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Tipped for success?

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Growth agenda

While ambitious goals are commendable, Boeing has a great deal of work to do if it is to clear a path to reaching them

Boeing's current strategy seems to be riven with contradictions. While these are not mutually exclusive, they appear a clear source of tension.

Take, for instance, the airframer's plan that by the middle of the decade it will once again be delivering 800 commercial aircraft each year and raking in $100 billion in revenue.

Achieving those targets would mean a return to a financial and delivery performance last seen in 2018 – or in other words, a return to the good times; a point before decisions taken by Boeing's previous management proved to be so catastrophic.

2018 was the last 'normal' year for Boeing: by the following March the 737 Max – the manufacturer's cash cow – was beginning the 20-month grounding from which the programme and the company are still struggling to recover.

True, Covid-19 was a crisis beyond anyone's control, let alone Boeing's – but as doctors will tell you, symptoms are more severe if the patient is already in a weakened state.

Therefore Boeing's predictions of a mid-decade rebound rest heavily on it resolving the problems that continue to linger: a toxic mix of external supply chain tension, geopolitics and issues spilling over from the Max crisis – undelivered inventory and heightened regulatory scrutiny, to name but two.

These challenges are not insurmountable but will require deft management footwork – and not a little luck – to navigate successfully if Boeing is to hit its 800-aircraft per year target.

Similarly, the company's misfiring defence division appears in need of repair. In the most recent financial quarter, forward charges were once more booked against several military programmes, a consequence of fixed-price bids that have left Boeing on the hook for billions of dollars in cost overruns.

Such loss-leaders are fine if you can execute aircraft development without a hitch – but as Boeing has discovered, they are hugely costly if you cannot.

Meanwhile, new aircraft development remains on hold. Boeing's leaders say they do not see sufficient maturity in next-generation engine technology or production systems to merit the launch of a new jet in the short term.

Perhaps so, but there is a feeling in some quarters that the airframer is merely justifying its own inertia. And as many note, there is sometimes a bigger cost to not investing rather than spending money: all the time that Boeing does nothing, Airbus will continue to chip away at its rival's market share in the narrowbody segment – particularly at the upper end, where the A321XLR faces limited, if any, competition.

What share of the market will Boeing ultimately tolerate? Based on total orders for re-engined single-aisles that figure is currently hovering around 44%, but there is a distinct possibility of further erosion. If it reaches, say, 30%, Airbus will have a huge installed base to count on when the time comes to launch a Neo successor.

Boeing's success or failure at this point is not pre-ordained, but the mess left after four years of disruption means there remains much work for the airframer's management to do if it is to achieve its lofty goals.

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Casualties of war
Russian losses in Ukraine remain unclear

Rich Cooper

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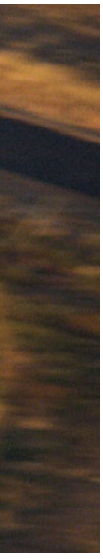
In depth



In the medium term, Boeing's profitability relies on success of the 737 Max programme

Boeing

Future proofed?

Although Boeing has ambitious plans for the mid-term, to reach that promised land the airframer must first resolve the numerous problems that have built up over recent years

Jon Hemmerdinger & **Ryan Finnerty**
Tampa

Boeing aims by mid-decade to be delivering 800 aircraft and taking in revenue of $100 billion annually, though its ability to meet those goals remains uncertain because of unresolved troubles that have kept its 2022 targets out of reach.

Company executives presented their goals on 2 November, laying out a plan to return the airframer to production and revenue levels it last achieved in 2018. Chief executive David Calhoun also made clear that Boeing has no immediate intention of launching a new aircraft development programme.

The messages came towards the end of a year in which Boeing has seemed unable to overcome many long-standing problems that plague aircraft programmes in both its civil and defence divisions.

Though the company has resumed 787 deliveries in 2022, it has also taken billions in losses on troubled military programmes, delayed several commercial aircraft certification timelines and failed to hit 737 output targets.

$3.3bn

Losses in the third quarter, with $2.8 billion of this coming from the Boeing Defense, Space and Security division

As a result, much about Boeing's future remains unclear, and opinions are split on whether postponing development of a new commercial jet is the right move. Financial analysts think it makes sense, while some of those in the aerospace industry think Boeing might be falling deeper into a competitive hole.

"There are consequences to not investing," says Michel Merluzeau, aerospace analyst with AIR, noting that Airbus continues taking market share in the narrowbody space.

By the time Boeing finally has a 737 replacement ready – which could be the early-to-mid 2030s – "Airbus will have a much more significant installed base of aircraft", Merluzeau says.

Chinese competitor Comac might also have secured a stronger position, he adds. "Boeing is going to have to fight... There is a cost to taking back market share".

Boeing has yet to rebound financially or operationally from a several-year slump that started with the 737 Max crisis and carried through the Covid-19 pandemic. Like competitors, it is working to overcome supply chain and labour troubles.

In late October, Boeing reported losing $3.3 billion in the third quarter, largely because Boeing Defense, Space & Security (BDS)

haemorrhaged cash, closing the period $2.8 billion in the red. Boeing Commercial Airplanes (BCA) did not have a banner third quarter either, losing $643 million.

Issues affected four major military programmes: the KC-46 aerial refuelling tanker, T-7A jet trainer, MQ-25 carrier-based autonomous tanker, and 747-based VC-25B presidential aircraft.

Boeing attributes its defence losses to pandemic-related supply chain and labour constraints, combined with engineering challenges.

> "We are trying to assess [firm fixed price] programmes with real clarity. We are not projecting a significant improvement in the future"
>
> **David Calhoun Chief executive, Boeing**

But firm fixed price (FFP) contracts have played a role. Boeing's previous executive team had adopted an aggressive and risky strategy to win programmes such as the T-7 and KC-46 through FFP deals, which specify delivery prices and schedules, leaving manufacturers on the hook for cost overruns.

There was reason behind the strategy. A recent Bloomberg Intelligence report notes that BDS had been "dwarfed by Boeing's commercial business until the pandemic". BCA, which in 2018 generated more than $60 billion of revenue and almost $8 billion in operating profit, could essentially subsidise the airframer's defence programmes through their costly engineering and manufacturing development phases, until they reached the more profitable production stage.

"We are trying to assess these programmes with real clarity and realism, with respect to what we are experiencing now," Calhoun said on 26 October. "[We are] not projecting a significant improvement... in the future."

Company has absorbed cost overruns from KC-46 tanker

US Air Force

Though many of Boeing's major defence programmes are now money-losers, Calhoun insists they will pay off: "These programmes... will be key to margin recovery in future periods."

But profitability at BDS remains elusive. "The largest defence programmes have become a persistent drag on profit and cash flow as costs rise on fixed-priced contracts," Bloomberg Intelligence says.

"They have been sort of living with death by a thousand cuts," adds George Ferguson, Bloomberg Intelligence senior analyst. "Every quarter there was another charge, another charge and another charge."

Recovery roadmap

At the same time, the financial backstop that had shielded the risky defence programmes eroded following the 737 Max disasters, declining air travel during the pandemic, and ongoing supply, labour and certification issues.

"They have got to get the supply chain stabilised, and delivering to the [final assembly] line on time," Ferguson says. "That's the key for next year."

Several weeks after disclosing its performance in the third quarter, Boeing executives revealed a recovery roadmap to investors. The near-term focus will be on addressing supply and labour problems and increasing aircraft production and delivery rates. Boeing has also been working to bring the 737 Max 7 and Max 10, and the 777-9 through certification.

In 2023, Boeing aims to deliver 400-450 737s – up from an estimated 375 in 2022 – and 70-80 787s. The company has had recent positive momentum on the Dreamliner programme, having resumed deliveries in August following a halt lasting most of the preceding 22 months. It had delivered 15 787s by the end of October, the most recent month for which the manufacturer has released data.

Executives also see a path for Boeing to be delivering the target of about 800 aircraft and generating $100 billion in revenue annually by 2025 or 2026. That would return the airframer – which reported revenue of $62 billion in 2021 – to its position in 2018, when it posted $101 billion in revenue and delivered 806 aircraft.

"I want nothing more than to return money to you," chief financial officer Brian West told investors.

To hit 800 annual deliveries, Boeing aims to produce at least 50 737s, four 777s and 10 787s each month.

Some financial analysts are reassured that the plan rests on ensuring the long-term success of the 737 programme, which Ferguson calls BCA's "most important programme – the money-maker".

"Everything else has little to no contribution to profits. So the 737 programme has to get going," Ferguson says.

But Boeing's ability to achieve those goals is not obvious. After all, 2022 – not 2023 – was supposed to be the turnaround year.

In 2022, Boeing aimed to resume Max shipments to China, bring 737 production to 31 jets monthly, deliver 500 737s, achieve the Max 7's certification, and resume 787 deliveries, which had been halted owing to quality shortcomings with the type's composite fuselage.

Certification delays

Analysts also expected that in 2022 Boeing would finally launch a new narrowbody aircraft to counter Airbus's hugely successful A321neo.

With the exception of resuming 787 deliveries in August, none of that has yet happened.

Instead, this year Boeing has delayed three aircraft certification timelines – the Max 7 to late this year or early 2023, the Max 10 to late 2023 or early 2024, and the 777-9 to 2025.

Meanwhile, deliveries of the 737 Max to China remain held up amid troubled Sino-US relations – a thorny problem for which Calhoun in October expressed pessimism for a quick fix.

"I have not gotten a single signal – and I'm surprised by it – that [Chinese airlines are] going to take deliveries in the near term," he said.

Likewise, twice in 2022 Boeing trimmed its full-year 737 delivery forecast, most recently in October, to 375 aircraft.

And though Boeing does not disclose month-to-month production rates, available information suggests its Renton 737 assembly site has been completing only around 20 – or perhaps a few more – 737s monthly. Boeing has attributed the slow pace to labour problems and shortages of parts, including galley and electrical components and CFM International Leap-1B engines, the exclusive powerplant on the 737 Max.

Staff errors

The 737 line has also suffered "quality problems", BCA chief executive Stan Deal said on 2 November. A source within Boeing says the company this year repeatedly stopped 737 wing manufacturing to fix production defects, including miss-drilled holes, partly because of errors made by new staff.

When Boeing will iron out its supply wrinkles remains an open question, but analysts suspect this will not be soon.

"In 2023, we are going to see the same disruptions, or possibly more," says Alex Krutz, managing director at aerospace and defence advisory Patriot Industrial Partners.

"I think it is going to take all of next year to correct some of these fundamental issues."

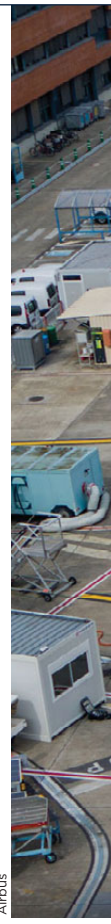
Calhoun has conceded BDS's performance has been lagging but says the company is focused on a turnaround, noting demand remains robust for military aircraft. The company received $5 billion in new orders during the most recent quarter, pushing its defence backlog to $55 billion, he says.

West adds that, after a year of hostilities in Europe and growing militarism in Asia, the company sees strong support in Washington for increased defence spending, with a similar trend in other Western capitals. "We see solid long-term markets both domestically and internationally," he says.

Boeing's legacy defence programmes – including the F/A-18 fighter, AH-64 attack helicopter and CH-47 Chinook heavy-lift helicopter – remain profitable thanks to overseas customers.

Also, the latest EX variant of the highly successful F-15 interceptor could provide a substantial source of new revenue.

