidate Taiwan's population. Other analysts agree that making such flights seem commonplace could drive a sense of acceptance, or even complacency, for example through Taipei deciding against having fighters meet every interloper.

Roderick Lee, research director at the China Aerospace Studies Institute, points out that in 2020 Taiwan's defence ministry started exclusively using file photos of

Chinese aircraft, instead of images taken during intercepts.

“Assuming the Republic of China Air Force [RoCAF] has indeed stopped intercepting most of these flights, the decision is smart,” he says. “The RoCAF is never going to be on the winning end of this readiness competition, and trying to keep up with PLA flights would accomplish little besides the optics of defending the homeland – that is, until they can't fly anymore because their pilots are exhausted, and their aircraft are grounded.”

Apart from attempting to cow Taiwan's population, the flights also offer a valuable opportunity for Chinese pilots to test their skills over water and in a littoral environment.

Beijing's bombastic *Global Times* newspaper has a more menacing take. In a 13 April story about the 25-aircraft mission it stated that the exercises are nothing short of a rehearsal for war – a warning to “Taiwan secessionists” and the USA.

Despite recent warnings from US admirals about China's threat to Taiwan, war does not seem imminent, and mustering the massive forces necessary for an amphibious invasion would take time and attract attention from the USA and Japan.

Nonetheless, Taiwan defence analyst Kitsch Liao sees the recent significant incursions as major exercises that raise the stakes, create more opportunities for miscalculation, and offer no clear path for de-escalation. “This is going to be increasingly dangerous,” he says. ▀



## THE GULFSTREAM DIFFERENCE

Your mission is our inspiration. Every investment we make—in advanced technology, precision manufacturing and worldwide customer support—is an investment in you.



**Gulfstream**<sup>™</sup>

A General Dynamics Company

# Demise of the double-decker

As delivery of the final A380 draws near, the question is now how long the superjumbo will remain in service



**Lewis Harper** London

Already considered on borrowed time at many airlines before the global pandemic devastated international air travel, the Airbus A380's demise has only been accelerated by events over the past 12 months. While Emirates is waiting for delivery of the final example, other airlines are looking to rid themselves of the double-decker.

Granted, dozens of Boeing 747s are also heading for retirement sooner than expected, but none of those departing -400s could be described as young. In contrast, the superjumbo's exit is supercharged: the A380's exodus from airline fleets is being discussed less than 15 years after its first commercial flight, with many examples barely reaching double figures in terms of age.

Issues with the Airbus jet's utility beyond a few niche markets were already well established pre-Covid,

as new-generation widebodies provided network flexibility and superior economics.

Exacerbating that fundamental issue, reduced air travel demand during the recovery from the Covid-19 crisis means carriers are likely to need fewer large aircraft for some time – and the A380 is particularly hard on the balance sheet when its hundreds of seats are not full.

## Still grounded

The vast majority of A380s remained grounded at the end of March 2021, despite Cirium fleets data showing that more than 61% of the world's widebody aircraft were in service at that point.

Indeed, of the 233 A380s that were in service on the eve of the Covid-19 crisis on 1 January 2020, just 23 were operating on 31 March 2021.

"I think if all A380 operators could start over with a blank sheet of paper, none would have the A380 in their post-pandemic fleet," says independent aviation analyst Brendan Sobie.

That said, formal decisions to remove the type from fleets have actually been few and far between since the Covid-19 crisis began.

Air France is the only carrier to have explicitly retired its A380s since the crisis began, although Lufthansa has all but condemned its 14 superjumbos to never fly again, without removing them from future fleet counts.

Notably, the German carrier's plans suggest it will retain its 747-8s – some of which have been kept in service through the pandemic – in preference to its similarly aged A380s.

Thai Airways International, meanwhile, said on 12 March that it was gauging market interest for two of its six A380s. Middle Eastern carriers Etihad Airways and Qatar Airways have also made similarly downbeat forecasts for the return of their superjumbos.

With the recovery of long-haul international travel expected to take some years, many carriers will be tempted to wait out some or all

Delivery to Emirates of the last example to be built is imminent



persist for the next few years, at least: Emirates will continue to operate by far the largest fleet of the double-decker.

Before the crisis, the Middle Eastern carrier operated 115 A380s – essentially half of the world’s total. Delivery of the last example to be built is imminent, with the jet in March transferred to Airbus’s Hamburg site for outfitting.

Emirates president Tim Clark has made it clear that, in his view, the airline’s pre-pandemic business model still holds up. That could mean A380s in Emirates’ colours well into the 2030s.

### Unclear outlook

Nevertheless, it remains unclear how many of the airline’s A380s will return – and at what speed.

John Strickland, director of JLS Consulting, notes that “the sheer size and scale” of the carrier’s Dubai hub “maximises the number of connections it can offer and traffic flows which it can manipulate to fill up large amounts of capacity”.

For Strickland, growth markets – particularly in Asia – and the “very important” point-to-point traffic to and from Dubai mean “Emirates has a better opportunity than any other carrier to sustain large-scale A380 fleet capacity”, he says.

Rob Morris, global head of consultancy at Ascend by Cirium, says although it is “too early” to tell whether Emirates can rebuild its network and volume, “it is already clear that even if they are able to do so, there will be fewer A380s within the network since there will likely be some permanent loss of demand and thus fewer routes which can support the very largest aircraft in their fleet.”

Despite those challenges, it is not just Emirates making positive noises about the A380’s role in the coming years.

British Airways chief executive Sean Doyle said earlier this year that the A380 “works very well in a number of larger markets”.

The type is therefore “an important part of our fleet, and at the minute our plans are to obviously fly [it again]”, he says, without discussing a timeline.

Pre-crisis, the Oneworld operator’s 12 A380s had been deployed to destinations including Johannesburg, Los Angeles, Hong Kong and Singapore.

In Strickland’s view, BA’s relatively young A380 fleet and its network dynamics, notably the number of high-volume routes from London Heathrow, mean the superjumbo is likely to be useful to the carrier in a “niche role”.

Qantas, too, has made positive noises about the prospect of eventually flying its A380s again, noting their utility at slot-constrained airports and the fact that its fleet is largely written down.

While the A380’s challenging economics are well documented, the superjumbo’s environmental performance is increasingly weighing against its return.

Carriers with heightened awareness of their sustainability are unlikely to see a four-engined superjumbo as the answer to any challenges in that regard.

Qatar Airways chief executive Akbar Al Baker has been particularly outspoken on the type’s environmental performance, although perhaps with one eye on the fleet make-up of rival Emirates.

### Environmental concerns

In July 2020, Qatar Airways released analysis showing that its A380s emitted 95% more carbon dioxide (CO<sub>2</sub>) per block-hour on its Melbourne, New York and Toronto routes than its A350s, and an average of 80% more across all services.

He describes the A380 as “one of the worst aircraft, when it comes to emissions, that is flying around today”.

Al Baker’s assessment reflects the fact that the A380 belongs in the same class as several older-generation types when it comes to CO<sub>2</sub> emissions.

Richard Evans, senior consultant at Ascend by Cirium, points out that the A380’s fuel burn and CO<sub>2</sub> emissions are “in the same class as the 777-300ER, 747-8 or A340-600” in terms of CO<sub>2</sub> per revenue passenger kilometre (RPK), based on the current average seat count of 501.

Newer twinjets such as the A330neo, A350 and 787 have

of that period without their A380s, while allowing newer and/or smaller twin-engined types to pick up the slack.

“A look at the order books of erstwhile A380 operators gives a hint of what is to come – most operators are betting on the Boeing 777-8/9, 787 and Airbus A350 to power their future long-haul networks,” says Arvind Chandrasekhar, associate partner at Lufthansa Consulting. “Many already have the 777-300ER in their fleets, which can take on the role of long-haul workhorse.”

As this plays out, one of the dominant features of the A380’s existence pre-Covid looks likely to

“I think if all A380 operators could start over with a blank sheet of paper, none would have the A380 in their post-pandemic fleet”

**Brendan Sobie** Independent aviation analyst

“roughly 15-25% lower emissions per RPK”, he says. CO2 performance is even worse when the effects of the A380’s poor cargo capacity versus its widebody rivals are factored in, he adds.

Of the chances for further second-hand sales – beyond Portuguese wet-lease specialist Hi Fly’s now ended foray – most analysts suggest that opportunities will be few and far between.

The high cost of refitting the superjumbo was already known, but that factor gains additional emphasis as the post-pandemic passenger mix shifts away from business-class travel and towards leisure markets.

Rather than returning to service with other carriers, Sobie reckons most retired airframes are likely to end up as spare parts.

“There will be a lot of aircraft parted out, which will help support the remaining fleet and perhaps make it a bit less expensive for the likes of Emirates, [Singapore Airlines] and Qantas to operate the A380,” he states.

### Secondary market

Morris notes that he had always believed “the secondary market for such a large aircraft as the A380 would be extremely challenging”, with few aircraft expected to serve with carriers beyond the initial operators.

What was not expected, however, was the “dramatic demand dislocation” that is causing airlines to remove aircraft from their operational fleets early.

Morris continues: “Curiously, the pandemic may in the fullness of time permit a few aircraft to transition, since A380 values have been driven down so quickly.

“This may mean that in a post-pandemic world the few operators who can support such large aircraft in their network may see opportunities to acquire the aircraft at a very low price, and then complete reconfiguration and maintenance.”

According to Chandrasekhar, the A380s that survive the Covid-19 crisis will be reduced to operating “some service on selected routes over the rest of this decade as global air traffic recovers”.

But he concludes: “A decade from now, we may see more A380s in aviation museums than in commercial passenger service.”



Thai Airways is likely to remove the type from its fleet

Phuong D Nguyen/Shutterstock

## In or out? The status of the world’s A380s

- **Air France (nine A380s in pre-pandemic fleet):** The carrier announced in May 2020 that it would retire its A380s immediately, rather than in 2022 as previously scheduled.
- **ANA (two):** The operator took delivery of its third and final A380 in October last year and immediately placed it into storage.
- **Asiana Airlines (six):** With the Star Alliance carrier in the process of merging with compatriot Korean Air, details on future fleet plans have been vague.
- **British Airways (12):** Chief executive Sean Doyle says the type has a future with the Oneworld carrier, with no retirements announced.
- **China Southern Airlines (five):** The carrier is one of the few to have used A380s during the pandemic, largely on infrequent domestic and international services. But in mid-April, an executive noted: “Maybe it’s too large for the routes, and the operating cost is very high.”
- **Emirates (115):** President Tim Clark says the type will play a key role in the airline’s fleet for some time.
- **Etihad Airways (10):** Chief executive Tony Douglas was quoted in UAE media in early March as saying it was “very likely that we won’t see [A380s] operating with Etihad again”.
- **Hi Fly (one):** The Portuguese wet-lease operator withdrew its former Singapore Airlines A380 from service in mid-December 2020, after less than three years of use.
- **Lufthansa (14):** The German carrier has not explicitly said its A380s will not fly again, but has repeatedly downplayed the type’s chances of a return.
- **Korean Air (10):** See Asiana.
- **Malaysia Airlines (six):** The carrier’s plans for its superjumbo fleet have been in limbo for years amid continued financial strife.
- **Qantas (12):** Chief executive Alan Joyce has said the type is likely to fly in Qantas colours once a recovery in international markets is sufficiently advanced.
- **Qatar Airways (10):** The Oneworld carrier’s chief executive Akbar Al Baker has indicated that the operator will retain half of its A380s, but that even those are unlikely to fly for several years.
- **Singapore Airlines (19):** The Star Alliance carrier said in November last year that seven of its 19 A380s would not return to service. It later confirmed that a cabin upgrade programme would continue for the four aircraft in its remaining fleet of 12 jets that were yet to gain the new configuration.
- **Thai Airways International (six):** Reports suggest a wider restructuring of the airline is likely to see A380s removed from Thai’s fleet permanently.



# WE PUSH LIMITS IN AEROSPACE

Aeronamic had the advantage of starting big, being part of former mother URENCO, which invented the world's first ultra-centrifuge for uranium enrichment. How this technology empowers thermal management solutions in Aerospace? Discover it here:



[www.aeronamic.com/aerospace-thermal-management](http://www.aeronamic.com/aerospace-thermal-management)

**AERONAMIC**



Mock-up will assess changes needed for long-range performance

Airbus

## The learning power of PISA

Derisking efforts for A321XLR include modified fuselage section to help with integration of narrowbody's systems

David Kaminski-Morrow London

One of the Airbus A321neo fuselage sections previously intended for delivery to South American operator LATAM has instead been supporting the A321XLR development programme as a system integration platform.

Originally a standard A321LR centre and aft section, the fuselage of MSN8531 was withdrawn from the Hamburg Finkenwerder production line and effectively de-equipped – its pre-installed systems removed in order to fit new ones specifically for the A321XLR.

Airbus calls the fuselage section a “pre-industrial system accelerator” – or PISA – a hybrid capable of supporting both A321LR and A321XLR interior configurations on the main deck while specially-developed systems for the latter model are installed on the lower deck.

Modifications to be considered for the accelerator naturally include the large rear centre tank which will provide the fuel capacity for the A321XLR's range, as well as a new 300 litre (80USgal) waste water tank, electronic rudder system, modified fuel lines and hydraulics, and changes to the main landing-gear area.

Virtual visualisation technology is used to explore the fuselage in 3D prior to the physical fitting of the components in the demonstrator.

### Major modifications

“The PISA demonstrator embodies the end-to-end process from design changes to industrialisation of the A321XLR,” says the airframer. “It is not just for the ramp-up of the XLR but also for future adaptations and major modifications.”

Airbus head of XLR demonstrators Frank Dohrmann, who leads the PISA project, adds that the demonstrator will provide a training facility

for workers to aid manufacturing of the flight-test aircraft as well as the heads-of-versions for customers.

The A321XLR development effort is being supported by other demonstrators and validation platforms aimed at de-risking the programme, which remains a central part of Airbus's post-crisis recovery strategy.

Another A321neo fuselage section, the nose of MSN9893, has been adapted, at a new industrial maturity centre on the Saint Nazaire site, into a physical mock-up to support changes to the A320neo family – including the XLR.

It is already being used to test integration of a new main instrument panel which will become a standard for the family.

“Pre-final assembly line operators in Saint Nazaire are now able to understand this new [panel] structure in real factory conditions with the installation and ergonomics validation on the physical mock-up,”

Harness the power of analytics with  
CAE Rise™ for more effective pilot training.



says Denis Abraham, of Airbus's single-aisle value-stream mapping programme management.

Other evolutionary changes will be integrated initially into the mock-up, he says, allowing the manufacturer to identify risks and potential disruption as well as optimise logistics and tooling placement ahead of production.

"This preliminary work will also help to achieve quality objectives more easily," says Abraham.

A321XLR airframe leader Martin Schnoor says the nose mock-up will be used to analyse structural reinforcement for the new aircraft owing to "different loads" on the forward section, as well as improvements to systems for cabin comfort.

### Industrial interfaces

"The [mock-up] gives us the opportunity to bring all modifications together from [the airframe, systems and cabin areas] to confirm the industrial interfaces," he adds.

Airbus is intending to put the A321XLR into service in 2023, and the aircraft is approaching the assembly phase for major structural components.

Demonstrators ranging from basic wooden replicas - to verify accessibility for electrical, mechanical, bleed-air and piping installations - to advanced digital augmented reality and 3D-printed parts have all been employed to support the XLR's development.

"Early physical demonstrators and the virtual demonstrators enable us to validate our design decisions and close these topics," says A321XLR programme head Gary O'Donnell, adding that most of this work was completed in 2020.

The full-scale production standard demonstrators will support industrial process maturity, training, and "help secure our ramp-up", he says, and will also be used by maintenance and customer-support teams to develop manuals and technical documentation.

"All these demonstrators help us to observe the systems, activities, workflows and premises under real conditions at an early stage before start of production," says head of XLR equipping Hauke Delmas.

"They provide a protected space for learning and further development. It is therefore possible to learn from mistakes on the mock-ups without endangering production or safety." ▀

## A320neo steered towards full electric rudder

Airbus is aiming to replace the mechanical rudder controls on A320neo-family aircraft, switching to a full electric rudder system by early 2024.

The modification will coincide with the entry into service of the long-range A321XLR, which is being developed with the "E-rudder" architecture in mind.

While the initial delivery had been intended at the end of this year, with an A320neo powered by CFM International Leap-1A engines, Airbus says it is "reviewing the introduction scenario" given the disruption from the pandemic.

The E-rudder will become standard on the A319neo, A320neo and A321neo range. But it will not be fitted to conventional A320-family jets, nor will it be available as a retrofit.

Under the current A320 and A320neo fly-by-wire architecture, seven computers - two flight-augmentation computers, two elevator-aileron computers, and three spoiler-elevator computers - handle the flight-control surfaces.

But although the flight-augmentation computers provide input for yaw damping, rudder travel limit and trim, the rudder system retains mechanical linkages between the pedals in the cockpit and the hydraulic rudder actuators.

The E-rudder programme will replace the mechanical interface with an electrical one, saving some 40kg (88lb) in weight by enabling the removal of several fixtures and three computer units.

Both flight-augmentation computers and one of the spoiler-elevator computers will be withdrawn, along with the yaw-damper and rudder-trim actuators, and the travel limiter unit.

Conversion to the E-rudder system involves installing a new rudder-pedal unit in the cockpit, new rudder-position sensors, and a back-up control module.

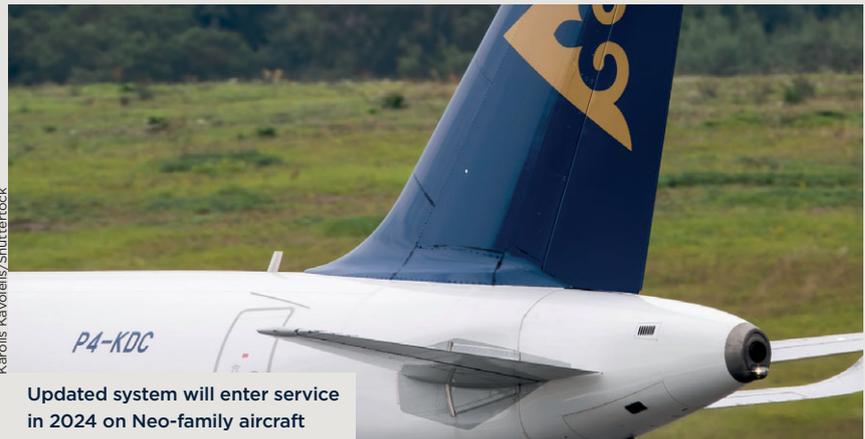
The rudder will be controlled through the two elevator-aileron computers, for normal law, and the two remaining spoiler-elevator computers, plus the back-up module, in direct law.

Airbus will also reconfigure control of the inboard spoilers, which were previously tied to the third spoiler-elevator computer.

The primary flight-control computers will have updated hardware and software, and software changes will be made to several others, while the rudder-actuation systems will be modified.

"Ramp-up will be done over 2023 to standardise E-rudder by early 2024," says Airbus, adding that the simpler system will also save fuel and reduce maintenance costs.

Suppliers including Collins Aerospace, Liebherr, Safran and Thales are participating in the equipment updates for the programme. Airbus adds that no relocation of the computers in the avionics bay will be necessary.



Updated system will enter service in 2024 on Neo-family aircraft



**WORLD  
DEFENSE  
SHOW**  
SAUDI ARABIA  
6-9 MARCH 2022



## *Ready for something different?*

World Defense Show – which debuts in Riyadh in Saudi Arabia in March next year – promises to be an industry event like none other. We find out what will set it apart from the rest

**A**fter a year in which there have been few opportunities for industry professionals to meet in person, the prospect of a brand new biennial global defence exhibition in early 2022 is doubly enticing. For it will take place in a nation that is not only one of the most dynamic markets in the world, but going through remarkable economic, political, and social change.

The World Defense Show, which was founded by the Kingdom's General Authority for Military Industries (GAMI) and is scheduled for 6-9 March in Riyadh, Saudi Arabia, will be an event unlike any other – both in its setting, and also in the context in which it will be staged. The Gulf kingdom – for decades one of the biggest oil producers and in a strategically vital region – is diversifying its economy by opening its door to investors and visitors, as it transforms its defence industrial sector.

As far as the setting is concerned, few trade shows can boast an exhibition site purpose-built for that

event alone. The location for WDS – a short drive north of the capital – is an 800,000sq m exhibition site, inspired by Saudi Arabian architectural styles, with two halls of a combined 58,000sq m, plus its own land demonstration track, 2.7km runway, a firing range, 120,000 sq m inner court yard and dedicated airspace for flying displays.

### **Unique advantage**

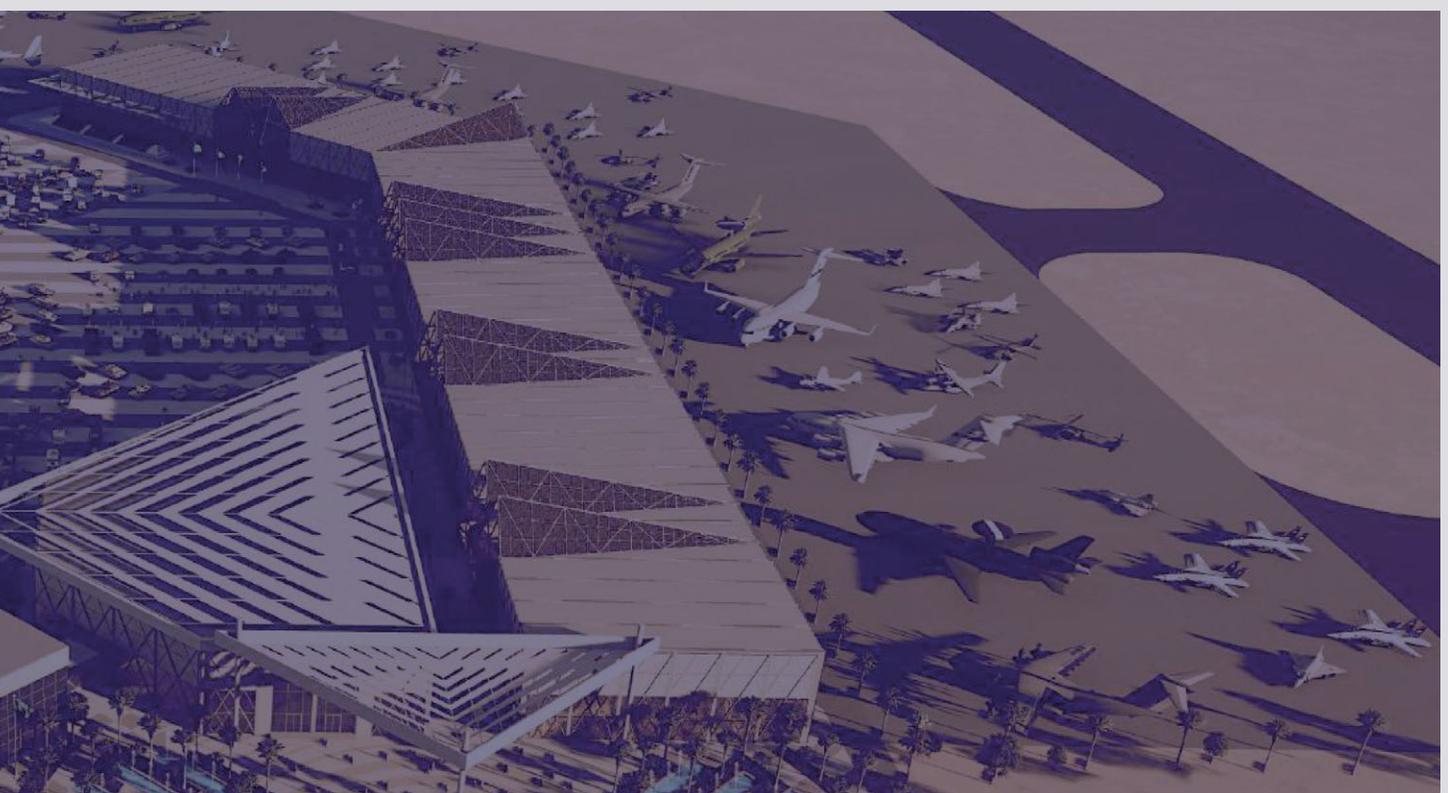
“We have had the unique advantage of being able to design this from a blank sheet of paper,” says WDS chief executive officer Shaun Ormrod, an events veteran who previously headed the company that runs the Farnborough Airshow. He and his Saudi colleagues have spent two-and-a-half years conceiving the event, which was formally launched in July last year.

