FLIGHT INTERNATIONAL

What might Farnborough deliver?

Rapid charge

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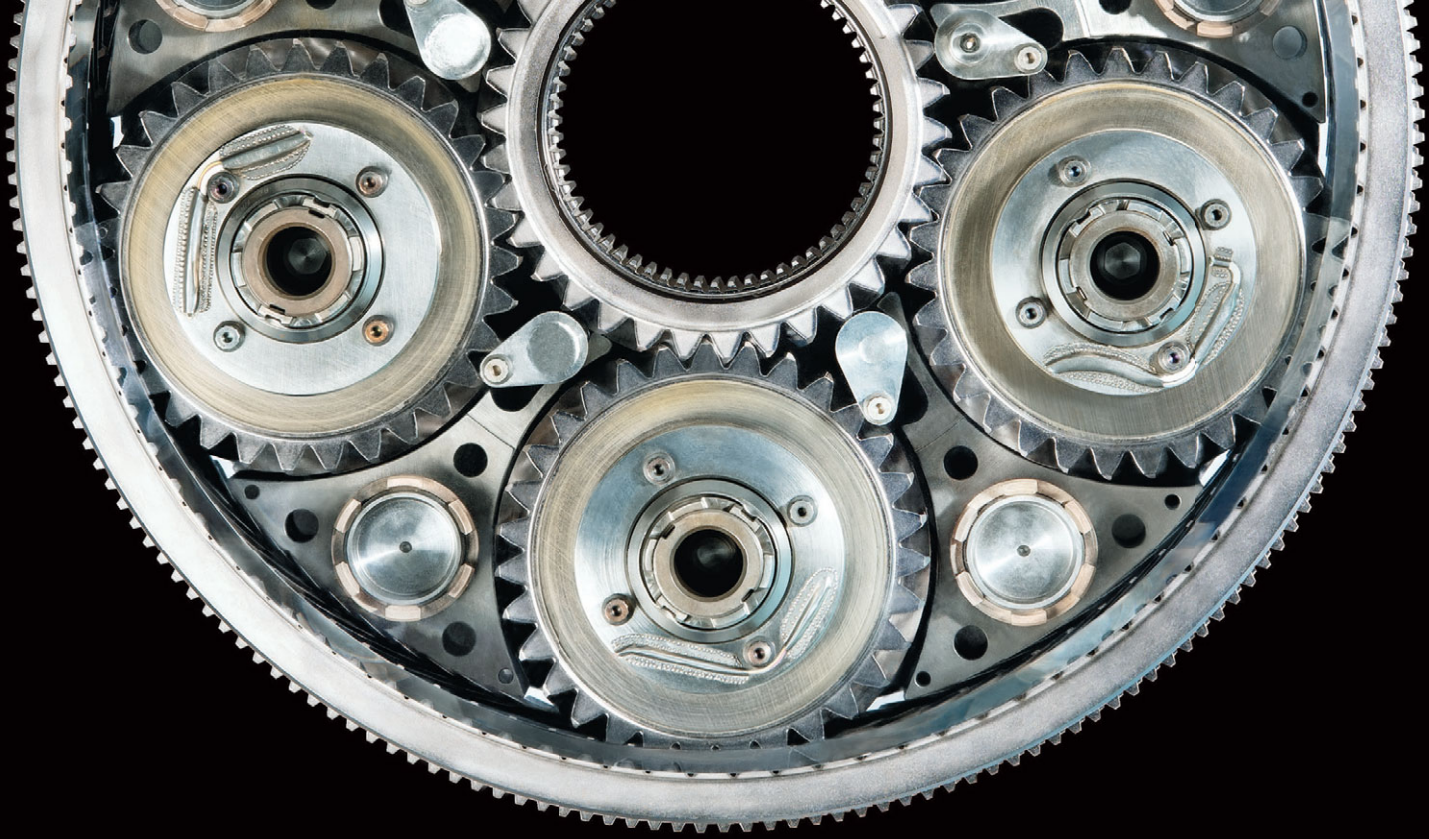

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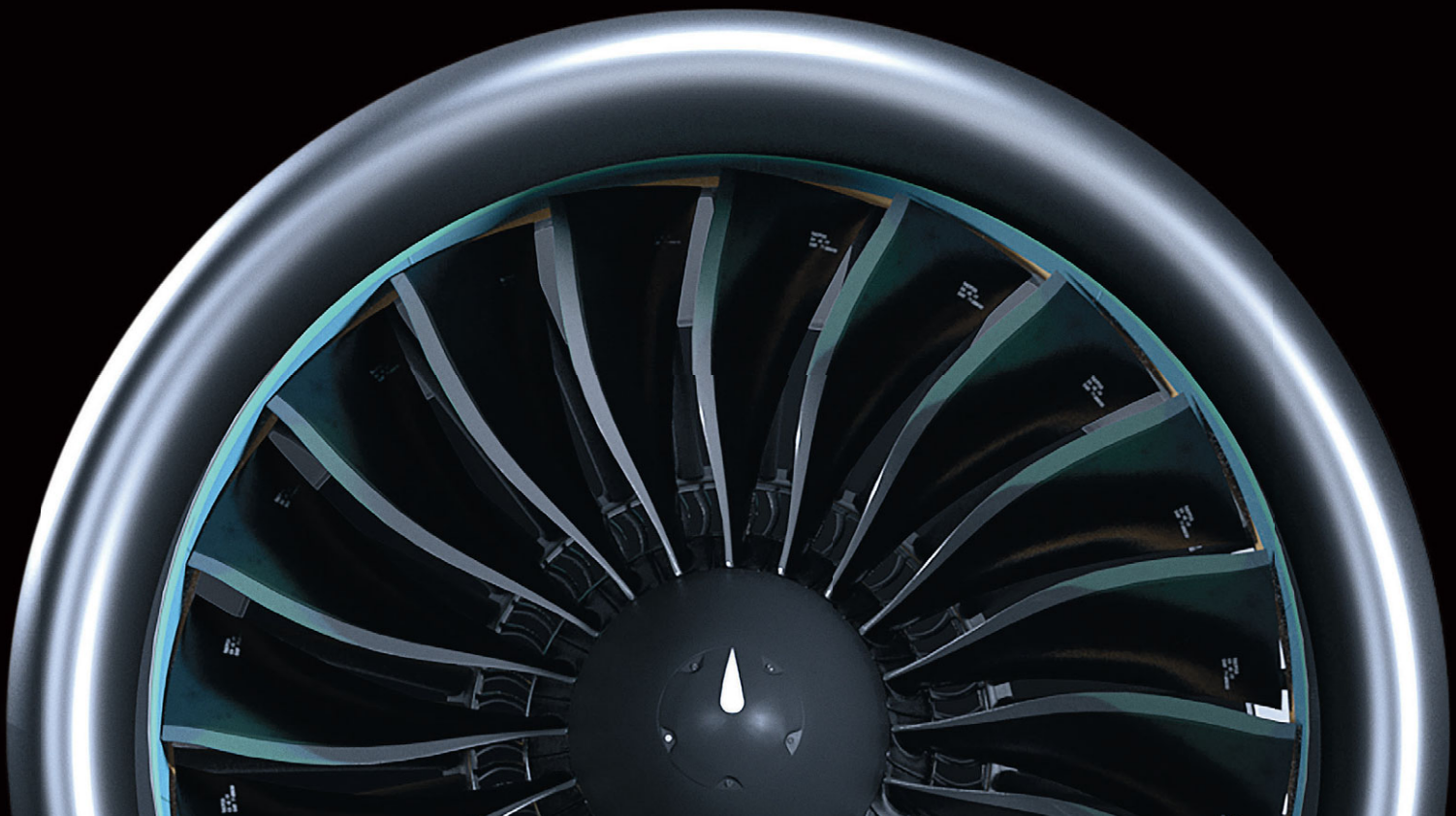


Days gone

FlightGlobal archive

Times change

The last Farnborough air show feels an age ago: before the 737 Max grounding, Brexit and Covid-19. Can it thrive in an era of climate crisis and help with the race to net zero?

Many love it and probably as many others loathe it, but there is no doubt that the Farnborough air show – returning after a pandemic-enforced four-year break – remains among the aerospace industry's marquee events.

Covid-19 challenges aside, the world of aviation has changed in a very dramatic way since the last gathering took place at the historic Hampshire airfield in 2018. Phrases like "climate crisis" and "net zero" were not hot topics at that show, but certainly look set to dominate proceedings this time.

The environment did not feature strongly in our show report from the last Farnborough – the headlines from which now read as though from another age.

Airbus made a passionate case for further A380 sales (while HiFly used one of the superjumbos to publicise the plight of coral reefs); then-Boeing chief executive Dennis Muilenburg was in no rush to launch a New Mid-market Airplane; a Boeing acquisition of Embraer's commercial arm was still on the cards; and Mitsubishi Aircraft was upbeat about its MRJ90.

That was before two fatal Boeing 737 Max crashes derailed one of the industry's "big two", Brexit, the pandemic, and now soaring global prices for almost everything – driven in no small part by Russia's war in Ukraine.

Farnborough's return feels hugely welcome, but its challenge is to transform with the industry and remain relevant by proving that face-to-face events still matter in a world where Teams and Zoom calls can remove the hassle of international travel. Add to this the unpredictable British summer weather and a risk of major travel disruption for those venturing from London by rail, and its organisers face quite the task.

This will not be the flying spectacular of decades past, with public displays at the end of the week no longer part of the plan. Instead, as well as championing the best of aerospace as it always has, Farnborough International wants to drive the conversation around its future, by hosting debates and seminars on topics ranging from sustainability to workforce challenges.

For those accustomed to watching the latest generation of airliners gracefully displaying a level of agility never called on in commercial service, and military jets drowning out conversation, Farnborough will still have attractions to offer. But perhaps its bigger contribution will be in drawing together the companies and minds capable of transforming the industry for the challenge ahead: how to fly without it risking costing the earth.

Thankfully, the UK's aerospace sector is showing the kind of innovation and commitment that will be needed to overcome the issues facing us – as detailed in our pre-Farnborough package, including the likes of Aeralis, BAE Systems, Rolls-Royce and Spirit AeroSystems UK.

Get it right, and Farnborough could recapture its past glory; but a failure to seize this opportunity puts the UK at risk of failing to draw on its proud and pioneering heritage.

See p48

In focus

Electric avenue Dash 8-100 takes hybrid path

BAE Systems

In depth

Tougher oversight slows Max approvals

Lengthy Federal Aviation Administration process for certificating the final pair of re-engined 737 family members hampers Boeing programme recovery effort

Jon Hemmerdinger Everett

New regulatory requirements and development of a supplemental angle-of-attack (AoA) system continue to keep Boeing from making faster progress in achieving certification of its 737 Max 7 and Max 10.

Though the company's Max 7 still seems poised to receive regulatory clearance this year, its ability to achieve certification of the Max 10 before a critical December 2022 deadline remains uncertain.

After that date, the US Federal Aviation Administration (FAA) will require that newly certificated aircraft have a modern pilot alerting system – something all Max models lack.

"We are working through a process which is different... from what we have done in the past," Mike Fleming, the Boeing vice-president charged with leading the 737 Max's return to service, said on 15 June.

"We are sort of learning as we go here," he told journalists visiting the company's Everett assembly facility in Washington.

Crash response

Progress has been slow partly because the FAA is no longer delegating, as it had previously, the evaluation of system safety assessments based on assumptions about pilot responses, Fleming says. Aircraft manufacturers design and certificate aircraft based on such assessments.

The FAA's tougher stance stems from two fatal 737 Max crashes in 2018 and 2019, which investigators attributed to erroneous activation of the jets' Maneuvering Characteristics Augmentation System (MCAS), a result of faulty AoA data.

But investigators also criticised Boeing's assessments of how pilots would respond to such a scenario – and the FAA's approval of them.

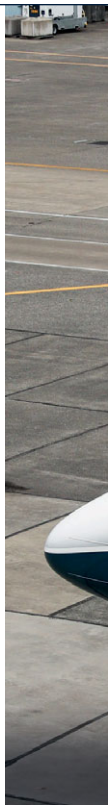
"We have been... identifying the system safety assessments that have human factors assumptions associated with them," Fleming says. The company has not, he adds, needed to "significantly redo" assessment work.

Addressing the Max 10's certification, Fleming says Boeing is "going through all of the development assurance activities" and working to secure a "type inspection authorisation" from the FAA. That authorisation will allow the company to move into Max 10 certification testing.

"We are very satisfied with the way the airplane has performed in our engineering test programme," Fleming adds. The Max 10 has completed more than 500h of flight testing, Boeing says.

The company's Max 10 development and certification work has also been complicated because Boeing is equipping the type with what European regulators call an AoA "integrity enhancement".

The European Union Aviation Safety Agency (EASA) required that system for the Max 10 as part of its agreement to lift the grounding of the Max 8 and Max 9. It also required Boeing to update other Max



767F has been popular with global delivery service companies

AirTeamImages

Emissions rule change threatens 767F sales

The US Federal Aviation Administration (FAA) has proposed new efficiency rules that could jeopardise Boeing's ability to keep selling 767 Freighters for delivery after 2027.

A Boeing official says the company hopes to find a means of ensuring that 767F deliveries can continue, but that it is evaluating a possible replacement, potentially including a freighter version of its 787.

The FAA released its proposed aircraft-emissions standards on 15 June. The move will align US standards with those set by ICAO in 2016, which had already placed the 767F's future in limbo.

Proposed emission caps are to apply to large aircraft

Airframer expects the Max 7 to be certificated this year

Seattle Times/Pool Reports

variants with the system, according to a 2021 EASA document.

The AoA enhancements are "to further reduce crew workload following single AoA failures and to improve the system's reliability", says the document.

Fleming says the change is "designed to eliminate... any of the erroneous indications that we think could happen on the airplane, and [to] significantly reduce the pilot workload associated with any kind of erroneous indication".

Additionally, he says, Boeing is developing a cockpit switch that will allow pilots to shut off the Max's stick-shaker function in cases of erroneous activation.

Costly option

"We still have a lot of human factors work to do," Fleming says.

Boeing expects to deliver the first Max 10 in 2023, meaning the FAA seems unlikely to issue the type's certification before December. The US Congress established that requirement in response to the Max crashes.

Equipping the Max with such a system at this stage would be costly and time consuming, and would erode commonality between Max variants – a valuable selling point for airline customers.

Fleming and other Boeing executives insist the Max is safe with its existing alerting system, and have warned that changes could actually erode safety.

Executives have also suggested that Boeing might seek an exemption from the rule for the Max 10, although they have not elaborated on this.

"It's indeterminate. It's all dependent upon... how we progress with the regulatory agencies," Fleming says. "Between the FAA and our congressional members, I think this will sort itself out."

The Max 7 seems poised to avoid the cockpit alert requirement, as Boeing has said it expects to have that type certificated before year end.

But even certification of the smallest family member, which Fleming calls nearly identical to the Max 8 and Max 9, has been slow.

Asked about delays to the process, he says: "It's documentation. We are in the process of working through all of the documentation requirements to provide to the FAA."

See p66

manufactured after 1 January 2028, "regardless" of when those types were certificated, says the FAA's proposal. The standards would also apply to new aircraft types submitted for certification after 1 January 2021, but not those already in service.

The FAA's proposal lays out emissions requirements and complex means of proving compliance. The administration says the standards will apply to "the upcoming 777X and future versions of the 787 Dreamliner", and to Airbus A330neos.

While its proposed rule does not specifically mention 767s, it is the FAA's regulatory response to aircraft-emissions caps required under a 2021 rule issued by the US Environmental Protection Agency, which called the type "non-compliant".

Boeing freight customer leader Brian Hermesmeyer says the company intends to explore means of producing 767s beyond 2027, but declines to specify how.

"We will continue to work with regulators and customers, within sustainability frameworks, to make sure that the 767 may have a possibility to continue," he says.

However, Hermesmeyer confirms that Boeing is considering potential 767F replacements.

"Are we looking at different freighter platforms in that space? Absolutely," he says, adding that a 787 freighter is "a natural place for us to look".

"For now, 767s will be delivered through the end of 2027, and we will make sure that we have the right airplanes in the right space for the market," he says.

Boeing found a winner in the freighter version of its ageing 767 platform, with the type having proved particularly popular among express package delivery companies. It holds outstanding orders for 61 767Fs, mostly for FedEx and UPS.

The FAA is accepting comments about its proposed rule through 15 August.

By setting fuel-efficiency standards based on carbon dioxide emissions, it "accommodates a wide variety of fuel-efficient measures when manufacturing planes, including improvements to aerodynamics, engine propulsion efficiency and reductions in an aircraft's empty mass before loading", the FAA says.

The US government has pledged for the country's airline sector to achieve net zero carbon emissions by 2050.

Company aims to ground test 1MW-class liquid hydrogen system and motor by 2025

GKN Aerospace

GKN confident fuel cells could power 96-seater

UK aerospace firm sees convincing route to market for powertrain being developed under H2GEAR effort

Dominic Perry London

GKN Aerospace has completed the preliminary design of the hydrogen fuel cell powertrain it is developing under the UK-funded H2GEAR programme and is increasingly confident that the efficiency gains it is building into the system will allow it to scale to power a 96-seat aircraft – or one even larger.

Disclosing the progress of the project on 16 June, GKN Aerospace chief technology officer Russ Dunn said that it has now "defined the architecture for a number of different aircraft".

This includes 19-, 48- and 96-seat models, he says, "and what we are actually seeing is that the technology we are developing scales very well – it actually becomes more attractive as you get larger and larger".

Under the H2GEAR programme, GKN intends to deliver to ground test by 2025 a 1MW-class liquid hydrogen fuel cell powertrain, including the electric motor.

However, as part of the process, it has been evaluating a variety of aircraft designs "to translate the aircraft requirements into the propulsion system", Dunn adds.

He says the key elements of the system – the fuel cells, hydrogen storage tanks, and motors – are fairly simple to scale.

"What we are seeing is a relatively straightforward – with some challenges – ability to go from 1MW, which is suitable for 19-seat platforms, up to 8MW and above."

That has been enabled by the efficiency improvements, such as the power density of the motor, GKN Aerospace believes it will gain through the adoption of a cryogenic system.

Dunn declines to go into detail, citing commercial confidentiality, but says it uses the cooling potential of the liquid hydrogen to improve the performance of electrical system components.

Tests of the cryogenic system at technology readiness level 4 will take place next year.

Moving barriers

Dunn sees the cut-off point to use liquid rather than gaseous hydrogen in a fuel cell system being more clear-cut at the smaller end of the market, or an aircraft with capacity for 10-13 passengers.

But the crossover point for a fuel cell system versus hydrogen combustion engines for larger aircraft is less well-defined, he says.

"What's the barrier at the top end? We thought getting to 48 seats was going to be a challenge, but I think what we are seeing now is we are looking at 96 seats – and arguably it looks even better."

However, to an extent the crossover point will be governed by the improvements to fuel cell and turbine engine efficiency, he adds.

Dunn sees the weight of a fuel cell system being "as light, if not lighter" than a standard turboprop powertrain once all the elements are included. And while internal hydrogen storage will require the sacrifice of perhaps 25% of the fuselage volume in a 19-seater, "there are some concepts we are looking at which might give you some of that back".

Additionally, GKN Aerospace continues to work on the thermal management of the fuel cells themselves, which becomes a harder problem to solve the larger the aircraft is. Dunn points out that elements of this will be out of the company's hands, as it is "going to rely on other parts of the aircraft".

"But we have convinced ourselves that this is feasible, and that we have understood how that level of heat can be safely dissipated through different aircraft structures and other systems on the aircraft."

As part of this work, Dunn says, GKN Aerospace is investigating the potential of heat exchanger concepts with an undisclosed partner. There are several UK experts in this field, notably Oxfordshire-based Reaction Engines.

H2GEAR is a £56 million ($68.4 million) project, with £27.2 million provided by the UK Aerospace Technology Institute.

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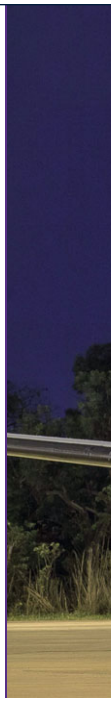


STOUT project is down but not out

Brazil's Embraer hopeful that short take-off, hybrid-electric concept could be revived if new partner comes on board

Jon Hemmerdinger Sao Jose dos Campos

Embraer sees the potential to eventually revive the development of a hybrid-electric short take-off and landing aircraft despite the project stalling due to Brazilian government funding issues.

In November 2020 the airframer revealed it was studying potential development of a hybrid-electric aircraft called STOUT – an acronym for Short Take-off Utility Transport – having signed an agreement with the Brazilian air force to study the concept, conceived as a replacement for its EMB-110 Bandeirantes and EMB-120 Brasilias.

But Jackson Schneider, chief executive of Embraer Defense & Security, confirms the government recently shelved further development due to "budget constraints".

Without a new contract, Embraer will not progress the design to the next stage, which would involve developing the aircraft and its production system, Schneider adds.

However, he is confident that the project can be resurrected. "We intend to [resume] as the conditions allow, even with different partners," says Schneider. "It's suspended – it is not interrupted for good."

Initial designs

Embraer's initial designs for the STOUT feature a pair of turboprop engines on the inboard section of the wing, supplemented by a pair of electric motors further outboard.

The aircraft would have around 1,310nm (2,420km) of range, a maximum payload of 3,000kg (6,615lb) and the capability to carry up to 24 troops.

Schneider says these initial design studies proved valuable, including for the hybrid-electric powertrain.

He stresses that the airframer likely needs "different potential partners" to advance the project, which would eliminate the effort's reliance on the budget-constrained Brazilian military.

Funding issues also led Brasilia this year to trim its commitment for Embraer's KC-390 tanker/transport, from 28 to 22 aircraft.

Although Embraer has recently added to the backlog with a five-unit deal from the Netherlands, announced on 16 June, alongside previous commitments from Hungary (two) and Portugal (five), Schneider believes recent geopolitical events, including Russia's invasion of Ukraine, will drive additional sales.

Schneider says nations are increasingly interested in replacing decades-old military cargo aircraft: "Many countries in the world... realise that their logistics systems are very old and need to be replaced as soon as possible."

He adds that Embraer has recently been engaged in "intense" C-390 sales campaigns,

Airframer pushes new passenger turboprop decision to 2023

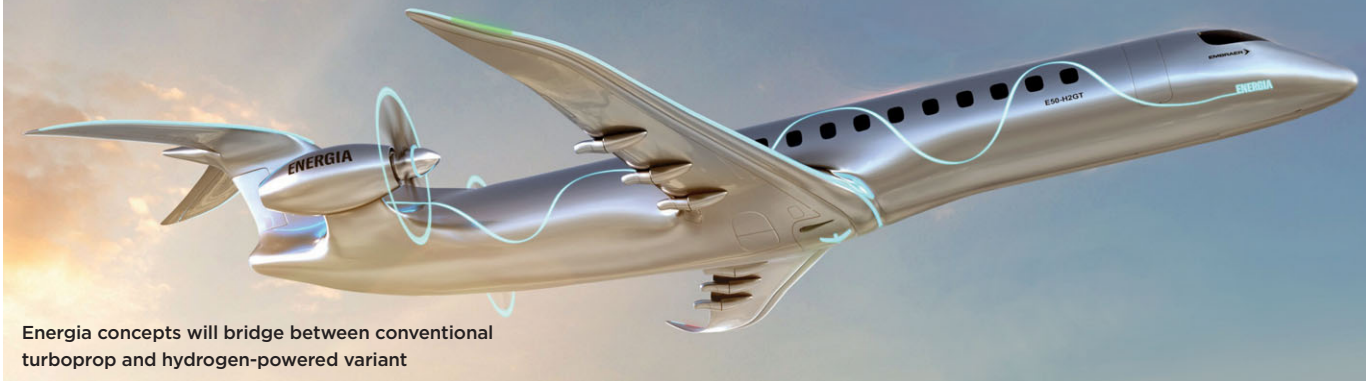
Embraer confirms it will wait until 2023 to disclose more information about its planned development of a new passenger turboprop.

The Brazilian airframer remains undecided about whether to first develop a 70- or a 90-seat variant.

"We hope that, at the beginning of next year, we will be able to announce a decision about the turboprop development," Embraer chief executive Francisco Gomes Neto said on 30 May. "We believe we will be ready by Q1 2023. We thought [it] could be the end of this year, but we prefer to be more realistic."

For several years Embraer has been hinting at the possibility of launching a modern turboprop, a move that could significantly disrupt a market dominated by ATR and De Havilland Canada, whose aircraft are based on decades-old designs.

Embraer has said its new turboprop would share a fuselage with its E-Jet regional jets. The company is eyeing two variants, one with 70 and another with 90 seats, an area of the market that is not fully exploited by the incumbent manufacturers: for



Embraer

Energia concepts will bridge between conventional turboprop and hydrogen-powered variant

Concept was studied as replacement for Brazilian air force's EMB-120 Brasilias

Brazilian air force

including with countries the airframer had not previously targeted as potential buyers.

Schneider attributes the bump in demand to several factors, including the USA's 2021 exit from Afghanistan. That event prompted US partners – notably those in Europe – to likewise pull forces from the country. It also prompted a broad exodus of Afghan refugees, Schneider notes.

The effort relied entirely on aircraft, including military airlifters and commercial charters.

"The Afghanistan withdrawal of troops and refugees... called attention for European countries... that their logistics systems are not up to date," says Schneider.

Then came Russia's February invasion of Ukraine, which further highlighted the need for European countries to update military assets.

"The world will not be the same after the Russian and Ukrainian war," Schneider says, which has "initiated, or reinforced, strong interest" in the C-390.

Revealing its selection of the C-390, Dutch secretary of state for defence Christophe van der Maat says deliveries will begin in 2026.

To replace the Royal Netherlands Air Force's fleet of elderly Lockheed Martin C-130Hs, the C-390s will support an increase in minimum annual flight hours from 2,400h to 4,000h. This was influenced by the coalition evacuation of personnel from Kabul, Afghanistan in 2021 and instability in eastern Europe.

example, the ATR 42- and 72-600 can carry up to 50 and 78 passengers, respectively.

"Hopefully next year we can get a green light on one of those aircraft," adds Embraer senior vice-president of engineering, technology and corporate strategy Luis Carlos Affonso.