But Richard Aboulafia, managing director of AeroDynamic Advisory,



Airbus

"In 2023, we are going to see the same [supply chain] disruptions. It is going to take all of next year to correct these fundamental issues"

Alex Krutz Managing director, Patriot Industrial Partners

787 deliveries resumed in August – the only 2022 business objective met by airframer

AirTeamImages

Boeing has yet to launch a new jet that can compete with the A321XLR

does not view that programme as a lifeline. While the US Navy will continue operating F/A-18s for years, foreign customers such as Canada have opted to replace the type with Lockheed Martin F-35s.

Aboulafia expects F-15EX purchases will be limited to the US Air Force because of the type's significant purchase price – which is looking to be even higher than that of the F-35A.

"No cylinders appear to be firing right now," he says of BDS.

West has repeatedly said Boeing intends to "de-risk" its military business. "Our mandate is to stabilise and deliver a very important product to our customers," he said in October.

But given the constraints of fixed-price programmes, Ferguson thinks Boeing can do little to dramatically improve defence profitability – other than by maximising its own efficiency.

Ferguson also thinks some high-volume programmes such as the KC-46 hold promise, noting Boeing Global Services – the company's aftermarket arm – stands to make money off long-term support for the tanker. "In time, they will have follow-on orders, which they should be better prepared to deliver on time," he adds.

Aboulafia is more sceptical, noting the KC-46 is already out of development and in production – and still losing money.

"This just looks like mediocre decision making, greatly exacerbated by leadership and cultural shortfalls," he says.

Aboulafia and Ferguson suspect the low-volume VC-25B programme will forever remain a money-loser for Boeing.

New aircraft

Boeing's failure to launch a new aircraft has particularly troubled some aerospace analysts who expected the company by now would be well into developing a "mid-market" aircraft.

Boeing executives had, just a few years ago, talked about such a jet, which was to carry 270 passengers 4,000-5,000nm (7,400-9,260km) and counter the A321neo.

The Airbus model – particularly the new 4,700nm-range A321XLR – targets a segment to which Boeing clings with ageing 757s and its uncertificated 737 Max 10, which cannot match its rival's range and payload. Observers expected Boeing would follow a mid-market jet by launching a 737 replacement.

In fairness, Calhoun never promised a new aircraft launch in 2022. During the investor day, he dashed such speculation, saying neither propulsion technology, nor digital development and production tools, are sufficiently mature to support a launch any time soon.

"I don't think we are going to even get to the drawing board this decade," he says.

Analysts understand Calhoun's interest in putting the Max's recovery first, but some fear Boeing's unwillingness to launch a new aircraft is compromising its future.

Aboulafia has long said Boeing's inaction has allowed Airbus to significantly expand its share of the market. Following Calhoun's revelation, Aboulafia thinks that trend will accelerate, warning BCA could "die on the vine" – or that Boeing could be broken into separate companies.

Likewise, Merluzeau views Boeing as sacrificing product development "on the altar" of the Max.

He thinks delays could leave Boeing behind in developing modern manufacturing processes, and says Boeing might eventually wake up without the engineering expertise needed for its next aircraft.

The risk of delaying "is that you lose the expertise, you lose the talent, you lose the knowledge", Merluzeau says.

C919 test aircraft performed in Zhuhai event's flying display

Approval rating

Beijing's certification of two Western types – announced during the Airshow China event – appears to be a mix of pragmatism and politics

Alfred Chua Singapore

At this year's Airshow China in Zhuhai there was some semblance of a buzz on the commercial aviation front, despite the long shadow cast by the country's strict zero-Covid policy.

For instance, Chinese airframer Comac clinched a first major order for its C919 narrowbody since the programme gained domestic type approval – a 330-aircraft commitment from seven Chinese lessors. A C919 test aircraft also performed in the event's flying display.

But it was the certification of not one but two Western programmes that was arguably the more significant development of the five-day show.

First came the Civil Aviation Administration of China (CAAC) validation for the ATR 42-600 twin-turboprop. The Franco-Italian manufacturer says the move "opens the opportunity" for it to re-enter the Mainland Chinese market, forecasting that the country will require 280 new turboprops over the next 20 years. ATR also disclosed a firm order from an undisclosed customer for three aircraft.

Then, two days later, Embraer announced its E190-E2 regional jet programme had been certificated by the CAAC, with approval for the larger E195-E2 expected to follow.

While the Brazilian airframer has yet to receive any Chinese orders for the E2 family, it says the jets are the "best aircraft to serve low-density but high-elevation markets in western China with the right performance [and] more profitability".

To make the point, the airframer sent an E195-E2 to Zhuhai – marking the type's debut in China.

That the two certifications were announced within days of each other – and at the country's most prestigious air show, no less – was enough to raise eyebrows.

For one, it comes as China is keen to burnish the credentials of its indigenous aerospace industry – a source of national pride and something of a reaction against wider geopolitical tensions.

The C919, for instance, has been described as proof that the country is "capable" of a creating "respectable... homegrown aircraft programme" – even though the narrowbody is almost entirely reliant on Western technology; China also has its own regional aircraft programmes, with the Comac ARJ21 already in operation, including with the country's three largest carriers.

330

Combined commitment for C919 from a total of seven Chinese lessors

But in a country where little happens without political say-so, the certification of two Western programmes is telling. Crucially, the manufacturers do not hail from the USA, whose relations with Beijing are more challenging than those of Brazil or Europe.

Managing director of Aerodynamic Advisory Richard Aboulafia welcomes the "progress" with certification of Western types, especially "given the dismal state of [Mainland China's] relations with the West".

"Hopefully, the CAAC's timing was purely about verification of technology and safety, rather than due to any politically induced motives. The organisation had achieved great things with China air safety, but the [737 Max] re-certification process indicates an unwelcome level of political interference," he adds.

Aboulafia says it is "hard to say right now" what Beijing's ultimate motive is in certificating the ATR and Embraer aircraft, adding: "[It] could be that they are signalling that they will work with all Western [manufacturers] except Boeing, for political reasons."

Aboulafia notes that the ATR approval is "the more interesting" of the two, given what it means for the MA700 programme, a larger twin-turboprop being developed by state-owned AVIC.

The MA700, which like Comac's aircraft are dependent on Western technology, faces big roadblocks, chiefly Canada's decision to block the export of Pratt & Whitney Canada PW150C engines.

"Recreating it with a non-Western engine would take a decade or more, so ATR is all they have for in-country 'prop demand," says Aboulafia, who points out that the larger ATR 72-600 could soon also gain Chinese approval.

As for the Embraer certification – and rumours around a similar move for the Airbus A220 – Aboulafia says the decision "might represent a degree of recognition" about demand in the regional market – and the state of the ARJ21.

"There has never been much of a regional market in China, for reasons of market density, high-speed rail, and other factors," he says. "While the ARJ21 is meant to fill demand in this limited space, it's a miserable aircraft."

Chine Nouvelle/SIPA/Shutterstock

First export AH-1Z is big hit with Manama

Latest Royal Bahraini Air Force addition makes show debut, as Turkish upgrade bolsters capability of legacy Cobra fleet

Craig Hoyle Manama

One of Manama's newly-delivered Bell AH-1Z attack helicopters made its public debut at the Bahrain International Airshow, as the nation also displayed its freshly upgraded AH-1 Cobras.

Appearing in the static display at the 9-11 November event, the Royal Bahraini Air Force's (RBAF's) new AH-1Z – with the registration 2201 – is one of 12 ordered via a November 2018 deal with an estimated value of more than $900 million.

"This is the first presentation of an FMS [Foreign Military Sales] AH-1Z anywhere in the world, so we're really excited," Bell H-1 programme director Mike Deslatte told FlightGlobal at the show.

Recent deliveries

Six of the combat helicopters have arrived in the country since earlier this year, shipped from the USA aboard freighter aircraft. Bell also has delivered a flight training device to Bahrain to support the RBAF's introduction of the new model.

Deslatte says work on the production programme for Bahrain is around 75% complete at Bell's Amarillo site in Texas. "We'll have all the rest of them built and completed by the end of this year," he adds.

With a maximum gross weight of 8,390kg (18,500lb), the AH-1Z has a useful load of around 2,600kg – sufficient to carry a variety of air-launched weapons, in addition to the 20mm cannon mounted beneath its nose.

MENA reacts to cargo, MRO need

Nation's aerospace sector advances as company moves to support narrowbody operators and boost air freight provision

Murdo Morrison Manama

The Middle East region's flurry of airline start-ups, growing single-aisle fleet and increased air freight demand have led MENA Aerospace to launch Bahrain's first MRO business, along with a new cargo joint venture.

Under the MENA Technics business established in partnership with US specialist Aviance Global and announced at the show on 9 November, the company will expand its hangar facility at Bahrain International airport, initially from the current two bays to three. However, it has also submitted plans for an additional two-bay MRO facility for narrowbodies.

Broad appeal

The business will serve both commercial airlines and private jet operators and will be European Union Aviation Safety Agency Part 145 accredited.

"There has been a huge growth in the fleet in this region," says MENA Aerospace managing director Dr Mohammed Juman. The new initiative "supports the kingdom's efforts in strengthening its position as a key aviation and logistics hub", he adds.

Aviance chief executive Phillip Edinborough says MENA was "the obvious choice" for its expansion into the Gulf market. "This partnership enhances the services and expertise offered in Bahrain and

Example on display was one of 12 ordered in November 2018

Craig Hoyle/FlightGlobal

While Bahrain's armaments choice for the type was not on display, the US Defense Security Cooperation Agency in April 2018 detailed a potential package including Lockheed Martin AGM-114 Hellfire air-to-surface missiles and BAE Systems APKWS II precision-guided rockets. The aircraft can also carry Raytheon AIM-9 Sidewinder air-to-air missiles.

The RBAF currently operates 30 examples of the legacy Cobra, in the E/F attack standards and P-model training configuration. The attack helicopters have been the subject of an upgrade programme performed by Turkish companies, and not involving Bell.

During the show, the modified type was on display with stub-wing-mounted pods for Roketsan Cirit 7.5in (20mm) laser-guided rockets. With a weight of 15kg, the Cirit round has an effective range of 0.8-4.3nm (1.5-8km), according to its manufacturer.

Meanwhile, Deslatte believes Bell could be well positioned when the RBAF identifies a need to replace its aged Bell 212/412 transport helicopters. Cirium fleets data shows that the service has 21 of the aircraft in use, with an average age of 39 years.

Bell's UH-1Y, which features 85% parts commonality with the AH-1Z, could be a candidate if a requirement emerges, but he notes: "Even our latest versions of the 412 could potentially be a good fit for the Bahrainis as well. We have got a number of different things in our portfolio that could serve them quite well."

In addition to producing Bahrain's new aircraft, Bell will in 2023 deliver four AH-1Zs and eight UH-1Ys to NATO member the Czech Republic, completing its current order backlog. The company in early November handed over the 189th and final AH-1Z for lead operator the US Marine Corps, which took its last Y-model transport in 2018.

Sales prospects

"We are laser focused on continuing our Foreign Military Sales and the production line of the UH-1Y and AH-1Z," Deslatte says, while declining to identify potential sales candidates for the pair.

Bell attended the Bahrain show hot on the heels of securing an order at the SOFEX event in Amman to supply the Royal Jordanian Air Force with 10 of its 505-model trainers. Signed on 1 November, the deal also covers the provision of a flight training device to be installed at the King Hussein Air College in Mafraq.

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paves the way for further expansion," he continues.