Ormrod has recruited 40 staff and is adding 20 more. His sales representatives in China, France, the UK, and the USA are working on signing up major international exhibitors: Chinese defence agency CATIC, missiles house MBDA,

and Rolls-Royce are among those who have confirmed, and Ormrod expects to announce more in the coming months. “Our international reach is growing,” he says.

Like other defence shows, WDS will be multi-sector, with aerospace, naval, land, cyber and satellite assets on display. Riyadh's inland location presents an opportunity for visitors to experience how interoperable technology works in practice – even on platforms that are not physically at the show. Attendees, for instance, might be able to stand in the “command and control centre” of a ship as a military exercise takes place, thanks to virtual reality, says Ormrod.

The reason for choosing the desert site was that “we wanted an area that we had complete control over”, says Ormrod. That means that – in addition to benefiting from a bespoke venue – visitors will also appreciate a full day's air display schedule, with those being entertained in 60 hospitality suites on the first and second floors enjoying a panoramic view of static and sky.



But what about, what is for some, the bane of the busy air show – the screaming background noise of a jet fighter interrupting a meal or meeting with its airborne display? It may be, as Americans term it, the “sound of freedom”, but amid a delicate business negotiation, it is often less appreciated. For those in the hospitality suites, however, it will not be a problem; each room is insulated to reduce external noise.

WDS has the backing of both national military champion Saudi Arabian Defense Industries, or SAMI, and GAMI, the General Authority for Military Industries, which is the regulator and enabler for the kingdom’s defence sector, and charged with realizing a national commitment to have local companies supplying 50% of Saudi armed forces procurement by 2030.

This pledge is part of Saudi Arabia’s Vision 2030 strategy, a vision spearheaded by Crown Prince HRH Prince Mohammed Bin Salman, which is designed to diversify Saudi Arabia from an economy reliant on exports of oil and other natural resources into a “global investment powerhouse”, turning the kingdom into a hub for trade between the three continents of Africa, Asia, and Europe.

The “rebalancing” of defence spending will involve nurturing an ecosystem of small and medium-sized enterprises, providing job opportunities and career routes within the country to a new



*Chief executive Shaun Ormrod has a wealth of experience*

generation of young Saudis. This will involve partnerships with international partners, prepared to invest in the kingdom’s burgeoning aerospace and defence sector.

One of the unique selling points of WDS, says Ormrod, will be the opportunity for exhibitors to have “meaningful, coordinated engagement with the Saudi government and defence community”. If visiting companies are willing to “align their strategy with Vision 2030, there will be opportunities aplenty”, he insists. “I make no excuses for making this one of our key USPs.”

Ormrod says he is aware that many defence professionals may not have visited Saudi Arabia and not know what to expect. The country, he says, is open for

international visitors and for business. Importantly, the visa process is much simpler than it used to be for most nationalities.

#### **Great expectations**

Many of Ormrod’s team are experienced in every element of airshows around the world. This, he says, helps with understanding visitors’ needs. “We are learning for ourselves what the expectations are. We are already doing the dry run – our priority is to ensure a smooth customer journey from start to finish,” he says. He says those considering exhibiting are welcome in Riyadh for a tour of the show site, which is under construction with a view to completion later this year.

World Defense Show has announced dates for 2024 and 2026. “We are making it crystal clear we are here to stay,” remarks Ormrod. “The Kingdom of Saudi Arabia is taking its rightful place on the world stage.” As for what visitors can expect, Ormrod has no doubt what the reaction of many will be: “I fully expect to be standing there as people leave and hear them say: ‘Wow! That was different!’”

● **World Defense Show will be held in the presence of Saudi Arabia’s key leadership, international delegations and prominent industry decision-makers from around the world. To learn more about the show, visit [www.worlddefenseshow.com](http://www.worlddefenseshow.com).**



Jon Flobrant/Unsplash

Briefing packages for flightcrew can include hundreds of notices to airmen

# ICAO targets information overload

Organisation aiming to eliminate 400,000 NOTAMs in 2021, as seven-fold increase over 20 years leaves pilots overwhelmed

David Kaminski-Morrow London

The overflight of a heavily-occupied taxiway by an Airbus A320 at San Francisco International airport illustrated the serious risks of overloading pilots with NOTAMs, an ICAO forum has heard, as the organisation launches an effort to reduce the volume of their use.

The Air Canada jet's crew, intending to land on runway 28R at night in July 2017, inadvertently lined up with the parallel taxiway C, which was occupied by four aircraft - only executing a go-around at 100ft after overflying the first of them.

US National Transportation Safety Board investigators found the pilots misidentified the taxiway because they had not recalled the closure of runway 27L contained in a NOTAM.

The crew's flight-release package was 27 pages long and the notice

advising of the runway closure was on the eighth, towards the middle of the second page of NOTAMs.

Although the entry included a 'NEW' marker in red with asterisks, and bold text for 'RWY' and 'CLSD', the inquiry said: "This level of emphasis was not effective in prompting the flightcrew members to review [or] retain this information, especially given the NOTAM's location, which was not optimal for information recall."

It points out that a psychological characteristic called the 'serial position effect' results in people being better able to recall the first and last items in a series than those in the middle.

"The failure to see this NOTAM was, in essence, the primary cause of this serious incident. That was a wake-up call," Mark Zee, founder of OpsGroup and a former pilot and air traffic controller, said during an ICAO event on 8 April initiating a

global campaign to overhaul the NOTAM system.

Zee presented the example of a typical briefing package for an A330 flight from Munich to Singapore, containing 24 pages of operational information - fuel, route and weather data, all clearly laid out - followed by some 120 pages of NOTAMs.

## Routine occurrence

"This is not a special case," he says. "This is routinely happening. Every flight, every day, is getting a very big package of NOTAMs."

Finnair A320 captain Lauri Soini points out that each page will contain some 10-15 NOTAMs.

"For every single one we should read, understand and decide if it's relevant for our flight," he says. But even reading at a rate of just 5s each, he notes, the process could take over 90min, whereas crews might only have 20min for pre-flight briefing.

Twenty years ago the total briefing package would have been "usable" at fewer than 20 pages, says Soini, but the increase in NOTAM data has been "staggering".

Some 1.7 million NOTAMs were published in 2020, ICAO says, with about 35,000 remaining active on

"A NOTAM should never be active for more than three months, and never be replaced more than once"

ICAO

any given day. While this number was a 5% reduction from the previous year, as a result of the air transport crisis, there has been a seven-fold increase over the past two decades.

"A NOTAM should never be active for more than three months, and never be replaced more than once," ICAO says. Currently, some are being replaced "multiple times, sometimes for years" - and this will not necessarily be highlighted on its monitoring tool because they do not individually exceed the 90-day limit.

Its "NOTAM2021" campaign - which will continue with bi-monthly sessions - will initially focus on eliminating the number of outdated NOTAMs still circulating in the system due to "widespread misuse". It estimates that it could potentially eliminate over 400,000 old notices this year and prevent recurrence.

During the launch event, several ICAO regional offices underlined problems of inadequate regulatory oversight and slow implementation of quality-management systems for aeronautical information services.

Only 19 out of 42 Asia-Pacific countries and administrative regions have introduced quality-management systems, says ICAO Asia-Pacific regional officer Shane Sumner, and there is evidence of poor upkeep in implementing states.

Just 12 countries have established formal arrangements with data originators and, among the latter, there is "insufficient knowledge and awareness" of regulations, he adds.

#### Non-compliant data

This situation is exacerbated by aeronautical information services' being frequently afforded "only low status" within civil aviation authorities, says Sumner, and not being empowered to refuse to accept raw or non-compliant data provided at late notice.

ICAO Eastern and South African regional officer Keziah Ogutu refers to similar issues on the continent, including inadequate infrastructure for information dissemination, lack of expertise, and poor training.

"A lot of our NOTAMs come from external service providers including

government agencies... some of which have no, or very little, knowledge of the requirements of issuing a NOTAM," she says.

"More often than not they'd want a message to go out as they had formulated it, and to remain in force much longer than the stipulated standard."

ICAO's campaign also aims to look at the quality of NOTAMs.

While a briefing package for a long-haul international flight might contain more than 100 pages of NOTAM information, "Findings have shown that 20% of these will be old NOTAMs, exceeding their three-month applicability period," it says.

The campaign is being supported by international pilot federation IFALPA.

"There have been numerous efforts through the years to improve the system, but none has been successful," says the federation. "This year will be different."

Improvements could include basic changes centred on the use of abbreviations and the use of letter case, along with aspects of sorting and filtering, IFALPA says. ▶

## INERTIAL SYSTEMS

# LITEF

**ENSURING SAFETY AND PERFORMANCE FOR TODAY AND TOMORROW.**



With light weight, small volume, outstanding environmental robustness and unmatched performance LITEF's Attitude and Heading Reference Systems deliver value to the operators of all types of civil and military aircraft.

[LITEF.COM](http://LITEF.COM)

# Canada backs Airbus for tanker replacement



Nation's four-strong fleet of A310s is set to be retired

AirTeamImages

## A330 MRTT clear to pursue Polaris successor requirement unopposed, as Ottawa rejects Boeing's rival offer of KC-46

**Craig Hoyle** London

The Airbus Defence & Space A330 multi-role tanker transport (MRTT) is the sole candidate to have been approved to bid in a process to replace the Royal Canadian Air Force's (RCAF's) A310 fleet, after a rival offer of the Boeing KC-46 Pegasus was rejected by Ottawa.

An invitation to qualify process for Canada's Strategic Tanker Transport Capability (STTC) project was launched on 12 February. Airbus announced on 1 April that this activity "has identified the A330 MRTT as capable of meeting the project's requirements".

A draft request for proposals to replace the nation's four A310s - a type named the CC-150 Polaris in Canadian service - is anticipated in the third quarter of 2021, the

company says. The air force currently operates two examples as dedicated tankers and two in the strategic transport role.

"The STTC programme looks to replace the RCAF CC-150 Polaris tanker fleet with a multirole aircraft capable of conducting a wide range of missions including NATO and NORAD operations, from air-to-air refuelling to strategic government of Canada transport and aeromedical evacuation," Airbus says.

Canada in July 2020 declared its A310 tankers as having attained initial operational capability (IOC) for NORAD missions - its air force had previously employed Lockheed Martin C-130H/Ts for such duties.

"This new aircraft will improve the flexibility, responsiveness, interoperability with allied nations, communications security, and self-protection of the Royal Canadian Air Force's current fleet," Ottawa says.

Its analysis phase for the STTC requirement began in March 2018.

The new tanker/transport fleet will be introduced at Trenton air base in Ontario, with Ottawa expecting IOC to be declared in 2028-2029. Full operational capability should follow by 2030-2031.

Airbus Defence & Space Canada president Simon Jacques notes the A330 MRTT "is certified to operate with [most] western receivers, including Canada's current fighters, transport and mission aircraft."

The company is already supplying Canada with a 17-strong fleet of C295 fixed-wing search and rescue aircraft. The service's first locally-designated CC-295 Kingfisher was delivered to its Comox air base in British Columbia last September.

Boeing confirms that its STTC candidate will not be considered for the next project phase.

"Boeing was informed by the government of Canada that the KC-46 did not qualify for the country's Strategic Tanker Transport Capability project," the company says. "While disappointed in the decision, we will remain ready to bring the full depth and breadth of Boeing to our offer in the event Canada decides to reopen the bidding process." ▀

**"This new aircraft will improve the flexibility, responsiveness and self-protection of the current fleet"**

Canadian government

**FlightGlobal**

IN ASSOCIATION WITH

**EMBRAER**

**Download the 2021  
World Air Forces Report**

**FlightGlobal.com/waf**



Bell is offering a version of its V-280 Valor tiltrotor for the requirement

## US Army accelerates FLRAA plans

Combined awards to rival bidders for Black Hawk replacement to speed decision on engineering and manufacturing phase

**Garrett Reim** Los Angeles

**B**ell and a Sikorsky-Boeing team have been awarded contracts worth a combined \$577 million to accelerate preliminary design review work on their Future Long Range Assault Aircraft (FLRAA) candidates for the US Army.

In particular, the service wants an early analysis of requirements for the US Special Operations Command, as well as medical evacuation missions and features supporting export.

"This strategy will enable the winning offeror to complete both air vehicle and weapons system preliminary design reviews in less than a year after the programmatic contract award, advancing the schedule to an earlier Milestone B decision," the army says. This "will provide more time for detailed design, building and testing of prototype air vehicles", it adds.

A Milestone B decision represents the point at which a service recommends a design to enter the engineering and manufacturing development phase.

Bell has received a competitive demonstration and risk-reduction Phase II contract worth \$293 million, with the Sikorsky-Boeing team securing \$284 million.

The FLRAA programme is intended to deliver a replacement for the

army's Sikorsky UH-60 Black Hawk utility helicopters. Bell and the Sikorsky-Boeing team are respectively offering refined versions of their V-280 Valor tiltrotor and SB-1 Defiant co-axial rotor/pusher propeller technology demonstrators.

The US Army has previously said it expects to launch the preliminary design review phase in the second quarter of fiscal year 2023. The rivals are expected to fly their FLRAA candidates for the first time by the third quarter of FY2024, with the army wanting its first unit equipped with the new rotorcraft by FY2030.

### Digital engineering

Meanwhile, Bell says that by embracing digital engineering and manufacturing technologies it will be able to cut the cost and lead-time on rotorcraft parts by double-digit percentages.

The company opened its new Manufacturing Technology Center in Fort Worth, Texas on 25 March, in support of pitches for FLRAA and the army's Future Attack Reconnaissance Aircraft need. Parts for the V-280 and 360 Invictus winged helicopter are now being worked on within the 13,000sq m (140,000sq ft) facility.

Bell says it has been able to use digital engineering software programs and new equipment to simplify its manufacturing process and eliminate errors.

"That is one of the key differentiators that we're going to be able to provide on the [army's Future Vertical Lift] programmes," says Glenn Isbell, the company's vice-president of rapid prototyping and manufacturing innovation. "We're able to build things in such a different way."

Isbell says the company has already achieved a 40% cost reduction when producing the V-280's mast part, and cut lead-time by 80%, from 12-18 months to less than 90 days. It has also reported similar results for a variety of air-frame parts.

Bell is also aiming to develop more streamlined ways of producing its aircraft.

"Our core philosophy is to simplify the manufacturing process, to remove as many steps as we can," says Isbell. "We'll then improve what's left and put digital control capabilities in, so that we can monitor how the part is being built in its lifecycle. The whole idea of making a batch of parts and then finding out they're bad is the exact problem we're trying to solve."

For example, the company has previously manufactured a parallel gear by using six different machines. Now, it has found a way of making the part using one machine, with just one setup.

"We've been able to significantly reduce the amount of steps required to build the part at the same level of quality," Isbell says. ■



# United sets pilot diversity target

US carrier offers scholarship scheme and improved access to funds in effort to increase minority representation in cockpit

AirTeamImages

**Pilar Wolfsteller** Las Vegas

United Airlines will train 5,000 new pilots in the next 10 years through its “Aviate” recruitment programme, with at least half of those to be women and people of colour.

The Chicago-based carrier on 6 April said that it and JP Morgan Chase will each provide \$1.2 million in scholarships this year to help finance crew training for candidates that might otherwise struggle with the cost. Additionally, United will partner with financial institutions to give Aviate’s students access to loans for flight training, which can cost \$100,000 or more.

The programme is designed to provide United with a solid pilot pipeline over the coming years, as the industry works to head off an expected shortage of cockpit crew.

“We had a pilot shortage before the pandemic. After the pandemic we will still need qualified, exceptional people on our flightdecks, and this is a way to get them there faster,” says Carole Hopson, a first officer at United, and a woman of colour. She adds that the programme gives diverse candidates a “career pathway that’s visible”.

Prior to the announcement, United had already indicated that it is ready to resume hiring flightcrew: the airline intends to take on 300 pilots who either had a new-hire class date that was cancelled, or who had received a conditional job offer that was rescinded after the huge drop in passenger demand last year.

United launched Aviate in 2019, aiming to train up to 10,000 new

pilots in a decade. In February 2020, the carrier bought a flight school in Phoenix, Arizona, which it renamed United Aviate Academy, where training is to take place.

The coronavirus crisis and near-shutdown of the industry in 2020 threw those plans off track, as carriers slashed networks, sent aircraft into long-term storage and trimmed staff.

## 5,000

Number of new pilots United aims to train in next decade, with at least 50% to be women or people of colour

United’s commitment to ensure half of pilot candidates are female or minority is notable. Only about 5% of all commercial pilot certificate holders in the USA are female, while non-white pilots compose a sliver of the ranks.

“My path [to aviation] was circuitous,” says Hopson, for whom aviation is a third career. She began pilot training when she was 36 years old. “I don’t want the next generation of people who look like me to wait that long.”

United wants to ensure it taps into a “deep talent pool” of candidates who have the aptitude and desire to become commercial pilots. It will partner with historically black colleges and universities, and with high schools, to identify and recruit top talent early, it says.

The Aviate Academy plans to begin training a class of 20 students

in the third quarter, with graduations in the first half of 2022. United expects to enroll 100 students in the programme this year.

Recommitting to a training initiative while the coronavirus pandemic is still raging and a full recovery is years away may seem counter-intuitive, but for airlines like United the focus is on the future, not the immediate present.

Indeed, recent forecasts suggest that while demand for crews in the near term is clearly depressed, further out, a shortage still looms.

Last November, Canadian training and simulator provider CAE raised eyebrows when it said the industry would need as many as 264,000 new pilots worldwide in the next 10 years.

Though that figure spurred push-back from the pilot community, the same general view is supported by a recent study published by management consultancy Oliver Wyman, which says that a shortage is still looming, even if its onset is delayed by the pandemic.

“The most important question is not whether a pilot shortage will re-emerge, but when it will occur and how large the gap will be between supply and demand,” the consultancy says.

Oliver Wyman says the global gap between supply and demand will be at least 34,000 pilots by 2025, and possibly 50,000.

Key contributors to the shortage are an ageing workforce – and mandatory retirement at 65 – plus the duration, difficulty and, above all else, high cost of pilot training that deters many from pursuing it as a career. ▶



# FIRST FLIGHT NEW HEIGHT

FALCON 6X FIRST FLIGHT. MARCH 10, 2021



**It's the tallest and the widest cabin in business aviation.** It's also the most comfortable and most advanced Falcon yet. The widebody Falcon 6X is on its way from first flight to the world. It's time to redefine your 5,500 nm travel experience.

**Falcon 6X**

[WWW.FALCON6X.COM](http://WWW.FALCON6X.COM) | FRANCE: +33 1 47 11 88 68 | USA: +1 201 541 4600

**DASSAULT  
AVIATION**

# Renewed authority

While the UK's decision to leave EASA remains problematic, the CAA's new boss Sir Stephen Hillier is determined that the agency can rise to the challenge

David Kaminski-Morrow London

UK withdrawal from the European Union Aviation Safety Agency (EASA) was one of the more incomprehensible aspects of Brexit for the air transport industry, but new Civil Aviation Authority (CAA) chairman Sir Stephen Hillier is not inclined to ruminate over the wisdom of the decision.

As might be expected from a highly-decorated military officer – Hillier is a Gulf War pilot who reached the rank of Air Chief Marshal and led the Royal Air Force – he is more focused on addressing the state of play on the ground than debating the government thinking which led to it.

“I think I’d characterise myself as realist and pragmatist,” he tells FlightGlobal. “This is the situation we’re in. How do we ensure we deal with that situation to the best of our ability?”

“How can we ensure, as an organisation and nation, that we continue to discharge responsibilities – and continue to be one of leading aviation nations in the world? That’s my approach to it.”

During Theresa May’s term as prime minister, a parliamentary industrial strategy committee heavily favoured remaining within EASA. Evidence from aerospace businesses, unions and academia, it said, was “unanimous” in support of continued UK membership.

“Close global regulatory alignment in aerospace has resulted in benefits in terms of safety, the ease of global trade and efficiency, while it is unclear that there are any benefits from divergence at this time,” it added. The committee said the UK’s influence on aerospace regulation from within EASA was “preferable” to “securing an escape” from European Court of Justice jurisdiction – especially given that the court had, in practice, “played no role” in EASA’s work and had never issued a ruling on an EASA decision.

## Full withdrawal

But the Brexit agreement negotiated by May’s successor, Boris Johnson, was founded on full withdrawal from European Court of Justice oversight – and therefore from EASA – forcing the CAA to re-establish itself as a standalone regulator from 1 January, outside of the agency in which the UK had been highly respected.

“We were a very strong contributor to EASA from the start,” says Hillier. “Working together across nations, to ensure we have the safest possible environment, has always been one of the things we’ve been very good at.”

The extent of UK involvement and the expertise it provided to EASA meant the CAA had a “very strong foundation already in place” ahead of the withdrawal, he states, with safety “absolutely covered”.



Hillier rose to the rank of Air Chief Marshal and was leader of the Royal Air Force

“It’s not the case that, over the years, everything to do with our regulatory functions in the CAA was handled by EASA. Particular aspects were certainly handled by EASA – but there remained a very strong core foundation in the UK looking after our national responsibilities,” says Hillier.

“Where things were not replicated in the CAA, but were delivered by EASA, we brought those functions back into the CAA. And I’m proud of the way in which we worked up that new capability, in the way we tested it out thoroughly, before [the exit from the EU], and the way we’re now implementing it in practice.

“I’m not saying that, on 1 January, every aspect was taken care of to the ultimate extent. It was a foundation. And in the [post-Brexit] period we’ve been steadily building on that foundation working with other nations to ensure that we can conduct business as efficiently as possible.”

The CAA is not aiming to engage in persuasion with EASA. “It’s not for us to run an influence campaign,” says Hillier, but adds: “We won’t be effective unless we have strong and enduring relationships with EASA – and likewise EASA has to have a strong, effective and enduring relationship with the CAA.”

UK industry is still suffering from effects of Covid-19 pandemic



Rich Higgins/Shutterstock



Oliver Dixon/Shutterstock

“Working together across nations, to ensure we have the safest possible environment, has always been one of the things we’ve been very good at”

While separation from EASA theoretically grants the CAA more freedom to adopt its own regulatory stance, the extent to which it can realistically make changes – given the trend towards harmonisation – is yet to become clear.

#### Practical reality

Hillier highlights the “practical reality” that the CAA can be “more agile and flexible” because it no longer needs to wait for consensus to emerge within a 28-country circle.