Embraer views the smaller variant as ideal for US carriers, which would probably outfit such an aircraft with only 50 seats in two classes. They would use it to replace ageing 50-seat regional jets, says Affonso, adding that the 90-seater would be likely to be more popular in other regions.

Affonso says the order in which the variants will be developed will be dictated by the market.

Embraer initially suggested its new design would have engines on the wing, but in 2021 the airframer released images of a proposed aircraft with aft fuselage-mounted engines, and a T-tail.

"Putting the engines in the back of that platform [means] the architecture of the airplane, the basic design, could be adapted... with innovative technology," Affonso says.

Specifically, an aft-mounted configuration could allow the company to modify the aircraft to have hydrogen-burning engines. Embraer could equip it with "a few tanks of hydrogen in the fuselage, without having to completely redesign the airplane," Affonso adds.

Embraer could bring such a variant to market in the first half of the 2040s, the airframer says.

"Our view is that there is a window of opportunity for a conventional engine in this power class that could... maybe after 15 years, evolve into a powerplant that would use new technologies," says Affonso.

Such a move would align with Embraer's broader plan to develop aircraft that emit less carbon dioxide. In 2021, it proposed four such aircraft, which it calls its Energia family.

Those include a nine-passenger hybrid-electric aircraft for 2030 service entry, followed in 2035 by a nine-passenger all-electric aircraft and a 19-passenger hydrogen-powered airliner. Then, in the 2040s, Embraer plans to bring to market a 35-50-seat regional jet powered either by hydrogen or biofuel.

In May, ATR disclosed plans to develop a hybrid-electric variant of its turboprop called Evo, with service entry by end-decade.

Embraer's Gomes Neto says ATR's move lends credence to the argument that the turboprop market is ripe with opportunity.

"The ATR announcement just validates that the ATR 72 needs replacement", he says, adding there is clearly a "market for a new turboprop".

Test aircraft MSN11000 was airborne for 4h 35min

Airbus embarks on A321XLR flight-test campaign with maiden sortie

Long-range narrowbody completes first flight from Hamburg base, but rival Boeing plays down jet's appeal

David Kaminski-Morrow London
Jon Hemmerdinger Seattle

Airbus has commenced the flight-test campaign for its long-range A321XLR variant, after the initial prototype of the twinjet lifted off from Hamburg Finkenwerder.

The aircraft, powered by CFM International Leap-1A engines, took off at about 11:05 on 15 June and completed a sortie that lasted for about 4h 35min.

It carried a crew of five, comprising two experimental test pilots and three test engineers, who checked the aircraft's flight controls, engines and main systems, including flight envelope protections, at both high and low speed.

Airbus intends the aircraft to enter service in early 2024, offering carriers a range of up to 4,700nm (8,700km).

The XLR is the latest version of the A321neo twinjet line. The first test aircraft, MSN11000, was rolled out in its paint scheme in May.

Airbus has already developed a long-range variant of the A321neo, the A321LR, but the XLR will further enhance range capability.

It will feature a substantial modification of its fuel system, with the inclusion of a large aft centre tank.

Airbus initially unveiled plans for the XLR at the Paris air show in June 2019, and structural assembly of the jet began last year.

Philippe Mhun, Airbus executive vice-president of programmes and services, says: "This is a major milestone for the A320 family and its customers worldwide. The A321XLR will open new routes with unbeatable economics and environmental performance."

However, rival Boeing has played down the competitive threat posed by the A321XLR: it claims the Airbus twinjet is a "niche" product and that its 737 Max has broader appeal.

4,700nm

Stated maximum range of twinjet on its planned entry into service in 2024

Boeing vice-president of commercial aircraft marketing Darren Hulst says the airframer's focus is not to match Airbus at the top end of the narrowbody market.

Boeing's Max 10 – the variant that can conceivably compete against the A321XLR – has a 3,300nm range and is as yet uncertificated. Boeing hopes to deliver the first Max 10 in 2023.

Hulst calls the A321XLR a "range machine", but says it is suited only for a small segment of the much broader single-aisle market. Airlines pick the Airbus jet, Hulst adds, "for a specific niche of air markets that they can't serve with a standard A321".

"So, you are talking about a fraction of the market," Hulst says.

"It's not our goal, necessarily, to match Airbus plane-for-plane at the top of the market, especially because, I think, we have a more compelling value proposition with the [Max 8 and 9]," Hulst adds.

Airbus has reported strong demand for A321XLRs, with customers such as American Airlines, JetBlue Airways and United Airlines lining up with orders. As of end-May, it held orders for "more than 500" aircraft from over 20 customers. Those commitments equate to about 12% of Airbus's total A321neo backlog of 4,211 jets.

Hulst says the Max 8 and 9 excel in the "heart" of the narrowbody market, for aircraft with 180-220 seats. "That's where our aircraft have more seats, lower cost-per-seat and more range flexibility," Hulst says.

"The 737 Max family represents the most versatile, but also the most complete, single-aisle family for the needs of the market."

Analysts generally view the Max 8 and 9 as at least equals to the A320neo. But they say Boeing has lost valuable market share because it lacks an aircraft that competes properly against the A321neo.

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Clark sizes up widebody offerings

President of Emirates Airline sees future need for aircraft comparable to A380 on back of predicted demand growth

Alfred Chua & **Lewis Harper** Doha

Emirates Airline president Tim Clark has again expressed concern about how airlines will cope with rising demand in the future without recourse to new Airbus A380-sized jets, warning that ticket prices could rise as a result of fewer seats being available into slot-constrained airports.

Speaking during the IATA annual general meeting in Doha on 20 June, Clark acknowledged that Airbus "has a great stock of aeroplanes", but said of the range-topping A350-1000: "That's too small.

"How are you going to cope with global demand if you pick up at [2019 levels of growth] and extrapolate to 2030 at 4%?," he asks.

"How are you going to cope with that with A320s and A350s? You need a bigger unit."

And amid delays to the delivery of the first Boeing 777X, Clark says "I don't know what will happen" if the 777-9 "doesn't come".

"You're left with the 787-10," he states. "Is that it?"

Noting that Emirates has six A380s flying into Heathrow each day, Clark says that to achieve the same capacity with 787s, the airline would need to operate two-and-a-half aircraft for every A380.

"And how are you going to fit in two-and-a-half 787s with all this growth into a restricted field like Heathrow?," he says.

"How are you going to do that in Sydney? How are you going to do that in San Francisco?

"What it will do is put the cost of air travel up through the roof," Clark suggests. "Somebody's got to do something, honestly."

Further evidence of a rebound for the A380 comes from Asiana Airlines, which will resume operating its double-deckers from late-June, to ease a shortage of seats amid an "explosive" increase in bookings.

It joins compatriot Korean Air – which will redeploy its A380s to New York from July – and other Asia-Pacific carriers, including All Nippon Airways, Singapore Airlines and Qantas, in returning their superjumbos to service.

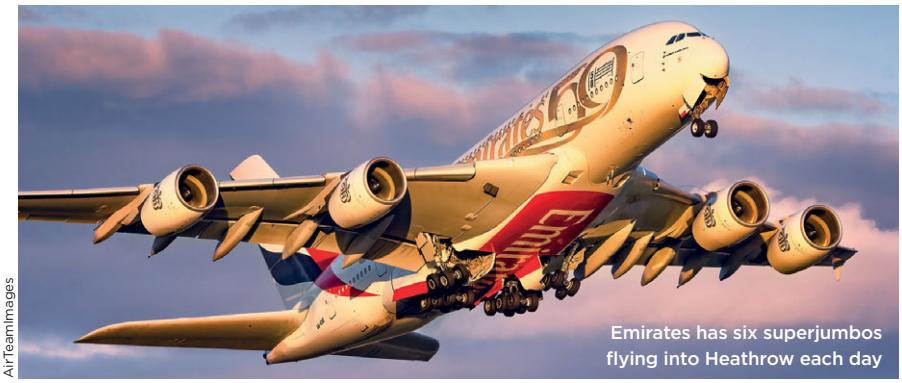
Asiana says it will deploy the A380 on two routes "with high travel demand": Los Angeles and Bangkok.

It will resume A380 operations into Los Angeles from 23 July, operating three flights per week, while it will recommence a daily service to Bangkok from 25 June.

Asiana says the superjumbo offers more seats – including in premium classes – compared with existing aircraft operating the routes, without the need for additional frequencies.

Currently Asiana operates the A330 to Bangkok and the A350 to Los Angeles. Carrying 495 passengers, the A380 offers more than 180 additional seats per flight.

Cirium fleets data shows that Asiana has six A380s in storage.



Emirates has six superjumbos flying into Heathrow each day

AirTeamImages

Hybrid Air Vehicles

Airline will be launch customer for 'ecological and versatile' airship

Air Nostrum deal lifts Hybrid Air Vehicles

Spanish carrier reserves 10 production slots for 100-passenger Airlander 10

David Kaminski-Morrow London

Spain's Air Nostrum Group has unveiled an extraordinary provisional agreement to acquire airships to operate commercial services in the country.

It is reserving production slots for 10 examples of the Hybrid Air Vehicles (HAV) Airlander 10, with a view to taking delivery from 2026.

Air Nostrum Group, which serves as a regional partner to Iberia, says it will be the launch customer for the "ecological and versatile" airship.

President Carlos Bertomeu says the company is looking to "explore all ways" to reduce its carbon impact. "The Airlander 10 will dramatically lower emissions," he says.

The carrier aims to introduce the Airlander fleet over a five-year period, through operational leases, as part of a sustainable mobility project.

"Air Nostrum is exploring different solutions that seek to improve environmental protection," the Spanish company states.

It says the Airlander can adapt to the specific needs of each destination, having the capability of landing on "any reasonably flat surface", including water.

"Given its ability to take off and land in small spaces, the Airlander 10 can be the perfect mobility alternative for air transport in cities that do not have airport facilities, as well as islands," it adds.

Air Nostrum Group and UK-based HAV have conducted six months of "rigorous studies and modelling", says the manufacturer.

The Airlander 10 is expected to "diversify and complement" the Air Nostrum fleet, with the capability of transporting up to 100 passengers. Production of the Airlander is set to begin this year at facilities in South Yorkshire in the north of the UK.

HAV chief executive Tom Grundy says the airship is designed to enable "new transport networks" and offer "rapid growth options" for customers.

Oslo says type is incapable of meeting its anti-submarine warfare needs

Leonardo Helicopters

Norway ditches NH90 fleet

Nation terminates 14-aircraft contract after years of delay and poor performance, and seeks refund from NH Industries

Dominic Perry London

Oslo has warned the partner companies in the NH Industries (NHI) consortium that they effectively risk being barred from future tenders if they fail to meet its demand for a NKr5 billion ($500 million) refund after it permanently removed its underperforming NH90 helicopters from use.

Norway on 10 June said it had terminated its contract with NHI – which comprises Airbus Helicopters, Leonardo Helicopters and GKN/Fokker – and intended to return the 13 NH90s already delivered.

"It is a serious decision, but no matter how many hours the personnel work, and no matter how many parts we order, NH90 will not be able to meet the needs of the armed forces," says Norwegian defence minister Bjorn Arild Gram.

Under its original contract schedule, 14 maritime NH90s were due to be handed over by 2008 – a date subsequently revised to 2022. Although its last example was ready for acceptance, the Norwegian defence materiel administration (NDMA) says work to upgrade all of its aircraft to a final operating configuration – completed on eight so far – would not end until 2024.

"Considering the severity of the delays, the pertinent question in our view is how a purchaser would not have a legal right to terminate," the NDMA says.

Describing the decision as "legally groundless", NHI says it was not "offered the possibility to discuss the latest proposal made to improve the availability of the NH90 in Norway, and to address the specific Norwegian requirements".

"We have repeatedly tried to solve the problems in collaboration with the supplier, but more than 20 years after the contract was entered into, we are still without helicopters that can do the job they were bought for, and without the supplier being able to present realistic solutions to the problems," says NDMA head Gro Jaere.

Failure rate

Jaere says that even in their final configuration, the helicopters' failure rate per flight hour is 40 times too high. Combined with maintainability problems, this frequently sees only one aircraft being available, and sometimes none.

Aircraft that were meant to fly 3,900h per year instead average 700h, the defence ministry notes.

Asked if it would work with the NHI consortium members in future, the NDMA says it "depends on our suppliers" to meet the needs of the nation's armed forces, but adds: "That being said, a decision to include or exclude [those] companies in future acquisitions would be made on a case-by-case basis based on a number of factors, not least... the resolution of this matter."

Oslo has begun the process of selecting a new maritime helicopter, with priority given to meeting coastguard requirements. It also has a looming requirement to purchase special forces helicopters.

"Maritime helicopters are something Norway must have, and it is therefore important that we quickly get started with the work of filling the gap created by NH90," says Gram. "We will look at several different alternatives to meet the operational needs, but we must be prepared for the fact that there is no easy solution."

Oslo had previously begun evaluating the feasibility of leasing helicopters from the private sector to meet coastguard requirements, freeing up NH90s for anti-submarine warfare (ASW) duties. That leasing option is still on the table, says the NDMA.

With the fleet now withdrawn from Royal Norwegian Air Force service, the nation must contend with a capability gap, particularly regarding ASW.

However, the NDMA says that "delays and limitations" with its delivered rotorcraft – including unresolved obsolescence of "several critical mission systems" – meant that it was already dealing with "a number of capability gaps, including ASW".

Norway becomes the second country after Australia to exit the NH90 programme: Canberra last December announced that it would retire its fleet of the type and acquire replacement Sikorsky UH-60M Black Hawks.

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Aircraft was making a routine 45min preservation flight

AirTeamImages

A320 thrust rollback traced to overspeed-protection valve

Event occurred on stored jet during serviceability flight

David Kaminski-Morrow London

UK investigators believe a thrust rollback on an Airbus A320, after which the affected engine would not respond to control inputs, resulted from inadvertent activation of a fuel-control protection valve.

But the inquiry says the issue – which has occurred previously on some International Aero Engines V2500 powerplants – has yet to be fully understood.

The Maltese-registered aircraft (9H-LOZ) was part of the Lauda Europe fleet but had been parked during the pandemic and was making a routine 45min preservation flight, at London Stansted on 28 May last year, to maintain serviceability. Only the two pilots were on board.

It departed runway 22 and was then vectored to carry out an ILS approach to the same runway.

The aircraft had its autothrust engaged. But during the approach, at a height of 950ft, the crew was presented with a fault warning on the right-hand engine's full-authority digital engine control.

According to the UK Air Accidents Investigation Branch, the electronic engine control had commanded an increase in target thrust to maintain the selected airspeed but, while that of the left-hand V2500 engine increased, the right-hand engine's thrust began to decline.

Its pilots executed a go-around and flew the missed approach manually before entering a hold to diagnose the problem. Within the holding pattern the right-hand engine remained at idle despite manual thrust-lever increases and re-selection of autothrust.

Throttle input

The crew informed that the engine indications "appeared to be frozen", and not responding to throttle input. After consulting the A320's operating manual, the pilots shut down the engine, declared an emergency, and conducted a single-engine approach and landing on runway 22.

During the landing roll, as the airspeed fell below 70kt (130km/h), an 'overspeed protection' fault was registered but not displayed to the crew. Investigation of the incident found that inadvertent activation of the overspeed protection valve in the fuel-control system was "most likely" to have been the cause.

This valve is part of the fuel-metering unit mechanism and works to reduce fuel flow to spray nozzles if the electronic engine control senses overspeed of the low-pressure or high-pressure engine spools. Exceedance on either spool is prevented by control logic that reduces fuel flow – but does not shut it off – maintaining the engine at a thrust slightly below flight idle.

Similar events have occurred on other V2500s, the inquiry says, and the engine manufacturer has investigated at component and system level to understand them. "Definitive identification of the root cause has not been possible, but several factors have been identified as possible contributors," it states.

These will be addressed as product-improvement changes to the fuel-metering unit, it adds, and are intended to be available in the third quarter of this year. Airbus also regularly communicates progress on the issue to operators with V2500 engines during customer meetings, the inquiry adds.

Carrier says video clip had been 'edited' from a staff briefing

Wizz Air

Wizz wakes up to 'fatigue' row

Low-cost airline defends itself against criticism from European Cockpit Association after CEO video is leaked

David Kaminski-Morrow London

Budget carrier Wizz Air is insisting that is not jeopardising safety, in response to a video recording of chief executive Jozsef Varadi apparently urging personnel to reduce disruption arising from calling in fatigued.

While the European Cockpit Association (ECA), which has obtained the video recording, is claiming that Varadi was effectively encouraging pilots to fly while fatigued, the airline chief does not actually mention pilots specifically in the short excerpt.

"I understand that fatigue is a potential outcome of the issues," he remarks, in reference to the difficulties of staff availability which the broader aviation industry is experiencing.

"But once we are starting stabilising the rosters, we also need to take down the fatigue rate."

Varadi says Wizz Air "cannot run this business when every fifth person of a base reports sickness because the person is fatigued".

Although he does not clarify whether he is speaking about aircrew or ground personnel, he does mention the "huge" damage, including compensation, when flights have to be cancelled.

"We are all fatigued," he says. "But sometimes it is required to take the extra mile."

Wizz Air states that the clip has been "edited" from a staff briefing attended not only by pilots, but cabin crew and office employees.

It says staff availability and welfare are among supply chain issues affecting all airlines, but adds that its own crew unavailability level is "very low" at around 4%.

Minimising disruption

"In this context, going the extra mile to minimise disruption was discussed," says the carrier. "What this does not mean is compromising safety.

"Wizz Air and the airline industry are highly regulated, and safety has, and always will be, our first priority."

The carrier says it has a "robust and responsible" crew-management system which "meets the needs of our people" as well as allowing the airline to serve "as many customers as possible" in the current situation.

Wizz Air has been forced to defend its reputation from pilot representatives, including the ECA, after being accused of having poor labour practices and an anti-union stance.

The airline has faced accusations from US aircrew labour groups after it sought to open services to the USA with a single Airbus freighter, which it operates on behalf of the Hungarian government.

In response to the ECA's objections, the European Commission and European Union Aviation Safety Agency (EASA) informed the US Department of Transportation, in March this year, of their activities relating to Wizz Air's safety oversight.

EASA became the competent authority of Wizz Air in August 2020, taking over the role from the Hungarian civil aviation regulator.

Confidential reports

It points out in the submission that aspects relating to labour arrangements between the airline and its employees are outside of EASA's mandate and scope, but it does have a process – free of conflicts of interest – to handle confidential safety reports from individuals.

EASA says that, since taking over as the competent authority for Wizz Air, it has received "several" such safety reports – either through the confidential reporting channel or emails from unions.

"All have been investigated... and all have led to particular actions conducted by EASA in the different domains specified in the reports received," it says.

"Regarding the specific case of reports related to Wizz Air's 'social climate', although EASA is not in charge of social aspects, they have all been taken seriously due to the perceived potential for affecting the safety culture of the operator if not addressed."

EASA says it has carried out investigation and verification work, including interviews with random pilots, cabin crew members, and other staff.

"No significant safety concerns were detected during all these activities," says the safety authority in its submission.

It insists it has found no evidence to substantiate ECA accusations about EASA's ability to exercise effective oversight at Wizz Air, including alleged safety implications arising from social matters within the carrier.

Driving Accelerated Change

The Farnborough Airshow's Aerospace Global Forum will set the agenda for many of the big challenges facing the industry during this decade and beyond

Launching at the Farnborough International Airshow in July, the Aerospace Global Forum (AGF) is a revolutionary global platform that aims to champion change and drive immediate action, accelerating transition towards the new, net-zero economy.

Developed by Farnborough International, AGF will bring global leaders together, across all industries, sectors, and geographies, for the very first time to drive conversation and interrogate issues to change the world for the better through an aerospace lens.

Taking place in tandem with the world-famous Farnborough International Airshow, from 18-22 July 2022, AGF will set the agenda for industry in the years ahead, discussing the new digital workforce and future leaders of the aerospace and defence industry, and preparing organisations for the new skills needed in an artificial intelligence (AI)-fuelled world. Topics include transitioning to net zero, sustainability across the defence sector, smart manufacturing, and hyper-scaling within the industry to speed up the pace of change.

Rolls-Royce

Warren East, Rolls-Royce

The future-focused forum will provide pioneers of change with an immersive platform to connect, collaborate, engage and learn through a diverse five-day programme of inspiring thought leaders and impactful discussions. Leaders from the finance and energy sectors, governments, climate consultancies, start-ups, OEMs and their supply chains will gather to debate and energise collaboration.

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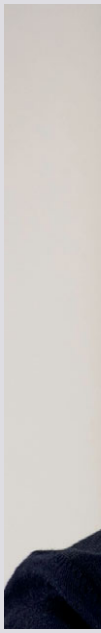
Charles Woodburn, BAE Systems

- Dr Charles Woodburn, chief executive, BAE Systems
- Warren East, chief executive, Rolls-Royce
- Willie Walsh, chief executive, International Air Transport Association
- Sir Stephen Hillier, chair, Civil Aviation Authority
- Kerissa Khan, president-elect, Royal Aeronautical Society
- Roger Camrass, research director, CIONET

Working with world-leading consultancies and networks, such as KPMG, CIONET, Deloitte, McKinsey & Company and World Economic Forum, as well as US government officials, UK government departments, ADS and other industry associations, AGF will drive cross-sector collaboration in order to achieve deep, long-term reductions in greenhouse gas emissions, and accelerate progress towards a net zero future. The aerospace industry plays a vital role in the global decarbonisation transformation.



"The 2022 Aerospace Global Forum will be the catalyst to create transformation and accelerate tangible change together"

Gareth Rogers Chief executive, Farnborough International

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Gareth Rogers, chief executive of Farnborough International, says: "The 2022 Aerospace Global Forum will be the catalyst to create transformation and accelerate tangible change through bringing the aerospace world together and tackling the challenges we are facing as an industry and the world.

"Climate change is the largest challenge to affect the world and we must react to it as an industry with the support of governments, academics, regulators and innovators. A diverse platform is needed to host these future-altering discussions, leading us to harness our pioneering spirit to develop and curate the Aerospace Global Forum.

"I urge industry leaders to join us in driving change and mapping out the next steps to achieve a net zero economy."

Kevin Craven, chief executive of ADS, adds: "The Aerospace Global Forum provides a real opportunity for the leaders of industry to come together with academics, government and innovators to consider the existential challenges that the aviation industry is facing both now and in the future. We need to understand what action can be taken within the sector to overcome these challenges and use the AGF to drive real action and change to ensure the aviation industry can adapt for the future."

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AGF isn't just a five-day platform. The thought leadership programme has been designed to drive change past July 2022 and create a springboard for a suite of spin-off forums and conferences in aviation communities around the world, throughout the year.

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HOW TO BOOK

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Agency expects some supersonic designs to be in use by the end of this decade

EASA sounds out views on supersonic rule update

Boom Supersonic

Regulator prepares ground for arrival of next-generation ultra-high-speed passenger jets

David Kaminski-Morrow London

European regulators are preparing an initial environmental-protection certification framework aimed at addressing the emergence of new supersonic transport aircraft designs towards the end of this decade.

The measures are being laid out in an advanced notice of proposals by the European Union Aviation Safety Agency (EASA).

EASA states that a new generation of supersonic commercial and business aircraft is expected to be operational from the late 2020s.

Noise and carbon emission requirements for such aircraft are topics that "need to be addressed", it says, to ensure a "high, uniform level" of environmental protection.

EASA points out that no ICAO standards exist for landing and take-off noise, or emissions, that would apply to supersonic aircraft – and that it intends to develop detailed requirements, which would apply until ICAO draws up its own.

"Pending ongoing work towards establishing an appropriate [carbon dioxide] limit for [supersonic aircraft], provisions for the standardised measurement and reporting of [carbon] emissions are proposed as an interim step," it adds.

Same standards

Its preliminary draft noise requirements would apply to all supersonic aircraft regardless of maximum take-off weight, number of engines, maximum operating Mach or required runway length.

ICAO defines maximum limits for subsonic aircraft and EASA is proposing to "apply the same noise limits" to supersonic types.

The effective perceived noise level for subsonic jet aircraft as well as the same noise measurement reference points can be "reused", it says, as the noise evaluation measure.

"Considering the specifics of [supersonic aircraft] designs, meeting those limits appears to be challenging but technologically feasible, as indicated by results from research studies," EASA adds.

The regulator says that, without limits in place, the "significantly" increased noise exposure around airports would potentially outweigh the advantages of quieter subsonic models.

Its proposal also outlines the complexities of translating subsonic emissions measurements for certification, based on three reference points, to the supersonic regime, given the specific performance and fuel characteristics of such high-speed designs.

EASA says the proposals "represent a first step" towards environmental protection requirements for supersonic models and will be "further developed" in subsequent steps. It is seeking comments on the measures by 25 July.

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Tiger upgrade ready to launch

Airbus Helicopters

Bilateral modernisation for French and Spanish fleets will progress using trio of prototypes, but German participation remains in question

MkIII will establish common standard for partner nations

Dominic Perry Marignane

Airbus Helicopters will use three prototypes for its Tiger MkIII upgrade programme for France and Spain as development work begins in earnest following contract signature with procurement body OCCAR in March.

First flight of the modernised attack helicopter will take place in 2025, using a donated customer airframe, followed by an additional pair of flight-test assets, also sourced from customers, says Victor Gerin-Roze, head of the Tiger MkIII programme.

The qualification phase will lead to the receipt of an initial example by France in 2029 and Spain in 2030, says Gerin-Roze, and deliveries are likely to run until the mid-2030s.

France will upgrade 42 of its 69-strong fleet to the new standard, with options covering another 25 airframes, while Spain will field 18 updated MkIII Tigers, from a current inventory of 23.

"We will adapt our production capacity," Gerin-Roze says of the potential additional airframes, noting that the impact of increased volumes will be "limited" and the programme phase extended.

"The idea is to minimise the retrofit duration – we will not pile up the aircraft," he adds.

Tri-national potential

The MkIII effort was originally envisaged as a tri-national programme, but Germany – which operates 55 Tiger UHTs – has until mid-year to decide on its participation. Berlin would still be able to join at a later date, albeit under slightly different terms, Gerin-Roze says.

Underpinning the MkIII upgrade is the idea of a common standard between the partner nations. Although certain differences in configuration will remain – Germany's Tigers will retain their mast-mounted electro-optical sensor, for example – the "common backbone" between the helicopters means it is just an "integration issue".