The MENA Technics partners plan to expand their collaboration to Saudi Arabia "in the near future".

MENA also used the show to confirm plans to launch a cargo partnership with Singapore-based Asia Cargo Network (ACN). This will see the companies operate an eventual fleet of 13 narrowbody aircraft in the Gulf, with plans to also add a Boeing 767.

The first two ACN aircraft – a 737-800F and 767-300F – will arrive in the next two months, joining MENA's 737-300 converted freighter, with operations to begin "immediately". The rest of the fleet will deploy over three years, says ACN, which is taking a 49% equity stake in the new venture.

Region has been experiencing increased cargo demand

Craig Hoyle/FlightGlobal

The "strategic alliance" will position the companies "among the key players in freight in the Middle East, South Asia and Africa", says MENA.

"Our thought process was to try to link and serve these markets," Juman says. "We identified ACN as the leading freight operator in Southeast Asia to be the perfect partner to expand our services."

ACN group chief executive Marco Isaak describes the partnership as a "milestone as we expand our operations into the [Middle East and North Africa] region". ACN was established in 2015 and also has companies in Indonesia and Malaysia.

Hub focus

The new venture will operate using a Bahrain air operator certificate under the MENA Cargo brand, established in 2020.

The move comes as the Bahrain authorities bolster the country's credentials as an air freight hub. DHL, which already uses it as one of its global hubs, is expanding its Bahrain-registered fleet. FedEx Express will become the anchor tenant of a new Cargo Village being built at the airport, while Texel is another significant air cargo operator.

Type entered operational use with the RAF in 1971

Four bidders for Puma successor

UK Ministry of Defence narrows field in search for medium rotorcraft supplier to replace aged Royal Air Force assets

Dominic Perry London

Defence officials have whittled down the number of bidders for the UK's New Medium Helicopter (NMH) contest to four companies, following an initial selection process.

Airbus Helicopters, Boeing, Leonardo Helicopters and Sikorsky all have progressed, after passing a dynamic pre-qualification questionnaire (DPQQ) issued to interested parties by the Ministry of Defence (MoD) earlier this year. Bidders were informed of the latest development on 31 October.

Airbus Helicopters is offering the H175M and Leonardo Helicopters the AW149 – to be built domestically in Broughton and Yeovil, respectively – while Sikorsky is promoting its S-70M Black Hawk.

Boeing's interest in the requirement is unclear, given the lack of a suitable aircraft in its product range: the only medium helicopter it could offer is the MH-139, a development of Leonardo's best-selling AW139, which is already being delivered to the US Air Force.

However, sources suggest that Boeing may instead be interested in securing the support and training elements of the NMH deal.

Seemingly dropping out of the race are Bell, which had proposed its 525 Relentless; NH Industries, with its NH90; and UK start-up AceHawk Aerospace, which had proposed upgraded, pre-owned ML-70 versions of the UH-60 Black Hawk.

Service entry for the NMH platform is due in 2025, with the type to replace the Royal Air Force's fleet of 23 Puma HC2 helicopters, along with Bell 212s and 412s respectively based in Brunei and Cyprus, and Airbus Helicopters AS365 Dauphins used for special forces tasks.

Next steps

The next step for the NMH programme will be the release of invitations to negotiate (ITN) to the shortlisted manufacturers, through which the MoD will set out its precise requirements.

The MoD has not commented on its procurement schedule, but defence minister Alec Shelbrooke – answering a written parliamentary question on 18 October – said: "The second half of the competition, in which we will ask the selected suppliers to provide more detailed responses, is due to be launched later this financial year." That period runs until 31 March 2023.

This is a considerable shift from when the MoD issued a request for information relating to the NMH requirement in late 2021, at which time it was expecting to select a winning bidder by early next year.

Launching the NMH programme in May 2022, the MoD said it was seeking between 36 and 44 helicopters via a contract worth an estimated £900 million to £1.2 billion ($1-1.3 billion), also covering training and support. However, a government spending review due shortly after *Flight International* goes to press could affect the procurement.

Additionally, the already delayed process means there are doubts about the potential for either Airbus or Leonardo to establish a new production and assembly line for the H175M or AW149 within a severely compressed timeline.

With the MoD's procurement schedule having shifted to the right and budget pressures mounting in the UK, one source indicates that as the Puma has been selected to take over operations in Brunei and Cyprus on a temporary basis, this could potentially move the HC2's retirement date to 2027.

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Photographic record made during the unpaved runway test campaign.

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Airbus

A350 interior conjures more space

Airbus introduces modifications to twin-aisle, growing cabin length and width, and enabling 30 more seats to be fitted

David Kaminski-Morrow London

Airbus has gained close to 1m (3ft) in cabin length by reconfiguring the A350's interior, including moving the rear pressure bulkhead further aft and the cockpit wall forward.

Its updated configuration also includes widening the cabin by 2in (5cm) either side, through re-sculpting the central fuselage sidewalls, taking the width to 225in at armrest level, 25in above the floor.

This configuration enables the previous nine-abreast seating arrangement to accommodate an increased seat width, from 18in to 18.7in. But it also provides a 10-abreast option – albeit with 17in seats – in a 3-4-3 layout.

The rear bulkhead has moved aft by one frame, or 25in, allowing a larger galley installation, while the cockpit wall has slightly shifted forwards and monuments have been optimised, giving an overall 35in of reclaimed cabin length.

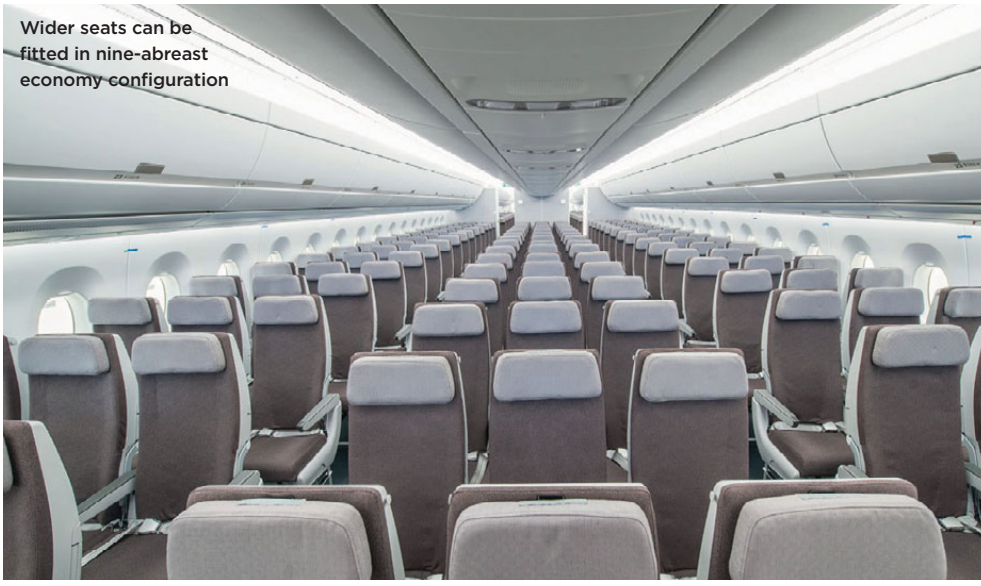
Airbus states that the collective effect of the changes means up to 30 more seats can be fitted in a three-class configuration, in both the A350-900 and -1000.

"Since the extra cabin width benefits all classes of passenger seating, the extra space can go towards widening the aisles, the armrests, seat-pan between the armrests, the centre console in premium-economy – or a combination of these," it adds.

Airbus points out that the aircraft can use the same seat rails, tracks and in-flight entertainment interfaces for both the nine- and 10-abreast layouts, providing flexibility to carriers wanting to switch from one to the other. It adds that the air-conditioning system already had the capacity to provide for the extra passenger load.

Moving the bulkhead and reshaping the aft galley area provides extra working space and trolley storage.

Airbus's interior redesign also features a new crew-rest compartment in the upper crown of the A350 – accessed by a relocated staircase



Wider seats can be fitted in nine-abreast economy configuration

Airbus

– and space to fit a larger lavatory for reduced-mobility passengers in the vicinity of the forward left-hand passenger exit.

Galley space has been freed ahead of the forward right-hand exit, following the cockpit wall shift, allowing extra inserts and trolleys.

Airlines will be given the option to select electronically-dimmable windows, rather than traditional pull-down shades. New Taiwanese operator Starlux is the first to choose the latest version, manufactured by Gentex.

Easy maintenance

"The windows also bring advantages for maintenance crews since they can be easily and quickly unclipped from the window bezels using a special tool, and without having to remove any seat or sidewall panels," says Airbus.

System optimisation on the twinjet – including changes to electrical installations, fitting a single water tank, new waste tank, and lighter floor heating – plus engine pylon and nacelle modifications have allowed the airframer to trim up to 1.2t of weight from the airframe.

Both the A350-900 and -1000 will be able to accommodate higher payloads or achieve longer range with a 3t hike in maximum take-off weight.

However, software changes to the high-lift system and faster landing-gear retraction will assist hot-and-high performance. Airbus claims a potential take-off weight improvement of 4t at Phoenix or 6t at Mumbai.

Full A321XLR test fleet flying, but delivery slips again

All three A321XLR test aircraft are now flying, but Airbus expects entry into service will not take place until the second quarter of 2024.

The airframer had previously indicated that it would be introduced in early 2024, as a result of a delay in the certification campaign to meet additional European Union Aviation Safety Agency requirements.

Chief executive Guillaume Faury gave the update in a third-quarter financial briefing in late October. He says that, with the three prototypes flying, the development and certification schedules are "more precise and stabilised". He adds that the revised entry-into-service date "fits", and is "not materially later" than the company's previous expectations.

Service entry for the aircraft, the longest-range member of the A321neo family, had originally been planned for 2023 but Airbus revealed in May that it had slipped to the following year.

Airbus says that A320neo-family production rates are "progressing" to the target of 65 aircraft per month in early 2024 and 75 in 2025.

"The groundwork continues throughout all sites to secure rate 75 and adapt to the higher proportion of A321s in the backlog," it adds.

Preparation for upgrading the second A320neo final assembly line in Toulouse is underway. Faury adds that work to upgrade the Chinese facility in Tianjin to manufacture A321s is complete, and that the site is "currently assembling" its first example of the variant.

Airbus is maintaining its full-year target of delivering 700 commercial aircraft. Faury says its earnings outlook, in the face of continuing pressures on the supply chain, "remains fragile" due to the pandemic, Ukrainian conflict, energy provision and constrained labour markets.

Over the third quarter Airbus's commercial aircraft adjusted earnings increased by a third to €599 million ($593 million), and by 5% across the first nine months of the year to €2.87 billion.

Commercial aircraft revenues for the nine-month period rose by 8% to €26.6 billion. The performance was assisted by higher commercial aircraft deliveries and a "favourable mix", says the airframer.

Airframer expects long-range narrowbody to enter service in second quarter of 2024

Airbus

Alleged 5G interference events mount up as bandwidths converge

US pilots report litany of aircraft system failures since rollout of new connectivity standard in January this year

Jon Hemmerdinger Tampa

The US Federal Aviation Administration (FAA) suspects new 5G cellular networks may have caused roughly 80 instances of aircraft system interference this year, with pilots reporting a range of malfunctions since the latest generation of mobile connectivity went live in January.

"The FAA has received several hundred reports of possible 5G interference and, as of mid-September, we have been unable to rule out 5G in approximately 80 cases," the agency tells FlightGlobal.

"None of these resulted in safety-related effects, and none affected a direct aircraft control input such as autothrottle or speed brakes/spoilers."