“We don’t want to be divergent for divergence’s sake,” he says. “We’re very conscious that, if we are divergent, there is also cost on businesses potentially and we need to be very mindful of that.”

But he also believes there is a “balance” to be achieved, to examine possible opportunities while maintaining smooth operations across international boundaries

– emphasising that the UK is part of ICAO and that “we shouldn’t just see this through a European lens”.

Renegade activity is unlikely to find much endorsement in the international air transport sector, but Hillier believes certain rapid changes within aerospace present an avenue worth exploring.

“The classic example, I think, is in relation to remotely-piloted air systems [RPAS],” he says. “The innovation, the development in those areas is really accelerating.

“It’s worthy of note that, throughout the pandemic, the one area where we’ve seen a consistent growth – in terms of applications for licences, applications for airspace use – has been in RPAS. That has continued to accelerate.

“Against that sort of backdrop I don’t think anybody has yet developed the perfect regulatory environment which best ensures the

exploitation, the innovation, and which best deals with emerging technologies. I don’t think anybody’s got that yet.

“Here’s an example of an opportunity where we might, as the UK, be able to frame a future in a new area of capability which is genuinely world-leading.”

Flexibility and agility, he says, could be a “powerful advantage” for an organisation trying to set standards in a field of new systems demanding new requirements.

#### Transition period

Although the final UK-EU post-Brexit agreement meant a ‘no-deal’ scenario was averted days before the 1 January split, the section on aviation is conspicuously one-sided.

All EASA certificates, approvals and licences that were in effect on 31 December will continue to be recognised by the CAA for up to two years. But UK-licensed pilots and UK-approved engineers will not be qualified on EU-registered aircraft, and UK-issued cabin crew attestations may similarly cease to be recognised.

UK aircraft are also restricted to third- and fourth-freedom services, losing the automatic intra-EU access that came with EU membership. UK users of the space-based EGNOS position-augmentation service, which supports approach guidance for landing aircraft, will lose access in June this year.

“I’m sure that every sector of the economy could look at that foundational document and say, ‘I wish it could have included X, Y and Z’. But there are practical limits, particularly in the timelines which were available, to cover every aspect we might have wished,” says Hillier.

He acknowledges that “there’s not full reciprocity at this stage” and the scale of the negotiation task, given that the UK needs to deal with every EU member while any individual EU state only has to deal with the UK.

“Listening to the sector, and understanding the issues people are experiencing in practice, we’ve put in a huge amount of effort to work bilaterally with other nations and start to secure the agreements we need to secure,” he says.

“That doesn’t mean that it’s all done. Twenty-seven countries is an issue there. It doesn’t mean that we have all of the reciprocity that we might hope for.”

But the UK's aim, he suggests, is to forge relationships rather than adopt an intransigent trans-accidental attitude.

"I think taking the view that we are going to be as open as we possibly can befits our status as a leading world aerospace nation," says Hillier, although he cautions that the strategy of being "open and accommodating" should not mean indefinite acceptance. "It has to be time-limited," he says.

New post-Brexit bilateral arrangements were put in place with several countries - among them the USA, Canada, Brazil and Japan - to ensure recognition of safety certificates and support operations, while ICAO membership provides assurances with others.

De-integration from EASA meant bringing two particular roles back within the CAA remit. For state-of-design, some 20-25 people were looking after UK interests in EASA.

"What we needed to do was either bring those individuals back into our system or find people to fit those roles," says Hillier. "It was a mixed response. Some decided to stay in EASA, some didn't. That was their choice."

### Aviation safety

But the CAA managed to recruit sufficient personnel to have the necessary governance in place by 1 January. The other major role being repatriated is aviation safety policy-making, which is being handled in conjunction with the Department for Transport.

"Nothing I've seen in the three months [since Brexit] would suggest that we are having any difficulties through a lack of the skills and capacities," says Hillier. "The one sort of caveat that I'll honestly offer is that we're clearly in 'Covid times'."

He says the CAA is aware of the "very low baseline" resulting from the pandemic's suppression of traffic and is concentrating on ensuring that it has capacity to cope as activity picks up during a recovery.

But out of the range of issues the CAA is monitoring, he states, the implication of being outside EASA is "not one that's a concern at this stage - it's just a consideration in there, it's not one that troubles us".

When the government was debating the merits of leaving EASA, it was told during industrial committee testimonies that replicating the European agency's functions

would be significantly more expensive than maintaining membership.

UK aerospace trade association ADS Group chief executive Paul Everitt, in November 2017, said the body had estimated the task would involve 200-300 people and cost £30 million (\$41 million) annually. "For us, it is very clear that going it alone is the most expensive option and, in most cases, not the most efficient," he stated.

Hillier insists the notion of rebuilding the CAA is misleading. "That would imply we gave all our responsibilities to EASA, and then those responsibilities were coming back, and we had to start from the bottom up and re-do the organisation."



**Hillier aims to maintain the CAA's reputation as a highly capable, 'world-class regulator'**

"It certainly isn't that way in structural terms, and doesn't feel like that in practice."

He says the number of people brought back to the CAA to support the reclaiming of functions from EASA is relatively small compared with the CAA's 1,200 employees, about half of whom are within safety and airspace regulation.

"I think that gives a little bit of the sense of perspective here," he says. "We're not rebuilding an organisation. We've just put new wings onto the building rather than come up with the new building itself."

He stresses that this nevertheless has taken "a lot of hard work and planning" and that a successful transition on 1 January was down to the effort and resources devoted over the previous four years.

And while Brexit might technically be over, the work to establish the CAA in the post-Brexit arena - with its blend of considerations on regulation, sustainability, innovation, relationships and Covid recovery - is only beginning.

"[We're not] saying we've all those bases covered, in a way that we're satisfied [will] take us through the next 10 years. No organisation can say it's covered," he says.

"For about the last year now, we've been working on what we would say is defining the 'CAA of the future'. What sort of organisation do we want to be? What will our responsibilities be, and how are we going to do our business?"

"That work is now coming to maturity and essentially laying out CAA strategy, taking us through the next 10 years."

### Core objectives

This strategy aims to combine core objectives with a sense of direction, while emphasising flexibility, he says: "Because we might think [we know] what the world's going to look like over the next 10 years but it's probably going to be different from what we planned."

"So this is under-the-bonnet activity that we need to do. I'm really enthusiastic about the progress that we're making, particularly in areas like sustainability. Aside from the recovery from Covid - and let's not underestimate that - getting to grips with sustainability, in all of its respects, all those sort of things I think are really exciting and challenging as well."

The realm of the future CAA, he adds, will not be limited to airspace. With legislation in progress to allow for CAA oversight of commercial spaceflight technologies, from vertically-launched vehicles to sub-orbital aircraft, space regulation is "part of the exciting journey", says Hillier.

"I would hope the CAA's calling-card continues to be that we're seen as a world-class regulator, that we have the skills and capabilities and experience to offer that others would find attractive," he says.

"We're a learning organisation. Working with others increases our learning. We learn from our dealings with other nations. By offering out our product, if we can be part of enhancing aviation safety across the world then we have not only the desire but the duty to do that." ▶



# TRANSPORT SECURITY CONGRESS

DETER / PROTECT / RESPOND

September 13-15, 2021  
Miami, FL



## INDUSTRY-WIDE COLLABORATION ON SECURITY AND SAFETY IN THE DIGITAL AGE

Featuring 50+ senior-level security and safety speakers across all transportation modes and government agencies:



**Alan Wapner**  
President  
Ontario Airport



**Darby LaJoya**  
Executive Assistant  
Administrator, Security  
Operations  
Transport Security  
Administration



**Christopher Maston**  
Miami International  
Airport Port Director  
Customs & Border  
Protection



**Drew Schneider**  
Assistant Director of  
Security  
Port of Long Beach



**Jose Aragu**  
Major  
Miami Dade Police



**Diana Quintero**  
Director - Information  
Technology  
Virgin Voyages

Supported by



Contact us about speaking or sponsoring:  
[www.TransportSecurityCongress.com](http://www.TransportSecurityCongress.com)

# Cost war of attrition

So-called attritable aircraft are of soaring interest to the US Air Force, but can manufacturers succeed in making such assets affordably disposable?

Garrett Reim Los Angeles

The sight of an aircraft crashing would be the stuff of nightmares for most engineers. But for those companies developing a new class of unmanned air vehicles (UAVs) called attritable aircraft, such destruction is unlikely to elicit more than a shrug of the shoulders.

The US Air Force (USAF) believes that by designing and building UAVs cheaply enough it can gain an edge over its adversaries in a war of attrition; it wants assets that it can afford to lose.

UAVs priced between \$2 million and \$20 million are being sought to accomplish a range of missions, including intelligence, surveillance and reconnaissance, air strikes, air-to-air combat and electronic warfare. Exactly what price point offers the best balance of affordability and performance is debated by the manufacturers vying to build the USAF's attritable aircraft in programmes such as MQ-Next and Skyborg.

"The philosophy behind an attritable aircraft is really around design for cost," says Andrew Glynn, programme manager for the Boeing Airpower Teaming System (ATS), which was first flown in Australia on 27 February. "It's about trying to get a good enough product at the right price."

"Good enough" represents a new mindset for the aerospace industry, which is usually doggedly focused on high levels of safety and

reliability. But with attritable UAVs there is no pilot to keep alive, and the equipment is so cheap by design that combatant commanders – and the US Congress – will not mind the loss.

Manufacturers say model-based systems engineering is at the core of making such aircraft viable. These software tools allow them to create a digital twin of a UAV and then explore its total lifetime cost in various simulations.

## Digital twin

"When you have a digital twin that goes all the way from the product through the production system into the operating environment, we can very rapidly model the impacts of any change," says Glynn.

"It could be really detailed-level decisions around informing how you transport parts around the factory, or what enables lean flow through the production system," he says. "Any number of those small decisions cumulatively add up to making a big difference to the overall cost base."

Manufacturers must also adopt a different mindset towards quality and reliability, says Steve Fendley, unmanned systems division president at Kratos Defense & Security Solutions. The company's XQ-58A Valkyrie on 26 March conducted its sixth flight, releasing an Area-I Altius-600 air-launched effect from its internal weapons bay.

As an exaggerated example, Fendley says a fuel valve part that might cost \$500,000 and is guaranteed to work for 5,000h could be



replaced by three \$50 valves each guaranteed to work for 1,000h.

"We're going to build redundancy. We're going to put in three parallel paths – all we need is any one of the three working and the system will keep operating," he says.

Sourcing parts and components from the commercial aviation sector is also helpful.

"Stay away from bleeding-edge technology," says Fendley. "Don't try to incorporate the very latest technology that still has risk associated with it [and] probably has additional costs."

Business jet engines were picked to power the ATS and Valkyrie aircraft. Boeing declines to identify the engine used with its platform, while Kratos confirms only that it employs a Williams International model.

"We need to have an engine that's super reliable, super predictable," says Fendley. "We understand the performance, it can be maintained, it is a reasonable cost, and it all fits within the system." In the future, there might be an opportunity to reduce the cost of such engines by changing materials or manufacturing some parts via 3D printing, he adds.

Another cost-saving method is to go without, for example by using fewer control surfaces. "If your attritable [aircraft] gets shot and you



CAE – Your worldwide training partner of choice

Download the Military Simulator Census online now.

[www.flightglobal.com/milisim](https://www.flightglobal.com/milisim)





Kratos Defense &amp; Security Solutions

XQ-58A made a sixth flight on 26 March, releasing Altius-600 air-launched effect

lose a control surface, you're probably going to decide to ditch and not try to bring it back," Fendley notes.

"An attritable [aircraft] doesn't need to survive decades of use and abuse - many will likely be only one-time use, no different from firing a missile - so the need for redundant systems is diminished compared with an aircraft that is designed for a 40,000-hour service life," says Mike Atwood, senior director for advanced programmes at General Atomics Aeronautical Systems.

### Looser tolerances

Allowing for less precision in manufacturing will also be helpful.

"The tighter tolerances are going to drive cost. It's going to drive the failure rates up, drive the number of things that don't make it out of the factory, that end up being rejected," Fendley says. Accommodating looser tolerances will also enable easier repairs if the aircraft sustains damage in flight or on landing.

Generally, manufacturers say attritable aircraft must be simpler than their peers, with modular

"An attritable [aircraft] doesn't need to survive decades of use and abuse - many will be one-time use, no different from firing a missile"

**Steve Fendley** President unmanned systems, Kratos Defense & Security Solutions

designs and an open architecture to easily accommodate new hardware and software.

"It really does almost become a kit perspective, like more of an Ikea furniture kind of mindset," says Renee Pasman, director of integrated systems within Lockheed Martin's Advanced Development Programs unit, known popularly as Skunk Works.

By using 3D printing, but also traditional CNC machining, attritable aircraft should have simple shapes that can be assembled quickly, even within a couple of hours, she says.

Boeing uses modular jigs to assemble its ATS, with "a common base that can be easily reconfigurable to accept different types of major structure components, for example the fuselage or wing," Glynn says.

Its first, production-representative prototype was built with high levels of automation, he says, noting: "We start by designing the full-rate [system] and work backwards or tune it from there."

General Atomics also is looking toward commercial manufacturing processes, including 3D printing.

"One of the key technologies is additive manufacturing of thermoplastics. Using tool-less part manufacturing enables minimised development cost," Atwood says. "In addition, this technology reduces

overall part count, which reduces touch labour and integration costs."

While there may be a place for several types of materials, composites seem to have a leading application. "The strength-to-weight ratio, the basic strength characteristics, the damage tolerance characteristics, the ability to evaluate a potential flaw in manufacturing, or for failure or a soon-to-be failure in the field, carbonfibre is just fantastic," says Fendley.

### Material qualities

Low-cost, resin-infusion composites have advantages, but material qualities are not the only important consideration for Boeing, says Glynn. "It's not just the material costs or the fabrication time, it's understanding how those materials and processes help to support lean, single piece flow through a factory," he says.

"Composites lend themselves to complex shapes," says Atwood. "But for small attritables, we might get away with high-strength, injection-moulded or additive-manufactured composites or plastics. Keeping touch points and maintenance to a minimum, and parts count and redundancy low, can make attritables affordable," he adds.

That might mean forgoing maintenance access panels, says Pasman, so broken or damaged UAVs might just be thrown away, rather than repaired. "If you can get the price point right that actually starts making some amount of sense," she says.

Lockheed argues that such UAVs need to be even cheaper than the USAF's \$2 million cost floor to make the grade.

"In order to really get that very large mass of small, low-cost vehicles, you really have to get to a cost point that you don't necessarily care if they come back," Pasman says. "\$20 million airplanes - are we really not going to care that they don't come back?"



Boeing's Airpower Teaming System was built using high levels of automation

Boeing

# Fresson takes new direction

Project to deliver green powertrain for iconic Islander switches course with move to hydrogen fuel cells, but change leads Rolls-Royce to depart consortium

Cranfield Aerospace Solutions



**Dominic Perry** London

A UK initiative to develop a retrofitable green propulsion system for the Britten-Norman BN-2 Islander has dramatically switched course, abandoning a previous drive towards hybrid-electric power in favour of hydrogen fuel cells.

Announced in November 2019, Project Fresson involved a consortium – led by Cranfield Aerospace Solutions (CAeS) – that was awarded a £9 million (\$12.6 million) government grant for the work. This planned to deliver a “first passenger-carrying sub-regional aircraft capable of all-electric flight” suitable for short “island hopping” missions by 2024.

But Paul Hutton, chief executive of CAeS, says that detailed analysis of the electric powertrain options – pure batteries or hybrid architectures featuring piston or turbine range extenders – concluded “around three to four months ago” that they were not viable for this application.

“The battery solution is clearly green, but with this particular platform you end up with such a small range that it’s just not feasible commercially,” he says.

With either a piston or turbine range extender “you can

absolutely get the range”, but with the additional weight on top of the batteries, particularly when taking safety and redundancy into account, “you end up producing the same or more carbon than the original aircraft.”

Instead, a fuel cell system using gaseous hydrogen is being pursued, which Hutton says is “both green and very much commercially viable”, particularly “on this platform and the way that it is used”.

## First flight

A first flight of the demonstrator aircraft is still envisaged in 2022, with CAeS currently negotiating to acquire an Islander for the effort. Providing there are no hiccups, entry into service is envisaged in late 2023 or early 2024, says Hutton.

However, Islanders powered by the fuel cell system will have a significant cut in range, which falls to around 100-135nm (200-250km) from 639-728nm at present,

depending on the engine. That equates to a flight time of 1h, with a 45min reserve.

Hutton argues that when the consortium analysed how the fleet is used “a very large percentage” of operators indicated that the 1h flight time was sufficient.

In addition, Jenny Kavanagh, chief strategy officer at CAeS, says operators were keen to retain other characteristics of the Islander, such as short-field performance and its nine-passenger capacity.

But crucially, hydrogen power should offer a significant operational cost saving against the current piston-engine options: Hutton estimates an annual saving of £150,000-£300,000 depending on usage and cost of hydrogen. Maintenance costs should also fall, in the region of 15% for the whole aircraft and up to 50% for the propulsion system alone.

Lara Harrison, business development director at Britten-Norman,

“The difference with the solution we are talking about now is that I have something I can take to my customers as a real-world solution”

**Lara Harrison** Business development director, Britten-Norman

says that there were always “concerns” around electrification, in particular the weight of the batteries, as well as the infrastructure and length of time required to recharge them.

“The difference with the solution we are talking about now is that I have something I can take to my customers as a real-world solution for them,” she says.

Should the powertrain developed by Project Fresson gain certification, CAES will offer it as a retrofit solution, while a line-fit option will be available direct from Britten-Norman.

A number of current operators, both in the UK and elsewhere, have been approached as potential “early adopters” for route-proving trials, Harrison adds.

She says the development will be an “iterative process” and dangles the prospect of a future “next-generation Islander” to be built around the fuel cell technology.

However, the change in architecture also sees the consortium altered: Rolls-Royce, which was to provide the power management system, has opted to leave, along with subcontractors Delta Motor-sport and WMG.

### Future opportunities

For its part, R-R says that due to the simplification of the architecture, its power management system was no longer needed. “Rolls-Royce will take the learning it has acquired from the project and incorporate it into future opportunities in this sphere,” it says.

The UK company continues to research the use of hydrogen in aviation and stresses that this decision does not reflect its overall view of hydrogen as a potential propulsion technology.

Appointed in the place of the departing firms are engineering services company Ricardo, which will supply the fuel cells and associated systems, plus hydrogen storage provider Innovatus Technologies.

Ricardo is not developing the fuel cell stacks itself, says Andrew Ennever, the firm’s solution lead for the technology. Instead, it brings its expertise to the re-engineering of the balance of plant around the fuel cell stack, and to the management and control of the overall system.

Islander aircraft are currently powered by either twin Lycoming

piston or R-R turboprop engines, respectively rated at 260-300hp (190-220kW) and 320hp; by comparison each fuel cell system will provide 250kW of power.

The composite hydrogen fuel tanks will be fitted underneath the Islander’s wings using an existing pylon modification.

Innovatus’s SHyFT multi-chamber tanks are a “key enabler” for the system, says the Scottish company’s business development director Stuart McIntyre. Their ultra-lightweight design and construction and flexible form factor

allow for better integration with the airframe, he says.

Hutton concedes a clean-sheet design could be better optimised around the new powertrain, but says that would not offer the “quickest way” to improve the industry’s environmental performance.

Similarly, although using liquid hydrogen increases the energy density of the fuel, the cooling and storage requirements “pose a different level of complexity”.

“You don’t want to add that complexity when you don’t need to,” he says. ▀

## SATE should slake appetite for dedicated test facility

The UK’s ambitions to develop an environmentally friendly air transport system will be aided through the creation of a dedicated test environment in the north of Scotland.

Under the Sustainable Aviation Test Environment (SATE) project, a new facility will be set up at Kirkwall airport in the Orkney Islands to support the evaluation of new propulsion technologies and the required airport infrastructure.

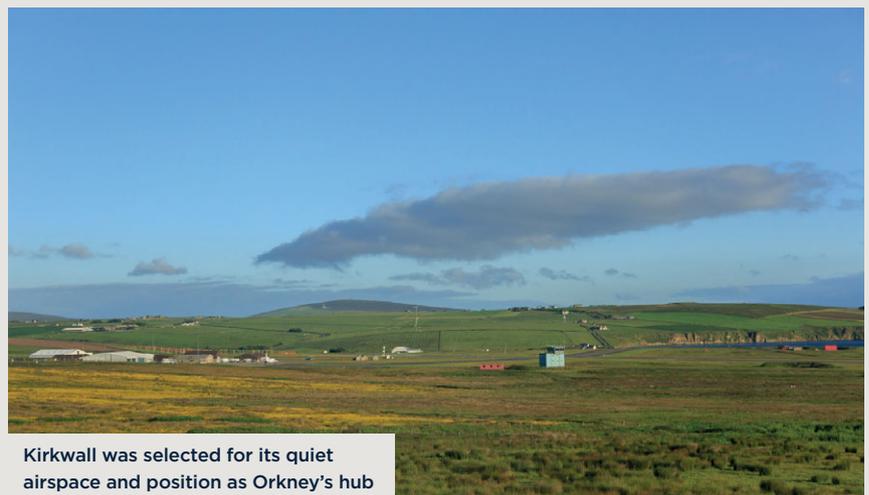
Jointly funded by the UK’s Future Flight Challenge and industry, the £3.7 million (\$5 million) project will explore how to implement zero-carbon airport infrastructure using green energy sources, and trial new clean aircraft.

Led by Highlands & Islands Airports (HIAL), the consortium includes energy providers, academia, aircraft developers Ampaire, ZeroAvia and Windracers, and Scottish carrier Loganair.

Implementation of the facility will be led by engineering consultancy Arcadis, which was recently appointed to the role by HIAL. The project, which began last November, will run for an initial 18 months.

Kirkwall airport was selected as an ideal test environment, due in part to its relatively quiet airspace but also because of its role as a hub airport, with a variety of short-haul routes connecting Orkney’s island communities.

In addition, “Orkney provides options to fly over water, in a challenging environment and climate, for real-world application testing of the technologies,” according to the project’s funding application documents.



Kirkwall was selected for its quiet airspace and position as Orkney’s hub



Airbus

Future aircraft will benefit from lighter systems as a result of research

# Airbus warms to cryogenic cooling

## Manufacturer launches powertrain demonstrator to investigate materials for next-generation electric propulsion

David Kaminski-Morrow London

Airbus has embarked on a programme to build a powertrain demonstrator showing the potential of cryogenically cooled superconducting materials to reduce weight and improve the efficiency of power conversion for electric propulsion.

Electric propulsion prospects have focused on light, regional aircraft because the power demanded for larger, longer-range types cannot be achieved without installing prohibitively heavy systems and generating large amounts of heat.

But the shift toward electrical designs raises the possibility of using low-temperature superconducting materials to increase power density, enabling a reduction in weight of electric current transmission systems.

Airbus will design and build the demonstrator over the next three years under a project called ASCEND led by electric power technology specialist Ludovic Ybanez.

"If we succeed it will be clearly a breakthrough in electric propulsion for aircraft," Ybanez tells FlightGlobal. "It's a game-changer for aircraft."

While there are already propulsion options for lower-power aircraft, he says the technology will "be an enabler" for high-power designs.

Superconducting materials that lose their resistivity when cryogenically cooled to extremely low temperatures are already used in systems such as medical scanners, electrical power grid transmission, and particle accelerators.