Similarly, the weapons available under the MkIII programme vary between operators: France will equip its helicopters with MBDA Akeron LP air-to-surface missiles, while Spain is expected to use Rafael's Spike ER2 munition.

Both nations will also gain laser-guided rockets from an undisclosed supplier, says Gerin-Roze, plus an enhanced chin-mounted cannon and "upgraded" version of MBDA's Mistral 3 air-to-air missile.

Other improvements include new avionics, a FlytX full glass cockpit and TopOwl helmet from Thales, enhanced communications and connectivity, Safran's Euroflir 510 electro-optical/infrared sensor, and an improved countermeasures system.

Additionally, the Tiger MkIII will be able to team with unmanned assets, although the level of interoperability to be available has yet to be revealed.

Is future NATO rotorcraft worth the weight?

Airbus Helicopters cautions that next-generation design must pile on the pounds if high-speed performance and current payload capability remain key priorities

Dominic Perry Marignane

NATO's next-generation helicopter will need a maximum take-off weight (MTOW) of up to 17t if high-speed performance and maintaining current payload capacity remain priorities, preliminary calculations by Airbus Helicopters show.

Under the alliance's Next Generation Rotorcraft Capability (NGRC) initiative a group of six nations are exploring a potential future programme to replace up to 1,000 8-15t helicopters in the coming decades.

Preliminary requirements released in 2021 called for a cruise speed of "optimally" 220kt (407km/h) or more, but no lower than 180kt. Radius of action was pegged at 400nm (740km), maximum range 900nm, and MTOW between 10-17t.

But Mathieu Louvot, executive vice-president, head of programmes at Airbus Helicopters, says that if operators want to achieve all those performance targets then "physics" will dictate an aircraft at the upper end of the weight range.

"This leads to 16-17t [MTOW] platforms in order to carry the same type of payloads that the helicopters carry today," he says.

Louvot argues that "much bigger machines" than those they are replacing will be required, leading to "a lot of consequences" on cost, logistics, and noise generated.

"It is not obvious that speed is the most important thing and that everything should be sacrificed to it," says Louvot, who estimates it will cost 25-30% more to carry the same payload over a given distance.

In his view, all high-speed architectures lead to a degree of performance trade-off, whether that is in low-speed handling, affordability or survivability.

Airbus Helicopters argues that its Racer compound architecture – which features twin V-wings and pusher propellers in addition to the main rotor – could offer a "very good technical answer" if speed is the "most important thing".

Louvot acknowledges that the configuration of the Racer – an EU-funded civil technology demonstrator – is unlikely to be suitable for certain military missions. However, "There are tweaks we can do to accommodate military needs," he says. "They don't change the whole architecture of the aircraft, it's more local adjustments."

Clear priorities

He stresses that those leading NGRC must clearly define their priorities in order to allow industry to respond with the best solution.

The project began in November 2020 with the signature of a letter of intent between France, Germany, Greece, Italy, and the UK, later joined by the Netherlands. The nations are assessing a memorandum of understanding for signature around mid-year, which will allow concept-stage work to begin.

Louvot asserts that it is important for Europe to develop its own solutions for next-generation rotorcraft, rather than simply buying into the US military's Future Vertical Lift programme. "It is important for independence and autonomy of Europe," he says.

Meanwhile, Airbus Helicopters and partner Leonardo Helicopters continue to wait for a response from the European Defence Fund to proposals submitted last year under the European Next Generation Rotorcraft Technologies framework.

Work under the first phase of the initiative will conclude in the coming months, with a tender for a follow-on project likely to be launched this year or in early 2023.

Although the next-generation technologies explored could support the development of a clean-sheet helicopter, Louvot says they could also be applied as an upgrade to existing platforms such as the NH Industries NH90, in which both Airbus and Leonardo are shareholders.

"A demonstrator is the next step – it's not a full programme," he says. "If you consider the European nations we speak about, even just the home countries of Airbus – Germany, France and Spain – there is clearly the capability, if there is the political will and the military need, to co-finance a demonstrator."

In-service types like H225M Caracal will need replacing in coming years

US Air Force

Distraction brought down Super Hornet

Royal Australian Air Force crew ejected from aircraft after its pilot failed to trim jet for take-off

Greg Waldron Singapore

Investigators have determined that a Boeing F/A-18F Super Hornet of the Royal Australian Air Force (RAAF) ran off the runway at take-off after a cockpit alert distracted the pilot, ultimately triggering a stressed response to the fighter's veering to the right.

The incident occurred on 8 December 2020, as the pilot attempted to take off from runway 33 at the RAAF's Amberley air base in Queensland.

According to a significantly redacted Defence Flight Safety Bureau (DFSB) report seen by FlightGlobal, as the aircraft taxied to the runway the pilot failed to trim it for take-off. Subsequently, after starting its take-off roll with the afterburners engaged, the pilot was distracted by a "Check Trim" alert.

Commonwealth of Australia

Aircraft A44-223 was returned to service in February

Acute stress

This "distracted the pilot from prioritising focus on directional control", and resulted in the Super Hornet deviating to the right, which went unnoticed for several seconds. A crosswind, as well as the asymmetric loading of unspecified stores, exacerbated the tendency to pull to the right.

"Upon noticing the heading deviation, it is likely the pilot suffered an acute stress response followed by a short duration of impaired cognitive performance," the DFSB says.

"During this period, a series of action errors were made in an attempt to correct and maintain directional control of the aircraft.

"Fixating on the task of regaining directional control during a cycle of impaired performance delayed the pilot retarding the throttles back to idle," it adds.

The fighter accelerated to a ground speed of 85kt (157km/h), at which point its right main landing gear exited the runway. The nose wheel then struck a runway edge light, causing its steering to fail.

After departing the runway and briefly leaving the ground, the weapons system officer in the rear seat initiated the ejection sequence for both crew members. The aircraft, now at idle power, came to rest about 930m (3,050ft) from the point of departure, and 200m right of the runway.

Investigators found that "substandard adherence to checklist actions" before the take-off resulted in the crucial "Check Trim" message.

Following the accident, adds the DFSB, the RAAF's Air Combat Group has taken safety actions around the "primary causal factors that led to the runway excursion".

Cirium fleets data shows that the incident aircraft (A44-223) was delivered in October 2011. Following repairs, it was returned to service in February 2022.

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Connect ties hopes to turboprop efficiency

Independent-minded US carrier rejects regional jets as it looks to build new North American powerhouse

Jon Hemmerdinger Tampa

US start-up Connect Airlines is banking on the efficiency of turboprop aircraft and an independent business model to help it carve out a niche in the North American market.

Connect chief executive John Thomas says the Massachusetts carrier aims to begin flying as soon as August from Chicago and Philadelphia to Billy Bishop Toronto City airport in Canada.

"We thought there was a great opportunity for a US carrier to go into Billy Bishop... to connect that [airport] to some of the major routes in the US," Thomas says. "The point-to-point traffic to Toronto is very important, but the connecting traffic will really underpin the economics of the operation."

Connect, which is still awaiting final operating authority from the US Federal Aviation Administration (FAA), will initially operate 76-seat De Havilland Canada Dash 8-400 twin-turboprops, of which it now has two, says Thomas, a longtime airline leader whose previous roles have included chief executive of Virgin Australia.

Lease agreements

Those two aircraft are leased from Canada's Chorus Aviation Capital and the carrier holds agreements to lease another three Dash 8s from Nordic Aviation Capital, Thomas says.

Two other US start-ups have launched since the pandemic started – Breeze Airways and Avelo Airlines, both of which operate large jets. By contrast, Connect will be a regional airline initially only operating turboprops.

Propeller aircraft have generally fallen out of favour in the USA in recent decades because, according to airlines, passengers typically shun the types, viewing them as outdated and noisy. Nearly all regional airlines in the USA now operate jets.

But because regional jets cost so much more to operate, Thomas says, the economics of the regional airline business sank with the transition.

Noise aside, Thomas insists turboprops make far more sense. The Dash 8-400s are 40% more efficient per seat than regional jets on shorter routes, he says, adding that turboprops can replace hundreds of small, ageing regional jets like the Bombardier CRJ200 and Embraer ERJ-145.

Connect's business plan calls for partnerships with major US airlines, though not in the same manner as has become typical in recent decades.

These days, nearly all US regional airlines operate under capacity purchase agreements (CPAs) with major US carriers. CPAs are deals though which majors pay the smaller airlines to operate regional flights, guaranteeing payment regardless of how many seats are filled.

Connect has no plans to sign CPAs. Rather, it intends to have only interline and codeshare agreements with major US carriers. Under those arrangements, Connect will remain independent and face the burden of filling its seats, though it will benefit from access to the majors' immense distribution networks.

"We are more than willing to take the revenue risk," Thomas says. "If we can codeshare – or in the very least interline – with the majors, we can tap into their distribution networks."

Brand awareness

Connect Airlines is a brand of Waltzing Matilda Aviation, which is based in Bedford, Massachusetts and operates Cessna Citation Excel and Bombardier Challenger 604 business jets, alongside ERJ-135s.

Thomas, who is also Waltzing Matilda's co-founder, was chief executive of Virgin Australia from 2016-2017. He also has experience as an airline consultant in the USA, having worked on projects including the Delta Air Lines-Northwest Airlines merger, Delta's joint business with

Mike C Photo/Shutterstock

Connect Air

Company aims to be 'the world's first true zero-emission airline'

Carrier will fly from Chicago and Philadelphia to Toronto City airport

"We thought there was a great opportunity for a US carrier to go into Billy Bishop... to connect that [airport] to some of the major routes in the US"

John Thomas Chief executive, Connect

Virgin Atlantic and Alaska Airlines' purchase of Virgin America.

Connect chose Billy Bishop as its initial destination because Toronto is among the largest North American air travel markets, and because Billy Bishop has limited competition, Thomas says. Porter Airlines flies to 12 cities from the facility, and Air Canada serves two. But the majority of traffic to the city is through the much larger Toronto Pearson airport.

Connect has secured 16 slots – allowing for eight daily round-trip flights – at Billy Bishop for the northern summer season, and expects to secure more for the coming winter. Beyond Chicago O'Hare and Philadelphia it will later add flights to Toronto from other large US cities like Baltimore, says Thomas.

Safety management

The FAA has already completed much of the work to certificate Connect's operation, having reviewed the airline's manuals, processes and safety management system, he says.

Steps still to be completed include proving flights for the FAA, which can only take place once the US Department of Transportation (DOT) grants permission for the those test sorties.

"We are now in a bit of a holding pattern, waiting for the DOT," Thomas says.

Additionally, Connect needs to secure foreign air operating certification from Transport Canada.

If all goes to plan, Thomas thinks Connect will launch revenue flights "around mid-August".

Universal appeal nets initial 75-unit order for ATR fuel-cell conversions

David Kaminski-Morrow London

Connect Airlines has ordered 75 converted ATR 72-600 turboprops, to be equipped with hydrogen-fuelled powertrains.

The firm agreement with Universal Hydrogen also covers an additional 25 conversions.

Universal Hydrogen was founded by former Airbus chief technology officer Paul Eremenko, and has an advisory board which includes ex-Airbus chief executive Tom Enders.

Connect Airlines is a planned scheduled airline company which is emerging from Massachusetts-based private jet charter carrier Waltzing Matilda Aviation.

It reached a provisional agreement last year with Universal Hydrogen covering conversion kits for De Havilland Canada Dash 8-300s and other aircraft types.

"We have committed to being the world's first true zero-emission airline and the only way to accomplish this in the near term is with hydrogen," insists Connect chief executive John Thomas.

Deliveries of the aircraft will start in 2025, says Thomas, who claims that the new airline's fleet could expand to over 800 aircraft to support a North American route network. "We see the partnership with Universal Hydrogen as the fastest path to zero-emission operation," he says.

Eremenko says the Connect order puts the company "firmly in the vanguard" of the "march" to set aviation on a path to meet emissions targets.

"This march will very soon need to turn into a sprint if the industry has any hope of decarbonising in time without having to curtail the growth in passenger volumes," he adds.

He says there will be a need to convert "most of the regional fleet" this decade and ensure that newly-built single-aisle aircraft in the 2030s are hydrogen-fuelled.

Under the deal with Connect Airlines, Universal Hydrogen will also provide fuel services to the carrier's fleet.

Universal Hydrogen is offering hydrogen fuel services to airports using a "modular capsule" technology which, it says, enables transport and handling of hydrogen using existing intermodal freight networks and cargo-handling equipment.

Dassault battles for NGF control

French airframer standing firm in contractual stand-off with Airbus over access to technology for future combat aircraft

Dominic Perry Geneva

Tensions between the industrial partners involved in a French-German-Spanish effort to develop a sixth-generation fighter appear no closer to resolution, with attempts to progress the project still stalled.

Airbus Defence & Space and Dassault Aviation were due to sign a contract last year covering the creation of a demonstrator aircraft for the New Generation Fighter (NGF) being developed as part of the wider Future Combat Air System (FCAS) programme.

However, that contract – known as Phase 1B – is no closer to being agreed, says Eric Trappier, chief executive of Dassault, the prime contractor for the NGF work.

"We were ready to go ahead but sometime between September and December it stopped. I don't know how it will start back," Trappier told FlightGlobal while attending the EBACE business aviation show in Geneva in late May.

While FCAS was originally a Franco-German project, the admission of Spain in 2019 has ratcheted up the tension, particularly on the NGF, where Airbus now represents both Berlin and Madrid.

"It is not only a political issue, it is also a matter of sharing the work between Airbus and Dassault," says Trappier.

"We have made big efforts, [but] as far as Dassault is concerned we have only one-third of the job. We are the prime architect taking overall responsibility in front of the defence ministries and want to be capable to take this responsibility without Airbus always saying they want to do more."

Dassault's main objection is the insistence that intellectual property relating to flight-control software be shared among the partners.

Guarding systems

Trappier points out that the system for the NGF demonstrator will be an "off-the-shelf" solution, derived from a Falcon business jet. "Why should we share our technology on the Falcon with Airbus? Airbus in Toulouse knows perfectly well how to develop flight controls," he says.

But with Germany and Spain likely to insist on full co-operation – or at least access to the technology – on the flight-control system for any future production aircraft, this appears likely to remain a thorny issue.

Trappier contrasts the impasse on the NGF with the four-nation Eurodrone project, which is led by Airbus Defence & Space. "We follow them," he says. "We are not trying to say we need to know everything, and they should do the same [on the NGF]." Dassault is developing the flight controls for the unmanned aircraft.

He says Dassault is still prepared to sign the Phase 1B contract, but only within the previously agreed framework, not to rules "that are changed every three months" to accommodate the demands of other parties.

While the delay to the launch of Phase 1B activities continues, Dassault has had to redeploy its project engineers elsewhere. Although a contract signature is still possible this year, "I will need time to gather the team again", Trappier notes.

Airbus, however, defends its position, noting that agreement has been reached on "all six other pillars" of the FCAS development, "where even under a defined leadership the competence and capacities of each partner are respected and can participate in an equitable manner".

"Airbus has made several proposals to converge also on the NGF and we are supporting any solution which will respect both the skills of each partner and the lead role of Dassault, leading to a fair agreement," it says.

"We are confident that a resolution can be achieved if the rules of the co-operation agreed by the nations are respected in the NGF, as it is the case on other pillars."

Dassault Aviation

Three-nation demonstrator will rely on know-how from Falcon business jets

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GAO highlights US programme delays

Multiple military aircraft developments are among projects failing to deliver on time for nation's armed forces

US Marine Corps

VH-92A presidential helicopter is one of six aviation efforts behind schedule

Ryan Finnerty Burlington

The US Government Accountability Office (GAO) has highlighted the significant delays being experienced in delivering new equipment to the nation's armed forces, including multiple aircraft types.

Detailed in a 9 June report, the watchdog's review of 29 Major Defence Acquisition Programmes (MDAP) looked at their performance since January 2021.

Seventeen, or 59% of the programmes, were experiencing contract-delivery delays of between two months and one year, and nine of those noted further delays as of January 2022. No MDAP achieved initial operating capability ahead of schedule during the review period.

Six aircraft development programmes were among the affected procurements: the Boeing KC-46A Pegasus (delayed 55 months), MQ-25 Stingray and T-7A Red Hawk (12 months); Northrop Grumman's MQ-4C Triton (92 months); and the Sikorsky CH-53K King Stallion (80 months) and VH-92A presidential helicopter.

While not yet officially reported, delays also are expected on another four: Boeing's CH-47F Chinook upgrade, MH-139A Grey Wolf utility helicopter (based on the Leonardo Helicopters AW139) and VC-25B presidential aircraft; and Sikorsky's HH-60W Jolly Green II.

The 747-8I-derived VC-25B has been affected by labour challenges including Covid-19-related work disruption, prompting Boeing to declare $660 million in cost overruns during the first quarter of this year.

While the US Air Force's (USAF's) KC-46A recently achieved a major milestone in being certified to conduct 97% of regular refuelling missions, the tanker development project has generated more than $5 billion in cost overruns for Boeing and continues to experience "design instability", the GAO says.

The GAO notes that although the USAF's contract with Boeing limits the government's cost risk on its new jet trainer, the T-7A "still faces schedule delays and the risk of future cost growth as the programme moves into production". The airframer rolled out the first engineering and manufacturing development-phase jet in late April.

Meanwhile, the GAO concludes that recent Pentagon efforts to accelerate the development and delivery of new capabilities have largely failed to generate results.

"We continue to find that the department misses opportunities to gain appropriate knowledge before making significant investment decisions," its report states.

It goes on to say that defence officials and Congress continue to have "limited insight" as to whether specific programmes are likely to deliver on promised capabilities.

Missed opportunity

The GAO also notes it has made hundreds of recommendations over a 20-year period for how the US Department of Defense can improve its acquisitions process, but many have never been implemented.

Separately, the GAO has outlined a reduction in so-called mission capable rates across a variety of operational aircraft.

The process looked at readiness rates for four USAF and four US Navy types between 2015 and 2021. These respectively included the Boeing B-1B and KC-135, Lockheed Martin C-5M and F-22; and Boeing F/A-18E/F Super Hornet, P-8A and Lockheed C-130T and KC-130T.

All eight saw their mission capable rates decline, and failed to meet their mission capable goals. Overall, the GAO review covered 1,355 airframes that cost about $13.6 billion to maintain in fiscal year 2020.

In the largest declines, the F-22's mission capable rate dropped by 16.7 percentage points, to stand at 50.3% in 2021; that of the KC-130T fell by the same margin, to 36.5%.

"Fewer mission capable aircraft can limit training and other flying opportunities for squadrons, and forces aircraft that are mission capable to fly more often," the GAO notes. It adds that a common practice of 'cannibalising' parts risks causing damage, exacerbating the sustainment challenge.

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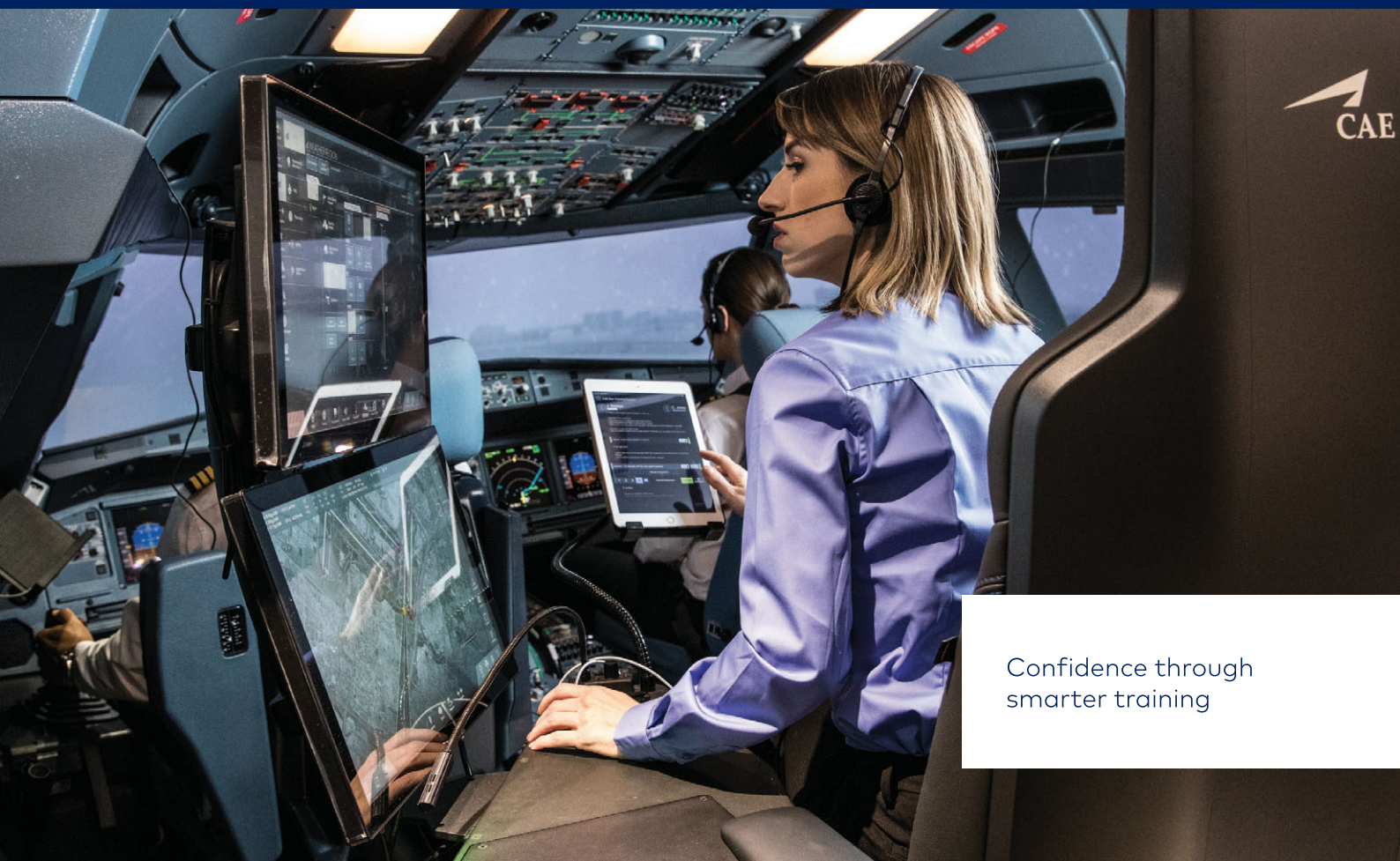


Backing business

The launch of Bombardier's revised ultra-long-range Global 8000 was highlight of EBACE show's return

Dominic Perry & **Kate Sarsfield**
Geneva

After a three-year pandemic-enforced absence, Europe's premier business aviation show EBACE returned to its home in Geneva in mid-May.

While commercial aviation has yet to return to pre-Covid levels, business aviation has emerged stronger from the downturn as those travellers able to afford the price tag switch to private flying.

In the meantime, the airframers have not stood still, with those at the top of the industry unveiling range-topping new aircraft in the form of the Dassault Falcon 10X and Gulfstream G800. The latter in particular, promising an 8,000nm (14,800km)-range and 2023 service entry, had threatened the segment leadership of the 7,700nm-range Bombardier Global 7500.

Somewhat inevitably, the Canadian manufacturer responded, launching at a lavish EBACE ceremony the long-promised Global 8000.

In addition to a range of 8,000nm, the new jet will have a maximum speed of Mach 0.94 and be capable of carrying 19 passengers.

But there is a twist: it is not the aircraft the Canadian airframer envisaged at the start of the programme. Back when Bombardier first touted the ultra-long-range twinjet, it was planned as a 2.6m (8.5ft) shrink of its 33.8m-long Global 7000 sister that was capable of flying 500nm further, hitting the 7,900nm mark.

However, while the Global 7000 progressed, eventually morphing into the Global 7500, the 8000 remained stuck on the drawing board.

With the changing market, notably the keener competition from Gulfstream, Bombardier needed a response – but in its view, building a jet that could fly only 200nm further than the Global 7500 at the expense of cabin volume, or two passenger seats, was not the right approach.

Instead, it has taken a radical – albeit lower-cost – step: rather than developing an all-new jet it has instead souped up the performance of the Global 7500 to create an aircraft that can cover 8,000nm and fly up to 1.3% faster than the current M0.925 maximum.

Launching the new jet on 23 May, Bombardier chief executive Eric Martel said customers had asked if it would still pursue the Global 8000 "given that the Global 7500 was performing so well – today we are happy to answer".

High performance

The new Global is "two aircraft in one", he says, providing "everything the Global 7500 has to offer" but with "a level of performance that has never been seen before in business aviation".

Bombardier has already begun validating the modifications required using its FTV5 flying testbed operating from a site in the USA. And on 18 May 2021 – accompanied by a NASA-operated Boeing F/A-18 fighter – the aircraft was taken past the sound barrier to M1.015, becoming the fastest civil aircraft since Concorde and taking a crucial step towards certificating the new standard.

Service entry for the Global 8000 is anticipated in 2025, says Bombardier. At that point two things will happen – thanks to a service bulletin all Global 7500 owners will be able to convert their jets into the Global 8000, and production of the earlier model will be phased out; list price will also rise from $75 million to $78 million.

"The speed and cabin size will be more than those of the G800 – we have taken a no compromise mentality to how we want to position this aircraft at the top of the pyramid," says Bombardier.

Bombardier

Service entry for Global 8000 is anticipated in 2025

BillyPix

Dassault has cited supply chain pressures for the delayed arrival of its Falcon 6X

The Global 8000 will be 33.8m long, with 16.59m of useable cabin space, compared with respective figures of 30.4m and 14.27m for the G800.

"We are doing everything that we wanted to do with the original Global 8000 but with the longer fuselage," adds Bombardier.

Weight savings

To turn one Global into the other, changes are needed to the control software for the jet's twin GE Aviation Passport engines and tweaks enabling additional fuel to be carried are required. "We are going to be utilising space and weight savings to be able to carry more fuel to unlock the range potential of the aircraft," says Bombardier.

A single prototype will be used for the certification campaign, the company says.

Development costs should be relatively modest, says Bombardier, and in line with its previously announced 2025 spending plan, the bulk of the programme investment has already been absorbed during the Global 7500's genesis.