But the revelation of the reports comes as the aerospace industry has in recent weeks asked the US Federal Communications Commission (FCC) to require cellular providers to take steps to prevent 5G signals from interfering with radio altimeters.

The FAA says it has not conclusively determined that 5G interference was responsible for the 80 issues reported, but it is assuming so for the purpose of risk analysis.

It adds that aviation is safe thanks to steps taken to mitigate interference, noting cellular companies have deployed 5G in areas nationwide using tens of thousands of antennae without serious flight problems. The cellular industry also insists 5G is safe for aircraft.

220MHz

Size of 'guard band' between cellular and altimeter spectrums to protect aircraft systems from interference

The FAA was responding to an inquiry from FlightGlobal relating to nearly 90 flight incident reports filed in the USA this year by pilots who cited "5G" as a possible cause.

Collected by the US government's Aviation Safety Reporting System (ASRS), the reports list about 50 cases of radio altimeter problems. Others detail failures of altimeter-dependent avionics and cockpit systems; many involved multiple system malfunctions. Numerous incidents occurred at low altitudes during critical flight phases. By comparison, pilots reported just three radio altimeter failures in all of 2021.

Incidents contained in the ASRS do not draw conclusions about actual causes, meaning other factors could be to blame. But they suggest 5G has caused some troubling aircraft system failures.

"Captain reported navigation systems malfunctions due to suspected 5G interference [that] led to an altitude overshoot during departure," a pilot noted of a May incident.

"Distraction resulted in climbing to 10,300ft, before correcting to 10,000ft during intermediate level off," the pilot wrote. "The issue may have been corrupt radio altimeter data in the aircraft sensors, which caused aircraft to think it was still on the ground."

Wrong altitude

IEEE Spectrum, a publication of the Institute of Electrical and Electronics Engineers, reported such incidents on 13 October.

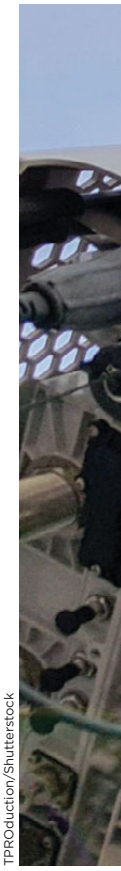
Another pilot wrote of receiving a "40ft call-out followed by additional alerts" while at 300ft during approach to Salt Lake City in June. "Maintenance indicated that other crews had experienced the same problem and that it may be caused by 5G interference."

The cellular industry notes that 5G services have been active for years in Europe and elsewhere without problems. In late 2021, trade group CTIA, which represents the sector, accused the aerospace industry of "fearmongering".

"FCC rules pertaining to operating 5G in the C-band have been shown to provide the necessary protection for aviation operations, and there have been no known safety-related impacts," CTIA tells FlightGlobal.

Flightcrew remain concerned about impact on automated systems

Skycolors/Shutterstock



TPROduction/Shutterstock

The cellular industry is collaborating with the FAA, the FCC and others "to continue to ensure that C-band 5G and air traffic safely coexist", the group adds. The FCC did not respond to a request for comment.

Cell providers have much at stake, having invested billions of dollars in their 5G networks, which use advanced components and transmit at higher frequencies than previous generations, providing faster data transfer and more capacity.

US firms only secured the required bandwidth in 2021 after bidding $81 billion for access to the 3,700-3,980MHz range through an FCC auction. They can initially transmit at up to 3,800MHz, gaining access up to 3,980MHz in late 2023. Radio altimeters transmit in a very similar range, at around 4,200-4,400MHz.

The FCC says a 220MHz "guard band" between the cellular and altimeter spectrums would "protect" altimeters, but has encouraged the aviation industry to study risks.

AT&T and Verizon were first out of the gate, firing up 5G on 19 January.

"The 5G antennas have higher gain and more power... in a band that is next door to the radio altimeter band," says Shawn Carpenter, electromagnetic programme director at engineering simulations company Ansys, which studies 5G-altimeter interference.

Spotlight technology

He also says cellular companies increasingly employ "beam-spotlighting" and other technologies to focus transmissions at users. If a passenger flips on their phone during landing, "you would have the potential where the base station would try to put a beam right on that aircraft", Carpenter adds.

The issue is complex because interference can vary as aircraft pitch and roll, ascend and descend.

> "This risk is widespread and has the potential for broad impacts to aviation operations including the possibility of catastrophic failures"
>
> Radio Technical Commission for Aeronautics

Concern within the aviation industry initially appeared muted. But a "5G Task Force" formed by radio-standards group the Radio Technical Commission for Aeronautics (RTCA) analysed risks and raised alarm in an October 2020 report.

5G poses a "major risk" of "harmful interference to radar altimeters on all types of civil aircraft", the RTCA concluded. "This risk is widespread and has the potential for broad impacts to aviation operations including the possibility of catastrophic failures leading to multiple fatalities, in the absence of appropriate mitigation."

Many pilots think they have experienced such scenarios.

"While at [a Tampa] gate, the captain's radio altimeter fluctuated from approximately -90ft to 400ft. Multiple call outs were observed such as 'retard' and various altitudes," a pilot said of a January incident. "I've been flying an aircraft with a radio altimeter for years, and never once have I seen a malfunction such as this – until the 5G turn-on. Coincidence? Probably not."

"Possible 5G event," another pilot reported of a February incident. "At 2,500ft... and again at 900ft, the [captain's] radio altimeter became inoperative with a red flag... In the flare I noticed a resistance ❱

Phoenix was one of several airports where incidents were reported

AirTeamImages

to pitching up. It almost felt like the autopilot was still engaged."

Late last year, in the weeks leading up to 5G's launch, the FAA and aerospace industry seemed to be scrambling to catch up. In November 2021, the FAA warned of interference, asking aerospace manufacturers to study the issue. In December it essentially prohibited aircraft – including large jets – from using some aircraft systems near 5G antennae, pending further action.

Meanwhile, the Department of Transportation (DoT) and FAA began negotiating with AT&T and Verizon, which then agreed to delay 5G's start by 30 days until 5 January and to reduce the power of upward 5G transmission and transmissions near airports.

"We have a case where the bureaucracy couldn't keep up to fully understand what was going on," says Carpenter.

Still concerned, on 31 December – five days before 5G's planned activation – the DoT warned air travel could still be widely disrupted. AT&T and Verizon caved in again, delaying 5G's start until 19 January and agreeing to create "C-band radio exclusion zones" near 50 airports.

Concerns addressed?

The companies called interference "utterly unfounded", accusing the Aerospace Industries Association (AIA) of seeking to force the telecoms industry to fund altimeter upgrades, and blaming the FAA for dragging its feet. The AIA and Air Line Pilots Association International (ALPA) insist they raised concerns, which the FCC failed to address.

The FAA says the 5G mitigations lessened, but did not eliminate, risks at the 50 airports. So, it began identifying which aircraft had sufficiently robust altimeters to safely perform low-visibility landings at those fields, eventually clearing most US airliners, with regional jets and Boeing DC-9-family aircraft being the exceptions.

But even for cleared aircraft, the FAA required airlines to adopt 5G-specific dispatch and landing procedures, saying faulty altimeter data can corrupt autothrottles, autopilots, flight controls, alert and collision avoidance systems, aircraft configuration warnings, and ground proximity warning systems.

The agency insists such measures have kept air travel safe. But the ARSA reports catalogue troubling incidents. "Second time this happened today in two separate aircraft at two separate airports. While on final approach, just about at the final approach fix, the autothrottles disengaged. Concerned about possible 5G issues," a pilot said of a January 2022 event.

"After rotation from runway 7L at [Phoenix], the captain's radio altimeter appeared to be frozen at the normal 'on the ground' indication," another pilot said of a June flight. "The preselected pitch and roll modes did not engage automatically on climb out. I feel it's important to make these events known for the safe implementation of the 5G network," the pilot wrote.

> "On final approach, just about at the final approach fix, the autothrottles disengaged. Concerned about possible 5G issues"
>
> **Aviation Safety Reporting System incident**

The reports include instances of faulty landing gear alerts and erroneous "too low – terrain" and "pull up" warnings, speed brakes and thrust reversers failing to deploy, and engines unexpectedly spooling up during approach. Pilots disconnected automated systems to fly manually, with some reporting that the distraction caused them to deviate from air traffic control instructions.

"I went heads-down to report the occurrences to the company... and failed to recognise we climbed through [18,000ft] and failed to complete the after take-off checklist," a pilot said of a January incident. "Most importantly, failed to reset the altimeters to 29.92. We levelled at [37,000ft]."

Close range

The issue is far from settled. More cellular firms are set to launch 5G, and in late 2023 they gain access to the 3,800-3,980MHz range – closer still to the band used by altimeters.

In recent months the FAA has continued negotiating, saying in June that cellular companies agreed to maintain "some level of voluntary mitigations" for another year, until 5 July 2023. By that time, it said, most aircraft should be fitted with altimeter "filters" or new altimeters.

And in early October, the AIA, ALPA, and other aerospace bodies asked the FCC to pass rules limiting above-horizon 5G transmissions and caps on "spurious emissions".

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Sriwijaya 737's unresolved throttle snag led to fatal thrust asymmetry

Jet rolled 37° left as engine output diverged during take-off climb, causing rapid descent that crew were unable to arrest

David Kaminski-Morrow London

Indonesian investigators have determined that the right-hand throttle lever on a Sriwijaya Air Boeing 737-500 did not move backwards when the autothrottle commanded reduced power, resulting in thrust asymmetry and a fatal in-flight upset.

None of the 62 occupants of the aircraft, flying from Jakarta to Pontianak on 9 January last year, survived after the imbalance caused the 737 to enter an uncommanded left roll and rapidly descend.

The aircraft's autothrottle computer was equipped with a cruise thrust split monitor, which uses spoiler positions to check for asymmetric thrust, and is designed to disengage the autothrottle to prevent an upset.

But the inquiry into the accident, on 9 January 2021, believes that an erroneous spoiler signal value prevented this function activating.

Some 2min after take-off, as the aircraft neared 8,000ft, a change in autopilot directional control led the autothrottle to command a reduction in thrust.

But while the left-hand throttle lever began to move backwards, causing the left engine's thrust to decrease, the right-hand lever did not move with it, instead remaining in position and leaving the right engine thrust unchanged.

Investigators state that the autothrottle system experienced a mechanical "friction or binding" which obstructed movement on the right-hand throttle lever.

Since this throttle lever was not moving backwards, the left-hand lever retarded further in order to compensate and achieve the required thrust reduction.

Bad weather

"The thrust levers diverged and a thrust asymmetry occurred," the inquiry says. "The asymmetry became greater over time and eventually resulted in uncommanded roll to left."

At the time of the upset the crew had been trying to conduct a right turn for weather avoidance. The inquiry says the aircraft initially banked to the right but, as it climbed past 10,450ft, it rolled wings-level and then continued rolling to the left.

The roll reached 37° left, triggering a 'bank angle' warning at about 10,700ft, the highest altitude achieved by the jet.

Flight-data analysis shows the left engine's speed reduced to 34% of N1 but that of the right engine remained at 91.8%.

The roll increased to more than 45° and was "further exacerbated" by left-roll pilot commands, the inquiry says, and the aircraft pitched nose-down, entering a descent from which the crew failed to recover.

According to the inquiry, the aircraft maintenance log had recorded 65 pilot reports relating to the autothrottle as well as 61 reports relating to differences in the engine parameters, particularly during descent.