NASA and other research agencies have looked into aerospace applications for superconductors and Ybanez says Airbus research indicates a potential halving of powertrain weight and electrical losses, as well as a reduction in the voltage required to less than 500V.

### Voltage reduction

He says the voltage reduction is "very interesting for aircraft" because high voltage presents problems such as arcing, requiring electrical network protection.

"If you want to develop low- or zero-emission aircraft you have to address two main problems: energy storage, and conversion from energy to propulsion," he says. "ASCEND is focused on the conversion part."

The project will explore development of a "generic" powertrain, he says, in the 500kW range.

"We want to do that because the objective of the project is not to be specific to an aircraft [type] but demonstrate the feasibility and potential of technologies for an aircraft application," he says, pointing out that a light vertical take-off aircraft might require "a few hundred kilowatts" but a long-range aircraft would require "multi-megawatt" power generation.

The ASCEND powertrain would include a transmission system, taking electrical power via superconducting cables and connectors to a motor control unit and then, with DC power converted to AC, a superconducting motor to generate mechanical thrust.

Alongside this transmission system a cryogenic system would provide cooling to the superconducting components.

Airbus has already started exploring the possibilities presented by liquid hydrogen as a fuel for future zero-emission engines.

Liquid hydrogen, which exists at temperatures of around 20 Kelvin (-253°C/-423°F) offers a source of cooling for a superconducting circuit. Since liquid hydrogen has to be heated from this temperature for injection into a fuel cell, using it as a heat-exchanger to cool a

cryogenic powertrain would be a “win-win situation”, says Ybanez.

But he points out that there are safety issues with distributing liquid hydrogen, which Airbus will need to avoid.

ASCEND will look at another scenario, without liquid hydrogen on board, with a neutral coolant such as liquid nitrogen or helium.

Ybanez adds that, although the overall superconducting system needs to be cold, around 30-50 Kelvin, the different components of the powertrain might require individual temperatures – perhaps 80 Kelvin for cables, 100-150 Kelvin for conventional semiconductors – and the project will look at changing the temperature of liquid hydrogen or developing specific cooling systems for certain components.

ASCEND will investigate feasibility of the system to “identify potential show-stoppers and kill them – or kill the project”, he says, and analyse whether overall performance benefits from the technology.

“Just because one system is very good doesn’t mean the

“If you want to develop low- or zero-emission aircraft you have to address two main problems: energy storage, and conversion from energy to propulsion”

**Ludovic Ybanez** Electric power technology specialist, Airbus

global system is very good,” he says. “We’ve launched the project because we don’t think we will have show-stoppers. But we will have difficult points to address.”

Ybanez is encouraged, however, by initial research focusing on the behaviour of semiconductors at low temperatures.

Airbus, through its UpNext future technology subsidiary, will construct the powertrain demonstrator at its E-Aircraft System House outside Munich, and test solutions that can be adapted to a range of engines – turboprops, turbofans and

hybrid propeller powerplants – by the end of 2023.

Ybanez says that, once the powertrain demonstrator has been completed, it will enable decisions to be made on whether the technology is sufficiently mature to develop a specific powertrain for flight testing.

Some of the technology – such as that used in terrestrial applications – is already available, and part of the strategy will focus on how to integrate it into aircraft, while Ybanez believes other aspects could be ready by around 2030. ▀

## Faury insists 2035 is ‘credible’ timeline for zero-emission aircraft

Airbus chief executive Guillaume Faury insists a 2035 entry-into-service horizon for zero-emission aircraft is “credible”, given the advancing work on hydrogen power.

Six months ago the airframer unveiled proposed designs for zero-emissions aircraft, including a blended-wing body concept alongside more conventional twinjet and turboprop configurations.

“We think it’s going to happen,” said Faury, speaking during a Eurocontrol-hosted event on 30 March. “These are different architectures we’re looking at – among others – these are the main ones we’re looking at for future hydrogen aircraft.”

Faury says the blended-wing concept is “very interesting”, because it is “well-suited for a high volume of fuel inside the aircraft” – pointing out that hydrogen is “bulky” compared with kerosene-based fuel.

“To go a certain distance needs more volume of fuel on board and that’s why we’re looking at different architectures,” he states.

Faury says the 2035 timeframe for hydrogen fuel technology’s entry-into-service “makes sense”

because it gives the aerospace industry five years to mature the technology.

He says that the industry is “working on that now, big time”.

Another two years would be necessary to prepare to launch an aircraft programme – sourcing funding and finding production locations – before a formal launch around 2027-2028, giving another seven or eight years before introduction to service, Faury says.

“That’s very credible,” he says. “It doesn’t mean all solutions are on the table.”

Although hydrogen fuel is “not a new technology”, he says, a “lot of engineering” will be necessary to adapt it safely and reliably to commercial aerospace.

Faury also stresses that a new regulatory framework is required, as well as a “level playing-field” for those regulations, plus “large quantities of decarbonised hydrogen at airports” by 2035.

“Obviously we’re far from being there,” he says. But he adds that there is “big momentum” on hydrogen technology in a number of industries.

“We think that’s really good to see, very encouraging,” he says.



Hydrogen power has ‘big momentum’, says Airbus chief

# BA zeroes in on hydrogen

Flag carrier invests in propulsion system developer to accelerate development of green powerplants for larger commercial aircraft



ZeroAvia says fuel cell-equipped 50-70-seater will enter service by middle of the decade

ZeroAvia

**Dominic Perry** London

British Airways has become the first airline to invest in hydrogen propulsion developer ZeroAvia – a move that could see the flag carrier replace its whole short-haul fleet with zero-emission aircraft by 2050.

Alongside a group of existing backers, including the Bill Gates-founded Breakthrough Energy Ventures, BA contributed to a total of \$24.3 million raised by the California-headquartered start-up.

BA declines to reveal how much it provided for the Series A4 funding round, but ZeroAvia says it will advance the development of a fuel cell-based powertrain suitable for a 50-70-seat aircraft.

Under the accelerated timetable, that aircraft could enter service in 2026, following a 19-seater which is scheduled to arrive in 2024.

Val Miftakhov, founder and chief executive of ZeroAvia, says that while he is happy to have secured the latest backing, “we are more pleased with the level of interest” shown in the next generation of its propulsion system.

“The investment is a manifestation of interest – it allows us to capture that demand sooner,” he says.

ZeroAvia has since January been part of the Hangar 51 technology accelerator run by BA parent IAG. Carrie Harris, head of sustainability at the carrier, says the financial contribution “gives us the opportunity to solidify our commitment to ZeroAvia and to the decarbonisation of aviation in the long term.”

The investment does not commit BA to purchase any future aircraft that use ZeroAvia’s technology,

but “at the moment hydrogen does seem to be emerging as a clear winner for the future”, says Harris.

The relationship built through Hangar 51 has allowed the airline to begin considering the operational requirements for a switch to hydrogen power, including the necessary fuelling infrastructure.

BA is also “looking at specific routes where there could be the opportunity for the early introduction of hydrogen aircraft,” she says.

While adding a sub-100-seat aircraft would not be entirely alien to BA – its CityFlyer unit uses 76-98-seat Embraer E-Jets – it currently operates no regional turboprops, a class of aircraft that would gain the new propulsion system being developed by ZeroAvia.

## Single minded

But Harris sees the potential for a larger hydrogen-powered single-aisle arriving from 2030 – a timeframe that aligns with Airbus’s plans to replace its A320neo family.

“As we phase that into the fleet we believe that by 2050 all short-haul flights could be on zero-emission aircraft,” she says, anticipating the arrival of a suitable 180-seater from about 2035 and considering BA’s typical replacement cycle.

ZeroAvia will later this year perform the maiden flight of the powertrain for the 19-seater, which is sized to deliver 600kW to each motor. This is being developed under the UK government-backed HyFlyer II programme.

Miftakhov says the company is in the process of acquiring a Dornier 228 twin-turboprop for that effort; conversion is to take place at a recently acquired site at Cotswold airport in the southwest of England.

Work on that programme will run “at full speed” with the aim of delivering a certifiable design by the end of 2022.

Although development will take place on the Dornier 228, discussions with potential operators will determine the eventual launch airframe. Miftakhov says “the target is to make that decision this year”.

“That’s not necessarily what they fly today, but based on what capability and mission profile they are looking for,” he adds.

Additional aircraft types will be retrofitted with the ZeroAvia powertrain via supplemental or amended type certificates, he says.

Miftakhov estimates the ZeroAvia fuel cell system will offer a maintenance saving of around 50% against a turbine-powered 19-seater, with a similar fuel cost saving.

In parallel with HyFlyer II, ZeroAvia will this year begin initial activities on the propulsion system which would equip a 50-70-seater, which would be capable of providing 1.6MW to each electric motor.

That development is likely to require close collaboration with an airframer. Miftakhov notes that the choice of suitable aircraft is limited to either the ATR 72 or De Havilland Canada Dash 8-300.

Further out, co-operation will be vital. “For the next size – to power a typical single-aisle – the timeline of potential engine availability is such that it is compatible with new airframes being designed,” he adds.

“We could partner on a clean-sheet [design] – it is much more efficient to do it that way than via a retrofit.”

Production of the 600kW system will be in the UK, although a final location is yet to be selected. ▀

# A powerful change

Industry-wide use of sustainable aviation fuels will provide a vital environmental bridging measure until technology's next propulsion shift, says **Geoff Hunt**

Commercial aviation has a unique opportunity when it comes to sustainable flight, and our industry must use multiple approaches to address the challenge.

We will of course continue to leverage our technical know-how and innovation to build future generations of ever-more efficient and capable aircraft.

One immediate opportunity to radically reduce our dependence on fossil fuels is to develop a viable and robust sustainable aviation fuel (SAF) infrastructure and marketplace as a bridge technology, as we design and build the future generation of commercial aircraft, powered by hyper-efficient engines.

At the risk of simplifying matters, industry – with appropriate government support – can develop a viable, affordable path to using SAFs.

Fact: by 2035, 44,000 aircraft are expected to be in service, and the majority of those will still be flying in 2050 and beyond. Airlines cannot re-fleet entirely when the next generation of technology is introduced from 2035.

We need a solution that bridges the technology gap between now and our sustainable future state.

A robust SAF infrastructure and marketplace would take us to 2050 with a new baseline carbon footprint from which the industry will apply our collective knowledge to reduce our footprint even further, through the diligent development and use of new technology and innovation that it has always shown.

Advancements in gas turbine engines have already reduced fuel consumption and emissions, so the near-term flying fleet is performing better. For example, Pratt & Whitney's geared turbofan technology, which entered service in 2016, delivers 16-20% better fuel efficiency and corresponding carbon dioxide

(CO<sub>2</sub>) emissions reductions. However, bringing future hyper-efficient technology to the market and into airline fleets will take time.

We know how to get there; those of us in industry, and our partners in government, need to get serious about a viable path for SAF development, production and distribution. The latest-generation engine technology today can fly on 100% SAFs under test conditions, though modifications to engine components may be required. This is not a pacing event for the industry.

We need SAFs developed at scale. Today, less than 1% of fuel needs are met by their use. Governments can provide the right mix of incentives and funding to stimulate supply and demand towards an economically competitive level.

## Tax credits

In Europe, we are seeing a move towards mandating a minimum level of SAF usage, while in the USA, the industry is calling for "blender's" tax credits to reduce the price differential versus kerosene. Ultimately, we will need both of these carrots and sticks to lift the growth in SAFs beyond the anaemic progress to date.

There are currently seven SAF production pathways available, and industry will also need to find a balance to avoid competition with food producers for arable land, for instance, by focusing on waste-to-fuel and power-to-liquid solutions.

Transitioning to SAFs provides benefits beyond reducing CO<sub>2</sub> emissions. By avoiding the impurities associated with fossil-based fuels, SAFs will also cut sulphur oxide and particulate emissions, which contribute to contrail formation and other climate change impacts.

These incremental benefits, along with those from other advancements in engine efficiency,



Solution exists for aviation to reduce emissions, says Hunt

will have a meaningful environmental impact – clearly an important factor given the scale of the challenge with boosting SAF production capacity.

Although we are also investigating zero emissions technologies like hydrogen- and electric-powered propulsion, these do not compete with the drive to implement SAFs at scale; in fact they are synergistic. The buzz around hydrogen helps build up our capacity for renewable energy sources that plays directly into power-to-liquid SAF production infrastructure.

Pratt & Whitney stands ready to work with regulatory authorities to test and develop global standards for SAFs to be used in engines as "drop-in" blends at or greater than the 50% blend with kerosene allowed today. Ideally, we need to develop standards to allow any and all SAFs to be used interchangeably throughout the world, by any airline on any large commercial aircraft.

The answer to more sustainable aviation is not asking people to travel less. This is unrealistic, and the past year has shown us how important it is to connect people and grow economies through affordable air travel. The answer is in employing smarter, more environmentally friendly technologies to help people and cargo take flight.

Our industry has proven its ability to meet any challenge with practical and pragmatic solutions, and we can, and must, do it again. ▶

## See p65

*Geoff Hunt is Pratt & Whitney's senior vice-president, engineering & technology*

# THE **FUTURE** OF THE AEROSPACE INDUSTRY



**14-18 NOVEMBER 2021**  
DWC, DUBAI AIRSHOW SITE

[www.dubaiairshow.aero](http://www.dubaiairshow.aero)  
Book your space today: [sales@dubai.aero](mailto:sales@dubai.aero)

Helping drive recovery and future growth  
at the most anticipated point of convergence  
for the aviation industry in a live format

Follow us on: [f](#) | [in](#) | [@](#) | [t](#)  
#DubaiAirshow

COMMERCIAL AVIATION | AIRCRAFT INTERIORS | MRO | BUSINESS AVIATION | AIR TRAFFIC MANAGEMENT  
SPACE | DEFENCE & MILITARY | AIR CARGO | EMERGING TECHNOLOGIES **NEW**



Supported by:



# Keeping resilient

We hear from an anonymous UK pilot made redundant in the pandemic about further stress caused by the loss of mutual licensing recognition after Brexit – and how to find support

**T**he past year or more has been very challenging for the aviation community. Being a pilot, I was made redundant by my former employer, and losing my dream job was a heartbreaking blow.

While dealing with the impact of the Covid-19-driven downturn, many airlines have understandably stopped or frozen recruitment, reducing the chances of re-gaining employment. Now UK pilots are facing the issues that Brexit has brought in terms of licensing transfer requirements.

This is the first redundancy that I have experienced, and I would not wish it on anyone. The feeling of isolation – multiplied by the actual isolation of lockdowns – really affects your well-being, particularly after being used to frantic flying schedules and meeting many different friends and colleagues each day while line flying.

Having a very supportive family and friends helps, but sadly they do not understand all of the stresses that pilots are facing after flying into a perfect storm of redundancy, pandemic and now licensing issues.

After losing my job, I wanted to transfer my UK Civil Aviation Authority (CAA) Flying Crew Licence (FCL) to a European Aviation Safety Agency (EASA) FCL. However, a number of EASA states responded advising that I would have to re-do all 14 Airline Transport Pilot Licence exams, as well as my instrument rating, English language proficiency test and EASA Class One medical.

Asking pilots to repeat all of their exams in order to hold the same licence gained previously under the same syllabus and regulations causes undue stress, and has a massive impact on well-being and mental health.

There was a transfer period where a pilot could convert their licence, but many missed this because they were still employed



Covid pandemic suddenly put brakes on dream job for many

and had no need to do so at that time, or were hoping that a mutual agreement would be reached as part of the Brexit negotiations.

A pilot being faced with so many issues could find themselves in a place of despair.

## Staying connected

I learned of an organisation called Resilient Pilot, created during the pandemic to keep pilots supported, current and connected. I have found this to be a great help during such an uncertain and unprecedented time. Supporting pilots to keep their licences valid, and reducing the cost of doing so, is really appreciated at this stressful and financially delicate time.

Having access to support and the latest developments in the industry by way of weekly webinars and offering one-to-one mentoring or coaching support is what pilots who find themselves in this situation really need at this time.

Even if it is just for a weekly chat about aviation, the connection provided reduces the feeling of isolation and the Resilient Pilot team have empathy with what you and

others are going through. This can really help with your well-being.

As an independent, not for profit organisation, its goals are to help pilots navigate their return to the flightdeck when opportunities emerge. It works to highlight the challenges they are facing and supports initiatives to overcome barriers where safe and appropriate to do so.

The CAA itself has a microsite designed to update post-EU exit developments, and has delivered several webinars to address the key issues that we are facing. These can also be watched on demand via the [resilientpilot.com](https://resilientpilot.com) website.

Pilots affected by the changes enforced by the UK's departure from the EU have launched a petition appealing to the UK government for reciprocal and fair mutual agreement on the transfer of FCLs between the CAA and EASA – without the need to repeat exams. For more information, see [petition.parliament.uk/petitions/578133](https://petition.parliament.uk/petitions/578133).

A second petition, asking the European Parliament for a similar reciprocal agreement, is currently awaiting approval. ▶



Embraer  
Embraer recently completed in-flight refuelling qualification work using a pair of KC-390 tanker/transports for the Brazilian air force

## Best of the rest

We showcase some of the other notable events covered by the FlightGlobal team between issues

Japan Airlines is retiring its Pratt & Whitney PW4000-powered Boeing 777s, following an uncontained engine failure affecting a US-operated twinjet



Crown Copyright



Viper-Zero/Shutterstock

The UK Royal Navy has launched operational training with its first Crowsnest airborne surveillance and control-adapted Leonardo Helicopters AW101 Merlin HM2



Russia's Ilyushin Il-112V military transport resumed flight testing on 30 March - exactly two years after its debut sortie

Lufthansa  
United Aircraft

This Lufthansa Airbus A350-900 (D-AIXJ) will receive 1.6t of container-housed instruments, for climate research duties



Boeing resumed deliveries of its 787 on 26 March, after a five-month pause, transferring a -9 example to United Airlines

United Airlines



Amit Agronov/israeli air force

The Israeli air force has welcomed its new Gulfstream G550-based "Oron" surveillance aircraft, ahead of conversion and service entry in 2023





# NOMINATIONS ARE NOW OPEN

Has your chief executive demonstrated outstanding leadership during the Covid-19 crisis?

What business innovation has your organisation demonstrated during the pandemic?

**Submit your nomination for free at [FlightGlobal.com/StrategyAwards](https://FlightGlobal.com/StrategyAwards)**

**Entry deadline: Friday 25 June 2021**

**Awards date: Monday 27 September | London**

ORGANISED BY



IN ASSOCIATION WITH



SPONSORED BY



# Next month

# FLIGHT

INTERNATIONAL

On sale  
**27 May**

US  
defence  
exports keep  
soaring as  
Washington  
targets  
buyers



**Fast mover**  
Racer speeds  
development  
pace after  
pandemic  
black-flagged  
last year



**Slow going**  
We review  
the business  
fortunes of big  
two airframers  
while crisis  
hits demand

US Air Force  
Airbus Helicopters

Boeing



Cyril Cosmao/Dassault Aviation

Dassault's newest type, the 6X, flew for the first time on 10 March

**Murdo Morrison** London

When the world started shutting down in March 2020 as Covid-19 took hold, business aviation enjoyed an unexpected, if short-lived surge. As airlines cancelled thousands of flights, and governments considered border closures, quarantines and stay-indoors orders, many stranded abroad wanted to get themselves and their families home quickly. Those who could afford it found that the sanitary capsules of private aircraft were the perfect solution.

Since then, the sector's performance has been bumpier, although business aviation has fared much better than its commercial counterpart. With airline networks slashed and concerns over catching the virus in crowded airports and cabins, some high-end travellers have switched to private aircraft for essential trips. Many have also managed to fit in leisure travel - to the likes of Dubai, Florida and ski resorts - when restrictions permitted.

However, with even politicians, Hollywood stars, and captains of industry forced to communicate virtually from their houses for much of the past year, business aviation has not escaped the impact. This has affected new aircraft deliveries. Figures from the General Aviation Manufacturers Association (GAMA) revealed that shipments of business jets in 2020 were one-fifth lower than in the previous year, with GAMA noting that pandemic-led supply-chain disruption contributed to the drop.

While the global situation remains uncertain, a new confidence on the back of vaccine breakthroughs

saw the decline in deliveries slow in the fourth quarter, and some believe that optimism will continue in 2021. "I am quite bullish on new airplane sales," says commentator Brian Foley, of Brian Foley Associates. "The manufacturers are conditioning shareholders for a gloomier outlook, but I think the opposite."

He says business aircraft utilisation figures for the first quarter in the USA - the biggest market - were "almost on a par" with 2019, and, despite stricter travel rules and higher infection rates, "I suspect Europe is just behind". With continuing negative headlines, Foley believes "it is hard to escape the brain fog to see better days". However, he is confident these will begin with a boost in leisure trips in the summer, followed by a return of business travel in the fourth quarter.

"There is a skew to lighter aircraft and to weekend travel. You can also see it in the destinations - Florida and ski country taking the place of business cities like New York and Chicago"

**Adam Cowburn** Director, Alton

The pandemic has buffeted private aviation more lightly than its commercial cousin – some areas have done surprisingly well. But Covid-19 continues to have an impact, with activity and sales down

# Open for business



Brian Foley Associates

Consultant Brian Foley predicts European business travel will rebound by the year end

Adam Cowburn, a director with aviation consultancy Alton, says that, in the USA at least, leisure travel “is driving the traffic trend”, with fewer people using business aircraft for business. “You can see it in the aircraft mix,” he says. “There is a skew to lighter aircraft and to weekend travel. You can also see it in the destinations – Florida and ski country taking the place of business cities like New York and Chicago. People have been getting off light jets in shorts rather than heavier jets in suits.”

## European exception

In Europe, the situation has been different. There, tighter lockdowns and a “greater pullback in scheduled airline activity” could be a possible driver for business aviation this year, if demand for essential travel recovers more quickly than airlines are able to reinstate services, Cowburn believes. Different national travel rules could also hamper recovery, with cross-border business aviation travel lagging domestic activity in the USA by 12 to 18 months, he suggests.

Like almost all industry events in the past year, the two main annual business aviation fixtures – EBACE in Geneva and NBAA BACE in the USA – fell victim to Covid-19 in 2020. EBACE 2021, due to have taken place in May, has also been replaced with a virtual programme. BACE is scheduled for Las Vegas in October, but this will mean manufacturers will not have had an opportunity to showcase products, schedule press conferences or meet customers for two years.

With product development having continued throughout the crisis, some believe NBAA BACE 2021 could therefore see an outpouring of delayed launches and programme updates by airframers. Dassault

It is rumoured to have had an announcement on a new top-of-the-range type originally lined up for EBACE 2020 – flew its newest product to date, the Falcon 6X, for the first time on 10 March. Service entry for the Pratt & Whitney Canada PW812D-powered, ultra-wide-cabin jet is due late next year.

The French manufacturer could certainly do with some fresh blood in its family. Although Falcon deliveries in 2020 were down by just six from 2019's total of 40, orders fell to just 15 from 40. Seven of these were for a French navy maritime surveillance programme, so only eight were business jets. In the company's annual results presentation in February, chief executive Eric Trappier admitted that "uncertainties led our clients not to order new aircraft" in 2020.

### Scaling back

One of Dassault's two main rivals, Gulfstream, said in January that interest in its ultra-long-range G650 and G650ER was holding up, despite the 2019 launch of its new flagship, the G700. The manufacturer – which delivered 127 aircraft in 2020, compared with 147 the year before – intends to continue offering the G650 alongside the larger and more expensive G700 after the latter enters service in late 2022.