Of course, it does not take a genius to predict what will happen next given Gulfstream's history of breaking speed records – it set another city-pair record flying a G700 test aircraft between Savanah and Geneva in the run-up to the show – and it would come as little surprise if the G800 boasts more range and a higher maximum speed at service entry than currently advertised.

Although private aviation may have come out of the pandemic in better shape than other parts of the industry, business aircraft manufacturers are suffering from exactly the same basket of troubles as their commercial colleagues.

Dassault has cited precisely those supply chain pressures for a six-month delay to the service entry of the Falcon 6X, pushing the milestone back to mid-2023.

"I'd like to stress that the Covid epidemic is still active – fortunately not at the crisis levels of before, but strong enough to disrupt business," says chief executive Eric Trappier.

He notes that "the fast recovery with limited resources of the global economy is creating unprecedented constraints on the supply chain, not only in our industry but across the entire manufacturing sector".

M1.015

Speed achieved by FTV5 testbed in validating Global 8000 modifications – the fastest civil aircraft since Concorde

In addition, the war in Ukraine is "adding disruption" with rising energy prices and raw material shortages. As a consequence, "our anticipated target of year-end 2022 for the entry into service of the 6X is shifting, and is now forecast by mid-year 2023", he says.

The super-large 5,500nm-range Falcon 6X was launched in 2018, following the company's cancellation of the troubled 5X programme. To date, three aircraft in the test fleet have logged over 850 flying hours.

Nonetheless, Dassault brought a Falcon 6X to EBACE, parking the fourth test aircraft (F-WZOA) on the static display. Fitted with a fully outfitted cabin, the twinjet was scheduled to embark on a global 40-stop "proving campaign" in June, to ensure the reliability of the aircraft and onboard systems in "real-world operating conditions".

Certification progress

Completed flight-test activities include cold-soak and high-elevation tests, and the flight envelope has been expanded well beyond the aircraft's M0.90 maximum operating speed. Flight trials remaining include natural icing and contaminated runway tests, says Dassault.

Meanwhile, production and assembly of the top-of-the-range Falcon 10X is gearing up at sites around Europe and North America, with final assembly of the ultra-wide-body twin to begin next year.

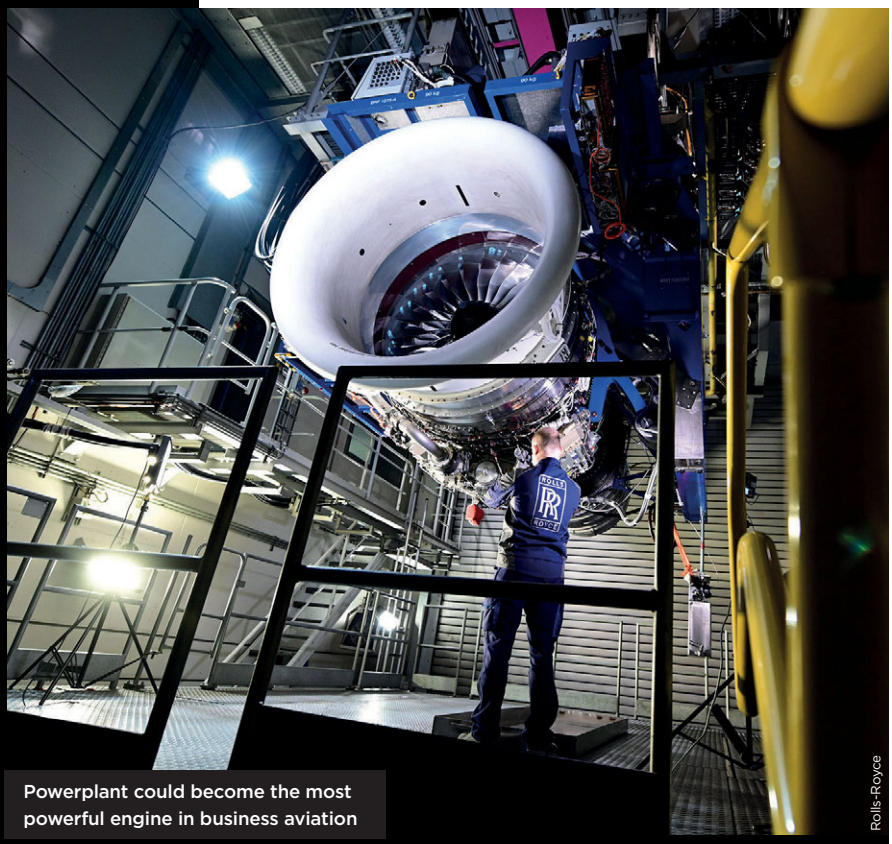
A new production hall at Dassault's Biarritz plant in southwest France is dedicated to the aircraft's all-composite wing. The initial example is in final assembly and will be placed in a static test rig in the third quarter.

"We are making excellent progress in getting this new aircraft into production, and the coming months will see an increasing flow of parts, subsystems and large structures into our facilities in the south of France," says Trappier.

Dassault has not disclosed when the 7,500nm-range 10X will make its maiden sortie, but it is confident the aircraft will enter service as scheduled in 2025.

Rolls-Royce polishes Pearl performance

Dominic Perry Geneva



Powerplant could become the most powerful engine in business aviation

Rolls-Royce

Rolls-Royce is accelerating testing of its Pearl 10X business aviation engine for the Dassault Falcon 10X, as it closes in on certification for the Gulfstream G700-powering Pearl 700.

An initial Pearl 10X powerplant was first run in January and the programme has since accumulated around 1,000h, including time amassed on the earlier Advance2 demonstrator.

The first full powerplant housed within its Spirit AeroSystems-designed nacelle will enter the test programme later this year.

Performance has so far been in line with expectations, says Philipp Zeller, senior vice-president for the Pearl 10X.

Four engines will be used for the ground-test campaign, with another four to be trialled aboard the manufacturer's Boeing 747 flying testbed.

Flying Falcon

R-R is also already in the early stages of producing the engines that will power the Falcon 10X on its first flight.

"We are starting already to build vehicles for the flight-test programme of Dassault," says Zeller. "It is a very mature engine from the start because we are building on the experience of the Pearl 700."

Neither R-R nor Dassault have revealed the exact power rating of the Pearl 10X, simply indicating it will produce in excess of 18,000lb (80kN)-thrust. However, Dr Dirk Geisinger, director of business aviation at R-R, says that it will be "the most powerful" of the Pearl-series engines, putting it above the 18,250lb-thrust-rated Pearl 700.

Depending on where the Pearl 10X eventually ends up, it could even claim the distinction of being the most powerful business aviation engine; that title is currently held by the GE Aviation Passport on the Bombardier Global 7500, which is rated at 18,920lb-thrust.

Despite its higher power, the Pearl 10X is contained in a nacelle no larger than that of the Pearl 700 or in-service Pearl 15.

"We get more performance out of the core – it is run hotter to achieve higher thrust. There is a big focus to package it as small as possible to minimise the drag factor," says Zeller.

Geisinger says that the results of the testing so far have been positive and Dassault appears pleased with the performance. Despite this confidence he cautions that "in these programmes both sides have to stay paranoid until certification".

Meanwhile, the propulsion specialist is closing on mid-year certification for the Pearl 700. Testing is now complete and the vast majority of paperwork has been submitted to lead regulator the European Union Aviation Safety Agency.

To date, more than 2,500 test hours and more than 8,000 cycles have been completed on the Pearl 700. While R-R has finished its certification programme on the engine, Gulfstream continues to rack up flight hours using its six-strong test fleet.

"We have almost stopped counting because they are going up so quickly," says Geisinger.

Although there is increasing focus on sustainability in the aerospace industry and the potential for alternative power sources to help the decarbonisation agenda, Geisinger cautions that the top end of business aviation will face similar limitations to long-haul commercial operations.

Battery limits

He points out that to take an aircraft like the G650 and maintain its 7,000nm (13,000km) range with eight passengers aboard, converting it to run on batteries would mean the "take-off weight would be 1,000t, not 45t".

Geisinger argues that sustainable aviation fuel (SAF) and more efficient gas turbine engines will be the key technologies to help the sector reduce its carbon emissions over the next 40-50 years. Both the Pearl 700 and 10X will be capable of running on 100% SAF.

"But that doesn't mean that we are not innovating and bringing what we are working on today as a step forward," he says.

He sees the potential for mild hybridisation of engines in future with the gas turbine augmented by a battery that could, for example, provide additional power during high-demand flight phases or for use while taxiing.

"We would like to offer our customers thrust and a power plug," he quips.

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Green pioneers get space to shine

Eviation Alice and VoltAero Cassio 330 highlight sector's low-emission efforts

Dominic Perry Geneva

Since the last edition of EBACE in 2019, the aviation industry's environmental performance has come under ever-tighter scrutiny.

Although business aviation's carbon emissions are a tiny fraction of those produced by the sector as a whole, they are much worse on a per-passenger basis given the low occupancy levels of private aircraft.

It was telling then that a chunk of the EBACE show floor was dedicated to those promoting zero-emission aircraft. In fact, electric propulsion specialist Magnix was occupying a piece of real estate previously allocated to the absent Honda Aircraft.

Testing times

Eviation, which opened its European order book at EBACE, is gearing up for the first flight of its all-electric Alice prototype in the coming months, having completed ground testing earlier in May.

However, the clean-sheet aircraft developer is staying tight-lipped on precisely when the proof-of-concept Alice prototype will take to the skies, simply saying the milestone will occur "this summer".

"We have a well-constructed programme schedule we are working towards now," says interim chief executive Gregory Davis.

In February this year the company promised that the Alice's maiden sortie was weeks away, but the aircraft has remained earthbound. Eviation has since moved the Alice to Grant County International airport at Moses Lake in eastern Washington, from where it will conduct the first flight.

Davis declines to specify the reasons for the delay but says the results of ground tests convinced it to slow the push towards first flight.

"The reason why we do the ground testing is so that we know how the aircraft is going to operate.

"When we completed the ground-test programme we found some things that we needed to tweak and that's what we are working on as we prepare for first flight," he says.

Evaluations of the systems under review have been conducted in recent weeks, Davis adds.

Low-speed ground testing was wrapped up on 2 May, says Davis, with the aircraft having been taken to a maximum speed of 86kt (160km/h). High-speed taxi trials, including the crucial rejected take-off test, will only be performed once the aircraft has secured its experimental permit to fly.

Davis says flights of the first of three certification aircraft will begin in 2024. This should lead to type approval for the unpressurised version from the US Federal Aviation Administration under Part 23 regulations in 2025. Eviation anticipates cargo operations beginning that year and passenger flights using the pressurised model starting in 2026.

Eviation continues to develop the supply chain for the Alice, with several key partners already identified; for example, sister company Magnix is providing twin Magni650 electric motors and GKN Aerospace is to build the wing. Final assembly will take place in Arlington, Washington.

Sales efforts for the Alice are meanwhile gathering momentum as Eviation looks to add to its current 87-unit backlog. Efforts at EBACE were largely focused on the six-seat Executive variant for which Eviation sees interest from individual aircraft owners, corporate flight departments, and larger fleet operators, such as Wheels Up, in the Part 135 charter and air taxi space.

"I look forward to announcing an Executive deal at some point before long, I hope," says Davis.

Fractional ownership

Describing its attendance as "very successful", French hybrid-electric aircraft developer VoltAero launched at EBACE a European fractional ownership programme for its five-seat Cassio 330.

VoltAero received initial expressions of interest in the scheme at the show and says it will now follow up with potential customers.

"We found EBACE to be oriented toward the operators, and we met many who conveyed strong interest in acquiring and flying the Cassio aircraft family on regional routes or segments," says the company.

The fractional ownership programme will launch in France but will expand elsewhere in Europe to meet demand. The scheme is based around a 20% share of 800 flight hours, potentially rising to 1,000h, per year, with a baseline of five operators per aircraft, says the firm.

VoltAero – led by former Airbus chief technology officer Jean Botti – will later expand the initiative to cover the follow-on six-seat Cassio 480 and 10-12-seat Cassio 600.

Powered by a 330kW parallel hybrid system in an aft pusher layout, the Cassio 330 will use the electric motors for taxi, take-off, cruise flight, and landing, while the internal combustion engine serves as a range extender to recharge the batteries during flight, plus as an emergency back-up. Service entry is scheduled for 2024.

Alice has completed low-speed ground testing but is yet to fly

Eviation

Eve Air Mobility

Eve programme has been spun out of Embraer

Study investigating certification challenges faced by eVTOL developers suggests current timelines may be optimistic

Jon Hemmerdinger Tampa

A US government report suggests certification of electric air taxis could take longer than some manufacturers are promising, citing the formidable hurdles still to be overcome.

The report from the Government Accountability Office (GAO) says industry goals of having electric vertical take-off and landing (eVTOL) aircraft certificated within one to five years may be unrealistic.

Indeed, the 9 June report notes that the Federal Aviation Administration (FAA) may "not have clear standards for how to certificate these aircraft, and the development of clear standards may extend well beyond this timeframe".

The GAO based its study on interviews with various parties involved in the advanced air mobility (AAM) market, including manufacturers, local governments, unions, universities and air traffic managers. Electric air taxis are a central component of the AAM landscape.

Despite timeline uncertainty, the report says many industry participants do expect some small electric aircraft may be operating in the next five years – though in limited numbers and in few locations.

Broader expansion will depend on overcoming numerous regulatory, technical and social challenges.

The report says air taxi technology "may pose difficulties for certificating", adding that "much work remains in order to certificate eVTOL aircraft for commercial service".

Most air taxi developers have been pursuing certification under the FAA's Part 23 rules, which apply to small commuter aircraft.

But those rules, written for fixed-wing aircraft, do not fully apply to characteristics unique to eVTOL types, such as their electric propulsion systems and ability to transition between vertical and horizontal flight, the GAO report notes.

For that reason, the FAA tweaked its regulatory strategy in May. It now intends to certificate eVTOL aircraft under a "special class" category, meaning it will use applicable Part 23 standards supplemented by other rules, such as those for helicopters, says the report.

Growing field

In recent years, many companies jumped on the air taxi bandwagon, with plans to develop small electric aircraft capable, broadly speaking, of carrying several passengers on flights of perhaps 50nm (92km).

Notable players include Embraer-backed Eve Air Mobility, Joby Aviation, Vertical Aerospace, and Boeing-funded Wisk Aero. Some start-ups have already flown prototypes and aim to have their designs certificated by 2023. Others have taken what Eve co-chief executive Andre Stein calls a more realistic track: it aims to deliver its first aircraft in 2026.

But much work remains. The GAO report says eVTOL manufacturers may struggle to establish air taxi take-off and landing facilities. Though developers have pitched their designs as capable of operating from existing structures like parking garages and rooftops, such "facilities would require extensive modification to make them useful".

"Infrastructure developers may be hesitant to finance" such projects due to the business case being untested, the report adds.

The infrastructure may also need updating. Large eVTOL fleets "could consume enough electricity to impact the electrical grid", the report says.

The AAM concept will also require a complex air traffic management system – one capable of handling large numbers of aircraft operating at low altitudes in crowded urban air space, says the report.

Other unresolved issues involve pilot training. Some companies say they are equipping their air taxis with such advanced flight-control systems that the FAA could safely allow eVTOL pilots to have less training and experience than pilots of conventional aircraft.

But the report says the opposite might be true. "Early AAM pilots will need not only traditional flight skills but also skills for monitoring the sophisticated computer systems of highly automated aircraft operations," says the report.

The whole air taxi concept also depends on public acceptance.

People must be convinced eVTOL aircraft are safe, and air taxis must not be so loud as to spark widespread public opposition, the report says. Manufacturers claim their aircraft will be quieter than helicopters due to their electric powertrains.

The report adds that ultimate public acceptance depends on air taxis being widely accessible and affordable, not simply "a luxury item for the wealthy".

SOCOM targets GPS vulnerability

US Special Operations Command seeks precision targeting capability free from reliance on crucial satellite constellation

Ryan Finnerty Burlington

America's elite troops want to move away from a reliance on GPS-guided munitions for precision strikes, according to a US Special Operations Command (SOCOM) officer.

"[We're] expecting the future operating environment won't have GPS readily available," says Lieutenant Colonel Matt Foertsch, who leads the precision strike team within SOCOM's procurement office for fixed-wing aircraft systems.

The US government-controlled GPS satellite constellation has fuelled a revolution in military operations, from navigation and encrypted battlefield communications to strike weapons.

Boeing's Joint Direct Attack Munition (JDAM) guidance kit has allowed more than 400,000 unguided gravity bombs to be quickly and cheaply converted into precision munitions. The system also is available with laser guidance.

However, some US operators think GPS-guided bombs' best days are behind them. China and Russia have successfully tested satellite-killing missiles in recent years, and it is also possible to jam, disrupt or even spoof signals. GPS spoofing has been suggested as one possible explanation for Iran's 2011 capture of a Lockheed Martin RQ-170 Sentinel unmanned air vehicle (UAV) which was being operated by the US Air Force (USAF) for surveillance purposes.

With such vulnerability in mind, SOCOM is asking the defence industry for options for replacing GPS in precision weapons.

"Right now, we largely do laser targeting," Foertsch notes; a task which requires ground forces, loitering UAVs or manned aircraft to 'paint' targets prior to weapons release. "But we're looking for future capability that industry has pushed along in the optical realm, or automated target recognition," he said at the Special Operations Forces Industry Conference in Tampa, Florida on 18 May.

"We're looking for greater range and stand-off distances," he notes. As an example, SOCOM is developing two miniaturised cruise missiles that incorporate features such as glide wings and electric propulsion, but these are years away from full-scale implementation.

Stand-in weapons

In a 2021 report, the Mitchell Institute's Mark Gunzinger argued that the USAF should focus on developing so-called "stand-in" weapons that can be released and fly independently to targets 50-250nm (93-463km) away.

Meanwhile, SOCOM expects to reach a decision in its Armed Overwatch competition during July. This seeks 75 manned, fixed-wing aircraft that can carry out intelligence, surveillance and reconnaissance missions, and provide close air support for troops on the ground.

To be suitable for use in an "austere and permissible environment", the selected aircraft will replace the Pilatus PC-12 U-28A Draco, which is not equipped for the close air support role.

L3Harris is teamed with Air Tractor in offering the AT-802U SkyWarden; Sierra Nevada is pitching the M28-derived MC-145B, developed in partnership with Lockheed-owned PZL Mielec; and Textron Aviation the Beechcraft AT-6 Wolverine.

Each of the competitors conducted demonstration and test flights for SOCOM in mid-2021, and its Acquisition, Technology and Logistics office is now in the source-selection phase.

Budget documents show that the US Department of Defense requested $166 million to purchase six Armed Overwatch aircraft in fiscal year 2022, and $246 million for nine more in FY2023.

The Armed Overwatch programme is being managed by SOCOM's Program Executive Office for Fixed Wing, which also oversees platforms like Lockheed's AC-130J Ghostrider gunship, UAVs and precision strike weapons.

US Air Force

SOCOM oversees AC-130J gunship among other platforms

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M. Goldschmidt
Ejendomme A/S

AirTeamImages

Aircraft would have been unable to stop on runway if take-off was aborted

Intersection data slip-up led to 737 using whole runway for take-off

Performance miscalculation following departure change and division of tasks in cockpit behind 2018 Schiphol incident

David Kaminski-Morrow London

Pilots of a KLM Boeing 737-800 did not amend a runway intersection designation when recalculating take-off performance data for Amsterdam Schiphol, leading the aircraft to accelerate too slowly and use almost the entire runway length before becoming airborne.

KLM only became aware of the incident two-and-a-half months after its occurrence, by which point neither the flight-data nor cockpit-voice recorder information was available.

But analysis of aircraft maintenance system data shows the jet rotated at the calculated speed of 157kt (290km/h) and lifted off just 176m (577ft) from the far end of runway 09, crossing the threshold at 28ft.

Dutch investigators have attributed the incident to operational and time pressures, with an unplanned last-minute change of runway intersection following a delayed departure from the gate.

The aircraft (PH-BXG), bound for Munich on 10 June 2018, had three cockpit crew – the captain, the first officer, and a safety pilot on the observer seat – because the captain was supervising as route instructor to the first officer.

To give the trainee first officer additional time for flight preparation, the captain and safety pilot took over some of the first officer's tasks.

The crew had expected a runway 36L take-off from intersection V3, but the flight was switched to runway 09.

Initially the crew tried a performance calculation for an intersection N4 departure from runway 09, but the weather and aircraft weight meant this could not be achieved, and the figures were recalculated for intersection N5.

As the flight queued for the runway, air traffic control asked the crew whether an N4 intersection departure was possible. Initially the crew replied in the negative but, after hearing the wind conditions given to another aircraft, the captain – based on his experience – believed the conditions would allow take-off from N4.

New information

The safety pilot recalculated the take-off data, using the new wind information, but crucially did not amend the intersection from N5 to N4. This meant that when the take-off data was presented, suggesting an N4 departure was possible, it actually showed data for an N5 departure. The difference in runway distance between the two is more than 1,000m.

The first officer taxied the aircraft to N4 while the safety pilot handed the print-out with the recalculation to the captain, who entered the data into the flight-management system, without noticing that the figures were based on the wrong runway intersection.

Neither the change of intersection nor the entry of new data into the flight-management system was monitored by the first officer, and the Dutch Safety Board says this division of tasks by the crew contributed to the incident.

"Use of erroneous take-off performance data led to a situation where no safety margins remained," it adds.

As the aircraft accelerated, both the captain and the safety pilot realised it was approaching the runway end quickly, but no adjustment to the thrust was made.

"The aircraft became airborne at the very end of the runway," says the inquiry. Only during the climb, when the captain and safety pilot discussed the abnormality, was the use of the incorrect intersection detected.

This error meant the take-off distance available to the aircraft was just 2,460m compared with the 3,490m used for the performance calculation – which resulted in a lower thrust setting being used and slow acceleration.

Analysis shows the aircraft would have been unable to stop on the runway if the take-off had needed to be aborted at the V1 decision speed.

Investigators state that the crew did not report the incident to the operator, adding: "This was caused by the fact that the aircraft took off without any problems and the crew did not recognise the seriousness of the situation."

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Ewan Hoyle Photography

Norse Atlantic Airways began Boeing 787 flights to the USA from Oslo, and from August will serve London Gatwick-New York JFK

Simon Fewkes

Dassault Aviation delivered the first of two Falcon 900LX trijets to be used as 'Envoy IV' VIP transports by the UK Royal Air Force

Jetstar

Qantas unit Jetstar's incoming fleet of 38 Airbus A321neo-family jets will feature an updated livery with an orange tail and underbelly

Bonza

Australian low-cost carrier Bonza plans to launch services in September using three Boeing 737 Max 8s

Bidders were given until 20 June to register interest in the UK's New Medium Helicopter contest, which seeks 44 Puma replacements

Crown Copyright

Best of the rest

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

AVIC performed a 20min first flight of its AG600 amphibian with an increased maximum take-off weight of 60t

AVIC

Romania's Mikoyan MiG-21s will retire in May 2023, replaced by ex-Royal Norwegian Air Force Lockheed Martin F-16A/Bs

Igor Bozinovski

Next month

Our half-year analysis of safety across the airline sector

FLIGHT INTERNATIONAL

On sale **28 July**

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Saab

Allied front
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Airbus

Farnborough
We bring you all the best stories and images from flagship UK show

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Spirit of change

Back following a four-year wait after pandemic-linked restrictions thwarted its 2020 edition, the Farnborough air show is the most eagerly-awaited aerospace event of the year. The industry will gather in a changed mood, however, with Covid-19 recovery still a work in progress and attention having swung dramatically towards environmental considerations. Our preview takes a UK focus, assessing the nation's progress towards a goal of meeting net zero carbon emission targets. We review Rolls-Royce's latest technologies, look at modular jet designer Aeralis's "best of British" approach, and see how BAE Systems and Spirit AeroSystems UK have fared through the health crisis and Brexit. Plus, we focus on activities at Airbus and Boeing, as the "big two" strive to restore past stability, and explore how the major engine manufacturers are preparing for the future.

Rolls-Royce

Aerospace Technology Institute

Wirestock Creators/Shutterstock

Airbus

Leonardo

Aeralis

Normally biennial, the air show is taking place in mid-July for the first time since 2018 – and its chief executive insists the post-pandemic version has moved with the times

Back with a difference

Murdo Morrison London

It was early March 2020 and the hard work of persuading companies to confirm chalets and exhibition space at that summer's Farnborough Airshow was all but complete. With the industry in buoyant mood, the team was making final preparations for a biennial event, which – despite Boeing's travails with its grounded 737 Max – was set to be one of the most successful in years.

The only worry was reports of a mysterious and potentially deadly flu-like virus that appeared to be spreading from Wuhan in China into other parts of Asia and even into Europe and North America.

That concern soon turned into a crisis and, on 20 March, just days before Prime Minister Boris Johnson announced a UK lockdown, Farnborough International said it was cancelling the show for the first time in over 70 years. The move caused consternation among some exhibitors after Farnborough refused to refund fees, but rather offered to roll bookings over to 2022.

However, speaking to FlightGlobal ahead of this year's event, Farnborough chief executive Gareth Rogers says the majority of customers backed the decision, especially as the impact of the pandemic became clear. "People understood why we had to do it. We have been very much supported by industry," he says.

Farnborough 2020 was, of course, just one of thousands of events, aerospace and otherwise, that fell victim to Covid-19 over the next 18 months; cancellation of the 2021 Paris air show followed shortly after. However, Rogers, who took over at Farnborough International in early 2018, says that having to scrap the event after almost two years of work was "devastating".

Two years on, his team are readying for the first major summer air show since Paris 2019, and Rogers promises a "celebration". The Covid-19 crisis has given the event an "added dimension", he says. "It's been too long. Everyone is excited to be here."

Visitors will notice a number of differences this year, says Rogers, including the introduction of the Aerospace Global Forum, a series of debates and seminars taking place over the five days of the show and covering issues such as the future of flight, workforce challenges, the digital challenge, and sustainability.

Conversation starter

"We wanted to move Farnborough away from simply being a convener of business to where we start to curate the discussions on the topics that are most important to the industry," says Rogers, who was previously chief executive of Southampton Football Club. "We wanted to layer that debate across the air show, to ask the hard questions and create a conversation for the industry."

Another change for 2022 will be the absence of the weekend public days. They were not part of the plan for the 2020 show, and the decision reflects the increasing difficulty Farnborough has had in attracting non-trade visitors to what had become a less-than-inspiring aerial spectacle. Air display restrictions imposed after the 2015 Shoreham tragedy did not help.