Quick-access recorder analysis showed that seven flights by the aircraft (PK-CLC) in the year before the accident experienced abnormal throttle-lever movement.

These included a service on 15 March 2020 which had been commanded by the same captain as the ill-fated flight.

During this service the aircraft had been passing 4,400ft when both throttle levers moved backwards, before the right-hand lever stopped while the left-hand lever continued. Asymmetric thrust developed and the aircraft rolled into a 41° left bank. The crew of the flight noticed the asymmetric

None of the aircraft's 62 occupants survived its impact with the sea

Xinhua/Shutterstock

condition and restored the throttle levers to matching positions.

There was "no pilot report" of any of the seven occurrences in the aircraft maintenance log, says the inquiry.

Investigators state that the aircraft was grounded for several months – from March to December 2020 – while a number of maintenance tasks were conducted. But after the jet was released to service, three weeks before the crash, the log recorded 43 pilot reports including three involving autothrottle issues.

"Corrective maintenance processes of the [autothrottle] problem were unable to identify the friction or binding within the mechanical system of the thrust lever, and resulted in the prolonged [lack of resolution] of the [problem]," the inquiry adds.

Complacency and bias contributed to crash, investigators suggest

Complacency over automation, as well as confirmation bias, contributed to the Sriwijaya Air Boeing 737-500's crew's failing to notice a split between the throttle levers.

The split throttles generated increasingly asymmetric thrust, as the left engine reduced power while the right engine did not, causing the aircraft to enter a steep uncommanded roll and fatal descent.

Indonesian investigation authority KNKT found that the crew was conducting a right turn towards a heading of 075° for weather avoidance, and climbing through 8,100ft, when the throttle split began to develop. While the pilot's control wheel should have returned to a neutral position after the right turn was initiated, it remained deflected to the right as the aircraft's autopilot attempted to maintain the turn.

This should have alerted the crew to a potential anomaly. But the inquiry says confirmation bias might have led the pilots to view the position of the control wheel, consistent with the direction of the turn, as normal. "The confirmation bias might have also contributed to the [reduction] of active monitoring by the pilot," says the inquiry.

With the autopilot and autothrottle engaged, it states, the pilots might have considered that monitoring the flightpath was "not so significant" because aircraft automation "was reliable".

Such "automation complacency", it adds, could have further eroded the level of flightpath and instrument supervision as the throttle levers began to split, especially since the aircraft was in a flight phase which did not require the crew to change engine power.

This asymmetry meant the aircraft could not maintain the right turn and it failed to reach the selected heading of 075° before it started to roll level and then to the left.

The inquiry says the instruments would have shown differences in the engine parameters, and the physically different positions of the throttle levers, and "should have been a cue" for the crew to identify the asymmetric condition.

Several previous incidents of throttle-lever split on the aircraft had gone unnoticed until other indications were detected, and simulations of the accident carried out by investigators in Jakarta and Las Vegas showed that pilots "did not realise" the split until they observed engine parameter changes.

The inquiry points out that the aircraft had passed 10,000ft before the roll to the left became substantial. At this altitude threshold, pilots carry out a number of standard actions, and the workload was further increased because the 737 was approaching its assigned altitude of 11,000ft.

These activities by the pilots "might have diverted [their] attention" from monitoring the aircraft's flightpath, the inquiry says.

But it also states that between two pilot call-outs – the notification of approaching 11,000ft and the setting of standard pressure on the altimeter – there was a 17s interval during which the aircraft was rolling out of its right turn and entering a left bank.

"The investigation could not determine the pilot activity during this 17s interval," the inquiry says. "However, this period should provide sufficient time for the pilots to revert to monitoring the flightpath."

Clean Aviation spearheads Europe's decarbonisation drive

EU-funded programme's first tranche of research projects will go live soon – with some taking advantage of existing R&D efforts to meet ambitious greenhouse gas-reduction targets

Dominic Perry London

Amid a blizzard of desperately contrived acronyms – Cavendish, Newborn, Ofelia to name but three – the EU's Clean Aviation programme on 27 September revealed the 20 research projects selected as part of the initiative's first phase.

Designed to spearhead aviation's drive to decarbonisation, the 20 projects will share €736 million ($718 million) in European funding.

These include research into multi-MW-class electric powertrains, hydrogen combustion, hydrogen fuel cells, and ultra-efficient wing and fuselage designs for future regional and short- and medium-range aircraft.

For reference, Clean Aviation sees regional aircraft as those with range of around 540nm (1,000km) and capacity of 100 seats, typically flown on sectors of 215-270nm. Short- and medium-range aircraft, meanwhile, are those with a range of 540-2,000nm, accommodating up to 250 passengers.

The successor to the EU's Clean Sky programmes, Clean Aviation has a total budget of €4 billion, including industry contributions, and lofty ambitions: "Making Europe the world's first climate-neutral continent by 2050 is our top priority," according to Rosalinde van der Vlies of the European Commission.

In practical terms, this means maturing low-emission technologies to support an end-decade launch of a new generation of aircraft for regional and short- and medium-range applications enabling a 30% reduction in greenhouse emissions by 2035. That will then allow the industry "to create the conditions to be able to replace 75% of the existing fleet" over the 2035-2050 period with the new low-emission aircraft, says Clean Aviation's head of programmes Sebastien Dubois.

"If we manage this, and we combine it with [the] use of drop-in and no-drop-in fuel, in addition to market-based measures and operational improvements, we will be close to net-zero by 2050," he says.

€4bn

Total programme budget, including industry contributions, against €12 billion requirement to meet net-zero goals

Clean Aviation's target is for its selected research projects to reach technology readiness level (TRL) 4 or 5 by the end of the first phase in mid-2026, leading to TRL6 by 2030 and their application on a new generation of aircraft from the middle of that decade.

Dubois sees most of the phase one work taking place on the ground, moving to flight tests of demonstrators in the subsequent phase.

Notable exceptions will be those projects assessing the feasibility of hydrogen combustion in turbofan engines where manufacturers have already committed to flight test the technology.

> "Making Europe the world's first climate-neutral continent by 2050 is our top priority"
>
> **Rosalinde van der Vlies European Commission**

Spreading risk

GE Avio and Rolls-Royce were both selected for phase one funding for their respective Hydea and Cavendish projects, which will tap into research initiatives that have previously been announced: in the former case, that means work being undertaken by the CFM International joint venture between GE Aviation and Safran, which earlier this year said it would work with Airbus to test a hydrogen-burning GE Passport business jet engine aboard an A380 flying testbed. R-R too is studying the potential of flight testing a Pearl business jet engine running on hydrogen.

Those two projects are not the only ones where investment from Clean Aviation is being used to accelerate existing research and development activity. For example, under the ultra-efficient short and medium aircraft topic, Safran, MTU and R-R have all secured funding that builds on work taking place under their respective RISE, water-enhanced turbofan (WET), and UltraFan technology demonstration programmes.

Intriguingly, the MTU-led Switch consortium which is examining the potential for the steam-injection WET engine also includes Airbus and long-term partner Pratt & Whitney, says Dubois.

He points out that the allocation of funding to multiple projects looking at the same broad topic – two consortia have also been selected to developed multi-MW-class hybrid-electric powertrains, for example – is entirely rational when such disruptive – and unproven - technologies are being examined.

"The reason is to reduce the level of risk... and to ensure at least one

Rolls-Royce

Rolls-Royce has secured investment to build on its UltraFan technology

solution emerges on time in 2035 to offer a solution to the market, or potentially more than one," he says.

Eyebrows may be raised, however, by the selection of projects proposed by both R-R's German and UK businesses. Although the presence of the former in an EU-funded programme is unsurprising, the tense relations between London and Brussels post-Brexit could have potentially ruled out a contribution from the Derby part of the business.

Although the UK has yet to agree participation in the Clean Aviation programme due to wider Brexit issues, the London government has agreed to fund the involvement of the UK companies selected for phase one, providing a total of £80 million ($91 million).

Besides, there are other recipients of phase-one funding – Collins Aerospace and Honeywell Aerospace, for example – which, despite a European presence, are headquartered elsewhere.

Knowledge base

Dubois says this approach will allow the development of European capabilities for future exploitation within the region, while benefiting from knowledge or skills that may be located elsewhere.

It will also help to meet the eye-watering cost of achieving net-zero aviation, he argues: Clean Aviation estimates a total funding requirement of €12 billion to meet its objectives, he says.

"Only one-third of that will come from Clean Aviation, the rest will come from other national and regional initiatives," he says.

Clean Aviation received 25 applications addressing its first call for proposals, issued in March, aimed across 14 topics; of those, 20, involving 300 different businesses, were successful.

A second call for proposals under phase one, with a budget of close to €150 million, will follow in early 2023, says Dubois; factoring in the UK's contribution, that takes the phase one budget to around €900 million, a figure that will be more than matched by industry, to reach a total budget of about €2 billion.

Submissions will be requested in 2025 for second-phase projects running over the 2026-2030 period and bidding for a share of around €900 million.

Although each project is attempting to mature a specific technology, Clean Aviation is cognisant that on an aircraft no system operates in isolation from any other and, through working in combination, they may achieve an effect greater than the sum of their parts.

With that in mind, Clean Aviation is already working to combine those individual technologies or systems into concept aircraft studies, with the aim of down-selecting a limited number of aircraft concepts – likely to be three to four – in the second phase for further maturation, says Dubois.

"That is what we are already starting right now – to link and associate the projects in their respective domains in order to contribute to the emergence of the future aircraft concept targeted at the end of that first phase."

Linking projects

Work on the concepts is expected to begin in January at the latest and "after six months we expect to have a clear plan in terms of linkage of the projects together and to start to see emerging from month six to month 18 the first aircraft concepts", he says.

A significant difference between Clean Aviation and its predecessor programmes is its focus. Clean Sky 1 and 2 were broader in scope, incorporating rotorcraft and small aircraft at one end, and technologies for long-haul aircraft at the other.

But in order for the industry to reach its ambitious decarbonisation objectives in the shortest possible timefarme, Clean Aviation has had to target its resources where they will have the biggest impact: on regional and short- and medium-haul operations, which are responsible for around two-thirds of aviation's greenhouse emissions.

"This is why we have narrowed the scope and not included business jets or rotorcraft," Dubois says. Although Pipistrel has won phase one funding for research activities on certain CS-23-category aircraft – those below 19-seats – that is because "these are considered as stepping stones on our journey towards, for example, fuel cell powertrains".

Once such systems have been demonstrated on smaller aircraft and their safety and integration issues fully addressed, they can then be scaled up to larger aircraft, Dubois says.

For long-haul, the operational limitations of such aircraft – their size, weight and the distances they fly – mean that technologies such as hydrogen or hybrid-electric power are "not a viable route", Dubois adds. And although improvements to gas turbine efficiency, for example, that are derived from Clean Aviation-backed projects "will be fully applicable to that kind of market", that is "not [their] primary objective", he says.