Phebe Novakovic, chief executive of Gulfstream parent General Dynamics, warned late last year that 2021 deliveries were likely to slip again for the Savannah, Georgia-based airframer, not so much because

# 15

Orders for Dassault Falcon in 2020, compared with 40 in the previous year

of the impact of the pandemic but because of the withdrawal from production of the older-generation G550. The still-young, large-cabin G500 and G600, together with the Israeli-built super-midsize G280, make up Gulfstream's range.

After a spate of divestments in recent years, Bombardier is now a business aviation-only manufacturer – its rail, regional aircraft, and aerostructures interests together with its one-time crown jewel, the CSeries, have all departed. However, even that side of the Canadian company's activities is set to get slimmer after the announcement earlier this year that it would be stopping Learjet production later in 2021, after years of struggling sales for the iconic light-jet brand.

The decision leaves Bombardier with two ranges – the super-midsize Challenger pairing, and the large-cabin, long-range Global family. In terms of 2020 deliveries, Bombardier almost kept pace with Gulfstream, with shipments falling by 28 to 114 units



Bombardier

Bombardier's fortunes are closely tied to performance of flagship Global 7500



G500 and G600 are key members of Gulfstream's large-cabin offering

Gulfstream



Airbus launched the ACJ TwoTwenty in late 2020, based on the A220-100

Airbus

versus the previous year. While the Challengers continue to dominate their segment, much depends on the success of the flagship Global 7500, which entered service in late 2018 and the 50th example of which was delivered in March.

Bombardier, Dassault and Gulfstream have had the top end of business aviation to themselves for decades – although Airbus and Boeing have offered airliner-derived ranges. Now, however, Airbus plans to take on the likes of the Global 7500 and the G700 with a business jet adapted from the A220-100 – formerly the smaller of Bombardier's CSeries pair – launching the ACJ TwoTwenty in late 2020. Deliveries will start in early 2023, with Comlux among initial customers.

While the larger airliner-derived segment is highly profitable but tiny – mostly head-of-state transports – Bombardier, Dassault and Gulfstream can together

deliver almost 200 large-cabin jets in a good year. Airbus believes it can steal a piece of that pie with a product whose main selling point will be its 73sq m (786sq ft) cabin. However, drawbacks are its relative lack of speed and a range of 5,650nm (10,400km), which leaves it short of the 7,500nm or more offered by its rivals.

Embraer, which has also dipped a toe in that large-cabin segment with its airliner-derived Lineage and Legacy 650, has done much better in the smaller-sized market, where its Phenom 300 is the strongest selling light jet. The Brazilian manufacturer also has two new midsize contenders in the recently reworked Praetor 500 and Praetor 600. It delivered 86 aircraft in 2020, down from 109 the previous year.

### All change

Like Bombardier, Embraer has had its convulsions at a boardroom level, after a planned joint venture with Boeing on the commercial aviation side collapsed in April 2020. However, its corporate aviation activities, which it launched two decades ago, remain a key part of its future. Its most significant development in 2020 was the December delivery of the first Praetor 600 to launch customer Flexjet, part of a 64-aircraft deal for Embraer types announced in 2019.

Textron Aviation – behind the Cessna and Beechcraft brands – remains the biggest player in business aviation in unit terms. It delivered 559 aircraft in 2020, including 132 Citation jets, down from 600 (206 jets) the previous year. The Wichita, Kansas-based manufacturer's in-development products are the delayed Denali single-engined turboprop and the twin-turboprop SkyCourier, although in February 2021 it

It did unveil a cabin update for its 11-year-old Citation CJ4, rebranding the light jet the CJ4 Gen2.

Late last year, Textron also introduced a new King Air variant, the 260, a smaller sibling to its recently launched King Air 360. The King Air family, which has been in production for almost 60 years, continues to dominate the twin-turboprop market, with 62 deliveries in 2020. This illustrates how, with regular, subtle improvements, several of the types introduced in the great 1960s' expansion of general aviation remain popular today.

However, Textron's ambitions to move into the large-cabin segment to compete with the likes of Bombardier's Challenger 650 and Dassault's 2000LXS remain on hold following the suspension of the Hemisphere programme in mid-2019, four years after the 4,500nm-range type's unveiling. That was triggered by the failure of Safran's Silvercrest engine to deliver as advertised, something that also put paid to Dassault's 5X and led to its replacement with the 6X.

### Brighter spots

Other manufacturers entered the second year of the Covid-19 crisis on the back of a reasonably strong 2020. Deliveries of Honda Aircraft's sole product, the HA-420 HondaJet, held up well, falling from 36 in 2019 to 31 in 2020. The 100th example of its rival in the light-jet segment, Pilatus's PC-24, was delivered at the turn of the year. The Swiss manufacturer shipped 40 examples in 2020, along with 83 units of its PC-12 single-engined turboprop: an almost identical performance to 2019.

For Cirrus, Daher and Piper, one of the most significant developments of the past 12 months has been the certification of Garmin's autoland safety system on the single-engined Vision Jet, the TBM 940, and the M600, respectively. The device, which each airframer brands differently, is designed to take control of and land the aircraft if the pilot becomes incapacitated and has been hailed as one of the most important developments in general aviation safety in years.

A question mark remains over the future of two once-innovative business aircraft programmes and the manufacturing operations behind them. An Italian state-appointed administrator has shortlisted four companies keen on acquiring Piaggio Aerospace, manufacturer of the distinct Avanti twin-pusher.



Vision Jet is one of three types to receive Garmin autoland system

Cirrus Aircraft

Meanwhile, an entity called AML late last year became the latest investor to take on the assets of Eclipse, the Albuquerque enterprise behind the original very-light jet, the Eclipse 500.

As well as the effect on travel, Covid-19 is likely to cast a shadow over the industry for some time, with cash-constrained manufacturers forced to delay or cancel investment in product development.

However, despite manufacturers being denied one of their biggest networking and promotional opportunities with the cancellation of EBACE, many in the industry do foresee better times ahead, with business movers and shakers desperate to ditch virtual meetings for human interaction.

"Yes, platforms like Zoom will remain important for business co-ordination," says Foley. "But that need to visit factories and to meet face to face will cancel out the Zoom effect, along with new entrants coming into the market."

100

Total deliveries of Pilatus PC-24 as of early 2021, with 40 examples shipped during 2020

Cowburn agrees that a recovery will quickly kick in once immediate health fears abate. "There is no structural brake on demand," he says. "And there is the competitive impact too – if your business rival is visiting a customer face to face, you cannot afford not to."

George Galanopoulos, managing director of Luxaviation UK, believes that, after a "tough" start to 2021, demand throughout Europe will pick up substantially in the summer, with leisure leading the way, and business travel following from September.

"People are desperate to get away, and have been holding back on arranging meetings, so there is a lot of pent-up demand," he says. "However, there will still be that fear of Covid, so people of a certain wealth will be attracted by private aviation."

This time last year, after organisers had taken the unprecedented step of pulling the plug on EBACE, few in business aviation imagined there would be a feeling of déjà vu 12 months on.

However, six months has proved a long time in the pandemic, and – assuming vaccine roll-outs remain on track and there are no surprises with jab-resistant variants – the industry landscape could look very different come October 2021, when NBAA BACE is due to open its doors in Las Vegas. ■



Praetor 600 is one of two recent midsize updates to Embraer's range

Embraer



# Cancer Patients Fly Free

## Filling Empty Seats With Hope

Corporate Angel Network arranges free travel on corporate aircraft for cancer patients traveling to and from treatment. Business jet travel makes it possible for patients, especially those in locations with minimal airline access, to travel to specialized medical centers.

Contact us today to learn more about patient travel services or to donate space on your aircraft.



“It’s wonderful that organizations like the Corporate Angel Network are able to help connect those most in need of flights to those who are flying.”

*-Henry Maier, President and CEO, FedEx Ground*

# Upping the pace



The determined band of airframers keen to see a reintroduction of supersonic passenger services are busy working with suppliers, backers and regulators to turn their plans into reality

Boom Supersonic

Boom's conceptual Overture airliner will fly at Mach 2.2

**Jon Hemmerdinger** Tampa

It seems reasonable to assume that at some point in the future – be it 2030, 2050, or whenever – civil supersonic jets will again be zipping between the world’s distant cities.

Exactly when that time might come remains open to debate, but there is no doubt that in the past year several civil supersonic jet developers stepped closer to making their projects a reality.

The handful of companies in the sector spent the past year partnering with major aerospace suppliers (including engine makers), lining up buyers, hiring known aerospace executives and, in the case of Boom Supersonic, rolling out a demonstrator jet.

Several companies predict their supersonic jets will be flying by 2030, if not earlier. And their efforts align with supersonic projects under way with the US government, including rules being written by the Federal Aviation Administration (FAA) and NASA’s development of its X-59 Quiet Supersonic Technology (QueSST) demonstrator.

All of this during a pandemic.

### Evaluating technologies

“XB-1 remains on track to fly in 2021,” Denver-based Boom tells FlightGlobal. “XB-1 is currently in the integrated testing phase, where we are testing all aspects of the aircraft, from landing gear to avionics systems, to ensure its flight readiness.”

XB-1 is Boom’s supersonic demonstrator – a single-pilot, triple GE Aviation J85-15-powered craft with which the company intends to evaluate technologies and designs ultimately intended for a conceptual passenger airliner called Overture.

In October 2020, Boom rolled out the needle-nosed XB-1 during a slick virtual event.

The XB-1’s test programme will involve ground and low-speed taxi tests at Centennial airport in Colorado, and flight tests over the Mojave Desert. Boom has hired Mojave, California-based aerospace company Flight Research to assist with flight testing.

“The goal of the flight-test programme is to safely expand the envelope of XB-1 to supersonic speeds,” Boom says. “This will be done through an incremental build-up of the aircraft performance while being monitored by a chase aircraft and a control room.”

All the while, Boom will continue developing Overture, its focus on “completing the systems definition review... and finalising Overture’s design”, it says.

“We are building Overture [by] leveraging the processes, design methods, principles and relationships we have built through XB-1,” the company adds. “We have been advancing Overture’s conceptual design throughout the XB-1 programme with these learnings.”

“XB-1 is currently in the integrated testing phase, where we are testing all aspects of the aircraft, from landing gear to avionics systems, to ensure its flight readiness”

### Boom Supersonic

The Overture is to be a Mach 2.2, 65- to 88-passenger airliner that will cost upwards of \$200 million and, Boom says, be capable of profitably operating some 500 transoceanic routes.

Also this year, Boom expects to select a location at which to manufacture the Overture. It aims to begin manufacturing in 2022 and to reveal the aircraft to the world with a roll-out in 2025. First flight would follow in 2026.

“We expect Overture to begin carrying passengers by 2029,” Boom says.



XB-1 supersonic demonstrator is on course to make its first flight during this year



Virgin Galactic

Virgin Galactic's delta-wing civil jet will be capable of reaching Mach 3.0 and cruising higher than 60,000ft

Boom has already secured at least two potential airline customers. Those include Japan Airlines, which in 2017 invested \$10 million in the company, taking purchase rights for 20 jets in the process. Virgin Group has also taken “pre-orders” for 10 Overture jets, Boom says.

Founder and chief executive Blake Scholl has predicted the Overture will be such a hit that Boom will eventually build more units than Boeing has produced 787s.

As the XB-1 has progressed, Boom has beefed up its team and cadre of industry partners. In February, it announced that former Boeing chief executive Philip Condit had joined as an adviser.

Rolls-Royce came on board in 2020 as an engine partner for the Overture, agreeing to evaluate whether “existing engine architecture can be adapted for supersonic flight”, Boom and R-R said last July. R-R has said an Overture powerplant could potentially be based on a Trent turbofan’s core.

Last November, Collins Aerospace also joined the Overture team as developer of the jet’s nacelles and other structures.

More recently, in March, Boom received a capital investment of an undisclosed sum from American Express Ventures, the innovation finance arm of that financial services company.

Though the civil supersonic sector must overcome various technological and regulatory hurdles, the jets will come to market, according to aerospace consultancy AIR. It predicts manufacturers will deliver more than 300 civil supersonic jets by 2040, with delivery rates hitting about 30 aircraft annually in the 2030s. Fractional aircraft ownership companies will buy about half of those jets, with private owners taking one-quarter of the total and governments 17%, AIR predicts.

### NetJets backs Aerion

Another supersonic player, Boeing-backed Aerion Supersonic, has also kept busy in recent months, pushing forward development of a business jet called AS2.

Aerion made a splash in March when it revealed a partnership with two Berkshire Hathaway subsidiaries: fractional aircraft ownership company NetJets and aviation training provider FlightSafety International.

Under the agreement, NetJets acquired rights to purchase 20 AS2s. Powered by three GE Affinity turbofans, the jet will carry eight to 10 passengers and have a 4,200nm (7,780km) range at M1.4, and a 5,400nm range at M0.95, according to Aerion.

NetJets also agreed to become the sole business jet operator on a planned booking portal called Aerion Connect. FlightSafety will help Aerion create a “supersonic flight training academy”, Aerion says.

While far from a firm order, securing NetJets’ backing is no small accomplishment – it is, after all, among the world’s largest operators of business jets, with a fleet of more than 750 aircraft.

Aerion is working along a timeline that calls for the AS2 to make its maiden flight in 2025 and enter service in 2027. Aerion says it will soften the AS2’s sonic boom by leveraging a phenomenon called “Mach cut-off”, which occurs when atmospheric and

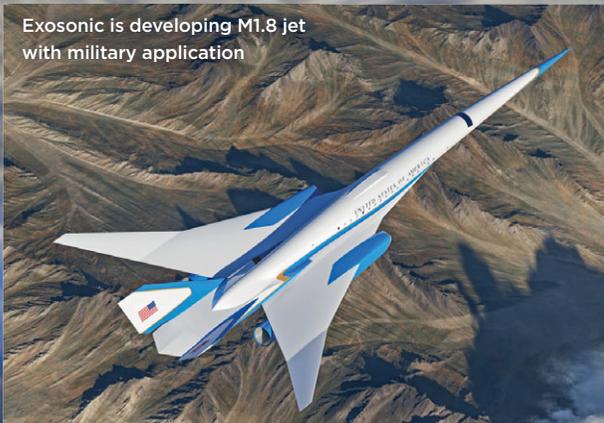
# 300

Number of civil supersonic jets that will be delivered by 2040, according to aerospace consultancy AIR



Aerion AS2 is due to fly in 2025 and enter service in 2027

Aerion Supersonic



Exosonic is developing M1.8 jet with military application

Exosonic

flight conditions cause booms to deflect up, not down, according to the company.

Like Boom, Aerion has secured an impressive array of suppliers as partners. Universal Avionics will make the AS2's enhanced flight vision system, BAE Systems will develop a fly-by-wire flight-control system and Spirit AeroSystems is working on the jet's forward fuselage. Other partners include Aernnova, Collins, GKN Aerospace, Honeywell, Potez, Safran Landing Systems and Safran Nacelles.

Aerion also stands out from the pack for its progress in building an actual manufacturing site for its supersonic jet. Before year-end, it is to break ground on Aerion Park, a campus and headquarters in Melbourne, Florida, at which AS2 production will begin in 2023, the company says.

Another competitor, Spike Aerospace, intends this year to begin building a supersonic demonstrator and to fly that manned aircraft "toward the end of next year", says founder and chief executive Vik Kachoria.



Spike says its S-512 will be suited for overwater and overland operations

Spike Aerospace

The Boston-based company is also evaluating locations at which to house a manufacturing site, and is seeking a partner to assist with fabrication, he adds.

Spike aims to develop the S-512, a twin-engined, M1.6 civil jet, for certification by 2028.

The company has spent the past year finalising the S-512's design to ensure it meets range, efficiency and sound requirements. Spike says the S-512 will be suited for both overwater and overland flights, thanks to aerodynamic features that will ensure it does not generate a "loud, disturbing sonic boom on the ground".

In a shift, Spike increasingly views the airline market as the most opportunistic for the S-512. Spike had pitched the aircraft primarily as a 12- to 18-passenger business jet. "It is now the primary market we are going for," Kachoria says of the airline sector. "We definitely believe it's going to be the game changer here."

The S-512, outfitted with up to 22 first-class seats, would be perfect for operating long-haul routes such as New York to Liverpool or Marseille, Kachoria says.

In February, Spike said it had partnered with Indian company Tech Mahindra, which will assist it with stress analysis and fuselage work. Aerospace veterans have also joined Spike's team in the past year, including Bill Boisture, who has been chief executive

# 4,200

Range in nautical miles of the Aerion AS2, flying at M1.4. The jet will be powered by three GE Affinity turbofans

of Hawker Beechcraft, president and chief operating officer of Gulfstream Aerospace and president of NetJets. Others include former Virgin Australia Airlines group executive John Thomas, Boeing and Dassault Aviation veteran Brian Foley, and Ray Benvenuti, a finance executive who had been chief executive of Stellex Aerostructures.

In 2020 another supersonic developer joined the fray: Virgin Galactic. In August last year, the company unveiled the design of a R-R-powered, delta-wing civil jet capable of reaching speeds of M3.0, carrying nine to 19 passengers and cruising higher than 60,000ft.

### Military transports

While the supersonic developers are eyeing the civilian aviation market, executives have said their products could be adapted for use by governments or militaries.

Indeed, a 3 March report from the US government's Congressional Research Service highlights several potential government applications for supersonic passenger jets. They could carry heads of state during times of conflict, or be used to shuttle nuclear warheads to forward bases, enabling such weapons to be stored in more-secure facilities in the USA, the report says. Supersonic jets could also be deployed on urgent humanitarian or special-operations missions, such as those involving hostage rescue or embassy defence, it adds.

The US Air Force (USAF) has shown interest. In 2020, several companies – among them Boom, Los

# “We are predicting first flight to be late spring, early summer timeframe 2022”

**Craig Nickol** Head of NASA’s Low-Boom Flight Demonstrator project

Lockheed Martin



X-59’s long, slender fuselage design should greatly soften its sonic boom

Los Angeles-based Exosonic and Atlanta-based Hermeus – won contracts to begin developing a supersonic military executive transport.

“We are showing the air force what an executive cabin can look like at 1.8 times the speed of sound,” says Norris Tie, who co-founded Exosonic several years ago with chief technical officer Tim MacDonald.

Exosonic has been working to develop a 70-seat M1.8 civil supersonic jet with 5,000nm range, for service entry in the mid-2030s. It also is tweaking that design for potential military applications.

The company’s conceptual 31-passenger military transport, developed with the USAF’s Presidential and Executive Airlift Directorate, would be outfitted with two private suites: one for three passengers, the other for eight. The jet would also have 20 business-class seats, two galleys and two lavatories, Exosonic says.

## X-59 advances

As the various companies work to bring supersonic civil jets to market, the US government has been advancing related efforts.

In January, the FAA finalised a rule intended to ease the process by which companies obtain approvals to perform civil supersonic flight tests. That followed a March 2020 proposed rule to establish noise standards – only at take-off and landing – for a new class of supersonic aircraft. The noise proposal begins the FAA’s process of again permitting overland civil supersonic flight, which it has essentially banned since 1973.

But overturning that ban requires the industry to solve the primary roadblock: disturbance caused by sonic booms. NASA is hard at work addressing that issue through development of the X-59, a jet intended to demonstrate a so-called “low-boom” design. Lockheed Martin is designing and manufacturing the X-59 at its famed Skunk Works site in Palmdale, California, and will be performing X-59 test flights.

NASA had aimed to have the X-59 airborne this year. But production shutdowns and delayed component deliveries – blame Covid-19 – forced the team to push back first flight until 2022, says Craig Nickol, head of NASA’s Low-Boom Flight Demonstrator project.

The team has overcome some relatively minor design issues that have required some rework, but has faced “no major showstoppers”, he says.

“We are predicting first flight to be late spring, early summer timeframe 2022,” says Nickol.

The team recently “closed out” manufacturing of the X-59’s wing, having installed the wing’s fuel

system and attached wing skins. Workers have also attached the jet’s empennage to its fuselage, and are “getting ready to mate the fuselage to the wing”, Nickol said in March. “Structurally, we should have what looks like an aircraft within a few weeks.”

The X-59 has features intended to significantly soften its sonic boom. It has a long, slender fuselage, and most external features are atop – not below – its fuselage.

Powered by a single 22,000lb-thrust (95kN) GE F414-100 engine, the X-59 will achieve speeds of M1.4 and cruise at 55,000ft, NASA says.

The agency has already received two F414s – one primary, one spare – and will conduct an engine “fit check” this summer, Nickol says.

The X-59’s initial “checkout flights” will be conducted from Palmdale. Next, the team will move the demonstrator to NASA’s Armstrong Flight Research Center in Edwards, California, where they will put it through a two-part flight-test programme.

The first phase of flight testing will last about nine months and involve envelope expansion and airworthiness evaluations. NASA will then take ownership of the jet from Lockheed and begin the second flight-test phase, also lasting about nine months and involving “acoustic validation” – measuring the sonic boom, Nickol says.

## Sound checks

NASA intends to deploy the X-59 between 2024 and 2026 on “community overflight testing” missions, during which it will fly the jet over the USA and survey public reaction to the noise. Regulators can use that data to write supersonic flight rules, NASA says.

NASA has hired Santa Clara, California-based Crystal Instruments to provide equipment that will measure the X-59’s boom. The system will collect “waveform and spectral data related to sonic booms and sonic thumps”, and enable NASA to “perform various specialised operations for real-time sonic-thump analysis”, NASA says. The agency will initially deploy the system at Armstrong and later in a 30nm-long “ground microphone array” near Edwards AFB.

The X-59’s design should mean that its boom, measured on the ground, will be less than 75 perceived dB – like “distant thunder”, Nickol has said. By comparison, Concorde had a boom of 105 perceived dB.

“All of our predications are currently pointing toward the fact that this aircraft should be able to meet those requirements,” Nickol says. “It looks good, and we don’t see any issues hitting that mark.”

# Aircraft Interiors | EXPO<sup>®</sup>

THE DESTINATION FOR THE CABIN INTERIORS INDUSTRY  
**ACCELERATE YOUR RECOVERY**

## Welcome to the AIX Hub

Take off with the latest industry updates and gain interior insights through articles, webinars, podcasts and more.

Find out more at:  
[aircraftinteriorsexpo.com/fg](https://aircraftinteriorsexpo.com/fg)

Co-located:

World Travel Catering<sup>®</sup>  
& Onboard Services

**EXPO**

Organised by:

 Reed Exhibitions<sup>®</sup>

The idea of eVTOL aircraft carrying passengers above crowded cities has rapidly moved from pie-in-the-sky to near-term prospect – but can public perception keep pace with the technology?

# Upwardly mobile

**Kate Sarsfield** London

Urban air mobility (UAM) has become the new frontier in aviation, driven by a desire for small, quiet and sustainable aircraft to provide mass transportation for intra-city, short-haul and regional travel.

What seemed like a pipe dream less than a decade ago looks set to become a reality, as the sector's early movers prepare their innovative, electric vertical take-off and landing (eVTOL) aircraft programmes for commercial service within the next three years.

In its recent analysis of the global UAM market, management consultancy Roland Berger forecast there would be around 160,000 eVTOL aircraft in service by 2050, generating annual revenues of \$90 billion.