However, an aerial element will still be a core part of Farnborough. "Doing an afternoon of displays is not the purpose of the air show," says Rogers. "But it is important for our exhibitors, both military and commercial, to demonstrate their products in real life, in front of potential customers. That will remain at the heart of the show."

Event will be the first major summer air show since 2019

Farnborough International

Another innovation will be an enhanced focus on careers on the final day of the week. In previous years, the emphasis on Friday had been on bringing primary school children and younger teenagers to Farnborough on what was dubbed "Futures Day" in the hope that many would be inspired to take up careers in science, technology, engineering and maths, including in the UK aerospace and defence sectors.

However, says, Rogers, 2022 will be more about enticing 16- to 25-year-olds to the show, with the focus on career opportunities. "Industry told us they loved Futures Day, but they have a problem they need to resolve in the next two years. This means engaging those embarking on careers right now," he says.

Farnborough will again have an international flavour, with exhibitors from more than 50 countries and visitors from many more. However, there will be no place at this year's show for the Russians. Soviet aircraft memorably featured at Farnborough throughout the Cold War. However, following Moscow's invasion of Ukraine, regular exhibitors such as Irkut and Russian Helicopters will be missing.

"It is important for our exhibitors, both military and commercial, to demonstrate their products in real life"

Gareth Rogers Chief executive, Farnborough International

Was Rogers worried that after two years where businesses have got very used to virtual meetings and getting by without travelling, the appeal of live events might have diminished? Farnborough itself staged two "Farnborough Connect" webinar programmes in 2020 and 2021 with some success.

"This is something the whole exhibition industry has grappled with, but people do want to get back to meeting face to face," he says. "Virtual meetings have their place, but these technologies existed before Covid-19. The pandemic got people used to communicating virtually, but it would have taken over before if it was a proper substitute."

Revenue generators

Before the crisis, Farnborough had been branching out into hosting other events between air shows, boosted by the opening in 2018 of its permanent Hall 1, one of the largest exhibition spaces in southeast England. They have ranged from the British Motor Show to an exhibition for builders. As well as being revenue generators in their own right for Farnborough International, the experience "hones our skills and ultimately helps us put on a better air show", maintains Rogers.

The 2022 Farnborough Airshow will represent not just a fresh start after two years of the pandemic. It is taking place at the beginning of what many believe will be the most exciting decade for aerospace in a long time. Several new disruptive technologies are on the cusp of becoming reality – from urban air mobility platforms and artificial intelligence to the replacement of carbon-burning engines with electric or hydrogen-powered alternatives.

Many of these will be on display – or the topic of lively debate – from 18-22 July.

Spend to save

For a previously high-flying sector still recovering from the pandemic, gaining the investment needed to fund a zero-emission future will be key

Aerospace Technology Institute

FlyZero project outlined three hydrogen-powered aircraft concepts

Dominic Perry London

The requirement to decarbonise aviation could arguably not have arrived at a worse time for the global aerospace industry: just at the point at which the sector is attempting to ease its way back to financial stability following the ravages of Covid-19, there comes the need to spend unprecedented sums on research and development projects.

While many of the technologies required – particularly those that will increase an aircraft's efficiency – do not represent a complete pivot away from previous research efforts, the new emphasis on zero-emission propulsion technologies, notably hydrogen, is a significant shift.

That switch, of course, comes with both risk and opportunity: whoever masters these new technologies stands to reap the financial rewards; on the flip side, however, the companies or countries that specialise in disciplines which stand to be fundamentally changed are in danger of losing their leadership position.

For UK aerospace, the risk is real. In the executive summary of its year-long study into the feasibility of zero-emission flight, released in March, the Aerospace Technology Institute (ATI)-led FlyZero project concluded that the country's specialisms – airframes, wings, fuel systems, thermal management, and turbine engines – are among those likely to be most affected by a potential switch to liquid hydrogen as a fuel.

"All these elements would need to be redesigned for a hydrogen aircraft, presenting the UK with both a threat and an opportunity," it says. "If the UK acts ahead or alongside other nations, it can lead the development of new technologies where it is currently strong and secure a greater share of activity."

And as ATI chief executive Gary Elliott and FlyZero project director Chris Gear note in their foreword to the executive summary: "The UK is ideally positioned to build on decades of expertise in aerospace innovation to develop, test and certify the advanced technologies which will propel a new generation of liquid hydrogen-powered aircraft into our skies."

But that will require rapid action to secure future work: in order to win a place on any programme entering service in the 2030s, "UK companies must be ready to demonstrate new systems by 2025", FlyZero says. In essence, those developments must be brought to technology readiness level 6 by that point, it says.

Market share

The reward? The UK could potentially see its share of large commercial aircraft global market turnover rise from 13%, or £11 billion ($13.8 billion) in 2019 to 19%, or £36 billion, in 2050. Conversely, if the nation does nothing, then market share could fall to 9%, the number of aerospace jobs could drop to 74,000 from 116,000 at present, and "crown jewel technologies" could be relocated overseas.

FlyZero's research has already had an impact, shaping the ATI's latest technology strategy, Destination Zero, which was released in late April.

> "If the UK acts ahead or alongside other nations, it can lead the development of new technologies where it is currently strong and secure a greater share of activity"
>
> **FlyZero**

The government-backed body identifies three core areas of focus: zero-carbon emission aircraft technologies; ultra-efficient aircraft technologies; and cross-cutting enabling technologies and infrastructure.

Pursuit of all three technology streams is an "imperative" for the UK as they are "interdependent and mutually supportive", says the ATI.

But this grand ambition is largely moot if the funding – whether public or private – to support the research required is not in place. Here, there has also been progress: following a difficult 2021 when the ATI had to suspend applications for new grants due to a pandemic-driven cash crunch, the government has now said it will provide an industry-matched £685 million to the body over the next three years; an increase over the £235 million of the previous period. Additionally, the ATI will also now be supported until 2031.

Rolls-Royce

Developing more efficient gas turbines like UltraFan remains vital

Sophie Lane, the ATI's chief relationships officer, welcomes the investment uplift but recognises there will be "a lot of competition for the funding available" given the scale of the challenge and the industry's broader financial state.

"We will need to make some clear choices about where we invest that money," she says.

Overall, she is "encouraged by the amount of support that the government is willing to give at this time", adding: "I think this will allow us to focus clearly on what needs to be done and to make clear choices."

However, there will need to be a "sustained commitment" from both government and industry until the end of the ATI's current term, she says. "That really allows you to not only invest in the technology development, but also ensures that you get the environment in which that technology can be adopted.

"In many ways, those are the areas that worry me more than the technology," adds Lane, noting the "chicken and egg" nature of the investment.

Infrastructure issues

To an extent, the wider infrastructural and operational considerations will be addressed by the UK's newly created Zero Emission Flight Delivery Group, a body that sits under the existing cross-industry JetZero Council. The collaborative approach taken by the ATI is also crucial, argues Lane. "When we made our [funding] application and in our discussions with government, the fact that the industry was willing to invest was incredibly important.

"I also think industry is really ambitious about what can be done. And there is a huge opportunity coming with the zero-carbon market because globally there is a lack of [technology] maturity."

However, she is acutely aware that there are plenty of countries dangling financial carrots at the aerospace industry in the hope of securing inward investment. "So really all we are trying to do is show why the UK is a good place to invest and a good place to do that technology development."

Rolls-Royce

The UK's ATI has invested in electrification research such as the ACCEL project's Spirit of Innovation (*left*)

On the face of it, Brexit would appear to be a factor in the UK's thinking, pushing London to re-enforce its position outside of the EU through higher spending. While acknowledging a likely impact from the UK's withdrawal from the bloc, Lane thinks it is "the technology advances in the last two years [which] have fundamentally changed the conversation about what the art of the possible is". It is this, rather than politics, which is driving the need to invest, she believes.

There are already signs that the funding committed to the ATI is having an impact. Announcing the establishment of a Zero Emission Development Centre (ZEDC) focused on hydrogen technology research at its Filton site near Bristol in late May, Airbus cited the financial uplift as a factor behind its decision.

"Establishing the ZEDC in the UK expands Airbus's in-house industrial capabilities to design, develop, test and manufacture cryogenic hydrogen storage tanks and related systems for the ZEROe project," says Sabine Klauke, Airbus chief technical officer.

"This, coupled with our partnership with the ATI, will allow us to leverage our respective expertise to realise the potential of hydrogen technology to support the decarbonisation of the aviation industry."

Airbus had previously said it would set up ZEDCs at its facilities in France, Germany and Spain.

Continuity also appears to have played a role. "We can continue to invest in one of our largest [research and technology] programmes, the 'Wing of Tomorrow', based in Bristol and Broughton, and launch new [research] development around fuel and landing systems," adds Airbus chief executive Guillaume Faury.

The progress on Wing of Tomorrow – another ATI-backed project – is illustrative of a broader point raised in the Destination Zero strategy: although not directly related to zero-emission flight, the development of ultra-efficient aircraft forms a vital component in the overall drive to lowering aviation's carbon footprint.

As such, Lane estimates that at least 50% of the projects that the ATI funds in future will be a continuation of previous work. While some projects – for example Rolls-Royce's ACCEL electrification programme – have a logical end point, there are others, like Wing of Tomorrow and the engine maker's UltraFan programme, which could naturally carry on.

"As aviation addresses the challenge of zero carbon and complex new mobility markets, the industry must develop a swathe of new technologies in short order and no single country can accomplish this alone"

Aerospace Technology Institute

But the financing of UltraFan also highlights another important point: the global nature of aerospace means that it is nigh-on impossible for the UK to act in complete isolation. Many of the technology bricks used in the UltraFan demonstrator – its Advanced Low Pressure System, for instance – have been developed thanks to funding from a variety of sources, including the ATI, its German equivalent LuFo, and the EU's Clean Sky initiative.

Alan Newby, director of aerospace technology and future programmes at R-R, believes it will be vital that those multinational efforts continue in order to "maximise synergies between European and national programmes" to ensure "there is no discontinuity" between the research activities in different countries.

Plus, the sheer level of investment required will drive companies and nations down the collaborative route, he adds: "We need to look at all possible funding sources to bring things together." Or, as the ATI puts it: "As aviation addresses the challenge of zero carbon and complex new mobility markets, the industry must develop a vast swathe of new technologies in short order and no single country can accomplish this alone."

EU funding

Despite Brexit there appears a strong likelihood that UK firms will still be able to benefit from the Clean Aviation programme, the EU's successor to Clean Sky. However, how deeply they will be involved is as yet unclear: although UK companies will be allowed to participate, their eligibility for EU funding hinges on London signing up to the Horizon Europe programme as an associate country.

If that does not take place, UK entities can form part of a bidding consortium but will not receive EU funds, instead potentially seeking additional financial backing at national level.

Lane says the UK has "an incredible amount that we can offer in this sector" and thinks it would be "disappointing" if companies are unable to take part. "We will continue to work as hard as we can to support their applications," she adds.

Newby says the advice R-R is receiving from the government is to apply for funding through Clean Aviation as the UK is keen to be an associate country to the effort. "Clearly we have a footprint outside the UK which we could use, but our prime role is in line with the guidance from the UK and we are planning an association to the programme."

But what if UK entities can take part in but not obtain funding from Clean Aviation? "There needs to be an alternative if they can't participate," says Lane.

At its heart, an investment in research and technology is a bet: it is a wager that whatever is developed or validated can eventually be commercialised. In normal times the aerospace industry tends towards a safe bet, but the capacity to tolerate higher levels of risk at institutional level may now have to rise. Indeed, the ATI argues that firms will have to "accept more risk within their technology portfolios to make the advances that will be needed".

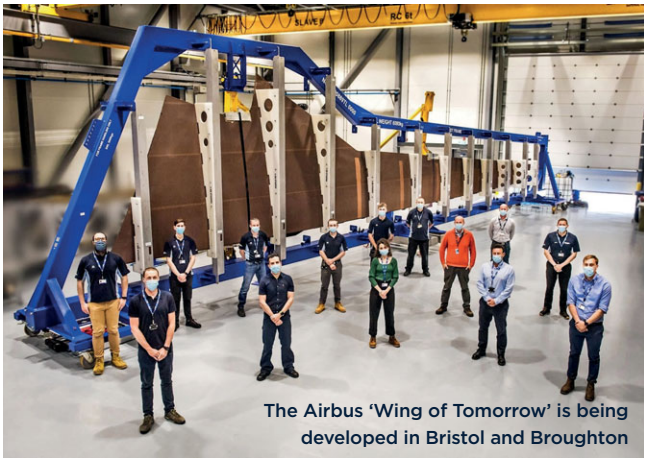
However, as many observers have noted, aviation appears to be on the cusp of a revolution as significant as the dawn of the jet age, with substantial rewards available for those that back the right horse.

"There's a lot happening now that could fundamentally change the way we fly in the future," says Lane. "But to do that we are going to have to make some investments that might not pay off and we're also going to have to learn lessons quickly and apply those into development. And that's going to mean for some people that they have to take a number of risks that maybe corporately they wouldn't ordinarily."

Aerospace Technology Institute

"There's a lot happening that could fundamentally change the way we fly in the future. But we are going to have to make some investments that might not pay off and we're also going to have to learn lessons quickly"

Sophie Lane Chief relationships officer, Aerospace Technology Institute

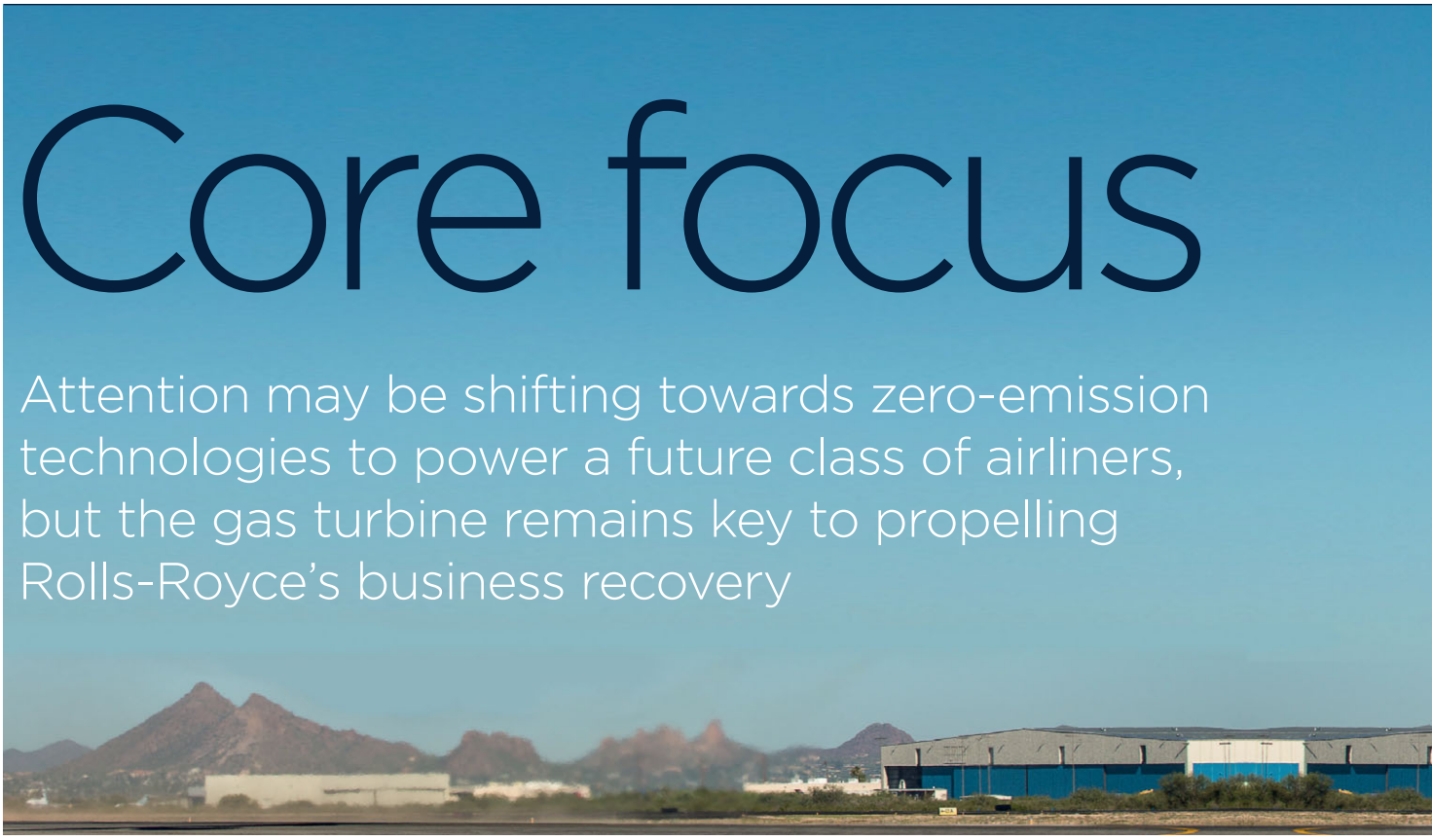


The Airbus 'Wing of Tomorrow' is being developed in Bristol and Broughton

Airbus

Core focus

Attention may be shifting towards zero-emission technologies to power a future class of airliners, but the gas turbine remains key to propelling Rolls-Royce's business recovery



Dominic Perry London

Rolls-Royce's commercial engines business arrives at this year's Farnborough air show a changed beast – leaner, more agile, heavily focused on decarbonisation – yet with the gas turbine still firmly at the heart of the unit.

The pandemic accelerated a restructuring initiative – the largest in the company's history – that was already in process at the UK-headquartered manufacturer, seeing it slash thousands of jobs and dramatically cut costs (*see p58*).

But while the business itself has been reshaped, its fundamental belief in the primacy of the gas turbine has not, says Alan Newby, director of aerospace technology and future programmes.

"I think sometimes there's a belief that the future is hydrogen and the future is SAF [sustainable aviation fuel] and the future is electricity, therefore the gas turbine has no place," he says.

Efficiency premium

"We would say quite the opposite – because in a future world, whether you are burning SAF or hydrogen in some form, you are going to need a highly efficient gas turbine. And quite possibly the premium on efficiency will go up because those new fuels could either be in short supply or more expensive than kerosene today."

That is not to say those other elements have no place, he stresses: in the short term greater SAF use will be the industry's main route to hitting net-zero goals, particularly for long-haul flying. Further out, hydrogen appears to be the future fuel of choice. Additionally, other breakthrough technologies such as full- or hybrid-electric systems will enable even greater levels of performance to be squeezed from the gas turbine, or can be employed in markets such as those for regional or commuter aircraft.

Rolls-Royce

UltraFan demonstrator is being readied for its first run

But the focus is still very much on the gas turbine, and, as Newby points out – only slightly tongue in cheek – "no presentation would be complete without talking about the UltraFan".

UltraFan is a subject that has loomed large in every R-R briefing since the programme was announced in 2014. But with the project now approaching a major milestone – the first engine run – it is becoming even more prominent.

Newby displays a palpable sense of excitement: "I was part of the team that launched UltraFan a few years back and it's so satisfying to see this coming together: you walk down to the shop and you can see the engine taking shape," he says.

While many of the underpinning technologies – the lean-burn combustor, high-temperature materials, composite-titanium fan blades and advanced low-pressure system – have already been validated in separate tests, the UltraFan engine will see these

Engine manufacturer has already validated new composite-titanium fan blades

Rolls-Royce

run in conjunction for the first time. "This is really bringing it all together as a system to make sure it works together and delivers what we expect it to. There's a real buzz around the organisation," he says.

Newby is coy on when the UltraFan will run – it is, he says, a "complex beast", owing to its level of instrumentation – but with a tank of SAF for the powerplant already delivered, that milestone feels imminent.

As currently sized, the UltraFan demonstrator will be the world's largest aero engine, with a fan diameter of 355cm (140in) and a power gearbox that delivered 64MW in early testing. It should achieve a 25% fuel-burn and carbon dioxide improvement against the first generation of Trent engines, or 10% over the newer Trent XWB. But the lean-burn combustor will also contribute to lower levels of nitrous oxide emissions and particulates, plus an engine that is 35% quieter too. "This isn't just about carbon [dioxide], it's about the way the whole set of attributes impacts on the environment," Newby says.

No thrust rating for the demonstrator has been disclosed, but R-R says the design is scalable from 25,000lb (110kN) to 100,000lb.

But as Newby is quick to point out, the UltraFan demonstrator is "not the end of the story", because "we will need that architecture which can be developed and can be grown and can be improved".

That means an eventual production engine – whether for single- or twin-aisle applications – which can be used with 100% SAF from the very beginning, has hydrogen compatibility in its roadmap, and could also make use of some form of hybridisation.

"If Airbus, or another manufacturer, is saying the answer for future narrowbodies is hydrogen, then we want to be capable of doing that. We believe the UltraFan architecture is the right solution for that."

> "I was part of the team that launched UltraFan a few years back and it's so satisfying to see this coming together"
>
> **Alan Newby Director of aerospace technology and future programmes, Rolls-Royce**

Eyeing alternatives

In R-R's view, for the vast majority of narrowbody and widebody applications, the most appropriate propulsion system will remain a gas turbine engine. Further down the size range – an area of the market long-since abandoned by the manufacturer – are other technologies such as full-, hybrid-electric and fuel cell-based powertrains.

"There are a lot of alternative solutions," says Newby. "We have been in this fortunate world where we've had one size fits all – a gas turbine burning kerosene for all applications – but it may not be like that in the future.

"But if you look at that space – the narrowbodies, widebodies and even some regional aircraft – where the fuel is burned today, or conversely where the CO2 is produced, those are the solutions that are still going to need a highly efficient gas turbine, which is why we are continuing to invest heavily in that."

Potentially supplementing the gas turbine, though, are a whole host of emerging technologies. Take, for example, electric power. The topic poses an interesting conundrum for R-R as a whole: battery limitations mean a large fully electric aircraft is all but ruled out, yet Rolls-Royce Electrical – created earlier this year as its own unit – is actively developing powertrains for the emerging urban air mobility market.

Rolls-Royce

PGS1 demonstrator produced 2MW of power

For Rolls-Royce Civil Aerospace, then, the interest centres on hybrid-electric power and is two-fold: first, what can it offer its large-engine portfolio by way of efficiency gains; and, second, can that technology take the company into new, or at least long-relinquished, market segments?

Solutions vary from a "macro-hybrid" architecture – where a significant amount of power is delivered by the electrical system – to a "micro-hybrid", where the electrical system uses "stored energy to support the gas turbine", whether in flight or on the ground.

Aided by the 2019 acquisition of the Siemens eAircraft business, R-R has been researching both the technology and the attributes of electric systems, allowing it to identify specific applications and tailor the company's approach to specific sectors, says Newby. Activities have included running its PGS1 demonstrator – a pair of generators married to a modified AE 2100 turboshaft – to produce 2MW of power. The PGS1 was originally due to be part of the powertrain on a converted BAe 146 as part of the E-Fan X project the manufacturer was running alongside Airbus.

Testing times

Pandemic-driven budget cuts called time on that effort prior to it taking flight, but "we learned a hell of a lot from the ground testing", Newby asserts.

"That was a really successful test – we learned about the electrical machinery, we learned about the integration with the gas turbine, the control, but also the heat management and the control of the gas turbine itself. So it was a really fascinating one," says Newby. Knowledge from the testing will feed into product studies as R-R looks to the commuter and regional markets.

"It's great doing the experiment, but what really matters is the knowledge you feed back into the system and the lesson you learn to inform the future."

Fuel cells may also feature in future and work is ongoing with R-R's Power Systems business to evaluate "what it would take to make a hydrogen fuel cell competitive for aviation".

Research is also being conducted into the feasibility of using liquid hydrogen as a fuel. "We are of the view that it looks likely there could be a role for hydrogen in the future. And therefore we need to start to understand the challenges of bringing it to market," says Newby. R-R is focusing on the "higher-risk and challenging technologies" required for liquid hydrogen use, chiefly issues around combustion and management.

"That will inform our view on how quickly [liquid hydrogen] could be brought to market and what the major challenges are to be addressed," adds Newby.

But with so much spoken about 'disruptive' technologies in aviation, for a company such as R-R, which still has the gas turbine at its core, there seems to be a perception problem. "People think that a gas turbine isn't disruptive, that it's old hat," he says.

But, as you might expect, R-R takes the opposite view. "You can enhance it with the technologies we have got here for a gas turbine to be a viable and disruptive solution for the future."

How tough restructuring process has made Rolls-Royce fit for the future

The restructuring undertaken by Rolls-Royce Civil Aerospace cut deep: operational costs were slashed by £1.2 billion ($1.5 billion), or 35%; footprint was reduced by 27%; and some 8,700 full-time posts, 34% of the workforce, were eliminated, including about one-third of management. Evidence of that exodus can be seen in the number of former R-R staff now occupying senior posts at businesses such as Lilium, Magnix and Vertical Aerospace.

These actions have contributed to making the business "stronger, leaner, simpler and more efficient", R-R civil aerospace president Chris Cholerton said during a recent investor briefing.

There are no arguments that the restructuring was necessary; even before the pandemic hit, R-R had been battling a succession of crises, notably around the Trent 1000 engine for the Boeing 787, on which turbine blade durability forced the grounding of customer aircraft and landed the manufacturer with a bill of about £2.4 billion.

Then as Covid-19 hit and the aviation industry reeled, R-R found itself hit with a double-blow: not only were deliveries of new aircraft placed on hold, cutting revenue from sales of new engines, but with the installed fleet also not flying, services revenue also dried up. And, as quickly became apparent, the long-haul market on which R-R relies was going to take substantially longer to recover than the short-haul segment. These factors contributed to underlying operating losses in 2020 and 2021 of £2.57 billion and £172 million, respectively.

As Cholerton points out, there was an "intense focus both before the pandemic and accelerating through the pandemic in driving cost reduction [and] efficiency". However, he asserts that it was not merely about slashing costs but significantly enhancing structure and process to "emerge with a fundamentally more efficient operating system".

A change in mindset has also taken root throughout the business, Cholerton argues, leading to "a greater belief that ambitious targets can be met and exceeded".