Clean Aviation Phase One Projects

Topic: Hybrid-electric-powered aircraft

Project title	Lead company	Project topic
He-Art	Rolls-Royce Deutschland	Multi-MW hybrid-electric propulsion system
Amber	GE Avio	Multi-MW hybrid-electric propulsion system
TheMa4Hera	Honeywell International	Thermal management solutions
Hecate	Collins Aerospace Ireland	Electrical distribution solutions
Herwingt	Airbus Defence & Space	Innovative wing design

Topic: Hydrogen-powered aircraft

Project title	Lead company	Project topic
Cavendish	Rolls-Royce Plc*	Direct hydrogen combustion
Hydea	GE Avio	Direct hydrogen combustion
Newborn	Honeywell International	Multi-MW fuel cell propulsion system
H2Elios	Aciturri Engineering	Lightweight, integral hydrogen storage
FlHYing Tank	Pipistrel	Near-term disruptive technologies
HyPoTraDe	Pipistrel	Near-term disruptive technologies

Topic: Ultra-efficient short- and medium-range aircraft

Project title	Lead company	Project topic
Ofelia	Safran Aircraft Engines	Ultra-efficient propulsion
Switch	MTU Aero Engines	Ultra-efficient propulsion
Heaven	Rolls-Royce Plc*	Ultra-efficient propulsion
Up Wing	Airbus Operations Gmbh	Ultra-performance wing
Faster-H2	Airbus Operations Gmbh	Advanced low-weight integrated fuselage and empennage

Project: Transversal areas

Project title	Lead company	Project topic
Hera	Leonardo	Aircraft concepts enabling 30-50% reduction in emissions
SMR ACAP	Airbus Operations Gmbh	Aircraft concepts enabling 30-50% reduction in emissions
Concerto	Dassault Aviation	Novel certification methods and means of compliance for disruptive technologies
Ecare	Aerospace Valley	Developing a European clean aviation regional ecosystem

Source: Clean Aviation Note: *UK company

A330 was in airspace where cruising altitudes are separated by just 1,000ft

AirTeamImages

Pilots did not clarify control after SriLankan A330 inadvertently pushed into descent

Sharp nose-down input by first officer disconnected autopilot and led to jet losing 1,540ft during cruise

David Kaminski-Morrow London

Investigators believe a SriLankan Airlines Airbus A330-300 lost considerable altitude during an in-flight upset after one of the pilots nudged the sidestick during cruise, disconnecting the autopilot and pushing the jet into a descent.

While the inquiry does not specify the reason for the "sharp nose-down input" by the first officer, who was flying, it refers to his being served a meal, but not handing control of the aircraft to the other pilot – a cruise pilot in the left-hand seat who was standing in for the resting captain.

The aircraft had been cruising at 39,000ft over the Indian Ocean, west of Jakarta, during a service from Colombo to Sydney on 21 March last year.

Some 3h into the flight the captain went to rest in the cabin, and the cruise pilot moved from the right-hand seat to the captain's left-hand seat. He acted as the monitoring pilot, while a relief first officer took over as flying pilot in the right-hand seat.

The incident occurred a few minutes after the changeover.

Analysis shows the first officer's sidestick deflected nose-down for several seconds, sufficient to trigger involuntary disconnection of the autopilot and generate a master warning.

The twinjet transitioned from 2.8° nose-up pitch to 1.1° nose-down and began to descend.

It was operating in reduced vertical separation minima (RVSM) airspace, where adjacent aircraft cruising altitudes are separated by just 1,000ft.

The cruise pilot, despite not being designated as the flying pilot, responded by engaging his autopilot, but without specifying that he was taking control. The first officer continued to make overriding sidestick inputs, which caused the autopilot again to disconnect.

Steep pitch

Investigators say the cruise pilot was "transfixed" by the changes in airspeed and "did not observe" the vertical speed or the loss of altitude.

The aircraft's pitch reached 5.3° nose down and it descended at a rate of up to 5,700ft/min, losing 1,540ft before the first officer's sidestick was released, and the cruise pilot's sidestick registered a nose-up input. The autopilot was subsequently re-engaged and the aircraft recovered, some 2min after the initial upset, climbing back to its assigned altitude.

Neither pilot had followed specific procedures for handing over, or taking over, the aircraft's controls, says the inquiry.

"The cruise pilot and first officer... had not displayed the expected level of competency," it adds. "There was poor crew co-ordination during the incident."

Although the cruise pilot advised Jakarta air traffic control about the altitude deviation, the pilots did not fully brief the captain when he returned to the cockpit. The cruise pilot did not involve the first officer in the discussion, briefed the captain in Sinhalese – not an accepted aviation language – and did not mention the exact extent of the altitude loss.

The seriousness of the incident was discovered only when it was detected during routine flight-data monitoring.

Mandatory occurrence reports were submitted on 2 April, nearly two weeks after the event, and all three crew members were immediately grounded pending an investigation into the circumstances.

The flight-data and cockpit-voice recorders had already been overwritten by this point, and the inquiry had to rely on digital access recorder information.

None of the occupants – just nine passengers, and seven crew members – was injured, and the aircraft (4R-ALR) was undamaged.

Investigators have recommended improved training in upset recovery and awareness of incident-reporting criteria, especially for altitude loss in RVSM airspace. SriLankan, the inquiry adds, should introduce procedures for handing over aircraft control when meals are served.

Canberra to double C-130J fleet strength

Australia decides the best replacement for its current Hercules are up to 24 new-build examples of Lockheed type

Commonwealth of Australia

Nation's air force inventory includes a dozen -30 transports

Greg Waldron Singapore

The Royal Australian Air Force (RAAF) will replace its current fleet of 12 Lockheed Martin C-130J tactical transports with up to 24 new examples of the Super Hercules.

Announcing the decision on 1 November, the Australian Department of Defence (DoD) said it "has identified that the new C-130J aircraft represents the only option that meets all of Australia's capability requirements and assures Defence's medium air mobility capability without introducing substantial cost, schedule and capability risk".

"As a result, new C-130J aircraft will be the only option that Defence will progress for government approval under Project AIR 7404 Phase 1 in 2023," the DoD says. It says the decision reflects Canberra's experience with previous defence acquisitions, as well as the RAAF's experience with the type.

Cirium fleets data shows that the service operates 12 stretched-fuselage C-130J-30s, which are aged between 22 and 25 years. Its experience with operating previous versions of the Hercules extends back to 1958, however.

Other options

Potential alternatives were considered, the DoD says, adding: "The relative merits of each aircraft type have been assessed against Australia's capability requirements." Canberra previously had been viewed as a potential customer by both Airbus Defence & Space and Embraer, respectively promoting their A400M and C-390 designs.

USMC completes Zulu acquisition

Service takes delivery of 189th and last example of AH-1Z, as Bell seeks additional international sales of attack helicopter

Commonwealth of Australia

Ryan Finnerty Tampa

Bell has delivered its final H-1-series airframe to the US Marine Corps (USMC). The Textron subsidiary said on 2 November that the handover of the service's 189th AH-1Z Viper – its final evolution of the Cobra – marks the completion of its programme of record for the H-1 family, which also includes the UH-1Y Venom utility helicopter.

"The first production lot of USMC H-1s was ordered back in 1962, and they changed the way Marines fight today," says Mike Deslatte, Bell vice-president and H-1 programme director. "Completing the AH-1Z and UH-1Y deliveries to the US Marine Corps adds one more chapter to the legacy of the H-1 platform."

Bell says the AH-1Z and UH-1Y share 85% parts commonality, despite their differing missions and airframes that are visually distinct.

The H-1 production line began making UH-1 Hueys for the US Army in 1959, and continues to manufacture aircraft some 63 years later. While the army in the 1980s replaced its Hueys and Cobra attack helicopters with Sikorsky UH-60 Black Hawks and Boeing AH-64 Apaches, the USMC still operates modernised versions of the airframes.

Combat missions

Bell in 2018 delivered the last of 160 UH-1Ys produced for the USMC, and both the transport and the AH-1Z were involved in combat for the service in Iraq and Afghanistan.

"H-1s are key to the 2022 Marine Corps Aviation Plan," says Colonel Vasillios Pappas, the USMC's programme manager for light and attack helicopters. "With the US programme of record now complete, the Marines have the flexibility to manage and deploy the helicopters based on current and future mission requirements as established at the start of the programme."

"While this is the end of the programme of record for the United States Marine Corps, it really represents a transition to foreign military sales," Deslatte says. He notes that Bell's line in Amarillo, Texas is currently halfway through producing 12 AH-1Zs for Bahrain, and building four AH-1Zs and eight UH-1Ys for the Czech Republic.

Work on Bahrain's order is halfway complete, Deslatte says, and Prague's aircraft are expected to be delivered to the US government in 2023 for turnover to the NATO member.

The US Defense Security Cooperation Agency on 2 November valued a 24-aircraft Foreign Military Sales deal as worth an estimated $6.35 billion, with the package also to include a range of avionics and defensive aids system equipment, L3Harris Wescam MX-20HD electro-optical/infrared sensors, plus maintenance, logistics and support services.

"This new procurement will provide the Royal Australian Air Force with one of the most modern and advanced C-130J fleets in the world, with a proven track record of versatility and reliability," says Warren McDonald, chief executive of Lockheed Martin Australia.

Canberra has cast a wary eye over the deteriorating geopolitical situation in North Asia stemming from Beijing's massive arms build-up and increasing belligerence. An expanded tactical transport capability would go some way to supporting possible operations far from Australia's shores.

Separately, the RAAF and Republic of Korea Air Force have agreed a pact to improve interoperability by aligning their air-to-air refuelling procedures. Both services operate the refuelling boom- and hose-and-drogue pod-equipped A330 multi-role tanker transport (MRTT), with six and four examples in use, respectively. They also are both users of the Lockheed F-35A fighter.

The services have already conducted combined tanking operations, most recently with South Korea sending one of its MRTT platforms to Exercise Pitch Black, staged in northern Australia from 19 August to 8 September.

Meanwhile, the Australian DoD has awarded Leonardo a A$70 million ($45 million) contract for a radio replacement and avionics upgrade for the RAAF's fleet of 10 C-27J Spartan transports.

Intelligence networks

"Upgrading the cryptographic radio function of the C-27J platform will ensure ongoing availability of secure communications, including interoperability with key strategic partners and intelligence networks, and increased overall safety for our Australian Defence Force personnel," the DoD says.

Modifications will be performed by RAAF and Northrop Grumman personnel at Amberley air base in Queensland between next year and 2026.

Operated by 35 Sqn, the C-27J fleet is optimised for duties including equipment and personnel supply, humanitarian and disaster relief, and supporting search and rescue missions.

See p42

Production of the UH-1Y and AH-1Z models totalled 349 aircraft for lead operator

Bell declines to reveal if it is currently in talks with any other potential customers for its H-1s.

"We have a lot of excitement about the potential future for military customer sales," Deslatte says. "However, we generally don't comment on any of those until they have cleared congressional notification."

Separately, the Royal Jordanian Air Force (RJAF) is to acquire 10 Bell 505s for training duties, under a deal signed on 1 November.

"The contract includes the delivery of the aircraft with a flight training device and a comprehensive computer-based training package," Bell says. The type's introduction will "enable an enhanced approach to basic and advanced rotorcraft flight training at the King Hussein Air College in Mafraq, Jordan", it adds.

"We look forward to... providing our pilots with one of the best possible aircraft for their training," says RJAF commander Brigadier General Mohammad F Hiyasat. "The addition of 10 new aircraft will enable us to further expand our operations."

Amman has a more than 130-strong combat helicopter fleet, with types including the AH-1E/F, UH-1H and UH-60, Cirium fleets data shows. It currently employs 12 Robinson R44s among its training assets.

Bell in early August delivered its 400th example of the 505, after launching the programme in 2017. Cirium records the Indonesian navy (two, plus another on-order pair), Jamaica (six), Montenegro (two) and the United Arab Emirates (12, plus two on order) as current military operators. South Korea's army also has 40 of the single-engined type on order.