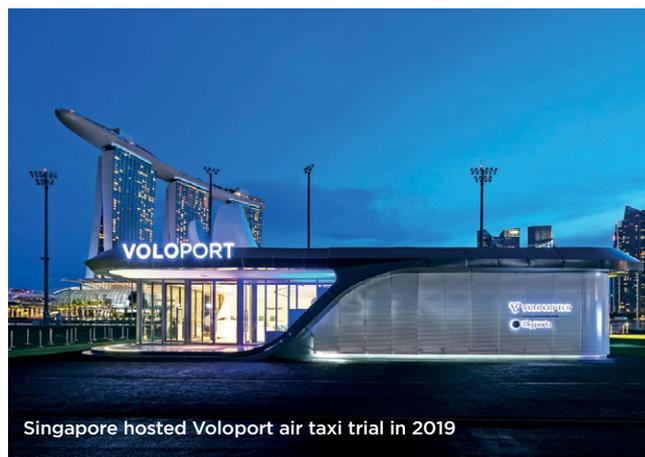
## Active programmes

"In just a few years [this sector] has gone from 'pie in the sky' concepts to a bustling industry with a multitude of passenger drones, air taxis and longer-range jets in development or undergoing trials," says Roland Berger. The report identifies around 100 active programmes in development globally, with more than half based in Europe.

"The market's flight trajectory is clearly only going one way," says Roland Berger. The consultancy attributes this bullish outlook to the strong backing from investors in UAM developers, despite the "lack of a proven business model".

"Investment in start-ups hit \$907 million in the first half of 2020 – almost 20 times the level in the whole of 2016," says the report. This interest has continued into 2021, with millions more pumped into the market.

What has become apparent in recent years, according to Duncan Walker, co-founder and chief executive of leading UAM infrastructure developer Skyports, is the shift in the type of investor. "Huge amounts of capital are flowing into the sector from blue chip, gold plated institutional investors and strategic partners [such as Uber Technologies, United Airlines, Stellantis and Baron Capital Group]."



Skyports



Volocopter

Volocopter's 2X could make commercial eVTOL flights during 2024 Paris Olympics

“Two years ago, I would have said there is no way the UAM market will become a physical reality for another decade, but my view has since changed”

**Duncan Walker** Chief executive, Skyports

He describes the willingness of these companies to invest in the fledgling UAM sector “as a good indication that they view this market as low risk, and likely to happen”.

Their backing is also a reflection, Walker adds, of a maturing industry, rising confidence in the technologies being developed, and positive regulatory developments such as the introduction in 2019 of the European Union Aviation Safety Agency’s (EASA’s) new special condition for VTOL (SC-VTOL) airworthiness regulations – the dedicated certification standard for Europe-based eVTOL aircraft.

“Two years ago, I would have said there is no way the UAM market will become a physical reality for another decade, but my view has since changed,” says

Walker. “Since then, I’ve witnessed a palpable desire among governments, regulators, technology companies, established and start-up aircraft manufacturers and infrastructure developers to work together to create this new mass transportation market.”

A key turning point for Walker came in October 2019, following the successful public demonstration in Singapore’s Marina Bay of partner Volocopter’s 2X eVTOL prototype and Skyports’ first full-scale air taxi vertiport, dubbed the Voloport.

“Public acceptance of this new form of transport has long been the primary hurdle [for UAM developers] and at this event we and Volocopter successfully demonstrated in real time the UAM market in action,” says Walker.

His view is echoed by Germany’s Volocopter, which is aiming to be first to market in Europe with the production version and fourth iteration of its two-passenger, 19nm (35km)-range, 18-motor eVTOL air taxi, known as the VoloCity.

#### Environmentally friendly

“We have notched up over 1,000h on the test fleet to date in our quest to create a safe, efficient and environmentally-friendly aircraft,” says Volocopter chief commercial officer Christian Bauer.

The Bruschal-headquartered company, one of the UAM market’s early pioneers, recently raised €200 million (\$239 million) in an oversubscribed Series D funding round, bringing the total investment to €322 million. “This has put us on track to launch



Drones are being tried in roles such as organ transport and cargo delivery

commercial services with VoloCity in 2024 following certification,” says Bauer.

He says gaining public approval of the aircraft and the UAM concept is a primary hurdle if Volocopter is to stick to this aggressive timetable. It is working well so far. As well as the public demonstration in Singapore, the company has also conducted successful public flights of test aircraft in Dubai, Helsinki, Las Vegas and Stuttgart.

In September 2019, 12,000 spectators in the German city took part in a survey led by the University of Stuttgart to gauge the public appetite for the 2X. The study revealed that nearly 70% of respondents would be likely or very likely to use the eVTOL aircraft: a result Bauer describes as “remarkably high”.

### Approval rating

A survey conducted following the demonstration a month later in Singapore of the full 2X air taxi experience delivered an approval rating of 75%. The majority of respondents at both events noted that the X2’s low noise profile “exceeded their expectations”, says Bauer.

However, feedback from both surveys reveals that there is little public appetite for autonomous eVTOL operations, which is the end goal for Volocopter and the UAM sector.

“I cannot see pilotless passenger aircraft entering service before the end of this decade at the earliest,” says Michael Cervenka, chief executive of UK start-up Vertical Aerospace, developer of the five-seat VA-X4 eVTOL aircraft.

“It’s a potentially long journey to automation, which will likely come with the rise of the new digital friendly generation,” Cervenka says.

To gain the public’s trust in pilotless aircraft, industry must demonstrate the vital role that unmanned

air vehicles – of which eVTOL types are after all only an extension – play in everyday lives, such as organ transport and cargo delivery, and illustrate the important developments in this technology. “It’s about education and reassurance,” Cervenka says.

There is also no defined regulatory path for autonomous passenger vehicles currently, he says, “so the industry’s focus for the time being must be on growing public acceptance for the piloted [eVTOL] models”.

Due to enter service in 2024, the electrically powered X4 is designed to carry a pilot and four passengers up to 104nm (192km), which Cervenka says will “open up the short-haul transport market in a compelling way”.

# 70%

Volume of respondents likely to use an eVTOL service, among those surveyed at 2019 demonstration in Stuttgart

“The X4 will be one of the safest and quietest passenger aircraft on the market, with a noise footprint 30 times lower than a helicopter in cruise and 100 times quieter than a helicopter in hover,” he says.

First flight is scheduled later this year from the company’s Bristol base, and the company plans to increase public engagement with the X4 through airborne demonstrations and marketing surveys as the programme progresses.

Such is the importance of societal acceptance to the success of UAM operations that EASA launched

a dedicated study in November 2020 designed to evaluate the public's appetite for commercial passenger eVTOL services.

Set for publication in May 2021, the study is designed, says the regulator, "to gauge EU citizens' preparedness to accept this new mode of transport and collect their possible concerns and expectations, for instance related to safety, security, privacy and environmental impact."

The study includes research work as well as a survey with the residents of six unnamed European cities, which EASA describes as a "potential target market for the future deployment of UAM". The results "will help us prepare an impact assessment and a future regulatory proposal and will also serve to raise awareness of UAM across the EU", it says.

### Commercial services

Paris is the frontrunner to host Europe's first commercial eVTOL aircraft services, with a 2024 launch timed to coincide with the Olympic Games in the French capital. In preparation for the launch, an industry consortium led by Airports de Paris (ADP), RATP Group, and Choose Paris Region, is creating what it describes as a "full UAM ecosystem around the Paris region".

Starting in June at Pontoise-Cormeilles-en-Vexin airfield, 25km northwest of the capital, some 30 participants from across the aerospace industry including Airbus, CAE, Pipistrel, Safran Electronics and Defense, Skyports and Volocopter, will begin a series of trials supported by EASA and Eurocontrol covering five key areas.

These span vehicle development, for manufacturers and equipment suppliers; urban infrastructure, targeted at energy companies and vertiport designers; operations, for suppliers of intermodal solutions, maintenance, or digital platforms; airspace integration, involving suppliers of unmanned traffic management or communication/navigation systems; and public acceptance. Led by laboratories or research

institutes, the last of these will deal with social and environmental issues.

"We expect Pontoise airfield to become a technical playground and act as a sandbox for acceptability challenges," says ADP's head of innovation and corporate venture Sebastien Couturier.

He adds that public engagement in the trials will be key to the venture's success. "The local community will be an active stakeholder in the project and will be invited to participate in live showcases, and offer their feedback," says Couturier.

**"I cannot see pilotless passenger aircraft entering service before the end of this decade at the earliest"**

**Michael Cervenka** Chief executive, Vertical Aerospace

The trials are expected to last until the end of 2023. "By that time, we should have acquired sufficient relevant information and operational data in order to launch the selected routes for the Olympic Games in 2024 and beyond," Couturier says.

"We hope the success of this venture will also provide a springboard to further expansion of UAM operations throughout Europe."

Skyports' Walker describes the UAM market as a "new form of transport for everyone, which just like airline travel, will eventually become normalised".

Everything is going in the right direction, and it will be "capital and brains that get us to the end point", he says. ▶

**See p62**



Electrically-powered VA-X4 is due to enter service in 2024

Vertical Aerospace



Vertical Aerospace

VA-X4 will carry a pilot and four passengers 100nm, but be equally suited to shorter-duration flights

## Dominic Perry London

The premise and promise of Vertical Aerospace are not unique: to deliver within the next few years a new, eco-friendly mode of air transport that will revolutionise urban mobility.

To that end, Bristol, UK-based Vertical is developing its VA-X4 electric vertical take-off and landing (eVTOL) aircraft, which is being prepared for service entry in 2024.

Featuring eight electrically powered rotors – the front four of which tilt – the winged VA-X4 can accommodate four passengers and a pilot, and is designed for journeys of up to 104nm (192km).

But Vertical is just one of hundreds of companies globally vying to do exactly the same thing.

What sets the company apart, argues chief executive Michael Cervenka, is its genesis. It was founded by energy entrepreneur Steve Fitzpatrick from the ashes of an ill-fated foray into Formula One (F1) with the Manor Racing team.

Looking to bring some of that motorsport engineering know-how into adjacent industries, Fitzpatrick settled on aerospace with the aim of disrupting sustainable aviation.

As Cervenka puts it, experience in key F1 technologies such as lightweight composites, advanced simulation and high-density powertrains are “useful ingredients for an electric aircraft developer”.

“Having those F1 roots means there are probably a number of differences between us and the competition,” he says.

Crucially, however, the “pace and agility” of F1 design and engineering has been married with “real deep aerospace experience and certification [expertise]”.

That experience is reflected in Vertical’s team, which has been drawn from the likes of Airbus, Bombardier and Rolls-Royce. In fact, Cervenka is an R-R alumnus, having most recently held the post of head of future business propositions, reporting to chief technology officer (CTO) Paul Stein.

Cervenka points out that of the combined 1,200 years of experience at Vertical, around 800 of those are in aerospace engineering. “It has started with a team that knows how to do certification,” he says.

And around 25 of its 120-strong team have an F1 background, including CTO Mike Gascoyne; a legend in motor racing circles.

### Pilots preferred

In its five-year existence, Vertical has so far flown two scaled demonstrators, the VA-X1 and -X2, which were more traditional-looking – in so much as anything is traditional-looking in this new segment – wingless multi-rotor vehicles.

But there is a significant jump in the size and promised performance of the VA-X4 versus those prototypes. And of the five people the VA-X4 is expected to accommodate, one of those will be a pilot, based on a belief that “we don’t think autonomy is viable, at least in this decade or well into the next”.

Therefore, to carry four passengers and a pilot over the distances envisaged and achieve the required economy – making the aircraft commercially viable to operate – a different architecture was required,

UK start-up Vertical Aerospace believes it has a headstart on its UAM rivals, thanks to a spirit forged on motor racing's elite grid that gives it the "pace and agility" of F1 design and engineering

# In pole position

says Cervenka, combining vertical lift with a "highly efficient wing".

With a wingspan of 15m (50ft), the VA-X4 will be sized to access around 80% of existing helipad infrastructure. Crucially, it will be a versatile machine, equally adaptable for short flights of around 15 miles (25km), "using only a small amount of battery charge", as it is for longer-range missions.

Battery charging time after such a short hop should be around 10min, says Cervenka, which is "critical for vehicle economics".

"There's no use flying 20 miles and then having the vehicle sat on the ground for 40 minutes between flights," he says.

Swapping battery packs was also ruled out, he says, owing to both practical considerations (the uncertainty of whether a landing site would have spares) and the unnecessary safety risk of having staff handle several hundred kilogrammes of cells.

While the batteries will be developed in-house, Vertical is sourcing other elements of the vehicle elsewhere: R-R on 9 March became the latest programme partner, signing on to provide the VA-X4's electric propulsion system. It follows existing suppliers Honeywell (flight-controls) and Solvay (composite technology).

This is a "different philosophy" from its rivals, Cervenka says, some of whom are developing individual systems from scratch.

## Relationships count

"Our strong view is that the best way to approach this [development] is to combine the pace and agility of a start-up with the expertise of suppliers." Essentially, Vertical has no desire to reinvent the wheel: why waste time and effort designing, say, flight controls or a powertrain, when there are companies out there for whom such things are their bread and butter?

Those supplier relationships "really enable us to leapfrog some of our competitors", he argues.

But with an aggressive timetable to stick to and the R-R agreement only recently minted, the planned first flight this year will be without the "highly integrated" powertrain of the final version.

"To build a prototype in this timeframe requires some compromises," says Cervenka. It will still be



Vertical was spun out of experience with Manor Racing Formula One team

Z Ryzner/Shutterstock

VA-X2 prototype was a 'conventional' wingless multi-rotor vehicle

It is a vehicle that is “very close to certifiable”, but without the “optimised performance” of the eventual propulsion system.

Meanwhile, talks are under way with “some major players” – airlines included – to secure launch orders. “We are in discussions. We are seeing a lot of interest,” says Cervenka.

While not ruling out Vertical operating some aircraft itself, he points out that is not the company’s area of expertise and that there would be a “huge cash impact” from creating such a service.

Profitability should come in the “2024-2025 timeframe”, says Cervenka, which will be in part dictated by the number of customer deposits it takes. At the moment, however, with development ongoing and no revenue coming in, Vertical is a loss-making business: in the year ended 31 December 2019 – the most recent period for which accounts are available – it made a pre-tax loss of £8.1 million (\$11.2 million).

During that 12 months it continued to be bankrolled by parent company Imagination Industries (which itself registered a pre-tax loss of £114 million during 2019), including an interest-bearing loan of £11 million.

Cervenka says that owner Fitzpatrick’s support has given Vertical “an incredible leg up”, but that “it doesn’t make sense to go all the way to certification funded by a private individual”.

**Quick start**

As such, an exploration of external funding opportunities is “progressing”, although he thinks that Fitzpatrick will “remain majority shareholder for a long period of time”.

Of course, when you are eyeing a market for possibly tens of thousands of aircraft, losses now pale into insignificance against the potential rewards

if you can be first to market. Cervenka expects that Vertical will “have produced several thousand [VA-X4s] within the first few years” after “quite a quick” ramp-up. “There is clearly an easy market demand for tens of thousands [of eVTOL aircraft] in relatively short order,” he says.

The location of its main production site has still to be decided, however. “Our strong view is that we would like it to be in the UK, at least the initial assembly line; it’s a really great place to build a future electric aircraft company.”

But that partly depends on what level of government support can be obtained, he adds. Initial certification will be sought from the UK’s Civil Aviation Authority, to be followed by European approval.

As previously noted, Vertical is in a crowded market, but Cervenka says there is already a “narrowing” of the field taking place “into the more credible players”. That said, given that there are probably half a dozen serious rivals who are likely to have vehicles



Vertical Aerospace

on the market in the same timeframe, it is vital that Vertical hits its certification and service entry targets.

“We are as confident as anyone can be in this game,” says Cervenka. “Compared with a year ago, we have a really good basis for certification requirements [from the regulators].”

While he concedes “the programme is aggressive” – and, this being aerospace, there is always the potential for unforeseen hiccups along the way – he is confident in the design, as “we have been looking at winged vehicles for quite a period of time.”

Equally, any timeline slippage is likely to be modest: “We aren’t talking about missing it by years if we do miss it. We have an opportunity to gain first-mover advantage: that’s measured in years, not in months. A slight slip will not materially matter in terms of investor risk or market capture opportunity,” he says.

“There is clearly an easy market demand for tens of thousands [of eVTOL aircraft] in short order”

**Michael Cervenka** Chief executive, Vertical Aerospace

Despite his having spent a goodly part of his career at R-R, Cervenka has not been thrown by joining a fast-paced aerospace start-up into which the complicating factor of an F1 attitude has been added.

“When you bring different cultures and organisations together there are always challenges, but we are really motivated to be successful,” he says, adding that this has led to a “collaborative” mindset taking root.

Besides, with his latter years at R-R spent looking at cutting-edge and disruptive technologies, Cervenka had great preparation for his current role.

“The difference is clearly that we are able to move very fast because we don’t have the legacy,” he says.

While he means that there is an absence of bureaucracy or a set way of doing things, Vertical also lacks legacy in another sense: it has no heritage, history or reputation. That “creates some challenges”, he says, noting that half the battle is “creating credibility”.

Still, in such a fledgling segment, credibility is only likely to be achieved a few years down the road. In the meantime, F1-influenced Vertical is hoping that it can secure pole position. ■



Vertical Aerospace

Signature Flight Support has seen customer demand that is 'off the charts'



# Sustainable strategy

The business aviation sector is embracing alternative aviation fuels as it seeks to meet rising customer demand and play its part in reducing the industry's greenhouse gas emissions



NetJets has seen interest from customers in environmental issues take off since 2019

#### Mark Pilling London

Hopefully, at some point during their career, people in the sales world are lucky enough to feel the buzz of selling a product that literally flies off the shelf.

Tony Lefebvre is incredulous that the product in question is boring old aviation fuel. “We have seen uptake of customer demand that is off the charts,” says the chief operating officer of Signature Flight Support, one of the world’s leading fixed-base operators (FBOs), with a network of 200 locations.

However, the product is not simply regular Jet A-1 fuel, but sustainable aviation fuel (SAF), bought by Signature, supplied by Finnish SAF manufacturer Neste and delivered to launch customer and operator NetJets at San Francisco International airport. This landmark deal, announced in September 2020, is one of many in recent months that demonstrate a significant ramp-up in commitments by the private and business aviation community to sustainability action.

Signature had been thinking about establishing the industry’s first permanent supply of SAF for private aviation for some time, but availability was restricted, and customers were interested but not always convinced, explains Lefebvre. The pandemic helped change that. Commercial airlines have not needed as much SAF because their networks are moribund, giving others a chance to step in.

“We said to ourselves, let’s flip an entire airport,” says Lefebvre. That airport is San Francisco. Signature began fuelling NetJets aircraft with a blend level of 35% SAF to 65% regular Jet A-1 last December. It

has committed to buying 1.3 million litres (5 million USgal) of SAF from Neste, and by the end of March, all customers taking fuel from Signature at the airport have been receiving the SAF/Jet A-1 combination.

#### Growing concern

NetJets has bought 792,000 litres of Signature’s SAF supply for the San Francisco hub, explains Pat Gallagher, its head of sales, marketing and services. Before the onset of the pandemic, NetJets, one of the world’s largest private jet operators, had been receiving “a great number of enquiries about what we were doing from a sustainability standpoint”, he says.

In 2019, this topic had overtaken faster wi-fi on board aircraft as the most pressing issue, but as the pandemic took hold, it took a back seat for a few months. Now, environmental concerns have returned in a big way, with customer interest ranging from high net-worth individuals to Fortune 500 companies seeking an overview of NetJets’ sustainability strategy to ensure they can satisfy their environmental, social and governance targets, says Gallagher.

NetJets took another step forward on its commitment to SAF at the start of this year, building on its

# 20%

Stake acquired by NetJets in WasteFuel SAF production start-up in January 2020

deal with Signature. “Rather than just procure SAF, we wanted to be far more strategic than that and invest in its production,” says Gallagher.

In January, the fractional aircraft ownership company announced that it was taking a 20% stake in WasteFuel, a US-based start-up planning to build a network of SAF production plants worldwide, with the first coming on stream in the Philippines in 2025. “As the world’s largest private aviation buyer of fuel, we can do this, we can lean in with our scale and our financial ability to invest,” explains Gallagher.

NetJets has made a commitment to buy a minimum of 26.4 million litres of WasteFuel’s SAF over the next decade.

One of the arguments against SAF has been its cost premium over Jet A-1. At the headline level, this is often said to be three to five times the cost of conventional aviation fuel. But at a blend of 35% SAF, customers will only see a relatively small difference in price because of the relatively modest proportion used, says Gallagher. And depending on where the SAF is taken, there may be a tax credit to offset this premium, as there is, for example, in California.

And as more SAF becomes available, the price will come down. “The price point with WasteFuel by 2025 will be negligible,” believes Gallagher. By then, the blend of SAF is likely to have risen, as engine manufacturers such as Rolls-Royce are already successfully conducting tests with 100% SAF.

### Top priority

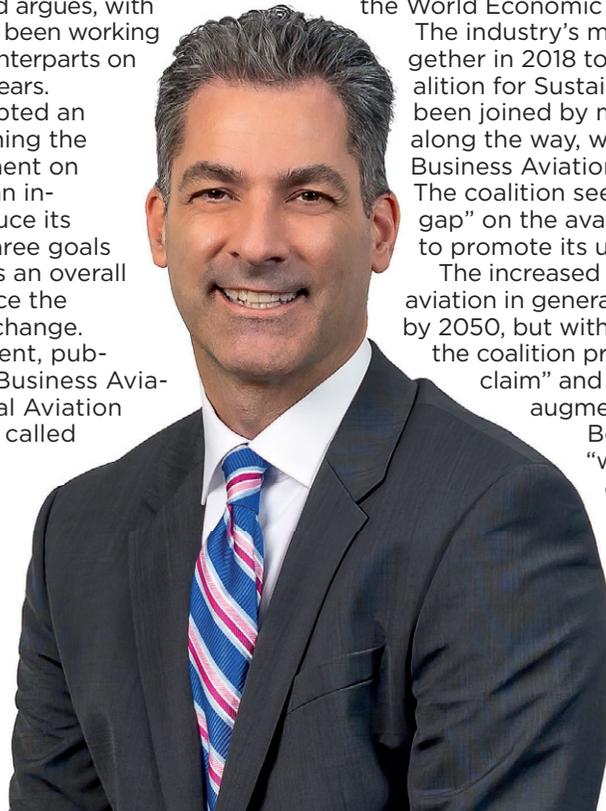
The importance of sustainable alternatives is clear for an industry that relies so heavily on fossil fuel. Aviation is working hard and fast on electric, hybrid and hydrogen propulsion as alternatives, but conventionally powered turbofan and turboprop aircraft will be around for decades to come.

The business aviation world argues, with some justification, that it has been working as diligently as its airline counterparts on sustainability strategies for years.

In 2009, the industry adopted an independent stance, publishing the Business Aviation Commitment on Climate Change (BACCC), an industry-wide promise to reduce its environmental impact via three goals and four key mechanisms as an overall basket of measures to reduce the sector’s impact on climate change.

At its core, this commitment, published by the International Business Aviation Council and the General Aviation Manufacturers Association, called for carbon-neutral growth from 2020 (updated in the 2015 review of the commitment) and an absolute reduction of 50% of carbon dioxide (CO<sub>2</sub>) emissions by 2050 relative to 2005. These players are currently reviewing this commitment to see if it

Signature spied an opportunity during pandemic, says Lefebvre



remains relevant and powerful enough with a decade having passed since it was originally written.

There is pressure from all sides, especially large corporations, to do more. The business aviation sector is all too aware that it must step up on sustainability, recognising that despite the good medical and humanitarian work it does, the perception of it being accessible mainly to the rich is a challenge.