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Best of British

Start-up military jet developer Aeralis approaches key design milestone as interest soars in its innovative modular family of products

Craig Hoyle London

Aeralis is one of the many companies hoping to help propel the UK aerospace industry out of the pandemic-driven downturn, as it attracts new industrial partners and fresh financial backing for its modular family of military jets.

The firm will conduct a preliminary design review (PDR) for a demonstrator aircraft "in the autumn", and is aiming for a first test flight within three years.

Interest in Aeralis has spiked since the aerospace sector began emerging from the Covid-19 crisis late last year. The start-up company's stand at last September's DSEI exhibition in London was inundated with visitors, and it also grabbed attention by unveiling two full-scale mock-ups at March's DIMDEX event in Qatar.

"The aim is to get the first article of the modular vehicle flying by 2025, so we can prove that the company is capable of getting approval to fly a modular jet training aircraft," says chief executive Tristan Crawford.

Aeralis's concept makes use of a core common fuselage, to which a variety of propulsion systems, wings and payloads can be integrated. Roles could range from basic and advanced jet training to light attack duties, along with operational/aggressor training and aerobatic display team use.

Originally piloted assets could later in life be converted for unmanned roles such as intelligence, surveillance and reconnaissance, "loyal wingman" or even autonomous in-flight refuelling, it believes.

Aeralis will be at the Royal International Air Tattoo (RIAT) at Fairford in Gloucestershire from 15-17 July, and at the Farnborough air show.

"Our focus is more on RIAT this year," Crawford says of the normally annual military spectacular, which is being staged for the first time since 2019. The company has taken a hospitality chalet and also hopes to have a full-scale mock-up at the event.

"We will be hosting a lot of people – military delegations and industry partners," he says. "Particularly some of the key international customers who have RFIs [requests for information] and RFPs [requests for proposals] out at the moment."

Emission statement

At Farnborough, Aeralis is taking space on the West of England Aerospace Forum stand: in May it opened a new office and "enterprise hub" in Bristol.

"We will be looking for the aerospace supply chain to come and talk to us about the technology options that we can bake into our technology roadmap to achieve net zero [emissions] in the timeframe that we are looking for," Crawford says. "That's everything from biodegradable aerostructures, sustainable aviation fuel [SAF], more electric aircraft systems and digital manufacturing and assembly."

Crawford believes Aeralis presents a real opportunity for UK industry to shine on the global stage. "We are looking to independently develop this aircraft system as a UK solution, and we are going to hold true to the model that we are using – best in breed, best in sector, best in UK – to do it. We are not looking to create an aircraft company on our own," he adds.

Development draws on off-the-shelf technology from multiple UK partners

Aeralis

Its core design organisation is now working with nine UK aerospace SMEs to design its demonstrator vehicle. "Including the large industrial partners, there are 16 companies involved in the programme, and 136 individuals working on the design," Crawford says.

There are pacts with the Aircraft Research Association (design), Atkins (structural and systems design), Aernnova-owned Hamble Aerostructures (core fuselage design), Martin-Baker (crew escape system), Rolls-Royce (propulsion systems), Siemens UK (digital enterprise and digital mock-up), Swift Aircraft (design), and Thales UK (synthetic training).

Asked whether Aeralis could explore establishing a manufacturing arrangement with a prime contractor such as the nation's largest defence company, Crawford notes: "We are open to working with the best companies in the UK. And if that included BAE Systems, we would be delighted – just as we were with everyone else."

"We don't want to hook ourselves to investors that will limit our ability to change the aeroplane later on"

Tristan Crawford Chief executive, Aeralis

Investment secured last year – including from Barzan Holdings, the sovereign wealth investment arm of Qatar's defence ministry – has enabled Aeralis to hone the design for its pre-production aircraft. "Their interest is, first and foremost, purely a financial one," Crawford says of the stake from Doha.

Earlier this year, the UK Royal Air Force's (RAF's) Rapid Capabilities Office (RCO) also strengthened its collaboration with the company, and could in the future agree additional work packages.

"We are now extending that to start to design and test the [RCO's] Pyramid avionics system that we are going to be baking into the preliminary design of the vehicle," Crawford says.

"When we go past PDR, that's the point at which the commercial model is set and agreed for investing deeply into the detailed design," Crawford says.

"That's the current drive: the next tranche of investment to get us to first flight." He says the company is in discussion with a potential "key sponsor", whose support "will unlock the other equity investors".

Staying flexible

However, he notes: "What we don't want to do is constrain the design by hooking ourselves to investors that will limit our ability to change the aeroplane later on. So we are narrowing that pool down to the three or four that actually will allow us to maintain the flexibility in the aircraft design."

Comparing its offering to urban air mobility products as an investment prospect, he notes: "It's nearer term, it's more real. There's much less R&D risk in what we are doing.

"We will be starting with an off-the-shelf engine, but making sure that it's going to be SAF-compliant. We are also having the debate now over whether some of the systems that we are putting into the design even for the first vehicle could be fully electric."

For an operator, equipping an Aeralis jet to serve as a companion trainer for a frontline type such as the Lockheed Martin F-35 – including emulating elements of the stealth fighter's cockpit – would carry "five or 10% of the operating cost", Crawford claims.

This could enable air forces to avoid a situation where perhaps 70% – or potentially even 90% for some platforms – of their training will be performed using simulators.

"We see the aeroplane providing this cross-cutting mix of synthetic and live flying experience which is a lot richer than you have today, which is basically 'make everything synthetic, and you might get to fly every now and then if you are lucky'," Crawford says.

So, when does Aeralis expect to attract its first customers? "Once the industry can see that it's happening and it has been invested into actually flying, that is when the first discussions on payments and deposits will start," Crawford believes.

An aspirational target for the company is to see its product become a candidate to re-equip the RAF's Red Arrows aerobatic display team, which is expected to stop flying its BAE Hawk T1s after 2030.

"I would be lying if I said that wasn't something that we would be really excited about," Crawford says. "We like to think that when they are ready to make that decision, we are a very good candidate. We are designing a jet that would be perfect in that role. It would display the best of British."

Neo normal

Airbus is plotting a major recovery to its operations as the pandemic effect lessens, with transformed and expanded final assembly lines due to deliver up to 75 narrowbodies per month

David Kaminski-Morrow London

If the French language has an equivalent of being 'not out of the woods yet', it is surely the expression 'not yet out of the inn' – a probable reference to a slang term for prison, and altogether far more apt when applied to a situation where lockdown, confinement and restriction have been part of the routine.

Airbus chief executive Guillaume Faury believes the air transport sector's recovery from the pandemic – "without question, the worst crisis the industry has ever faced" – is gaining traction, but acknowledges that crucial areas of the world, notably China, are still struggling to bring Covid-19 under control.

"It is clear the global supply and logistical chain faces further disruptions this year from the Covid pandemic in China," he said at an event in the UK during May, pointing out that circumstances in Europe, where concerns over Covid have given way to those over the conflict in Ukraine, are also adding to Airbus's risk profile for the rest of the year.

Long-haul activity remains mired. Since the end of 2019 the total number of A330s and A350s ordered has contracted by nearly 70. The A330neo has been hit hard by mass cancellations from key customer AirAsia – a carrier which had driven the aircraft's development – while the A350-1000 has experienced an order erosion offset only by gains from the A350 Freighter launch.

The freighter has offered a glimmer of widebody optimism, attracting the interest of blue-chip operators and lessors, as Airbus pursues the Boeing 747 and MD-11 cargo replacement market.

Qantas has also signalled a long-haul revival and given the A350-1000 a high-profile lift through its ambitious 'Project Sunrise' initiative to serve routes including London-Sydney non-stop.

Airbus has continued to tweak the A350, quietly raising the maximum take-off weight for the -900 to 283t to provide airlines with "more choice and flexibility", it says. It also recently obtained certification for the 251t version of its A330-800.

Faury believes the long-term trend "does now point towards a durable recovery", underpinned by strong customer demand, and the airframer's immediate attention is concentrated on its single-aisle business.

Over the first four months of 2022 the monthly A320neo-family delivery rate has been picking up, averaging around 36 aircraft per month, although still below the pre-crisis figure of 45.

But there is conspicuous evidence of a shift in the mix. While logistics issues with deliveries, prominent during the depths of the pandemic, might still have

"The UK is the best place in the world to make wings and it will continue to make a massive contribution to meeting future demand"

Guillaume Faury Chief executive, Airbus

Upgrades at four production sites will help airframer boost output of A320neo family

Airbus

an influence, Airbus's records this year show that deliveries of the largest model, the A321neo, overtook those of the A320neo in the period to the end of May.

The popularity of the A321neo – its backlog exceeds that of the A320neo by more than 1,100 – is highly relevant to Airbus's ramp-up strategy.

Airbus is developing a flexible final assembly line in Toulouse for manufacturing A321neos, which it intends to put into operation around the end of this year. The Chinese plant at Tianjin is to be modernised in order to accommodate A321neo production, with deliveries potentially commencing in 2023.

Shared burden

The airframer is further enhancing single-aisle production capability at its US plant in Mobile, Alabama, where it will construct a new final assembly line, with a view to commissioning it by the second quarter of 2025. Mobile already has the ability to handle A321neo production, and is also a manufacturing site for the A220.

With all four of its A320neo-family assembly sites upgraded to handle the largest variant, the airframer will be able to distribute the burden of the heavy A321neo backlog, which stands at more than 3,400 aircraft, more efficiently.

Faury says the company is "progressing" towards a monthly production rate of 65 A320neo-family aircraft in summer 2023, "which is where we were just before Covid", but it is laying foundations to take this up to 75 monthly over the subsequent two years.

Airbus

Guillaume Faury says Airbus will create more high-value UK jobs

"That's unprecedented in this industry," Faury says.

Ahead of the Farnborough air show, he flagged the benefits of the ramp-up to the UK business. "It means investment in new production facilities and new high-value jobs," he says.

"The UK is the best place in the world to make wings and it will continue to make a massive contribution to meeting future demand."

Airbus's influence on the UK economy had been detailed in a March 2022 study by Oxford Economics, which set out to analyse the company's benefits to the country's aerospace industry and the impact of the pandemic on its operations.

The UK operation generated £6.8 billion ($8.5 billion) in pre-crisis 2019, of which £5.5 billion came from the commercial aircraft division.

But this overall revenue level slipped to £4.2 billion in 2020, as the pandemic took hold. Although Airbus's UK commercial aircraft workforce stayed relatively stable, at about 8,500 personnel – mostly at the Broughton and Filton facilities – the number of jobs in the country that the division supported dropped by close to 40%, to around 65,000. The commercial aircraft operation was the most affected business area, and its contribution to UK GDP tumbled from £7.5 billion to £3.7 billion.

Recovery of civil aircraft manufacturing is important to the UK government's efforts to 'level up' – addressing the gap in prosperity between the northern and southern parts of the nation – given that Airbus

spends a "disproportionate" amount of its procurement funding in deprived areas, with 45% of the £2.6 billion spend in 2019 with suppliers based in the 10% most-deprived local authority areas.

While production of current models is crucial to the UK economy, Airbus is capitalising on the country's specialised wing capabilities through its 'Wing of Tomorrow' research initiative, under which three full-scale prototype wings will be developed to examine system integration, structural analysis, and industrial production of new wing architecture and aerodynamic concepts.

Airbus says the programme, in which other European sites will participate, will introduce more than 100 new technologies, including simplified high-speed manufacturing, with the intention of exploring sustainable operations through wing design.

Future fuel

Faury underlines his optimism that Airbus will advance development of hydrogen-fuelled aircraft to achieve entry-into-service in 2035, and will set up a UK hydrogen technology and zero-emission centre – focused on end-to-end fuel system and cryogenic testing – to complement research in other parts of Europe. The airframer is aiming for initial tank ground-testing next year and flight-testing in 2026.

For flight tests, Airbus is co-operating with propulsion specialist CFM International's partners, Safran and GE Aviation, to develop a hydrogen-fuelled demonstrator based on the GE Passport engine, and mounted on an A380.

The airframer will convert the A380 testbed MSN1's fuselage to carry the powerplant and install four liquid-hydrogen tanks – capable of carrying 400kg (880lb) of fuel – and a distribution system to transfer fuel to the engine. Airbus chief technology officer Sabine Klauke says the manufacturer is "starting to mature the technological bricks" for hydrogen aviation.

Airbus has stressed that aircraft technology is only one aspect of the evolution towards hydrogen flight, and it is exploring crucial issues such as operational and infrastructure challenges, and the effects of aircraft performance and range on airline networks, with partner carriers – among them Wizz Air, already one of Airbus's strongest single-aisle customers.

The airframer is configuring its industrial operation for single-aisle ramp-up, as well as subsequent aircraft development, putting new aerostructures entities in place in Germany and France which will bind Airbus more closely to its partner facilities.

> "All the flight crew [including pilots and engineers] will be seated in the simulator where they will run through all the phases which they will subsequently perform in the real aircraft"
>
> **Vincent Claudel Integrated product team leader for laboratory and flight tests, Airbus**

Crucial to the single-aisle strategy is the A321XLR, the longest-range variant of the A321neo, the first example of which, MSN11000, made its debut flight on 15 June, after being rolled out in a colour scheme highlighting its 4,700nm (8,700km) capability.

Three flight-test aircraft are being produced at Airbus's Hamburg Finkenwerder plant, and a set of system ground tests will support the certification campaign. Among them is a 'virtual first flight' programme, which began in March, to allow the crew to assess flight-control laws, the autopilot and modifications with a fixed dedicated development simulator in Toulouse – featuring pilot controls and displays for flight-test engineers – co-located with an avionics test laboratory.

This laboratory contains the same avionics modules as those that will be fitted in the A321XLR. They are linked to the simulator to enable crews to explore the aircraft's envelope and its response during certain phases of flight. Before being tied to the simulator the modules undergo fine-tuning on associated integration benches.

The virtual first flight process was to reach its apex with a "rehearsal", says integrated product team leader for laboratory and flight tests Vincent Claudel.

Airbus

Qantas has plans to operate direct services from London to Sydney using A350-1000s

"All the flight crew [including pilots and engineers] will be seated in the simulator, where they will run through all the phases that they will subsequently perform in the real aircraft."

These include electrical and engine power-on, taxiing and take-off, climb, and the opening of the flight envelope, followed by landing, taxi back and power-down. "They will do everything they will do in the real flight, and in the same order," Claudel says.

While a new aircraft development would normally entail 'iron bird' rig testing, the A321XLR is a derivative and the physical flight-control tests will be limited mainly to the electronic rudder which Airbus is introducing on the A320neo family.

Saving weight

The aircraft's rudder architecture currently features mechanical linkages from the pedals to the hydraulic actuators. The 'E-rudder' will replace this with an electric interface – saving around 40kg in weight and enabling removal of a number of flight-control computers as well as other systems.

Claudel says several other A321XLR test programmes have been in place for more than a year, at facilities in the UK and Germany, to supplement the main flight-test work being conducted in Toulouse.

Hamburg serves not only as the site of the aircraft's physical production, but also as the base for various system checks – including those for air conditioning and the water-and-waste installations for the twinjet. Use of the single-aisle aircraft for long-haul services brings particular demands for passenger comfort, and the cabin is being refined through the use of a multiclimatic chamber at the Hamburg test facility.

Airbus's operation in Bremen specialises in high-lift devices and has been tasked with validating the A321XLR's inboard single-slotted flap configuration, which Claudel says is "specific" to the variant.

The UK's contribution to the aircraft's testing includes bench checks on the uprated landing-gear, wheels and brakes. The A321XLR achieves its longer range through a higher fuel capacity and a corresponding increased maximum take-off weight of 101t.

Airbus's Filton aerospace centre is carrying out the landing gear validation, as well as fuel integration and inerting tests. But it will also assess modifications to the high-capacity rear centre fuel tank, says Claudel. This is arguably the most fundamental change from the previous A321neo architecture.

This tank – which will hold nearly 13,000 litres of fuel – is located in the aft hold. But Airbus's planned modification has raised concerns from the European Union Aviation Safety Agency (EASA) over the tank's crashworthiness, as well as its potential vulnerability to penetration or explosion resulting from a fuel-fed ground fire, and the need for sufficient protection for evacuating passengers if regular insulation material cannot be installed.

Satisfying EASA's certification requirements for the A321XLR has forced Airbus to push back entry into service of the twinjet, from 2023 to 2024.

"Unfortunately it's not completely uncommon in development of new versions," says Faury, acknowledging that the airframer needs to undertake modifications which are "more specific to this variant".

"We are working hard with our customers to try to mitigate the impact of [the delay]," he adds.

But he insists the postponement is not a dramatic shift in the A321XLR development schedule, and that it is "not changing the picture" of the overall programme, ahead of the year-long flight-testing for the long-range jet. He remains optimistic over the aircraft's prospects.

Regardless of whether the door to recovery belongs to an inn or a prison, Faury believes Airbus has access to the key.

Certification requirements have postponed A321XLR entry into service from 2023 to 2024

Airbus

Slow recovery

Boeing has a broad raft of programme challenges to overcome, spanning its commercial and defence portfolios, while also calculating when to launch its next major airliner development effort

Lufthansa expects to take delivery of its first 787-9 in the next few months


Lufthansa

Jon Hemmerdinger Tampa

Supply chain constraints have hit Boeing's 737 production system particularly hard, limiting the airframer's output as it works to regain ground lost to Airbus.

Such supply issues are not unique to Boeing, but they are among several major hurdles – others being 787 quality problems and delays to certification of its 777-9 – that it must overcome to recapture some semblance of health.

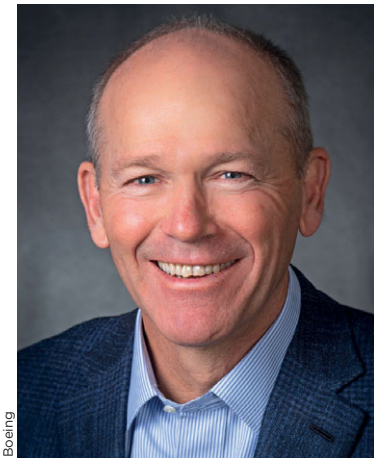
Amid all that, Boeing still faces a familiar question: when will it launch a new aircraft development programme?

Many analysts think the airframer should strike soon with a product launch, lest it fall further behind Airbus in the battle for market share. Its next jet should either be a 737 replacement, or a larger narrowbody capable of beating the A321neo in the so-called mid-market, analysts say.

But recent comments from Boeing chief executive David Calhoun suggest the company is not ready to strike.

Speaking at an investor conference in early June, Calhoun said technological advances remain insufficient to justify launching a new aircraft programme.

Calhoun notes that aircraft manufacturers historically launch programmes only when new engines can deliver efficiency improvements in the order of 10-20%.


Boeing

David Calhoun says Boeing is waiting for advances in design technologies

Waiting game

"That's not happening today," he said at the conference, hosted by financial firm Bernstein. "There are a lot of good ideas that are being tossed around on the subject of sustainability and new ways to power airplanes."

Indeed, aircraft and engine manufacturers, facing enormous pressure to reduce emissions, have been studying varying means of improving efficiency, including the use of hybrid-electric and hydrogen propulsion systems. But such advances are far from ready for prime time.

"That timeline is well out there... at least a decade from now," Calhoun says, adding that he is unwilling to "bet an airplane" on "incremental" efficiency gains.

That does not mean, however, that Boeing intends to wait a decade before coming to market with a new jet.

Rather, Calhoun says, other technology improvements could produce sufficient benefit to justify a new aircraft – even one lacking significantly better fuel efficiency.

He mentions cockpit technology advances, improved autonomous systems and, notably, use of a "digital thread"; a system that connects various aspects of a programme from design and development through to production and aftermarket support.

Such design and production technologies need "at least a couple of years before I'm confident that those tools are tested and mature enough to implement on the next airplane", Calhoun says. "When that happens – then we design the next airplane. We don't do it the other way around."

> "We have one particular wiring connector that has been slowing things down. It is a reflection of a crazy supply chain world"
>
> **Brian West Chief financial officer, Boeing**

Delayed delivery

Perhaps Boeing has a card up its sleeve, but analysts generally suspect the company will seek to fix its problems before turning to a new programme – especially at a time of intense scrutiny by the US Federal Aviation Administration (FAA).

That scrutiny led Boeing in April to delay its expected first 777-9 delivery by two years, until 2025, attributing this to "an updated assessment of the time required to meet certification requirements".

There is also the question of cash. A new aircraft programme, from launch through to certification, can easily exceed $10 billion. Boeing lost $4.3 billion in 2021, though it aims to turn cash-flow positive this year.

The company should be on sounder financial footing as it gets its 737 Max programme back on track, with increased deliveries meaning more cash is coming in.

But the Max's recovery has been slow. Boeing has faced shortages of critical parts, which kept it from meeting its goal of producing 31 of the narrowbodies monthly by early this year.

Output unknown?

In May, Boeing chief financial officer Brian West addressed the supply issue, noting: "We have one particular wiring connector that has been slowing things down. It is a reflection of a crazy supply chain world."

In mid-June, director of 737 business operations Dennis Eng said his team is addressing supply troubles. "Our components are arriving when we need them to," he says. "We try to mitigate any disruptions or shortages on an everyday basis. But, I'd say right now, we have the parts that we need."

Boeing delivered 115 737s in the first four months of 2022 – an average of about 29 per month. But many of those were from its stored inventory of jets produced but not delivered during the type's 20-month grounding.

While Boeing does not disclose its actual production output, aircraft data provider Cirium tracks first flights, which typically occur immediately after production. In the first five months of 2022, 102 737s completed first flights, or about 20 per month, Cirium data shows.

Boeing

Orders are coming in for the 777-8 Freighter, but certification of the 777-9 has been delayed

Under pressure

Ryan Finnerty Burlington

It has been a tough few years for Boeing's defence business. Despite some victories, the aerospace giant failed to secure wins in some of the US Air Force's (USAF's) marquee programme contests, including for the next generation of strategic bombers.

But even where Boeing Defense & Space has won contracts, all has not been well. An aggressive bid to produce the USAF's latest refuelling tanker, the 767-based KC-46A Pegasus, has resulted in more than $5 billion in losses for the company.

Other notable programmes, including the T-7A Red Hawk advanced jet trainer and the 747-8I-derived VC-25B Air Force One replacement have been fraught, combining for more than $1 billion in cost overruns in the first quarter of this year alone.

During an April earnings call, Boeing chief executive David Calhoun went so far as to express regret for accepting the contract to deliver two new presidential jets – a commitment that has so far racked up some $600 million in extra costs, for which the company is liable.

Despite those setbacks, Boeing's defence arm still posted a tidy $1.5 billion profit in 2021, while the company's commercial airliner business suffered.

However, if commercial sales do not rebound in the coming years it will probably spell trouble for Boeing's defence division, says Richard Aboulafia, managing director of consultancy firm Aerodynamic Advisory.

"A lot depends on the commercial market, and whether they can get their commercial programmes back on track," he notes.

Aboulafia explains that before the pandemic disruption, Boeing adopted a strategy of ultra-low-cost bids for defence programmes. The company knew this would drastically reduce profitability, but decided the move would be worthwhile to claw back market share in the defence space.

Boeing leveraged its previously healthy profits on commercial sales to protect against potential overruns or losses in its low-cost defence bids. "If that commercial revenue returns, big time, they will get true," Aboulafia declares. But he also cautions that losses on programmes such as the KC-46A tanker will probably persist for years.

However, Aboulafia distinguishes between newer, loss-riddled programmes such as the KC-46A, which he describes

"We have to get stability," Calhoun says of 737 production. "Our company has to be patient. We have got to work our way through these supply constraints."

Meanwhile, Airbus delivered 146 A320neo-family jets in the January-April period – an average of around 36 monthly. It aims to hike deliveries of the type to 65 monthly by mid-2023, and to 75 per month in 2025.

Boeing faces the added challenge of clearing hundreds of jets it accumulated during the 737 Max's grounding. When regulators cleared the type for service return in November 2020, that inventory stood at about 450 aircraft. At the time, Boeing said it expected to deliver most of the stored jets by the end of 2022, but in June Calhoun said 240 still remain in its hands.

Stifled demand

Boeing leaders stress that their ability to hit delivery goals depend significantly on Chinese carriers resuming taking delivery of the type. While China issued an order in December 2021 that cleared the Max to fly, its airlines have yet to resume receiving their on-order jets.

US industry analysts say China's foot-dragging reflects geopolitical factors – including tense bilateral relations and an associated trade war that has embroiled Boeing – plus the impact of Covid-19 lockdowns, which have stifled demand for air travel.

"There is no doubt that the current [pandemic] shutdown is impacting" deliveries to China, Calhoun says.

Further complicating the picture is the March crash of a China Eastern Airlines 737-800, which killed all 132 people aboard. Aviation safety experts say flight data suggests the aircraft went down as a result of deliberate pilot action, but analysts believe it gives China another reason to delay receiving the re-engined model until investigators have completed their reporting work.

If its production and delivery challenges were not enough, Boeing also faces the possibility of needing to develop a new pilot alerting system for its largest 737 Max 10, and, potentially, for its smallest 737 Max 7.

The requirement comes from a US law passed in late 2020 that, starting in December 2022, prohibits the FAA from certificating transport aircraft lacking a modern "flight crew alerting system", sometimes called an Engine Indicating and Crew Alerting System (EICAS). The US Congress established the mandate in response to two fatal 737 Max crashes – events which presented those jets' pilots with what investigators called a confusing and distracting array of cockpit warnings.

Boeing expects to secure certification for and deliver its first 737 Max 7 this year, but the Max 10 seems unlikely to meet the schedule, with first shipments due next year. The already certificated Max 8 and Max 9 are not affected by the pilot-alert-system rule.

"The big question is the EICAS requirement at the end of the year," Calhoun says. He adds: "We are totally committed to the -7 and the -10."

Calhoun has expressed confidence that Boeing will secure some type of exemption from the requirement if necessary. He notes that Congress never intended the rule to apply to the 737 Max, which is why lawmakers made the provision effective after two years; by when everyone expected the FAA would have certificated all Max variants.

Without an exemption, certificating the Max 10 would require Boeing to undertake the costly and time-consuming process of modernising the jet's alert system. Critically, such a change would leave

US Air Force

Boeing has suffered heavy losses on the KC-46A Pegasus programme

as being "bought at a price", and legacy product lines such as the F/A-18E/F Super Hornet, F-15 – in production again in Eagle II standard for the USAF – and AH-64D Apache attack helicopter that remain highly profitable.