Additional reporting by Craig Hoyle in London

The Royal Bahraini Air Force's lead V-model aircraft, earlier this year

Nate Perry/Lockheed Martin

F-16 revival ready for take-off as interest soars

Lockheed Martin will in 2023 deliver the first fighter from its new Greenville final assembly line – a Block 70 jet for repeat customer Bahrain – with international sales potential rising

Craig Hoyle London

Instead of dying out as Lockheed Martin's fifth-generation F-35 Lightning II scoops up an increasing number of international orders, the manufacturer's older F-16 is enjoying a late-life revival.

At a new final assembly line for the F-16 in Greenville, South Carolina, the US airframer is within months of delivering its first customer example of the type since it in 2017 transferred the last to be completed at its Fort Worth site in Texas.

The Royal Bahraini Air Force (RBAF) will have the distinction of taking the milestone jet – also the first built to Lockheed's latest Block 70/72, or V-model standard.

"The first F-16 Block 70 jet, for Bahrain, is now in the final assembly and checkout process. Flight tests will begin in early 2023," Lockheed says. The company expects to complete the so-called DD250 delivery process to the US government – which is providing the aircraft to Manama via a Foreign Military Sales (FMS) programme deal – in the first quarter of the year, it adds.

Already an operator of 21 F-16C/Ds, Bahrain in June 2018 ordered 16 new-build examples to strengthen its air force fleet, under a deal worth $1.2 billion. The aircraft will use GE Aerospace's F110 engine, in common with its legacy assets.

Structural assembly

Images released by Lockheed show the nation's lead new aircraft – one of an eventual four two-seat examples – undergoing structural assembly in Greenville around the middle of this year, including undergoing landing gear installation and the wing to fuselage mate.

Five countries have signed firm contracts for the Block 70 and Pratt & Whitney F100-powered Block 72 aircraft, with their combined commitments totalling 128 jets. Along with Bahrain, these buyers are repeat F-16 customers Morocco (24) and Taiwan (66), plus two future new operators: NATO members Bulgaria (8) and Slovakia (14).

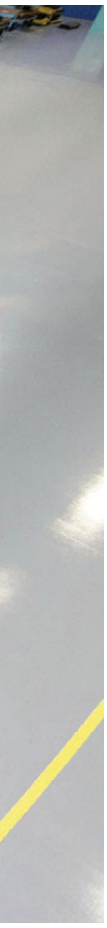
"Block 70/72 production continues to make significant progress, with multiple aircraft in work for Bahrain, Slovakia and Bulgaria," the company says. "The Block 70 production rate will increase… throughout 2023, with DD250 deliveries for additional customers continuing into the mid-to late-2020s."

Beyond its current backlog, Lockheed notes that "Jordan has signed a letter of offer and acceptance for eight new aircraft, and Congressional notification for a second fleet of [8] jets for Bulgaria was released earlier this year."

Jordan – which already operates 59 A/B-model F-16s – in June 2022 signalled its intention to obtain the Block 70 examples.

Lockheed says a broad range of enhancements have been incorporated with its new-standard jet. These include the Northrop Grumman APG-83 active electronically

Lockheed Martin



scanned array radar, installation of conformal fuel tanks, plus a datalink and advanced weapons.

The US Defense Security Cooperation Agency in May 2019 outlined a potentially $750 million armament package for the RBAF's Block 70 jets, with air-to-air munitions to include Raytheon AIM-120 AMRAAM and AIM-9X Sidewinder II missiles.

Advanced weapons

Air-to-surface stores mentioned included the Boeing AGM-84 Harpoon Block II anti-ship missile and GBU-39 Small Diameter Bomb; Raytheon AGM-154C Joint Standoff Weapon and AGM-88B High-Speed Anti-Radiation Missile; plus precision-guidance kits for use with a variety of bomb sizes.

The fighter's modernised cockpit features updated avionics and a Joint Helmet Mounted Cueing System II, along with safety enhancements including an automatic ground collision avoidance system. Airframe life also has been extended to 12,000 flight hours.

Lockheed declines to outline its planned delivery schedule beyond the first RBAF aircraft, referring questions about FMS transactions to the US government. Likewise, it directs queries regarding Manama's plan to also modernise its in-service F-16s to the customer. However, it notes: "Regarding upgrades for the current fleet, we know this remains a priority for Bahrain."

The US Department of State in September 2017 gave its approval for a potentially $1 billion project to update the RBAF's Block 40-standard aircraft – which are aged between 20 and 32 years – to the V-model standard.

Meanwhile, asked about the task of establishing its new assembly facility in Greenville against the backdrop of a global pandemic, Lockheed confirms: "We have experienced some supplier challenges, many of which were Covid-19 related, as well as challenges with starting a new production line in a new location, and staffing challenges related to a competitive labour market.

2,810

Total number of F-16s in current operation for 25 nations worldwide, with another 128 examples on order

"However, we continue to take proactive measures in partnership with the US government, our suppliers and our international partners to maximise production efficiency," it says. This has included "hiring more than 300 employees at our Greenville site to support F-16 operations", and implementing digital engineering technologies "to maximise efficiency".

As Lockheed prepares to begin the new chapter in the F-16's already almost 50-year operational story – the type was first flown in 1974, and entered service with the US Air Force four years later – it remains the most widely-operated fighter in use today. Cirium fleets data used in FlightGlobal's 2023 World Air Forces directory shows that 2,184 examples are currently operated as combat aircraft, with another 626 employed as dedicated trainers.

Those 2,810 jets are in use with 25 nations in Africa, the Asia-Pacific region, Europe, Latin America, the Middle East and North America.

Once deliveries resume next year, Lockheed has an assured production path for several years – but sees a clear opportunity to sell yet more examples to export customers.

"We see significant potential for additional new production F-16s based on international interest," says Danya Trent, the company's vice-president of F-16 programmes. She refers to the prospect of sealing further business with "customers in Europe, Asia and Africa".

"Based on that level of demand, we see production opportunities in Greenville well into the late 2020s and beyond," Trent says.

One major opportunity lies with the Indian air force (IAF), which has a long-standing need to acquire 110 new fighters. Indeed, the scale of the potential deal is strong enough to have encouraged Lockheed to from 2019 offer a unique F-16 variant renamed as the F-21.

Unique configuration

"Our F-21 is uniquely configured to meet or exceed all of the IAF's Multi-Role Fighter Aircraft requirements as we understand them to date," Lockheed says. Noting the nation's government has yet to release a formal request for such a fleet, it says: "If requirements deviate from our current understanding, this may yield changes to our configuration and ultimate offering."

Lockheed will, however, face strong competition for an Indian order, with Boeing, Dassault Aviation, the Eurofighter consortium, and Saab also interested in the deal.

The US company stresses that its F-21 proposal concerns "an indigenously-produced aircraft... which addresses the goals of self-reliance while providing India with an improved security co-operation relationship with the United States".

"Production of the F-21 in India will create thousands of new highly-skilled jobs within the Indian industrial base," it adds.

See p42

More than 300 employees have been hired to support production

Greater risk awareness could have averted BA 787 nose-gear incident

Embarrassing event at London Heathrow might have been avoided by faster implementation of airworthiness directive

David Kaminski-Morrow London

UK investigators believe a British Airways Boeing 787-8 nose-gear retraction accident at London Heathrow might have been prevented if health and safety risks in an airworthiness directive had been given greater attention by the operator.

The incident occurred when a nose-gear locking pin was inserted in the wrong location on the parked jet (G-ZBJB) before the landing-gear was cycled during a maintenance check. When the nose struck the ground, a pilot and a cargo loader received injuries, and the 787 sustained substantial damage.

According to the Air Accidents Investigation Branch, the operator's engineering department assessed an airworthiness directive and service bulletin – with a three-year compliance period – detailing modification to prevent incorrect lock-pin insertion.

"Their assessment concluded that the issue was not flight-safety related or an airworthiness risk and embodiment towards the end of the compliance period was acceptable," says the inquiry into the event on 18 June last year.

"Despite the warnings in the [directive], the potential risk of serious injury to personnel working around the aircraft and boarding passengers was not given sufficient consideration."

While implementation of the remedial action was initiated, it was put on hold and "repeatedly deferred" owing to the economic impact of the pandemic, the inquiry says.

Clear risks

If greater consideration had been given to the risks to personnel safety – which were "clearly highlighted" in the directive and service bulletin – the operator might have "escalated" the priority for the modification.

BA has since completed modification of its 787 fleet, having accelerated the process following the accident.

It has also reviewed its procedures for assessing directives and service bulletins, in order to identify health and safety risks more effectively, the inquiry states, and has taken a number of other preventive steps.

While the operator had a safety-management system in place at the time, it had not been adopted by its maintenance organisation because there was no legislated requirement for such measures.

But the carrier has started implementing a safety-management system for maintenance following a proposal from the UK Civil Aviation Authority for introduction by the end of this year.

The incident took place at stand 583 at London Heathrow as the jet was being prepared for a cargo service to Frankfurt.

Technicians were attempting to clear maintenance messages relating to a deferred defect. This required the landing-gear selection lever to be cycled with hydraulic power applied to the aircraft.

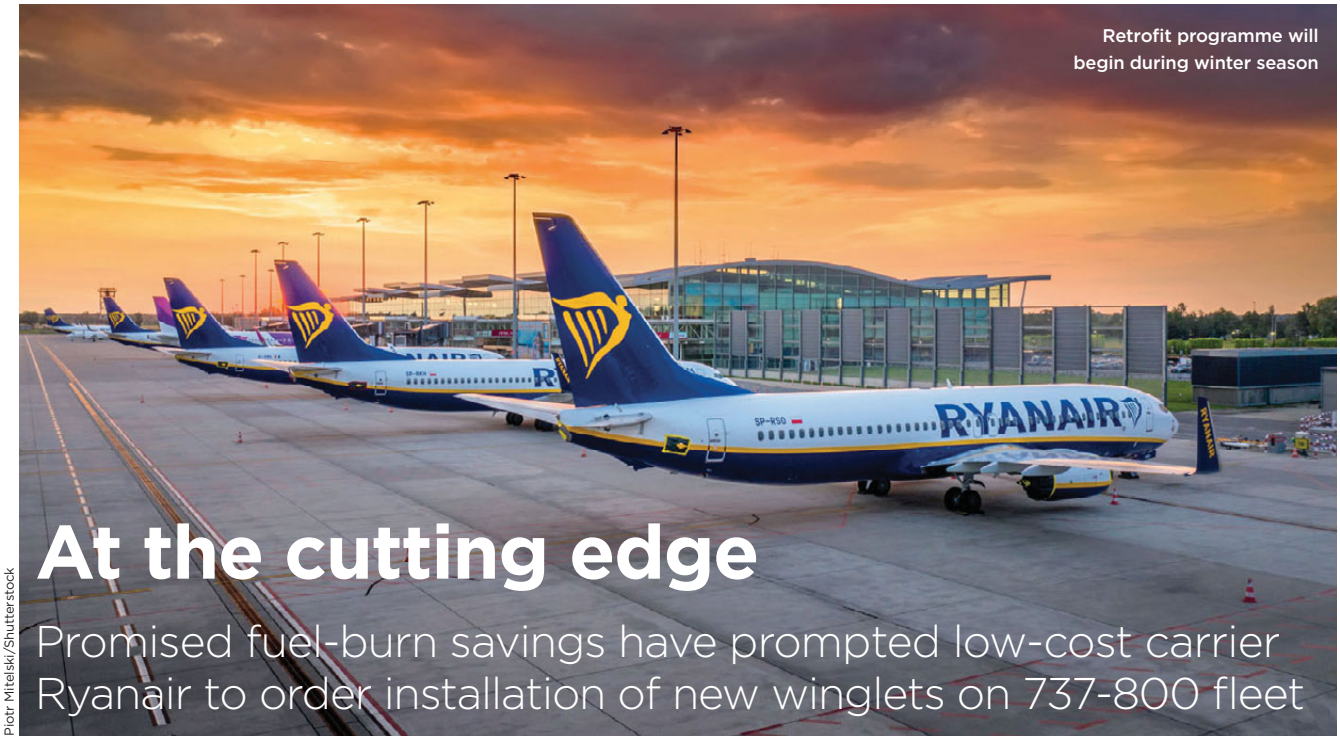
To prevent the landing-gear from retracting during this procedure, pins were required to be inserted in the nose-gear and main landing-gear downlocks.