In the past couple of years, there has been a refreshing change of pace from this community. “The real game-changer is that the flight departments of the FBOs and the fuel suppliers are getting clear customer demand,” says Steve Csonka, executive director at the Commercial Aviation Alternative Fuels Initiative (CAAFI).

There have been several initiatives such as SAF being available for aircraft flying to shows such as EBACE in Geneva and NBAA in the USA to

“The real game-changer is that the flight departments of the FBOs and the fuel suppliers are getting clear customer demand”

Steve Csonka Executive director,  
Commercial Aviation Alternative Fuels Initiative

demonstrate its availability and efficacy. Another high-profile public relations exercise involved providing SAF to fuel private aircraft leaving Zurich after the World Economic Forum in January 2020.

The industry’s main associations banded together in 2018 to form the Business Aviation Coalition for Sustainable Aviation Fuel. They have been joined by many industry stakeholders along the way, with CAAFI and the Canadian Business Aviation Association joining in 2020. The coalition seeks to address a “knowledge gap” on the availability and safety of SAF and to promote its use among all stakeholders.

The increased use of SAF is seen as vital for aviation in general to achieve the BACCC goals by 2050, but with limited availability right now, the coalition promotes so-called “book-and-claim” and carbon offset programmes to augment or stand in for its use.

Book-and-claim is a programme “where business jet operators can purchase SAF at an airport where it is unavailable, and receive credit for its supply and use at an airport where it is available”, explains the coalition’s Fuelling the Future guide to SAF.

The principle is important, explains Csonka, as many operators will not be able to buy SAF directly, either because they do not have the

buying power, or because it simply is not available at the airports they operate from.

Aviation's main associations are close to announcing the creation of a standard that will help establish an industry-wide, accountable, and transparent global book-and-claim system.

SkyNRG has had an in-house book-and-claim system called Board Now since 2019, allowing firms such as PwC to reduce their business travel emissions, says Stephen Wetmore, head of business development at the Dutch SAF developer. "We have demonstrated that it works, and it is accepted by the carbon credit bodies," he says.

This book-and-claim standard is an important step for the entire aviation industry, enabling users to gain the carbon reduction credit for the SAF they buy, whether it is used to fuel their aircraft or one taking SAF at any airport anywhere in the world.

### Stop-gap measures

Book-and-claim will be limited by the amount of SAF being produced, but will increase in popularity as SAF plants come on stream in the coming years.

In the meantime, many operators are buying carbon offsets. These enable users to compensate for a proportion of an aircraft's carbon emissions by investing in carbon-reduction projects that have lower emissions, according to Fuelling the Future.

Operators such as Flexjet, NetJets and VistaJet all offer offset products to customers. Other stakeholders are coming in. Recognising that many players may find it challenging to navigate the offset world, Boston-based 4AIR has developed a rating system. In January it was the first to buy carbon offset credits on IATA's Aviation Carbon Exchange for charter firm PrivateFly.

For the next couple of years, all players will need to get up to speed quickly with the new and complex world of sustainability. This includes the associations that represent the industry.

With the arrival of larger business jets such as the Bombardier Global 7500 and Gulfstream G650, which are becoming comparable to the take-off weights and missions of airliners, the business aviation sector felt it was increasingly important for its own voice to be heard in policy-making circles.

Lobbying is focused on the largest business aviation markets of the USA and Europe for now. And this activity is stepping up, even though business flying is minuscule compared with global airline operations, representing only 0.04% of global CO2 output.

In the USA, the arrival of the new Biden-Harris administration, with an agenda more focused on the environment than the previous one, is encouraging the industry. Several business aviation players were among an array of 49 stakeholders who in April wrote to Pete Buttigieg, US Secretary of Transportation, urging "the Biden-Harris administration to support the inclusion of a SAF-specific blender's tax credit in the American Jobs Plan as you work with Congress to address infrastructure and the climate challenge".

The proposal is a credit of up to \$2 per USgal, which would make a difference and would be a starting point in helping to make SAF more affordable, says Stewart D'Leon, director, technical operations at the NBAA. "We believe a blender's tax credit will

"I still see a large number of operators and people on the legislative side with some very basic questions about SAF"

Stewart D'Leon Director, technical operations, National Business Aviation Association

Gulfstream has been using blends of alternative fuels and Jet A-1 since 2011



Gulfstream



NetJets has prioritised investing in SAF production capacity, says sales and marketing head Pat Gallagher

# 50%

**Business Aviation Commitment on Climate Change emissions reduction target by 2050, from 2005 levels**

May. The European Business Aviation Association supports the initiative, but stresses that any rules or mandate stipulating that a percentage of SAF to be used “has to be scaled up as time goes on”, says Bruce Parry, its senior environment manager.

It is possible the rule might demand SAF usage at a minimal level starting in 2025, rising to a low single-digit figure by 2030 as more of the fuel becomes available. “What we don’t want is a mandate that creates an issue because there is not enough fuel to satisfy it,” explains Parry.

### Providing answers

Talk of mandates, tax credits and book-and-claim may baffle those just getting their head around SAF itself. “A really important part of this is education,” says D’Leon. “I still see a large number of operators and people on the legislative side with some very basic questions about SAF.” The industry coalition is seeking to answer these questions.

Signature, meanwhile, is very much operating in the here and now. In addition to San Francisco, it has made SAF available at London Luton airport in the UK and Mobile Downtown, Van Nuys, and Boeing Field in the USA. “We will be live with actual [SAF] product across the whole network by the end of 2021,” says Lefebvre.

Whether via actual pumped SAF, or via book-and-claim, business aviation is taking SAF and sustainability seriously. For D’Leon, the message is simple: “SAF works, it’s here and it’s now.”

allow us to accelerate the widespread production and use of SAF. It is something we need to put the entire nation on an even playing field,” he says.

In the USA, the lobbying effort is to support the tax credit, whereas across the Atlantic, the European Commission’s focus is on compelling operators to embrace SAF-using mandates. The first approach offers a carrot, the second is more stick.

The Commission is expected to publish its proposed legislation, called ReFuelEU Aviation, to boost the supply and demand for SAF in the EU, in

## Bringing SAF use into the mainstream

There is a group of sustainable aviation fuel (SAF) “geeks” that have lived and breathed the rise of this fuel from an oddity over a decade ago to the mainstream carbon reduction instrument it has become today.

Bodies such as the Commercial Aviation Alternative Fuels Initiative, and manufacturers Bombardier, Dassault and Gulfstream, among others, have been intimately involved in SAF since the mid-2000s.

Gulfstream’s SAF story dates to 2011 when, at the behest of Honeywell, it supported a G450 transatlantic flight to that year’s Paris air show, recalls Charles Etter, staff scientist/technical fellow responsible for environmental and regulatory affairs at the Savannah, Georgia-based firm.

One of the G450’s Rolls-Royce Tay 611-8C engines was operated with a 50:50 blend of World Energy’s SAF and Jet A-1, while the other was 100% Jet A-1. The experiment generated widespread publicity for all involved and prompted potential investors to contact World Energy.

Gulfstream began searching for a regular SAF provider and signed an offtake deal with World Energy (then called AltAir) in 2015. Fuel began arriving a year later and the airframer has used it ever since for demonstration flights and at air shows with a 30:70 SAF/Jet A-1 blend. “Some customers also insist their new aircraft are delivered with SAF,” says Etter.

The initiative went a step further on 14 February 2020, when the G700 ultra-long-range business jet took its first flight with SAF, he says.

Aircraft manufacturers are making further strides on sustainability. Bombardier says the development plan for its clean-sheet Global 7500 involved obtaining business aviation’s first environmental product declaration.

“This unique achievement means that Bombardier is providing a comprehensive view and public disclosure of the Global 7500’s environmental footprint throughout the aircraft’s life cycle stages from the cradle to the grave,” says the airframer.

Learjet epitomised style, speed and sexiness for celebrities and corporate high-fliers from the 1960s on. After Bombardier's decision to end production, we look at the brand's six-decade legacy

# King Lear's long reign

Murdo Morrison London

The early to mid-1960s were arguably aerospace's most creative age, outside wartime. From the first manned space missions to the genesis of vertical take-off fighters, supersonic transports, and jumbo jets, engineers were dreaming big. The period also saw the birth of the business jet, an invention that fused glamour, security, and time machine for those Tom Wolfe would term the Masters of the Universe in booming corporate America.

Bill Lear's Learjet 23 was the only US contender among a trio of types - with France's Dassault Falcon 20 and the UK's Hawker Siddeley HS125 - that over a few months between 1962 and 1963 took to the skies to usher an era of fast, comfortable and private transport for those companies and individuals who could afford them. Of all the brands that emerged at the time, Learjet, along with Gulfstream, has perhaps endured longest in the public consciousness and become synonymous with the sector.

## Competitive segment

But in February, Bombardier - owner of the Wichita, Kansas-based airframer since 1990 - announced that Learjet production will cease by the end of the year, blaming slow sales in a highly competitive segment.

Although the Canadian company delivered the 3,000th Learjet in 2017, and more than 2,000 examples remain in service according to Cirium fleets data, annual deliveries of the current 70/75 models have been well below 20 annually for some time.

Bombardier's wider problems have not helped. Weighed down by debts from the ill-fated CSeries development, the company has been offloading

assets and slashing costs to stay afloat. It could little afford to keep a subsidiary that was struggling to make a profit. There have been missteps too specifically with the Learjet brand. Since the scrapping in 2015 of the Learjet 85 - an attempt to bridge the midsize to super-midsize segments - there has been little money available for product development.

Today, the Learjet name may command recognition among those who have a casual knowledge about aviation, but it is no longer pre-eminent, being just one of five brands competing in the broad light jet segment - including several new players that have emerged this century.

However, in the 1960s and early 1970s it would have been difficult to overstate the sheer star appeal of the fast and stylish Learjet 23. Frank Sinatra was one



How Flight International reported on the Learjet 23 in December 1963



Bombardier

Learjet 23 first flew in October 1963



The Learjet 75 is the final variant in production

of its first customers, and for years it was the favoured mode of transport for Hollywood celebrities.

Born in Hannibal, Missouri in 1902, Bill Lear failed at high school but became a serial entrepreneur and inventor, making money during the Second World War. In 1960, he started working with Swiss-based engineer Dr Hans-Luzius Studer on a business jet version of Studer's FFA P-16, a supersonic fighter that never entered service. Abandoning plans for a Swiss factory, in 1963 he set up in Wichita, home of Cessna and Beechcraft. The Learjet 23 flew in October that year.

Two months later, *Flight International* approved of the "sleek compactness" of the six- to eight-seat twin-jet in a piece headlined "Car comfort, fighter speed", noting that what it lacked in cabin space compared with other fledgling business aircraft it made up for in

# 1,600nm

Range of the General Electric CJ610-1 powered Learjet 23, the first aircraft to be built by the Learjet Corporation

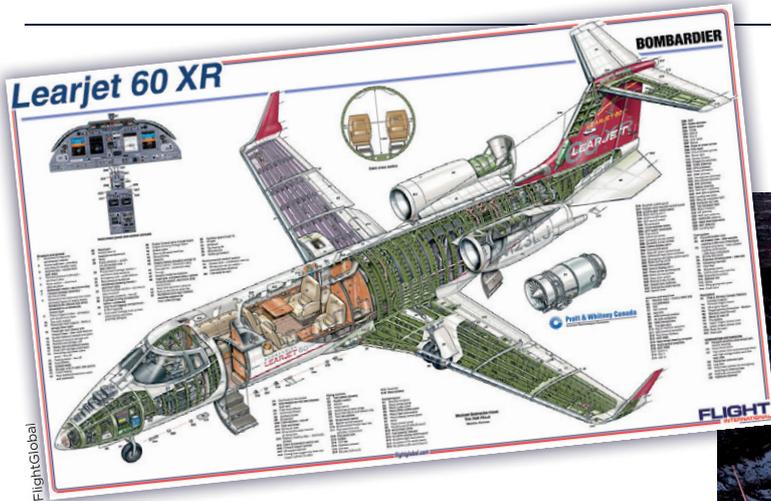
pace. The General Electric CJ610-1-powered type featured swept wings and integral wing and tip tanks that gave it a 1,600nm (2,960km) range. We reported that Lear planned to build 10 Learjet 23s a month by 1964.

In 1967, the Gates Rubber Company acquired a majority stake in the company, although Lear, by now approaching 70, remained on its board until 1969. By the time of the first flight in 1971 of the Garrett FTE731-2-powered Model 25 - later the Learjet 35 - the firm had become Gates Learjet.

In 1975, the Learjet Corporation delivered its 500th aircraft, going on later that decade to launch the Learjet 28 (a re-winged version of the Learjet 25), and the midsize Model 54/55/56 prototype.

### Space Shuttle

The 1980s witnessed a move into producing parts for the Space Shuttle programme, a short-lived relocation to Tucson, Arizona, and a further acquisition that saw the company revert to the name Learjet Corporation, although its new parent soon filed for bankruptcy. In 1990, Learjet was scooped up by the fast-expanding Canadian combine Bombardier, which had recently bought Canadian and Northern Ireland's Shorts, and would later add de Havilland.



Flight International reported in July that year that Learjet would be an autonomous subsidiary of Bombardier, with its management team in place, although the Canadian outfit planned to establish a new flight-test centre for its products at the Wichita site. Bombardier chairman Laurent Beaudoin said production of Learjet's then current models – the 31, 35A and 36A light jets, together with the larger 55C – would continue as “niche” products within the wider Bombardier range.

### Huge ambition

During the 1990s, the Learjet 60 (an evolution of the Learjet 55) and all-new Learjet 45 flew for the first time. Around the time it was preparing to launch the CSeries, a bullish Bombardier also announced in 2007 the all-composite Learjet 85, a hugely ambitious project that involved outsourcing specialist fuselage production to Grob in Germany.

But the complexity of developing the Learjet 85, together with Bombardier's growing cash crisis, saw the programme cancelled in 2015.

Despite attempts to reinvigorate what had become a one-aircraft range with the launch of a Learjet 75 Liberty variant in 2019, the move to end production has surprised few industry watchers. “There have been tell-tale signs leading to this decision for years,” says Brian Foley of consultancy Brian Foley Associates.



Bombardier has announced an upgrade programme for variants such as the 40XR



The Learjet 31A was one of several successful types launched by the Wichita-based airframer

## The lost brands of business aviation remembered

These are some of the families or types that pioneered new segments or were highly successful in their own right, but are no longer being produced:

### Lockheed JetStar

While Lockheed Martin remains one of the biggest names in aerospace and defence, Lockheed's days as a business aviation badge are long over. The Lockheed JetStar was in production from the early 1960s until the late 1970s and some maintain the four-engine, 10-passenger type was the first true business jet. Elvis Presley and Frank Sinatra were among celebrity JetStar owners.

### Hawker

Hawker Siddeley was behind another 1960s-era business jet – the HS125 – which evolved into the Hawker 1000 under Raytheon ownership in the 1990s. The Hawker family – the 400XP and the super-midsize Hawker 4000 – continued to be produced until shortly before Hawker Beechcraft went into Chapter 11 bankruptcy protection in 2012. Textron Aviation then acquired the Hawker and Beechcraft brands in 2014, but Hawker production was never restarted.

### Grob SPn

Grob continues as a manufacturer of trainer aircraft, but the

Bavarian company briefly dipped its toes into business aviation under then-owner South African entrepreneur Niall Olver. The all-composite Grob SPn, unveiled and flown in 2005, was one of a flurry of light and very-light jets to hit the market in the mid-2000s. As with many of its contemporaries, the programme was cancelled in 2008 when Grob fell into insolvency. Four prototypes were built, but none entered service.

### Adam

Another start-up from the noughties that failed to survive the financial crisis, Colorado-based Adam Aircraft's range comprised the A500 piston twin



The all-composite Learjet 85 was an ambitious attempt to broaden the range in the 2000s, but was a costly failure

Bombardier

“There have been no real enhancements to the Learjet line since 2013, when the Learjet 40XR and 45XR were tweaked to make the Learjet 70 and 75.”

Daniel Hall, a senior valuations consultant with Ascend by Cirium, notes that values for the Learjet

“The Learjet remains one of the most iconic business aircraft ever. We have enjoyed many successful years with it”

Siegfried Axtmann Chairman, FAI

70 and 75 have “continued to rapidly depreciate” during the pandemic, although he says that values for the older Learjet 45 and 60 families have “performed quite well”. When it announced it was ending production, Bombardier also said it was launching an upgrade programme for Learjet 40/45s, including new avionics, cabin improvements and updated in-flight connectivity.

Even loyal Learjet customers have accepted the inevitability of the decision. Siegfried Axtmann, chairman of German air ambulance specialist FAI, one of the biggest Learjet operators in Europe with a fleet of 12 Learjet 60s, describes the move as “regrettable but understandable”, and on the cards since the cancellation of the Learjet 85 programme. However, he adds: “The Learjet remains one of the most iconic business aircraft ever. We have enjoyed many successful years with it.” ▶



Lockheed's JetStar was produced from the 1960s

James Mellon/FlightGlobal

and the A700 very-light jet. Seven A500s – based on an original design by Burt Rutan – entered service, but the A700 never made it to production.

#### Eclipse

If founder Vern Raburn's vision had come true, the skies would be full of Eclipse 500s and their successors by now. The former

Silicon Valley executive planned to mass produce the original very-light jet in the early 2000s, offering them to early adopters for just \$2 million a time. But it was not to be. Eclipse Aviation failed in 2008, and, although the Eclipse name has survived under successive companies, Raburn's dream of a brand that would disrupt the world of general aviation came to nothing.

#### Sabreliner

The North American and later Rockwell Sabreliner was a midsize jet developed for both military and business use in the late 1950s. After a number of civilian models were made, from the Series 40 to the Series 80A, production was halted in 1981.

## Ode deer!

Lines on the occasion of the safe arrival of four reindeer from Moscow Zoo to Frankfurt after a flight on a Boeing 747-400F, operated by AirBridgeCargo:

*'Twas the month before Easter, no word of a lie,  
When a group of four reindeer crossed over the sky  
But nothing to do with the usual chap  
Or post-Christmas problems with reading the map  
Or gifts being carried from nation to nation  
No shiny red noses to aid navigation  
They weren't doing circuits for currency training  
And all of them flew with no hint of complaining  
Their level of comfort turned up to eleven  
Locked up on the deck of a 747  
From Russia with love (and a captain and crew)  
They caribou-classed it to Wuppertal Zoo  
We weren't there in person; this bit might be doubted  
Our sources have sworn that the loadmaster shouted:  
"Come Yuri! Come Lenin! Come Vodka and Tonic!  
"We trust you've enjoyed your time cruising subsonic.  
"Unfasten your seat-belts, it's time to deplane.  
"We hope that you'll choose to fly AirBridge again."  
Our story ends there but the message is clear.  
You know who to call if you're short of some deer.  
But don't write in complaining we aren't quite  
Tennyson.  
What did he know about airlifting venison?*



It'll be warmer at Wuppertal

Northrop Grumman



Retirement on the radar

## Royal flush

UK air navigation service provider NATS issued a briefing sheet on 12 March advising that air restrictions were being put in place for a week for an upcoming visit by Queen Elizabeth to the Firth of Clyde.

For security reasons, it said, no flights would be allowed below 6,000ft or within 3nm - with exceptions for certain aircraft including those in the service of local law enforcement agency Police Scotland.

Police Scotland proceeded to announce on social media that this restriction would be in place for the duration of Queen Elizabeth's visit to Glen Mallan, only to receive an indignant reply from someone irritated that the monarch had the freedom to swan around Loch Long while a pandemic lockdown was in effect, and who added: "Can I visit Aberdeen or Cheltenham?"

Which might have been a more withering barb had the *Queen Elizabeth* in question been the current head of state and not, as it turned out, the Royal Navy aircraft carrier.

### From the archive

## 100 1921 Fifteen minutes to go

Generally speaking the air services between London and Paris are very managed, but there are one or two minor points that call for friendly criticism. The main advantage of an air service - one might say its *raison d'être* - is speed. That being so, it is distinctly annoying for a busy man who had expected to leave Croydon at 12 o'clock to be kept waiting for, as far as he can see, no apparent reason whatever. The man who gets to the aerodrome a quarter of an hour before the machine is leaving, gets through customs, takes his seat and makes his journey to scheduled time, will retain an impression of reliability and punctuality which will encourage him to use the service again. If he is kept waiting for close on an hour before a start is made, he will go by train and boat next time.

## 75 1946 Atmosphere of luxury

On Wednesday, May 1st, we had the unique experience of flying at 25,000ft sitting in a beautifully upholstered armchair, smoking a cigarette and chatting comfortably with our fellow passengers. The cabin temperature was kept pretty constant in the region of 75 deg F, and from the lack of noise and luxury of travel, we might all have been sitting in a superbly appointed special train - apart from the utter absence of apparent motion. In point of fact, we were flying in the first production Avro Tudor I. The average person needs oxygen at altitudes in excess of 15,000ft. Yet here we were, nearly five miles up and with an outside temperature of -24 deg F being carried through the sky at 300 m.p.h. in the most luxurious form of transport man has yet devised.



## EuroHawk's rest

Along with the new Berlin airport – massively over budget and delayed nine years, only to open in the midst of the pandemic – the EuroHawk is one of Germany's aviation white elephants.

The centerpiece of a bid by the Bundeswehr to establish its own signals intelligence capability, the programme – based on the Northrop Grumman RQ-4 Global Hawk high-altitude, long-endurance unmanned air vehicle – collapsed in 2013, ruffling many political feathers as it did so. In the end, just one demonstrator was built.

Despite talk about restarting the project over the years, the prototype has been formally retired, and will see out its days in the military history museum at Berlin-Gatow.

## Air showbiz

With no income from what would have been the 2020 air show – or any other event for the past 12 months, for that matter – Farnborough International is going into the movie business.

The company has applied for planning permission for two sound stages on its site, behind the permanent Hall 1. Film-makers will also be able to use hospitality chalets for offices, and erect temporary stages and workshops, under the proposal.

Although few movies have been shot during the pandemic – due to social distancing complications and no cinemas to release them in – the UK remains an attractive location for producers thanks to country's sizeable creative industries. However, studio capacity around London is limited.

Although the application covers the period until August 2024, presumably the likes of Tom Cruise and Steven Spielberg will have to work around the next two air shows.

## Love is in TindAIR

Yuckspeak acronyms #1,324: TindAIR, which “stands” for Tactical INstrumental Deonfliction And In-flight Resolution (yes, these capitals are in the right place).

The European project is intended to find a way to keep unmanned air vehicles apart in urban settings. So best not confuse it with the popular dating app of nearly the same name, designed to bring users into the closest possible proximity.

## Taking the Michael

Michael O'Leary's wicked barbs at politicians, airport authorities, and feather-bedded competitors are always the highlight of a Ryanair press conference. The outspoken Irishman did not disappoint at the carrier's recent financial results, likening Lufthansa to a “drunken uncle at a wedding hoovering up state subsidies”.

## 50 1971 Boom time for Beirut? 25 1996 AST flies into the past

If the extra cost of operating Concorde can be kept to no more than 50 per cent, and full use can be made of its speed, Middle East Airlines will buy it. This statement was made by the airline's general manager, Asad Nasr, on May 13. About 65 per cent of passengers flying by MEA are businessmen, and Mr Nasr estimates that by the mid-seventies, when Concorde comes into service, the airline could justify a daily supersonic flight on its key route between London and Beirut. This assumes that Concorde can cruise at Mach 2, thus cutting two hours off the flying time from Beirut to London, and depends on permission being granted to fly supersonically over part of France. If not, MEA does not believe Concorde would make commercial sense on the routes between Europe and the Middle East.