"It's the older programmes – and many of them are going to sunset this decade – that are really driving profitability. The others are losing money," he notes, describing the split as a "bifurcation" in the business.

Notably, most of those profitable, legacy programmes were inherited by Boeing when it acquired McDonnell Douglas in 1996, or the result of partnerships with other firms.

Boeing itself has proved less adept at securing and delivering profitable defence contracts over recent years. Lockheed Martin secured the sprawling multi-national contract to build the fifth-generation F-35 Lightning II Joint Strike Fighter, defeating Boeing's rival X-32 design. Northrop Grumman beat the company for a contract to build the B-21 Raider stealth bomber, and also to produce a new generation of intercontinental ballistic missiles.

However, Boeing has secured a number major US contracts that could reverse those fortunes over the coming decade.

The MQ-25 Stingray carrier-based autonomous tanker has already commenced test flights for the US Navy, successfully refuelling the F/A-18, F-35C, and Northrop E-2D Hawkeye. The Stingray has also already demonstrated fully autonomous take-off and landing capability.

Airframer is hoping the 737 Max 10 will be granted crew alerting exemption

Boeing

the Max 10 different from other variants, removing some of the training efficiencies enjoyed by airlines operating the family.

Boeing's 787 troubles are no less pressing. The company halted deliveries of the type in October 2020 because of manufacturing quality issues that included gaps between fuselage sections being larger than specified. Other issues have also surfaced.

Deliveries remain paused and will resume only after the FAA approves rework being done by Boeing. In April, the airframer said it had completed such activity on some undelivered 787s and submitted a "certification plan" to the FAA.

Success story?

The agency's response was "very constructive", Calhoun said in June. "There's some pretty good recognition... over the last two years that we are going to be transparent – straight – every step of the way.

"We can't do anything without them," Calhoun notes of the FAA. "They want to see American industry succeed," he adds.

Boeing has declined to provide any prediction as to when Dreamliner deliveries might resume, but there is reason for optimism. Lufthansa, for instance, has said that it expects to receive its first 787-9 "this summer".

Troubles aside, Boeing has enjoyed recent sales successes, landing orders for 213 jets in the first four months of 2022. Among those were 178 737 Max from customers including American Airlines, Arajet and Southwest Airlines, plus lessors AerCap, Air Lease and Aviation Capital Group.

It also received orders for 35 777s, including a deal from Qatar Airways for 14 of the newly-launched 777-8 Freighter.

Boeing secured another major win in May when IAG, parent of British Airways and Iberia, ordered 25 737 Max 10s and the same number of the high-capacity Max 8-200 variant, and took options for up to a further 100 of the narrowbodies.

But several recent customer defections have also been experienced, in significant wins for Airbus. Last December Qantas said it intended to order 20 A321XLRs and 20 A220s, and take purchase rights to acquire a further 94 aircraft, which it will use to replace 717s and 737-800s.

The same month, Air France-KLM ordered 100 A320neo-family jets and took rights to acquire another 60. The group will use them to replace the 737NG fleets of KLM, Transavia and Transavia France.

Boeing vice-president of commercial aircraft marketing Darren Hulst downplays the threat posed by the "niche" A321XLR, noting: "The 737 Max represents the most versatile, but also the most complete, single-aisle family for the needs of the market."

Boeing is also in the mix for part of the US Army's Future Vertical Lift programme, partnering with Lockheed subsidiary Sikorsky to offer the Defiant X as a Future Long-Range Assault Aircraft, intended as a successor for the UH-60 Black Hawk utility helicopter.

A selection between the coaxial rotor/pusher propeller design and Bell's V-280 Valor tiltrotor is due later this year.

Aboulafia notes that Boeing has a track record of relying on other firms to handle the heavy lifting when it comes to engineering new airframes – ultimately a successful strategy on programmes such as the V-22 Osprey, built in conjunction with Bell.

"To be fair, they [Boeing] weren't as important as Bell on the V-22, but they still got something like half the business – so, you know, it might work for them," he says.

However, Aboulafia argues that this strategy resulted in the loss of the B-21 contract, and contributed to cost overruns on the T-7A partnership with Saab.

What started as a cost-saving measure in some cases may have resulted in the loss of internal research and development expertise needed to win standalone bids, he argues.

"They [Boeing] just consistently underestimated the resources needed both to win programmes and to execute on them," Aboulafia says.

So will the low-cost bid strategy ultimately pay off? Aboulafia thinks it is possible, given the decades-long time horizon for some of the contracts, and especially if commercial sales recover with the post-pandemic uptick in travel. Foreign sales of legacy products will also potentially provide a lifeline, particularly around the F-15.

However, the success of Lockheed's F-35 has substantially narrowed the market. More than 750 examples are now in service with the US military and nine other nations, while Canada, Finland, Germany and Switzerland all have selected the stealthy type since last year.

Such factors point to a coming decade filled both with potential and peril for Boeing, whose impact is so massive that it has been credited by US media and government officials as having the power to influence the entire $21 trillion US economy.

Despite recent setbacks, Boeing is still a major player in the defence industrial ecosystem – it received 21% of the total Pentagon procurement budget in 2020, according to financial analysis firm Trefis.

Faced with an expansionist Russia and an increasingly bellicose China, support for more defence spending appears to be one of the few points of political agreement in Washington DC. If Boeing can get its commercial business back off the ground, the company is potentially well positioned to capitalise.

GIFAS

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Commercial engine manufacturers have their sights firmly set on developing the technologies needed to meet the industry's challenge of delivering sustainable flying

A clean future

Mark Pilling London

Today, every aerospace engine manufacturer has a roadmap charting its course towards achieving net zero carbon emissions by 2050. Important waypoints include a massive increase in the use of sustainable aviation fuel (SAF), and making decisive progress on "disruptive technologies" such as hydrogen.

As Eric Dalbies, senior executive vice-president research & technology and innovation at Safran, told the EU's Clean Aviation Summit in March: "For the coming decade the focus is on ultra-efficient aircraft... reducing fuel burn is a no-regret choice."

The speed at which sustainability has rocketed to the very top of the aerospace agenda is astonishing, especially because the shift in focus took place amid a global pandemic that saw the air transport industry grind to a halt.

Design issues

From late last decade, each of the big three engine manufacturers had encountered design issues and in-service problems, as supply chains were stretched in the face of bulging aircraft order books and steep production ramp-ups.

By 2019, Rolls-Royce was getting to grips with the premature turbine blade deterioration problems affecting its Trent 1000 engine, which is an option for the Boeing 787. Similarly, Pratt & Whitney's Geared Turbofan (GTF) – the manufacturer's big bet on returning to the narrowbody market – was, after three years in service, overcoming its early high-profile issues.

At GE Aviation the story was different, but no less troublesome. Having been selected as the exclusive choice for the 777X in 2013, issues with components in the GE9X's high-pressure compressor came to light in 2019, forcing a redesign that delayed first flight. While GE has fixed the issue, Boeing now expects the lead 777-9 to enter service in 2025, largely due to expanded certification requirements.

Despite these hiccups, engine makers entered this decade in good health, with record order books and strong aftermarket revenue flows. But that changed abruptly with the onset of the pandemic in March 2020. As revenues from all-important service contracts fell off a cliff, the manufacturers shed staff, raised liquidity, and restructured their businesses to cut losses and preserve cash.

20%

Reduction in fuel burn GE Aviation claims it will achieve using advanced manufacturing techniques on its engines

After two years of eye-watering losses and unprecedented business trauma, the recovery in air travel means revenues are flowing again as flying hours rise and maintenance shop visits return.

But as business revives, the strategic landscape has changed for the propulsion experts, with the climate

R-R's UltraFan demonstrator features 'the building blocks that will go into a next-generation engine'

Rolls-Royce

crisis and decarbonisation challenge becoming an overwhelming obligation.

While the manufacturers had already been deeply absorbed in R&D to find more efficient, lower emissions engines prior to Covid-19, that occupation has turned into an obsession. The technologies under scrutiny include electric, hybrid-electric, and the use of liquid hydrogen or hydrogen fuel cells.

Speaking at GE's investor day in March, Mohamed Ali, vice-president of engineering, highlighted the introduction of composite fan blades to replace metals on the GE90, the creation of highly durable ceramic components for the Leap, and the use of additive manufacturing to produce hitherto "impossible-to-make" lightweight parts.

Future advances

"We are excited about building our arsenal of technologies for the future with sustainability as our north star," Ali says. These advances will reduce fuel burn by more than 20%, whether the fuel is kerosene, SAF or hydrogen, he adds.

The key component of GE bringing its roadmap to fruition will be a batch of "breakthrough technology demonstrators", with ground and flight tests to show technology readiness this decade, says Ali. This is the critical timeline to meet Airbus's and Boeing's ambitions for next-generation aircraft using "disruptive" technology being in service from 2035.

GE has three demonstration programmes lined up. The first is a partnership with NASA and Boeing, with BAE Systems recently added to provide electricity management systems. Through NASA's Electrified Powertrain Flight Demonstration project, hybrid-electric configurations will be tested on a modified Saab 340B turboprop with GE CT7-9B engines. Full hybrid-electric flight tests will take place by the mid-2020s.

"Anybody can do a motor – a hybrid-electric motor or an electric motor and test it on the ground," says Ali. "Anybody can fly perhaps even up to 10,000ft. Above 10,000ft, high-voltage electric machines behave very differently. We are testing at the NASA facility a Megawatt electric motor in a 40,000ft environment... and we believe we have the technology to enable that."

In February, Airbus and GE/Safran joint venture CFM International announced one of the most significant moves by the aerospace majors to date on the hydrogen front. The airframer will use an A380 prototype as the demonstrator for a future hydrogen-fuelled engine. The aim is for first flight by the end of 2026, says Sabine Klauke, chief technical officer at Airbus.

CFM will modify the combustor, fuel and control system of a GE Passport turbofan to run on hydrogen.

> "We are excited about building our arsenal of technologies for the future with sustainability as our north star"
>
> **Mohamed Ali Vice-president of engineering, GE Aviation**

De Havilland Canada

Pratt & Whitney Canada is partnering with De Havilland Canada to equip a Dash 8-100 turboprop with hybrid-electric propulsion

The engine will be mounted on the rear fuselage to allow emissions, including contrails, to be monitored separately from those powering the aircraft.

The physical property of hydrogen means it has many challenges to become a viable liquid fuel for either gas turbine combustion engines, or to make electricity in a fuel cell. However, many players in aviation believe it has a future role in the decarbonisation picture.

"There are only a limited number of ways of getting to net zero emissions," explains Arjan Hegeman, general manager advanced technologies at GE. "Hydrogen combustion does get to zero carbon emissions, so it is a logical thing to look at."

Collaborative effort

GE's third demonstrator – using technology called adaptive cycling – is already running. This is being conducted in collaboration with the US Air Force to develop the XA100 as a potential option for the Lockheed Martin F-35. The latest phase of tests began in March at the Arnold Engineering Development Complex in Tennessee.

"An adaptive cycle means the engine actually changes its geometry depending on which part of the mission it is in to maximise the fuel burn advantage," says Ali. It has the potential to give the "best of both worlds", switching between delivering 10% more thrust or 25% better fuel efficiency than today's engines.

He adds: "We are going to be taking all of these technologies and putting them in what we call the RISE [revolutionary innovations for sustainable engines] demo." This demonstration programme, launched in June 2021 by CFM, aims to develop open-fan powerplants that can be fuelled by 100% SAF or liquid hydrogen and include hybrid-electric capability for the next generation of single-aisles.

The target is to reduce fuel consumption and carbon dioxide emissions by more than 20%, with a flight demonstration engine planned for mid-decade.

P&W, meanwhile, has identified three core themes in its roadmap to net zero: smarter technology; clean fuels; and greener business.

The company was selected by NASA in October 2021 for the Hybrid Thermally Efficient Core (HyTEC) project, to develop advanced high-pressure turbine technologies for next-generation single-aisles.

These include ceramic matrix composite (CMC) materials that are capable of operating at higher temperatures than current CMCs, environmental barrier coatings, advanced cooling, and aerodynamic approaches that will make new component designs and efficiencies possible, according to P&W.

HyTEC is part of NASA's Sustainable Flight National Partnership, which aims to enable breakthrough innovations and help accomplish the industry's decarbonisation goals.

Using a raft of advanced fan technologies, new core development, increased use of hybrid-electric power to augment the engine, and more efficient propulsion-airframe integration, P&W will build the future GTF, chief sustainability officer Graham Webb explained at the Sustainable Skies World Summit, which was hosted by Farnborough International Airshow in early April.

Last December, P&W launched the GTF Advantage configuration. After completing a year of ground and flight testing it will be available for A320neo-family aircraft from January 2024, offering greater thrust and a 1% increase in fuel efficiency via technology enhancements throughout the core.

P&W's key demonstrator in the hybrid field is work led by Pratt & Whitney Canada, which is partnering with De Havilland Canada to equip a Dash 8-100 turboprop with a hybrid-electric propulsion system

developing 2MW. P&W's roadmap sees such technology coming into service from 2030.

Ground tests are planned this year, with flight-testing scheduled to start in 2024, says Webb. The target is a 30% reduction in fuel burn and CO2 emissions compared with today's turboprops. Collins Aerospace is providing the electric motor and controller.

P&W says this project will provide technology and component learnings that will directly feed into larger applications. The idea is to marry an electric engine capable of delivering 18MW with the GTF, to "enhance the flight operations" of a single-aisle, says Webb.

The company's roadmap sees it as ready to field a hydrogen-fuelled engine for a 100-plus-seat airliner from 2035. In February, it was awarded a US Department of Energy project called the Hydrogen Steam Injected, Inter-Cooled Turbine Engine. This is described as a revolutionary hydrogen combustion system that uses water vapour recovered from the exhaust stream to increase engine efficiency, promising a reduction in narrowbody fuel consumption of 35% compared with the GTF.

Further study

"There is a lot more work and study to be done, but we look at hydrogen as a promising fuel," says Webb.

The industry's drive to increase SAF use also is critical to achieving net zero. In March, P&W tested the GTF Advantage configuration with 100% SAF, in what it describes as a key milestone. Today, SAF is approved in blends of up to 50% with regular kerosene.

For R-R, the three big themes are a step change in the efficiency of gas turbines; leading SAF demonstrators and adoption; and developing third-generation technologies, chief technology officer Grazia Vittadini explained at the Clean Aviation Summit. "Engines are at the core of the decarbonisation challenge... and are the most impactful," she says.

> "There is a lot more work and study to be done, but we look at hydrogen as a promising fuel"
>
> **Graham Webb** **Chief sustainability officer, Pratt & Whitney**

Of the engine majors, R-R is exploring the widest range of potential power and propulsion technologies and applications, from small propeller aircraft and advanced air mobility vehicles to widebody airliners and large business jets.

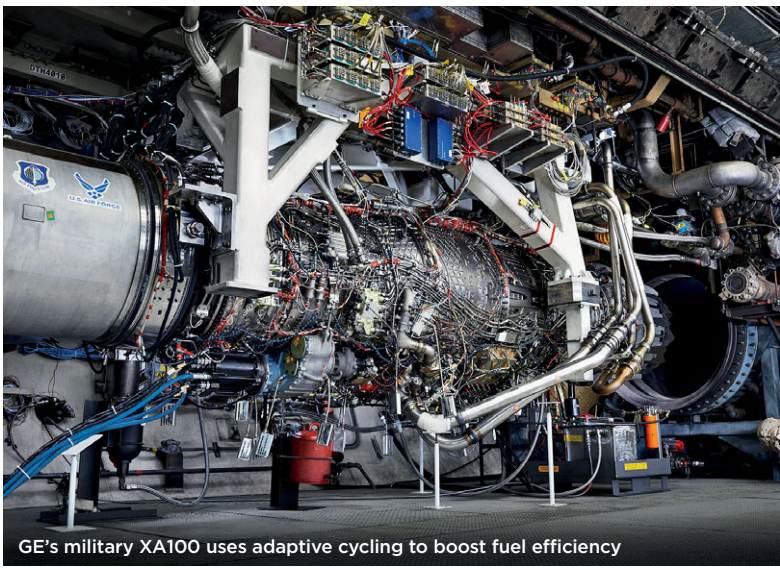
All-electric power will be viable for smaller aircraft with short range requirements and is a relatively mature technology, says R-R. Last November, it flew the Spirit of Innovation, a high-speed demonstrator that set two new world speed records for an all-electric aircraft.

This effort was part of the UK government's Accelerating the Electrification of Flight project, and the advanced battery and propulsion technology developed has applications for the advanced air mobility market, says R-R.

On the electric front, the company is the engine partner for Italy's Tecnam on the 11-seat P-Volt. The utility aircraft will feature two electric powerplants of 320kW each, with Norwegian regional airline Wideroe set to take the first examples in 2026.

R-R has created a division dedicated to furthering its efforts in the electric engine space. Another key programme is providing the technology to power Vertical Aerospace's four-seat VX-4 vertical take-off and landing vehicle, due to be certificated in 2024.

The UK company's research into potential propulsion pathways encompasses hybrid-electric, hydrogen fuel cells, and gas turbines burning hydrogen, with likely applications scaled up to regional and narrowbody aircraft. But as aircraft move up to widebody size, the gas turbine remains the clear favourite.



GE Aviation

GE's military XA100 uses adaptive cycling to boost fuel efficiency

"There is still life in the gas turbine. Whether fuelled by kerosene, SAF or hydrogen, we need to invest in the basic efficiency of the gas turbine," Alan Newby, R-R's director of aerospace technology & future programmes, said at the Clean Aviation Summit.

Its key demonstrator is UltraFan, which features a new architecture, power gearbox and material to prove "all the building blocks that will go into a next-generation engine". Engine UF001 is now being built and will be tested with 100% SAF this year, says Newby.

R-R says the engine will be available in the second half of the 2020s and will be 25% more fuel efficient than a first-generation Trent. Although initially sized for a widebody jet, UltraFan would be scalable for narrowbody aircraft.

Summing up the efforts of engineers, Vittadini describes the technologies being explored as a "buffet" from which engine makers will choose to meet the low-emission aircraft applications coming down the line. "Revolutionary breakthroughs are required," she says. "There are a series of daunting challenges."

The biggest unknown is whether "disruptive" technologies such as hydrogen will be one of the ingredients, or if super-efficient gas turbines burning SAF will be the right choice.

Ready for tomorrow

As the UK's largest defence company, BAE Systems is leading the way in developing next-generation technologies – and closer relations with international partners

BAE Systems

Team Tempest partners include BAE Systems, Leonardo UK, MBDA UK and Rolls-Royce

Craig Hoyle Warton

The launch of Team Tempest and the UK's Combat Air Strategy delivered big defence headlines at the last Farnborough air show – but what impact have factors such as the Covid-19 pandemic had in the four years since then?

Now in its £250 million ($313 million) concept and assessment phase, the nation's future combat air system (FCAS) effort involves Team Tempest partners BAE Systems, Leonardo UK, MBDA UK and Rolls-Royce, working with the Ministry of Defence (MoD) and Royal Air Force (RAF), and also in partnership with industry champions and defence bodies in Italy and Sweden.

The next major milestone will come in 2024, when the programme partners submit their so-called outline business case 2 (OBC2) proposal, seeking full programme launch the following year and service introduction from 2035.

Their objective is to deliver an operational capability in half the time and at half the cost of previous combat aircraft projects.

Long-term threat

"What we are doing through the activities around the Tempest and FCAS programme is very much driven by the future threat landscape, which is that 2040-plus view," says BAE business development director John Stocker. "The solutions and the concepts that we are developing are very much there to meet that long-term threat," he told journalists during a pre-show briefing at the company's Warton site in Lancashire.

"We have continued to iterate concept work around the core platform, and in due course will share information about some the work that has been going on," Stocker says, standing beside a full-scale mock-up of an early concept for Tempest, which, he stresses, "is not the end solution".

Other programme elements will include unmanned adjunct vehicles; kinetic and non-kinetic "effectors"; command and control/information systems; and digital through-life services.

BAE Systems

Muldowney says government has shown clear capability objectives

"In terms of how we develop the evidence over the next couple of years as we go towards the OBC2 gate, we are very much focused on proving the value of the programme – not just by military capability and cost, but a broader national value assessment," Stocker says. The latter will consider factors such as net economic impact of the major investment, and its ability to support the UK government's so-called levelling up agenda, which seeks to address regional economic inequality.

BAE Systems Air chief operating officer Ian Muldowney notes the major such contribution made today via the company's role in the production, final assembly and export of the Eurofighter Typhoon. BAE says the combat air sector typically accounts for 85% of international defence sales by value from the UK each year, and supports 46,000 high-value jobs – many in the northwest and southwest of England, plus in Scotland.

"The UK is one of the last vestiges of platform whole-system capability around combat air: sensors, propulsion, airframe, flight systems and the ability to integrate all that together. That's not just about BAE Systems – that's a UK endeavour," he says.

Muldowney points to the importance of the Combat Air Strategy in driving investment into FCAS and Tempest, noting: "2018 saw a statement of intent by the UK government that I had never seen before on any of our future programmes. It was clear about its objectives around the UK wanting sovereign capability around combat air – not just inside the armed forces, but across industry."

BAE did not furlough any of its Warton workforce during the pandemic, and even recruited around 100 staff who were facing redundancy from a Safran site in east Lancashire.

Remote working

While the company increased its flexibility for workers during the crisis, including issuing "tens of thousands of laptops" to enable remote working, Muldowney notes: "You can't design and build aircraft from the kitchen table. You've got to be inside the factory to do that." Now, during the recovery, it wants to "shift from a culture of potential presenteeism to one that is about delivering outcomes", he says.

Referring to a goal of moving from full programme launch to initial operational capability (IOC) within 10 years, Muldowney notes: "We are confident we can get there with our partners and working with that enterprise approach."

But FCAS is by no means a UK-only activity – it also involves Italian and Swedish companies – and BAE is separately involved with future fighter projects with industry in Japan and Turkey.

"We are very much targeting an international programme here," Stocker notes. "Everybody is very clear that that is a really important part of how we stand up the next phases of this programme. We're making some fantastic progress on that front, in

> "The UK is one of the last vestiges of platform whole-system capability around combat air: sensors, propulsion, airframe, flight systems and the ability to integrate all that together"
>
> Ian Muldowney **Chief operating officer, BAE Systems Air**

terms of how the different sets of requirements and military and industrial capabilities come together and form a core element of that future partnership."

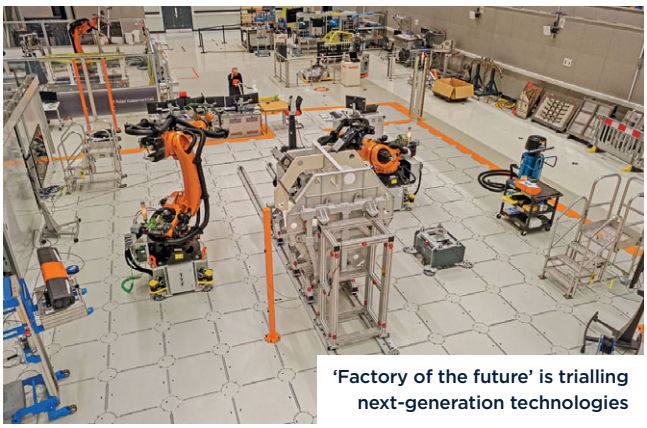
Stocker says export control, security and intellectual property considerations are central themes under the programme's multi-national construct. "It is a challenge, and a very different way of doing things. What we are doing is developing a construct that will allow future partners to join in a way that they are not penalised for not having been there at the start."

Real opportunity

Referring to the strengthened military and industrial relationship between the UK and Japan, Muldowney says their collaboration on advanced fighter technologies represents "a real opportunity".

"There is a real close match on how we are working together to refine that – there is a lot of work going on," he says. Tokyo also is working with Leonardo UK, MBDA UK and R-R, respectively on radar/electronic warfare equipment, weapons, and propulsion.

"We have got to work hard collectively as a UK enterprise to make sure that from government through the MoD into industry that we are working at this in the right way, to make sure we are the right partners for Japan, and that they are the right partners for us," he says.



BAE Systems

'Factory of the future' is trialling next-generation technologies

"MHI [Mitsubishi Heavy Industries] are working closely with us in terms of how we evolve things. It is moving in the right direction. They have got great technology, great engineers, have a drive and a similarity in terms of where we see the FCAS system going."

Meanwhile, around 100 BAE personnel are in Turkey supporting Ankara's TF-X future fighter development activity, with around a year left to run on the UK company's current contract. "It is a good programme – a very ambitious sovereign capability," Muldowney says. "There are opportunities for us to continue into the next stages of that contract, both with work in Turkey and potentially in the UK. We would like to remain partners on that programme if we can."

> "We have got to work hard as a UK enterprise to make sure that we are the right partners for Japan, and that they are the right partners for us"
>
> **Ian Muldowney Chief operating officer, BAE Systems Air**

Typhoon production has declined over recent years, with BAE currently performing final assembly of jets for Qatar and manufacturing parts for aircraft on order for Germany and Kuwait.

"We would like to have a steady flow of Typhoon final assembly, but we have had a gap before," Muldowney notes of the period between now and FCAS work ramping up.

A new programme is key to reinvigorating the UK combat air sector, Muldowney says. "Yes, we are on [the Lockheed Martin] F-35 [manufacturing aft fuselages], which is great revenue and great volumes for UK industry, but it doesn't sustain that [whole-system] capability and doesn't allow us to

How electric investments could charge BAE's future

BAE Systems is poised to begin UK flight testing with a Pipistrel Velis Electro, with the Slovenian-built light aircraft having been delivered to its Warton site in Lancashire in May.

The company has bought the single-engined, 600kg (1,320lb) aircraft to conduct research as it eyes emerging requirements including a Royal Air Force (RAF) aspiration to field an all-electric type for use during air experience flight, university air squadron and elementary training activities.

The RAF has identified the need as part of its target of achieving net zero carbon emissions by 2040.

Housed inside a hangar at Warton when *Flight International* visited the site recently, the asset carries the registration G-EPWR (nicknamed "E-Power"). BAE was awaiting the completion of paperwork activities in advance of flights getting under way.

BAE earlier this year also signed a memorandum of understanding with Pipistrel – which was recently acquired by Textron Aviation – to explore the potential for jointly developing a future military trainer.