The UK's oldest flying training school has become the first victim of a Government policy loophole enabling UK pilots to gain UK commercial pilot's licences in foreign training establishments. The 60-year-old Air Services Training (AST) at Perth, Scotland, announced on 26 April that its pilot-training section will be wound up by October 1996. Schools in the USA and Australia started training pilots for UK commercial licences in 1995, offering cheaper courses and better flying weather than their British counterparts. AST marketing manager David McKinnon says that overseas training was “a very important factor” in the decision, and that UK policy had “...added insult to injury by allowing national vocational qualification tax relief to be claimed by trainees while they are overseas”.



Ceri Breeze/Shutterstock

Booking system mix-up caused TUI crew to miscalculate passenger load by 1.2t

## Weighty matter

With reference to the story 'TUI 737 weight incident traced to 'Miss' interpretation of female passengers' (FlightGlobal.com, 8 April 2021), there have been many incidents and accidents where the weight of the aircraft has been erroneously entered into the flight management system.

This risky procedure involves approximating the weight of the passengers, their luggage, the fuel and any cargo, and matching it to the length of the runway and air density, which additionally varies with temperature and altitude.

To add to the above, the thrust of the engines may vary also with temperature, altitude, fuel quality and mechanical conditions.

A simple solution to this problem, which eliminates all these uncertainties, would be to calculate the precise thrust needed for safe lift-off based on the acceleration the aircraft has seconds after spool-up and brake release.

Relatively modern aircraft already have the accelerometers and computational capacity to do this, and for older aircraft, it could even be calculated with an iPhone.

**Rodolfo Serna**  
Bogota, Colombia

## Bad blood

Reading the article 'Ratcheting up', about the ongoing Airbus/ Boeing World Trade Organization dispute (*Flight International*, February 2021), I was reminded of a letter I submitted in September 2015, regarding a suggestion that Boeing had once been promised that it would be the only airframe manufacturer for civil aircraft in the western world.

I believe there is a quiet rage that Boeing not only has a

competitor now, but one that is even assembling some of its aircraft within the USA.

It is worth remembering that the UK gave up airframe manufacturing suddenly – especially with the Vickers VC10 and BAC 1-11 – which effectively ended real competition at that time.

Boeing has not been itself for a long time, even though it is the only US airliner manufacturer; hence the serious spat with Airbus.

**W D Barbut**  
London, UK



Tad Denson/Airbus

Built in the USA



The UK's developmental Nimrod AEW3 programme was cancelled in 1986

## Nott again...

Regarding your coverage of the UK's recent defence review (*Flight International*, April 2021): it is smoke and mirrors regarding the airborne early warning (AEW) gap between this year's retirement of its Boeing E-3Ds and the later introduction of just three E-7A Wedgetails.

We are stepping back to the days of [defence secretary] John Nott, when he cut the Royal Air Force's (RAF's) Shackleton fleet from 12 to six, and then, when the replacement Nimrod AEW3 was cancelled, we were left with five antique aircraft to help defend the UK.

One of the points of having AEW is to cover for gaps in ground sensor coverage – not the other way around.

Much as I'm sure those at the RAF's 1 Air Control Centre will love the opportunity to pack their tents and deploy, there are many places they won't be able to go, so we need AEW.

And on the UK's future investment plans: how can reconnaissance satellites track airborne objects?

Ian McClellan  
via Twitter

## Under pressure

In your article 'Engines stay core for NASA' (*Flight International*, April 2021), it says the stated aim is 'increasing an engine's bypass ratio to 15% – up from around 12% today – and its pressure ratio to about 50%'.

Call me dull, but what on earth does that mean?

A ratio is normally expressed in the form of 1:8, for example – I have never seen it expressed as a percentage. A further explanation would be helpful.

Paul Burch  
Farnham, Surrey, UK

**Editor's reply:** We may require some boffin assistance here; NASA's own "kid's" web pages about propulsion swiftly go the beyond normal-level comprehension that engines "suck, squeeze, bang and blow". Calculators at the ready...

## Small print

Your 'Best of the rest' section frequently uses a green font against a purple background to caption the pictures.

That doesn't look too bad in the digital version, but it is almost impossible to read in print.

Please consider those of us who prefer the paper version when selecting fonts and colours for your otherwise excellent magazine.

Ian James  
via email

**Editor's reply:** Apologies for any problem with legibility – to our eyes green text on blue background usually reads very well. However, individual caption colours are now picked by our designer for their best presentation; we hope you find the mix in this issue (p42-43) more agreeable, and enjoy reading the online articles associated with them by using your FlightGlobal Premium login.

We welcome your letters about our coverage, or any other aerospace-related topic. Please email [flight.international@flightglobal.com](mailto:flight.international@flightglobal.com), or write to: The Editor, Flight International, 1st Floor, Chancery House, St Nicholas Way, Sutton, Surrey, SM1 1JB. Letters should be no longer than 350 words in length, and supplied with the correspondent's name and location. Letters may also be published on FlightGlobal.com, and do not necessarily represent the views of the editor.

## EDITORIAL

**1st Floor, Chancery House, St Nicholas Way, Sutton, Surrey, SM1 1JB, UK**

[flight.international@flightglobal.com](mailto:flight.international@flightglobal.com)

**Editor** Craig Hoyle  
+44 7795 486691 [craig.hoyle@flightglobal.com](mailto:craig.hoyle@flightglobal.com)

**Deputy Editor** Dominic Perry  
+44 20 8912 2164 [dominic.perry@flightglobal.com](mailto:dominic.perry@flightglobal.com)

**Head of Strategic Content** Murdo Morrison FRAeS  
+44 20 8722 8389 [murdo.morrison@flightglobal.com](mailto:murdo.morrison@flightglobal.com)

**Consulting Editor** David Learmount  
+44 7785 901787 [david.learmount@ntlworld.com](mailto:david.learmount@ntlworld.com)

**Contributing Editor** Mark Pilling  
[markpilling55@gmail.com](mailto:markpilling55@gmail.com)

**Magazine Enquiries**  
[flight.international@flightglobal.com](mailto:flight.international@flightglobal.com)

## AIR TRANSPORT TEAM

**Executive Editor** Graham Dunn  
[graham.dunn@flightglobal.com](mailto:graham.dunn@flightglobal.com)

**Editor – Airline Business** Lewis Harper  
[lewis.harper@flightglobal.com](mailto:lewis.harper@flightglobal.com)

**Air Transport Editor** David Kaminski-Morrow  
[david.kaminski-morrow@flightglobal.com](mailto:david.kaminski-morrow@flightglobal.com)

## AMERICAS

**Americas Managing Editor** Jon Hemmerdinger  
+1 617 397 2809 [jon.hemmerdinger@flightglobal.com](mailto:jon.hemmerdinger@flightglobal.com)

**Americas Air Transport Editor** Pilar Wolfsteller  
+1 510 634 3496 [pilar.wolfsteller@flightglobal.com](mailto:pilar.wolfsteller@flightglobal.com)

**Aviation Reporter** Garrett Reim  
+1 571 216 5327 [garrett.reim@flightglobal.com](mailto:garrett.reim@flightglobal.com)

## ASIA/PACIFIC

**Asia Editor** Greg Waldron  
+65 9489 4153 [greg.waldron@flightglobal.com](mailto:greg.waldron@flightglobal.com)

**Reporter** Alfred Chua  
+65 9643 4228 [alfred.chua@flightglobal.com](mailto:alfred.chua@flightglobal.com)

## CIRIUM DASHBOARD EDITORIAL

Michael Allen, Oliver Clark, Steve Goldstein, Michael Gubisch, Naomi Neah, SiMin Ngai, Niall O'Keeffe, Thomas Risen, Jonathan Robins

## FLIGHTGLOBAL.COM

**Online Content Manager** Amber Elias  
+44 7816 991648 [amber.elias@flightglobal.com](mailto:amber.elias@flightglobal.com)

## EDITORIAL PRODUCTION

**Group Production Manager** Isabel Burton

**Art Editor** Tim Noonan

**Layout Copy Editor** Tim Norman

**Consulting Technical Artist** Tim Hall

## DISPLAY ADVERTISEMENT SALES

**1st Floor, Chancery House, St Nicholas Way, Sutton, Surrey, SM1 1JB, UK**

## EUROPE

**Key Account Manager** Grace Murphy  
+44 20 8092 4080 [grace.murphy@flightglobal.com](mailto:grace.murphy@flightglobal.com)

**Sales Support** Gillian Cumming +44 20 8092 4082

## NORTH & SOUTH AMERICA

**Vice-President, North & South America** Rob Hancock  
+1 703 795 5155 [robert.hancock@flightglobal.com](mailto:robert.hancock@flightglobal.com)

**Sales Director, USA & Canada** Brett Ryden  
+1 630 450 1164 [brett.ryden@flightglobal.com](mailto:brett.ryden@flightglobal.com)

## ITALY

**Sales Manager** Riccardo Laureri  
+39 (02) 236 2500 [media@laureriassociates.it](mailto:media@laureriassociates.it)  
Laureri Associates SRL, Via Alessandro Volta, 40,  
22100 Como, Italy

## ISRAEL

**Sales Executive** Asa Talbar +972 77 562 1900  
Fax: +972 77 562 1903 [talbar@talbar.co.il](mailto:talbar@talbar.co.il)

Talbar Media, 41 HaGiva'a St, PO Box 3184, Givat Ada  
37808, Israel

## ASIA/AUSTRALASIA

**Key Account Manager** Jay Ee  
+65 9173 3502 [jay.ee@flightglobal.com](mailto:jay.ee@flightglobal.com)  
DVV Media International (Asia) Pte. Ltd.  
15 Beach Road, 2nd Floor, Singapore 189677

## RUSSIA & CIS

**Director** Arkady Komarov Tel/Fax: +7 (495) 987 3800  
[komarov@worldbusinessmedia.ru](mailto:komarov@worldbusinessmedia.ru)

World Business Media, Leningradsky Prospekt, 80,  
Korpus G, Office 807, Moscow 125190, Russia

## RECRUITMENT

**Sales Manager** Katie Mann  
+44 7792 152097 [katie.mann@flightglobal.com](mailto:katie.mann@flightglobal.com)

**Business Development Manager** Lauren Cooper  
+44 20 8092 4085 [lauren.cooper@flightglobal.com](mailto:lauren.cooper@flightglobal.com)

## CLASSIFIED

**Key Account Manager** Jay Ee  
+65 9173 3502 [jay.ee@flightglobal.com](mailto:jay.ee@flightglobal.com)

## ADVERTISEMENT PRODUCTION

**Production Manager** Sean Behan +44 20 8092 4078

## DATA

**Data cited in Flight International is sourced from Cirium, a data and analytics company in the wider travel industry. For Cirium's data team, contact:**

Trevor Mountford  
[trevor.mountford@cirium.com](mailto:trevor.mountford@cirium.com)

## PUBLISHING MANAGEMENT

**Managing Director** Andy Salter

**Commercial Director Publishing** Sophie Wild  
+44 7715 364765 [sophie.wild@flightglobal.com](mailto:sophie.wild@flightglobal.com)

## SUBSCRIPTIONS

Flight International Subscriptions,  
DVV Media International,  
PO Box 302, Haywards Heath,  
West Sussex, RH16 3DH, UK

**Subscription Enquiries** If you have any subscription queries, please contact customer service:  
+44 330 333 9533

To purchase a FlightGlobal Premium subscription, visit [FlightGlobal.com/subscribe](http://FlightGlobal.com/subscribe)

**Print & Digital Subscription Rates**  
(best rates are quoted)

1 year: £212.50/€229/\$293.25 Save up to 15%

2 years: £450/€484.50/\$621 Save up to 10%

3 years: £600/€645.85/\$828 Save up to 20%

## Digital Subscription Rates

(best rates are quoted)

1 year: £187/€205.78/\$263.50 Save up to 15%

2 years: £396/€435.80/\$558 Save up to 10%

3 years: £528/€581/\$744 Save up to 20%

Only paid subscriptions available.  
Cheques payable to Flight International

**Flight International is one of FlightGlobal's (publishing, events and FlightJobs) products and services.**



FlightGlobal uses data and analytics sourced from Cirium.

[www.cirium.com](http://www.cirium.com)

Flight International welcomes unsolicited contributions from readers but cannot guarantee to return photographs safely.

© and Database Rights 2021 DVV Media International Ltd. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission in writing of the publishers.

Registered at the Post Office as a newspaper  
Published by DVV Media International Ltd,  
1st Floor, Chancery House, St Nicholas Way,  
Sutton, Surrey, SM1 1JB, UK.

Newstrade distributed by Marketforce (UK),  
2nd Floor, 5 Churchill Place, Canary Wharf, London,  
E14 5HU, UK. Tel: +44 20 3787 9001

Classified advertising prepress by CCM.  
Printed in Great Britain by William Gibbons and Sons

Flight International published monthly 12 issues a year.

This periodical is sold subject to the following conditions: namely that it is not, without the written consent of the publishers first given, lent, re-sold, hired out or in any unauthorised cover by way of trade, or affixed to, or as part of, any publication of advertising, literary or pictorial matter whatsoever. No part of the content may be stored electronically, or reproduced or transmitted in any form without the written permission of the Publisher.

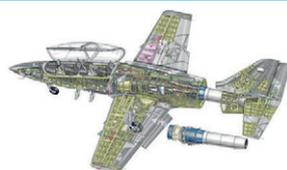
ISSN 0015-3710 (Print) ISSN 2059-3864 (Online)



DVV Media International



When you have finished with this magazine please recycle it.



## Check out Flight International's Image Store

Browse or customise a gift or memento from our **CUTAWAY ARCHIVE** of more than 1000 aircraft drawings

[www.flightglobalimages.com](http://www.flightglobalimages.com)

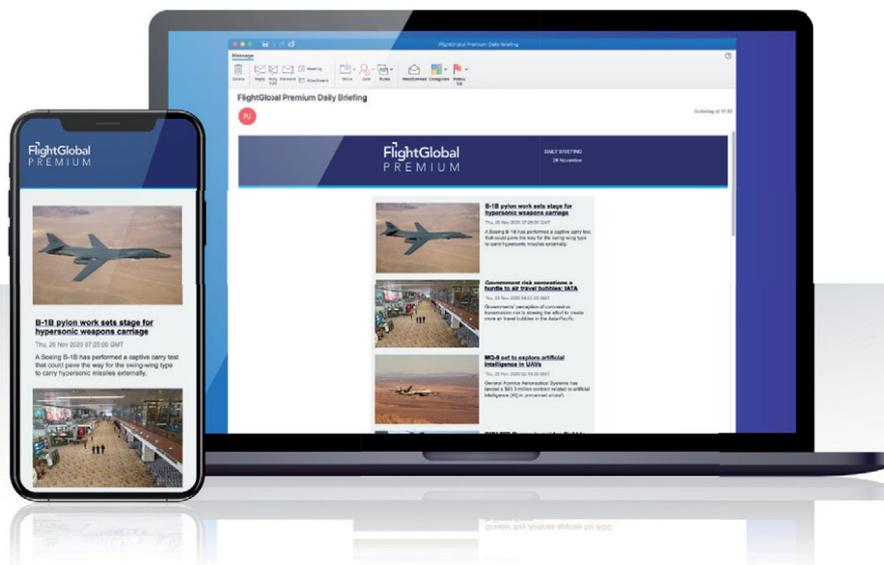


FlightGlobal



The Premium Daily News Alert is just one of the benefits of a FlightGlobal Premium subscription. Subscribe today and the latest aerospace and aviation stories to be making the headlines will be emailed to you every Tuesday to Saturday.

## Take a look for yourself...



*"Featuring the latest on major developing stories and key insight into the issues impacting the aviation industry, the Daily Briefing provides must-read insight from our team of global journalists into the most important stories every day."*

Graham Dunn, Content Director

**SAVE  
UP TO 15%**  
SUBSCRIBE TODAY

Alongside the Premium Daily News Alert, you'll also secure these subscriber-only benefits:

- Unlimited access to all FlightGlobal content, including our webinar series
- Flight International magazine in print or digital format
- Exclusive interviews with industry thought leaders
- Unrestricted access to the FlightGlobal news archive

New and used aircraft



The Regional Aircraft Marketing Specialist

Tel. + 44 1753 832088 juliet@skyworld.co.uk

## For sale or lease 2 x ERJ-170-200 (E175)



Library picture. Aircraft is available with fresh white paint



88 leather seats

- Operated in Europe since new
- Two aircraft - 2012 & 2013 build
- Ideal corporate shuttle aircraft
- Good C check status
- Good component status
- Available immediately

Flexible lease terms considered

Contact [juliet@skyworld.co.uk](mailto:juliet@skyworld.co.uk) for more information

[www.skyworld.co.uk](http://www.skyworld.co.uk)

Equipment, maintenance and service

**FlightJobs**

Take your career to new levels

Register your CV and start your job search today

Start your journey today  
Register at [Jobs.flightglobal.com/register](http://Jobs.flightglobal.com/register)

@flightjob  
@flightglobaljobs  
in FlightJobs

**mt-propeller**

**FLY GREEN - FLY MT**

Development & Production of high performance 2-blade to 7-blade hydraulically controlled variable pitch propeller and 2-blade to 4-blade electrically controlled variable pitch propeller.

Sales & Service for products made by McCauley, Hartzell, Sensenich, Woodward, Goodrich.

Pilatus PC12 with 7-blade MTV-47 Propellers

Airport Straubing-Wallmühle, EDMS 94348 Atting / Germany  
Phone: +49(0)9429-9409-0  
Fax: +49(0)9429-8432  
sales@mt-propeller.com  
[www.mt-propeller.com](http://www.mt-propeller.com)

## TRAIN SAFELY, FLY SAFELY



### Unmatched Resources

Leverage the unequalled experience of our master instructors. Train on advanced-technology simulators and precision training devices.

### Safety Protocols

Our highest priority is keeping you safe. Enhanced safety protocols include cleaning and disinfecting all facilities and training equipment.

### Online Training

Pilot recurrent and maintenance training available through instructor-led LiveLearning or self-paced Online Ground School.

Interested in a career at FlightSafety International? Visit [www.flightsafety.com/careers](http://www.flightsafety.com/careers).

+44 (0) 1252 554 500 • +1.201.528.0170 • A Berkshire Hathaway company

**FlightSafety**  
international

If you are **CREATIVE, INNOVATIVE** and **PASSIONATE** about Aeronautics, and would like to become a part of highly innovative Aeronautical Engineering organization, you will be in good company if you apply to a unique organisation which has a track record of innovation and creativity in Aeronautics.

For employment opportunities please visit <http://bishop-gmbh.com/index.php?page=Jobcenter>

### Contact Us:

E-mail: [application@bishop-gmbh.com](mailto:application@bishop-gmbh.com)

Tel: +44 (0)1794 341184

 **Bishop GmbH**  
Aeronautical Engineers

---

**Heather Ross** has a job that many aviators would dream of. She is a test pilot at Boeing, currently working on the airframer's newest project, the 777X. It's a very different career to her original aspiration

---

# In tune with the largest twinjet

**Pilar Wolfsteller** Las Vegas

---

**H**eather Ross was not destined to be a test pilot. She stumbled into the cockpit "very much by accident", thanks to two brothers who were also interested in aviation. She had initially planned to be a musician.

But at university, the woodwind specialist quickly recognised that music would not be a career in which she could thrive.

"It was kind of the same thing over and over again. I'd played in all sorts of groups - marching bands, jazz bands, orchestras, and all that. Maybe I was burnt out. And I wasn't sure if I could eke out a career."

Her first cockpit experience was "an epiphany".

"That's when I realised, 'Oh, wow, this is incredible'. I mean, the world is three-dimensional... There's now this vertical aspect to seeing the world. The things that were familiar to you in two dimensions take on another one as you fly above it all."

## Personal views

With an aviation career that now spans almost four decades, 59-year-old Ross has come a long way since that epiphany. In the meantime, she has personally seen the industry from all sides.

Ross arrived at Boeing in 1985 with a degree in aeronautics and astronautics in hand, and worked as a flight-test analysis engineer.

"I loved the job. It was great. I got to fly on the airplanes - but in the back of the airplanes," she says.

What she really wanted was to be up front.

However, at the time, Ross had nowhere near the level of flying experience needed to compete for a job as a test pilot.

So, in 1988 she joined the US Air Force, becoming type-rated on the Cessna T-37 and Northrop T-38 trainers and the Lockheed Martin C-5 and C-141 airlifters, and flew more than 40 missions in the first Gulf War. She then had a stint at United Airlines as a Boeing 737 pilot, and flight engineer on 727s and 747s.

Nine years after leaving Boeing, Ross was back, this time with the credentials to sit up front.

Of her 9,200h total time in the cockpit, more than half are flight-testing hours accumulated with Boeing. Ross now holds US Federal Aviation Administration type ratings on the airframer's 737, 747, 757, 767, 777 and 787 models - every commercial aircraft the company builds.

As deputy chief pilot for the 777X programme, she is an "engineering project pilot", meaning she is one of the professional aviators to be involved in the programme from day one. She spent 10 years on the 787 before shifting to the 777X development programme six years ago.

"I get to focus on that airplane. There are so many paths that an airplane design can go down," she says. "If some of them don't work or meet pilot expectations, or if they are hard to implement, having a pilot help early on with the design really prevents last minute changes and realisations."

The test campaign associated with any new aircraft design is extremely meticulous and disciplined, with all systems verified over and over in simulators and labs on the ground.

As deputy chief pilot for the 777X, Ross has focused on programme from day one





Ross has FAA type ratings on every commercial aircraft Boeing builds

Boeing

“Flying any airplane, regardless of whether it’s the first time that particular airplane is flown, or the first time that type has ever flown, is always exciting”

“By the time that the crew gets in the airplane for the first flight, we’ve tested all of the parts of the airplane and the pieces and all the different components,” Ross says. The pilots and the equipment have prepared for all possible scenarios. “It’s a very, very methodical, very careful build up in preparation for first flight.”

Though Ross has never been at the controls during a type’s first flight, she maintains an excitement and a fascination for the process and the teamwork that goes into making an aircraft defy gravity.

“Flying any airplane, regardless of whether it’s the first time that particular airplane is flown, or the first time that type has ever flown, is always exciting,” Ross says. “I still feel the same every time I push the power up, even on an airplane that I’ve flown 100 times.

“It’s that realisation of everything coming together. People’s efforts, expertise, knowledge and care. Everybody’s focused on achieving the same goal, which is to get the airplane airborne, and offer a great product, ultimately, for our customers and for the flying public,” she says.

Ross is among a handful of women doing a job that thousands of professional pilots – male and female – would covet.

“Airplanes are built so that you don’t have to have unusual strength, which is great because it means that women can fly them just as well as men can,” she says.

“The airplane doesn’t care.” ▶



**Access all areas**  
 Subscribe to **FlightGlobal Premium**

Get unrestricted access to all FlightGlobal content, including the latest from Flight International and Airline Business, plus more.

Subscribe now at  
[FlightGlobal.com/subscribe](https://FlightGlobal.com/subscribe)



# Energizing the future of flight

[baesystems-ps.com](http://baesystems-ps.com)

We are applying four decades of experience and know-how in energy management, power conversion and controls to enable the electrification of aircraft. Our offerings are modular, scalable, and adaptable for regional and business jets, advanced air mobility, and military applications.

**BAE SYSTEMS**