"Our aim is to learn about the aircraft," says BAE test pilot Neil Dawson, whose preparation for operating the 50min-endurance type included five flights in Slovenia.

He notes that an operational electric-powered trainer would need to be "significantly larger" than the European Union Aviation Safety Agency-certificated Velis Electro, which also lacks the aerobatic capability required for a role with the RAF.

Neil Appleton, head of electronic products at BAE Systems Air, says that the acquisition from Pipistrel forms just part of the company's current exploration of sustainable flight technologies.

Typhoon is set to be upgraded with Leonardo UK's ECRS Mk2 AESA radar

BAE Systems

maintain the scale of jobs and skills that pull through the economy that you see on the back of something like Typhoon."

However, the in-service type remains a focus of considerable activity at Warton, regarding both sustainment and capability enhancements.

One of the UK's most important current areas of focus is on preparing the fighter to receive Leonardo UK's ECRS Mk2 active electronically scanned array (AESA) radar.

A first flight-test example of the new sensor will be delivered before year-end, and Tranche 3 aircraft BS116 (ZK355) is already in the flight-test hangar at Warton in preparation to receive it.

Following integration work and ground-based testing, the AESA system is due to undergo flight-testing from late 2023, the MoD says.

Ross Wilson, Leonardo UK's radar chief engineer, says the sensor is now in testing on its roof-top laboratory in Edinburgh, Scotland. "It is real, tested equipment, and we are now testing software," he says. The system re-uses some equipment previously employed during a UK trials campaign named Bright Adder.

For the test phase, a spare radar also will be supplied to Warton, plus around "six additional items" which will support work up to the IOC milestone being declared. At least two flight-test aircraft will be involved, along with personnel and additional assets from the RAF's 41 Sqn test and evaluation unit.

The MoD says service introduction – now targeted for 2030 – will represent the availability of "a robust capability... something that you can rely on and take to war".

The UK will acquire ECRS Mk2 sensors to equip 40 Tranche 3 Typhoons, with integration work expected from 2026. The technology – which also will offer electronic attack functionality – is additionally suitable for incorporation with Tranche 2 examples.

Fresh funding for the ECRS Mk2 effort is due to be approved from late this year, clearing the way for production and equipment delivery.

Separately, BAE is continuing flight testing from Warton of the P3EB capability update package for the Typhoon, along with ground trials in support of a future P3EC modification.

The company also is performing rig and simulator trials of a replacement cockpit display for the Typhoon, developed using internal funds. Featuring a large area display and two back-up high-integrity panels – similar in size to mobile phones – this is being proposed as part of a long-term evolution upgrade for the Eurofighter platform.

Manufacturing skills

Among multiple other initiatives BAE is taking now to develop new manufacturing skills is its factory of the future – a hangar at Warton dedicated to trialling next-generation technologies.

This involves partnerships with around 50 organisations, and is trialling the use of equipment ranging from smart machining benches – now employed at BAE's nearby Samlesbury manufacturing site – to a robotic-assisted assembly station. This can be swiftly reconfigured to work on different fuselage sections or aircraft types with tolerances of tenths of a millimetre, BAE says.

Around 30% of a future fighter's airframe could be produced using additive manufacturing, BAE believes, while innovations such as hot isostatic pressing would reduce its reliance on scarce materials by using powdered titanium during parts production.

The company plans to potentially double the size of its factory of the future to continue such research, which will only benefit projects like FCAS and Tempest.

Pipistrel Velis Electro was delivered to BAE Systems in May

BAE Systems

Other examples are a joint study into potential military applications for the Embraer-backed Eve electric vertical take-off and landing (eVTOL) urban air mobility product. The pact with the Brazilian company was initiated last December via what Appleton describes as a "modest investment".

BAE also expects to fly Malloy Aeronautics' electric-powered T-650 unmanned air vehicle at Warton "towards the end of this summer". Appleton says the activity will focus on assessing the battery technology and lift capability of the type, which will be able to carry a 300kg (661lb) payload.

"This is not just a bit of 'greenwashing'," notes BAE Systems Air chief operating officer Ian Muldowney. "We see a real opportunity in electric products and sustainable aviation, whether that's in the basic trainer market, eVTOL, heavy-lift, or unmanned applications."

Northern Ireland's largest manufacturing business – once Short Brothers – is bouncing back after the pandemic under new ownership, and with big ambitions for growth

Belfast Spirit

Dominic Perry London

In the four years since the last Farnborough air show, much has changed for the Belfast-based aerostructures business that started life as Short Brothers. Back in 2018, it was still part of Bombardier and was led by Michael Ryan, a Belfast native who had been involved with the company since the early 1980s.

But in early 2019, cash-strapped Bombardier announced that it had slapped a for sale sign on the aerostructures operation – which in addition to Belfast also includes sites in Dallas, Texas, and Casablanca, Morocco. A buyer quickly emerged, with USA-based Spirit AeroSystems in October that year striking an agreement to acquire the three sites for a total consideration of $1.1 billion. The deal eventually closed around a year later, for a reduced figure of $865 million.

Last year, Ryan – whose lengthy full title is now vice-president, European space & defence, and government affairs; chairman, Spirit AeroSystems UK – also saw a change on a personal level, gaining a knighthood for his services to the economy.

The $235 million reduction in the asking price was, however, symptomatic of the wider issues hitting the industry at that point: mere months after Spirit announced its intention to acquire the Bombardier business, Covid-19 arrived, putting air travel on ice and triggering an unprecedented downturn.

As demand for new aircraft dried up and deliveries and revenues dropped, the aerospace industry scrabbled to stay upright. For many, that meant job cuts and Bombardier in Belfast was not immune, shedding around 600 positions from its 3,500-strong workforce.

With that as a backdrop many observers wondered if Spirit would still press ahead with the deal. But Sir Michael was not one of them: somewhat counter-intuitively he saw a separate crisis being dealt with by the Kansas aerostructures giant as offering a clear reason for proceeding.

"The other pressing issue for Spirit at the time was the challenge of the 737 Max setbacks which had started before they had agreed to buy us," he says.

Spirit AeroSystems UK

Michael Ryan was knighted last year for his services to the economy

Output reduction

Boeing's initial reduction to 737 Max output was eventually followed by a halt to production as the airframer grappled with the ramifications of the type's grounding on the back of two fatal crashes. Spirit, as a supplier of complete fuselages to the narrowbody programme, was deeply affected by that move. However, the heavy exposure to Boeing was also pushing the company to seek alternative revenue streams: on that basis, the Belfast business – and its wing production for the Airbus A220 – was a logical target.

Composite wings for Airbus A220 are key business line

Spirit AeroSystems UK

"When they decided that this [purchase] was still so strategically important to them that they would continue with it even in the face of the 737 Max crisis then I was less concerned with the pandemic's interference in the acquisition," he says.

"Spirit were very transparent about this, that the 737 circumstances reinforced their need for diversification and that's why they went into it at the time."

The assumption was that the industry would emerge from the pandemic at some stage, Ryan says, and "Spirit still believed that the diversification strategy was the right way to go".

Of course, concluding the purchase and then integrating the new acquisition at the height of the pandemic was not made easier given the travel restrictions in place.

"Spirit actually completed the biggest acquisition that they have done without being able to visit us," Ryan says.

> "The other pressing issue for Spirit at the time was the challenge of the 737 Max setbacks which had started before they had agreed to buy us"
>
> **Michael Ryan Vice-president, European space & defence, and government affairs; chairman, Spirit AeroSystems UK**

Despite this, the integration has proceeded smoothly; as an example Ryan highlights the migration of the unit's IT systems from Bombardier to Spirit, a process that was concluded around six months early and, crucially, was "invisible to the customer".

But almost two years since the acquisition closed, what has actually changed? From an outside perspective the answer appears to be very little: the Belfast plant is still churning out composite wings for the A220 – one of the things that made the plant so attractive to Spirit in the first place – along with composite horizontal stabilisers for Bombardier's Global 7500 business jet, plus nacelles and other structures for a variety of platforms. Support of the company's products, particularly nacelles, on the in-service fleet also continues.

Engineering expertise

However, Ryan says it is only once you peer under the surface that the changes become apparent. Although a core part of the business is its manufacturing capability and composite competence, Belfast also has a substantial engineering organisation, employing around 300 people. Since "becoming part of the Spirit family", as he puts it, the site has taken on engineering responsibility for the company's contribution to the A350 widebody, for which it makes the section 15 central fuselage panels.

That work has transferred from Spirit's Wichita headquarters and is also ramping up, thanks to the launch last November of the A350 Freighter.

"Not only were we supporting the A350 from a sustaining engineering point of view but we are actually hugely involved [in the] product development of the A350 Freighter, which includes a significant

redesign of our part of the fuselage, and then supporting it into service as well," he says.

The acquisition by Spirit has also given Belfast the freedom – a mandate, even – to seek work outside of Bombardier, particularly in the business and regional aircraft segments. "Now we are not part of Bombardier then the opportunities to work with other business aircraft OEMs is more possible than it had been within Bombardier," Ryan says.

"Spirit are prepared and willing to look at engagements with other business aircraft OEMs, other regional aircraft OEMs, as well as the big two [Airbus and Boeing]."

But to date, the only contract win for the Belfast plant is with Airbus for the development of the 16m (52ft)-wide single-piece composite wing for its CityAirbus NextGen electric vertical take-off and landing (eVTOL) aircraft.

Involvement in the fledgling eVTOL market makes sense for Spirit and Belfast, says Ryan, because they are "going to require the capabilities and skills all of [the aerostructures suppliers] have developed over the years, designing something, testing it and bringing it to market".

Mass production

Spirit Belfast believes its experience with composite technology and links with the regulators "can be exploited in that marketplace", he says, although the challenge will be to ensure that the structures can be built at rates much higher than those seen in aerospace today: "There's things that we will have to learn in terms of mass production going forward."

One obvious area of change though is the Belfast site's relationship with its former owner Bombardier. Although there was always an arm's-length relationship between the different parts of the business, "we were also really ingrained in the process", Ryan says. "We would have seen what they were developing months, maybe years ahead of a third-party supplier."

Obviously that has now changed, and Belfast is adjusting to its new role. "I don't think it would surprise anybody that it has been a challenge for us to move from being part of the family with Bombardier to being a supplier," he says.

Ryan asserts, however, that this has "forced us" to "up our game", helping the company to overcome the loss of "familiarity and understanding" – he doesn't use the word complacency, but it is close – that comes from being an in-house supplier.

Spirit AeroSystems UK

Recruitment has re-started following job cuts due to the pandemic

> "I don't think it would surprise anybody that it has been a challenge for us to move from being part of the family with Bombardier to being a supplier"
>
> **Michael Ryan Vice-president, European space & defence, and government affairs; chairman, Spirit AeroSystems UK**

Competition on cost to get onto any aircraft programme is fierce, he notes, and "therefore when Bombardier comes up with another product launch we are going to be competing as other aerostructures providers will do, so we need to be on top of our game".

As Northern Ireland's largest manufacturing business, Spirit Belfast's continued health is vital to the country's economy. And as the market for civil aircraft ramps up again, the plant is once more taking on staff.

Apprentice scheme

Around 300 people across all disciplines have so far been recruited over the past six months, an apprentice scheme is up and running once more, and graduate recruitment has also recommenced. Pre-Covid levels of employment should be attained within "a couple of years", assuming customer demand remains strong, says Ryan.

Despite the size of the UK's aerospace sector, prior to the Belfast acquisition Spirit's only presence in the nation was its plant in Prestwick, Scotland, which makes wing leading and trailing edges and spoilers for Airbus programmes.

Ryan sees the strong links between the government and industry in the UK through bodies like the Aerospace Growth Partnership and Aerospace Technology Institute as offering a key advantage to Spirit, helping to fund the development of the capabilities required for future programmes.

"And now we are bringing from Belfast opportunities as well, over and above what they [previously] saw and hoped for," he says.

Spirit AeroSystems UK

Company has deep expertise in composite manufacturing

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Bird's eye view

You can take the controllers out of the east London weather, but you can't take the east London weather out of the controllers.

At least that seems to be the case for London City airport, whose tower personnel no longer work at the facility but instead – through the magic of digital tower technology – oversee the traffic from 115km away, in the cosy Swanwick en route centre near Southampton.

But air navigation service NATS' London City watch manager Lawrie McCurrach says the "immersive" nature of the high-definition panoramic view means the chill of an airport downpour is felt just as keenly.

"You forget you're not at the airport and you're actually in sunny Swanwick," he says. "You still get all wrapped up and get your jacket on."

And – as predicted by us last year – the controllers are having to cope with the occasional "huge bird face" popping up in front of the cameras, admits NATS engineering deputy service manager Graham Lewis.

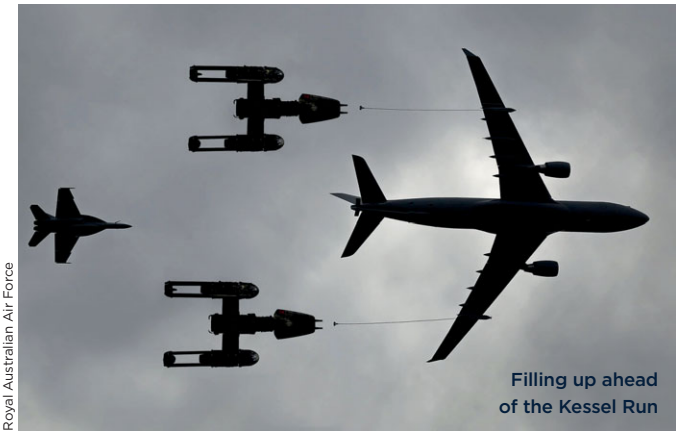
"We have to constantly remind ourselves that we can't tap the screens to get them to go away," he says.

Museum piece

Emirates has revealed an Airbus A380 in a special livery dedicated to Dubai's latest attraction, the Museum of the Future. Several more similarly-painted superjumbos are being deployed.

The initiative "underscores the airline's unwavering commitment to support Dubai's vision to become a hub for innovation and testbed for emerging technologies", says the press release.

But is there some irony in promoting the Museum of the Future on a type that – following Airbus's decision to cancel the programme in 2019 – has been very much consigned to the past?



Royal Australian Air Force

Filling up ahead of the Kessel Run

May the air force be with you

The Royal Australian Air Force marked *Star Wars* Day on 4 May ("May the fourth...") by posting this image on its Facebook page of one of its Airbus Defence & Space KC-30As fuelling Y-wing starfighters from the franchise.

"Crews from No 33 Sqn train with a wide variety of receivers," notes the service. "While the KC-30A isn't rated to provide coaxium [a highly-prized fuel that enables travel through hyperspace], it can carry more than 100t of jet fuel – giving these starfighters the flying range to reach a galaxy far, far away."

From the archive

1922 Close to the edge

I hear that as a result of the competition for commercial aeroplanes held at Brussels on Sunday, June 25, and won by the Handley Page "W.8.b.," this firm have obtained an order from the Belgian Government for six of these machines. The "S.E.5's" which the Aircraft Disposal Co. sent to these competitions have been flown back to Croydon during the week. Mr. Courtney, while flying one of these machines, experienced engine trouble while still five miles out over the Channel, and had the utmost difficulty in reaching the English coast. He succeeded, however, in arriving over the Dover aerodrome, only to discover that it was covered with sheep and hurdles; so he was compelled to land on the cliffs, pulling up within 20 yds. of the edge.

1947 A slick manoeuvre

As the main float caresses the first crest of the swell at 50 knots, the pilot swallows his heart and offers thanks, to await the impact of the second. His trained hand jerks open the throttle to regain lost speed. His ears are deaf to the roar of the engine because his eyes are devouring the lessening distance between him and the towering wall of the ship's hull and measuring his chance of "sitting" on the second crest and sliding gratefully into the trough. If he misses it with his main float, his tail will catch it and toss him nose-down into the trough, where the next swell will fall on him without mercy, and the side of the ship will ride the heaving sky above him like doom. But somehow or other he will pull out, and his machine will taxi smoothly to the net and hook-on.

Back to the future

Emirates Airline

Un-Oxfordable

Speaking at a rather-belated New Year event – towards the end of May – in a venue in central London, Airbus chief executive Guillaume Faury proclaimed that the company was investing in a new UK facility for its rotorcraft business.

"I'm very pleased to confirm that we are starting construction of a new Airbus Helicopters headquarters building at Oxford airport with a value of...," he said, pausing momentarily, before adding: "... in excess of £40 million."

After noting the wording in the speech, Faury remarked: "I hope that's not my team telling me it's going to be more expensive."

Back later

Aerospace firm Honeywell's website features, among many high-tech products, a range of alternative navigation systems designed to step in and assist aircraft in finding their way around when GPS satellite signals are interrupted.

Alas, no such comfort for visitors to the website recently. On a number of pages – including those showing alternative navigation equipment – a notice popped up informing them that the company was currently experiencing "interruptions" and "intermittent outages" and that it was "working diligently to restore services".

"Please check back at a later time," it suggested.

50

1972 TriStar treatment

Throughout the TriStar one is conscious of spaciousness, for the 206-seat configuration is more than modest for an aircraft of this size. All the seats have inflatable lumbar supports which can be adjusted to suit the individual and add markedly to the comfort on a longish journey. Other novel features include a stowage for large pieces of hand baggage, automatic coat racks which convey hung articles of clothing up out of sight, a stand-up bar in the economy section, and of course, two-abreast seating means that there are no middle seats. Three separate cinema screens and no-smoking sections all add to the pleasure of a long flight. Light catering is prepared and cooked in below-floor kitchens and then conveyed to the passenger deck in electric elevators.

25

1997 Pressure on Germany

Three of the four Eurofighter partner nations (Italy, Spain and the UK) will be ready to sign-off the production phase of the Eurofighter EF2000 combat aircraft project by the end of the month. John Weston, British Aerospace group managing director, says that by the close of the month the three countries will be in a position to sign a key memorandum of understanding, clearing the way for aircraft production. The move is aimed at pressurising the fourth partner nation – Germany – into committing to the programme. The German cabinet is due to meet on 11 July, with the EF2000 one of the critical issues to be discussed. Senior UK Government officials claim that Chancellor Helmut Kohl has given his "personal commitment" to the project.

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As the first woman to command the USA's largest Air National Guard unit, Brigadier General **Denise Donnell** wants to use her position to inspire anyone to follow their aviation dream

On Guard for New York State

Ryan Finnerty Burlington

Denise Donnell was a third-year undergraduate student at Georgetown University when she had her first taste of flying. While home in Montana over the Christmas holiday in the early 1990s, the international politics major was gifted 10h of flight lessons from her father.

The experience changed the course of her life. "I was hooked," she recalls.

At the time, she was enrolled in the Naval Reserve Officer Training Corps programme, and on the path to becoming an officer in the US Navy (USN), but changed course to pursue a set of naval aviator's wings.

Some 30 years later, she is a Brigadier General and the first female commander of the New York State Air National Guard, the largest such formation in the USA.

A sub-component of the US Air Force (USAF), it has a squadron of General Atomics Aeronautical Systems MQ-9 Reapers, a pararescue combat search and rescue unit, and the USAF's only 10 Lockheed Martin LC-130s, used for Arctic and Antarctic resupply flights.

Through her career, Donnell qualified on the Lockheed P-3 Orion anti-submarine warfare aircraft, Lockheed C-5 Galaxy and Boeing C-17 strategic transports, and two variants of the C-130, has logged more than 4,000 flight hours – including 280h in combat – and travelled all over the world.

With her father a USN doctor and her mother a service nurse, she attended elementary school in Japan, and middle school in Tennessee. "All I knew was navy," she says. "That was what I grew up in and that was what I was planning to do. Initially I wanted to be an intelligence officer."

LC-130 'Skibirds' perform Arctic and Antarctic resupply flights

US Air Force

After graduating, she earned a slot in the highly competitive naval aviation programme. It was early 1993, the US military was being downsized as the Cold War receded, and women were becoming more widely integrated into the services.

Donnell says she has never felt held back in the military by her gender, and cites an incident that occurred two years before she joined as having spurred positive change.

The 'Tailhook' scandal followed a 1991 naval aviation conference in Las Vegas, Nevada, at which USN and US Marine Corps officers were alleged to have sexually assaulted 83 women and seven men.

"That started a tremendous change in the navy," says Donnell. By the time she reached flight school, "what people really cared about was how well you could fly".

Hunting submarines

Then, for the next four years, she flew patrol missions, operating 300ft above the water in a P-3 hunting Russian Oscar-class submarines and chasing pirates in the South China Sea. At the age of 27, she deployed to the Persian Gulf, where she commanded flights with "release authority" to launch live ordnance.

Her favourite USN flight experience came during a deployment to Japan: a search and rescue mission to locate a sailing boat that had been severely damaged in the western Pacific.

After searching through the night, with sunrise approaching and just 15-20min left before the crew would have to turn for the 3h return flight, "we saw a flare off in the horizon", she recalls.

The crew dropped a life raft containing food, water and an emergency radio, then directed a passing cargo ship to the stranded boat, saving three lives.

After six years of flying, Donnell was ready to leave the navy, pursue a career in maritime law and settle down with her future husband.

Donnell commands 5,900 part-time 'citizen airmen'

US Air Force

Then 9/11 happened. During a flight briefing while assigned to a squadron near the capital, she learned about an opportunity to fly the C-5, applied for a position at the 105th Airlift Wing and was accepted into the New York Air National Guard. After completing flight training, she married and started a family – and began dealing with being a mother and a working pilot.

"Especially with strategic airlift, you're gone for five, six, seven days," she says. Once or twice per month, the unit would fly resupply missions to Afghanistan and Iraq, and then return cargo to the USA, or fly American service families from Europe for their summer vacation.

Now commanding New York's 5,900 part-time "citizen airmen", Donnell's priority is securing funding to recapitalise a "national treasure": the 109th Airlift Wing's LC-130s. The 'Skibirds' make the 11,000 mile (18,000km) trip from New York to Antarctica several times each austral summer: a five- to seven-day route via stops in California, Hawaii, American Samoa and New Zealand.

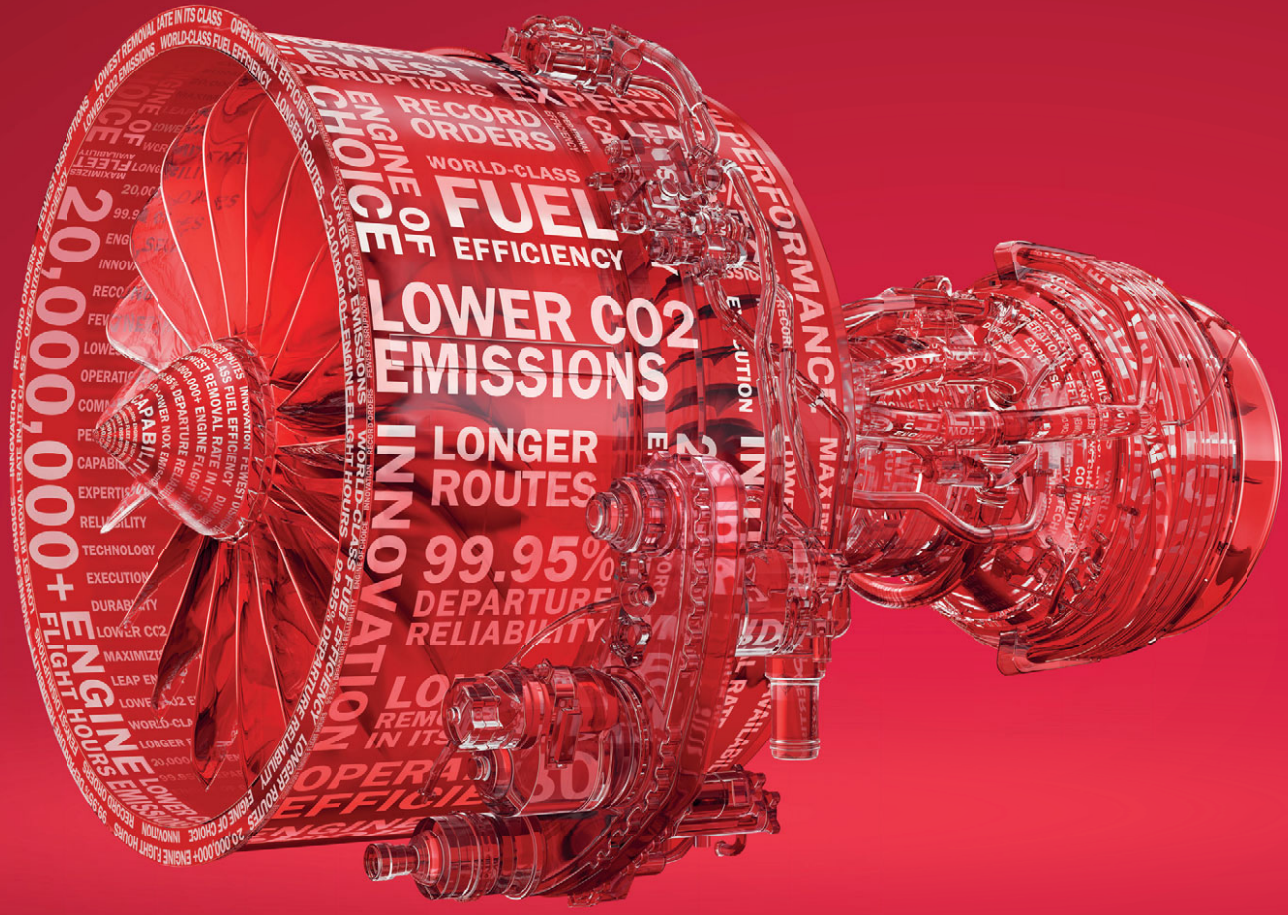
While earning her master's degree, she authored a paper laying out the imperative of expanding the USA's fleet of LC-130s and icebreakers. Polar competition is a hot topic today – but Donnell laughs when recounting the feedback she received from her professor at the time: "You needed to write on something more strategically relevant."

Describing her career experience as "phenomenal", she says: "Responding to tsunamis in Japan, taking cargo to the South Pole. Those are adventures that most people read about in a fiction novel."

Her advice for anyone interested in turning that kind of fiction into their own reality?

"You can't wait for someone to bring it to you. You have to pursue it.

"The airplane doesn't care if you're a man or a woman; black or white. The passengers don't care either. They just want someone to operate the aircraft safely and return them home."



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