Two mechanics had been tasked with inserting the locking pins. But the inquiry revealed that one of them was "not tall enough" to reach the insertion point on the nose-gear, and so he simply pointed to the location while the other mechanic fitted the pin.

The 787 sustained damage to its lower forward fuselage and engine cowls, and one of its passenger doors detached during the event.

AirTeamImages

BA accelerated the modification of its 787 fleet, following the accident



Retrofit programme will begin during winter season

Piotr Mitelski/Shutterstock

At the cutting edge

Promised fuel-burn savings have prompted low-cost carrier Ryanair to order installation of new winglets on 737-800 fleet

David Kaminski-Morrow London

Budget carrier Ryanair is to retrofit split scimitar winglets across more than 400 Boeing 737-800s in its fleet, in order to trim fuel consumption.

The retrofit programme will commence during the winter season, the airline states, and represents an investment of more than $200 million.

Manufactured by Aviation Partners Boeing, a joint venture, split scimitar winglets are an evolution of the blended winglet on the 737, and incorporate curved aerodynamic tips and a ventral strake.

Ryanair says the agreement covers 409 aircraft and will cut fuel burn by 1.5%.

It referred to the agreement in a half-year briefing in which Ryanair Group revealed a net profit of €1.37 billion ($1.37 billion) for the six months to 30 September, higher than its last pre-crisis figure. This included €4.9 million from Malta Air and €22.4 million from other group airlines.

Ryanair attributes the performance to "record" traffic in the second quarter and "robust" summer fares, along with "strong" operational reliability.

The carrier had introduced a total fleet of 73 737 Max jets across its group fleet by the summer peak, rising to 77 by the end of September, but it is irritated by delays in deliveries.

Ryanair is expecting only 10-12 additional Max arrivals before the Christmas holiday period, out of 21 contracted, and chief executive Michael O'Leary claims growth is "being hampered" by the "inability" of Boeing to meet the third-quarter timetable.

He adds that Boeing has assured the airline that it will complete all 51 of the Max deliveries scheduled before summer 2023 – pointing out that 2023-2024 growth plans are based on these fleet additions – but states that there is a "risk that some of these deliveries could slip".

$200m

Investment in scimitar winglets to be retrofitted on 409 Boeing 737-800s, set to deliver a fuel-burn saving of 1.5%

While O'Leary says the carrier remains dependent on Boeing meeting its delivery commitments, it is "modestly" raising its full-year 2022-2023 activity forecast to 168 million passengers from the previous 166.5 million.

This would equate to a 13% increase over pre-pandemic figures.

O'Leary says he hopes that full-year fares will remain ahead of pre-crisis levels, but cautions that yields could still be affected at "very short notice" by events in the second half.

But if such setbacks are avoided, O'Leary says the airline could "minimise" winter losses and deliver pre-exceptional net profits of €1-1.2 billion for the full year.

"This cautious guidance will remain hugely dependent on not suffering adverse events this winter – as we did last, which were clearly beyond our control," he states.

Additonally, O'Leary insists that concerns over rising inflation and recession on Ryanair's business have been "greatly exaggerated".

"As the lowest-cost producer in Europe, we expect to grow strongly in a recession as consumers won't stop flying – but rather they will become more price-sensitive," he says.

"Our very strong [post-pandemic] recovery shows that price will continue to drive market-share gains as we add low-cost, more fuel-efficient, aircraft to our fleet over the next four years."

O'Leary argues that, over the course of the pandemic, short-haul capacity has undergone a "considerable contraction" and claims that much of this "will not return in the medium term".

"Consumer propensity to travel remains high in Europe as a result of full employment, rising wages and two years of pent-up-demand and accumulated savings," he says.

"We expect these strong fundamentals will continue to underpin robust traffic and average fare growth for the next 18 months at least."

VoltAero picks Italy's TESI to build airframe for Cassio 330 prototype

Salerno-based metallic parts specialist also invests in French developer as momentum builds for five-seat hybrid aircraft

Dominic Perry London

Hybrid-electric aircraft developer VoltAero has signed up Italian aerospace supplier TESI to manufacture the airframe for the first prototype of its Cassio 330 aircraft.

In addition, Salerno, southern Italy-based TESI has invested in VoltAero, contributing to the start-up's €32 million ($31.6 million) Series B funding round.

VoltAero says the capital raised will cover the costs of certification and the launch of serial production for the Cassio 330.

Jean Botti, VoltAero's founder and chief executive – a former Airbus chief technical officer – confirms that the agreement covers solely fabrication of the initial prototype airframe, rather than those for serial aircraft.

"For us it is a way to test their [TESI's] capabilities," he adds, noting that the firm is already a supplier of metallic components to both Airbus and Boeing.

TESI is already manufacturing parts for the initial aircraft, he says, with the goal of completing assembly in April 2023. A first flight should follow in June or July that year.

For the maiden sortie, the Cassio 330 will be powered only by a thermal engine in order to "validate the flight envelope", says Botti. This will subsequently be swapped out for a 330kW hybrid-electric powertrain.

Safran is to provide the electric motors and EPS the batteries, while the Japanese supplier of the internal combustion engine will be disclosed shortly.

Sufficient funding

Botti hopes to firm up VoltAero's supply chain by mid-2023, enabling production to begin by the end of 2024 following certification earlier that year.

While the current funding round will be sufficient to see the five-passenger Cassio 330 through to service entry, Botti says VoltAero's follow-on projects – the six-seat Cassio 480 and 12-seat Cassio 600 – will be bankrolled by sales of the smallest model.

"They are going to be very dependent on the success of the Cassio 330," he says. VoltAero has gained almost 200 pre-orders for the Cassio 330, worth around €480 million, and aims to begin converting these to firm commitments once the prototype is flying.

Customers include regional carriers across Asia, Europe and the USA, plus those in the medevac segment.

Botti sees the hybrid-electric design as ideal for the market, enabling greater range and flexibility than with battery-power alone.

The Cassio design incorporates a forward fixed canard and an aft-located wing with twin booms, supporting a high-set horizontal tail.

Batteries power the electric motors in the aft fuselage-mounted propulsion system for the taxi, take-off, climb and landing phases, while the internal combustion engine serves as a range extender, recharging the batteries during cruise. It also provides a back-up in case of an electrical system failure.

VoltAero has been flying its 600kW propulsion system in its Cassio 1 testbed since 2020, and has logged 5,400nm (10,000km) across 135 flight hours.

"We have been impressed by VoltAero's highly intelligent approach with Cassio, applying its dual-source electric-hybrid propulsion concept for regional aviation that will be both sustainable and operationally safe," says Luigi Punzo, TESI chief executive.

VoltAero

Cassio 1 testbed has logged 135 flight hours since 2020

Start-up will deploy all-electric Alice on scheduled regional routes

Evia Aero outlines zero-emission goals

Carrier plans to launch operations in 2026 with converted Britten-Norman Islanders – but investment in charging infrastructure will be key

Eviation

Dominic Perry London

German start-up carrier Evia Aero believes it is launching into the market with a fleet of zero-emission aircraft at the optimum time, as it looks towards the start of operations in 2026.

Evia has so far placed orders for 25 examples of Eviation's Alice all-electric commuter aircraft, together with 15 conversions of the Britten-Norman BN-2 Islander with a new hydrogen fuel cell powertrain from Cranfield Aerospace Solutions, plus 10 examples of an as yet undisclosed fuel cell-powered 19-seater from the same provider.

To arrive from 2026, the modified Islanders will be used for short-range operations serving island communities and ferrying in workers to support the offshore wind power industry, says chief executive Florian Kruse, a former chief commercial officer at Bremen airport in Germany.

"We will be the first commercial regional airline that's able to operate sustainable aircraft," he says.

He sees the BN-2's traditional role as an island-hopper only enhanced by the hydrogen-electric conversion: "It's a really interesting product for us."

Cranfield Aerospace believes it can obtain a supplemental type certificate for the modification by 2025 and Kruse says the near-term availability of the platform was also a selling point.

"I think sustainable aviation is a race – but you can't be in the market without an aircraft; you have to work with a manufacturer you can trust."

Deliveries of the Alice are due to follow later in the decade – certification is not expected before 2027 – and Evia will use the all-electric nine-seater to launch scheduled routes linking secondary or tertiary airports in Europe with double- or triple-daily flights.

€70m

Upper range of expected cost to launch operations, with majority of investment for ground infrastructure

So far, tentative agreements have been reached with airports including Bremen, Friedrichshafen, Munster and Weeze in Germany, Antwerp in Belgium, Groningen in the Netherlands, and Esbjerg in Denmark, but Kruse says the carrier is "talking to 22 European airports to bring the network to the right stage". While the focus so far has been on northern Europe, Kruse says tht potential locations also include sites in Austria, France and Scotland.

Crucially, though, Evia will not just focus on airline operations: Kruse says it will also establish a group company to set up and run solar-powered charging stations and hydrogen-electrolyser facilities at airports.

In addition to enabling the carrier to charge or fuel its own aircraft, it will also sell the electricity or hydrogen produced to the wider market, helping to offset and manage costs.

Installation of the photovoltaic plants will begin later this year or early next, says Kruse, as it works to finalise agreements with airport operators; these should come online from 2024, he adds.

While the start-up's aims are ambitious, Kruse believes it can be successful: "We are here in the right place, at the right time, with the right product."

The lack of a legacy fleet requiring conversion to zero-emission operations will also stand it in good stead, he argues: "We are starting with a clean-slate... that's why we will be successful."

Around €60-70 million ($60-70 million) will be required to bring the carrier to operation, he estimates, with the majority of the investment on infrastructure. The aircraft will be acquired via dry lease.

Leading the charge

New chief executive at electric motor developer outlines plans to manage nascent segment's growth

Rolls-Royce

Electroflight and Evolito had worked together on the Rolls-Royce Accel project

Dominic Perry London

Electric motor developer Evolito has welcomed back as chief executive one of the individuals responsible for spearheading its development as an aviation business inside automotive supplier Yasa Motors.

Dr Chris Harris rejoined Evolito in November, having assisted with the integration of Yasa into Mercedes-Benz after its acquisition by the German giant in 2021. Evolito was spun out of Yasa earlier this year.

Harris says the appointment suits his mindset: "What I have always enjoyed doing is taking early stage technology all the way through to market and to profitability," he says.

"So it was a perfect fit to take a technology that I understand, having gone through that whole journey with Yasa, and start again in the aerospace market with Evolito."

Harris is now leading Evolito's efforts to commercialise its axial flux aerospace motors, which it says are lighter and more compact than alternative radial motor designs. Harris claims a weight-saving of 30-50%, depending on configuration.

Development activities are ongoing in collaboration with several undisclosed aircraft manufacturers, from both the fixed-wing and electric vertical take-off and landing (eVTOL) segments; Evolito aims to "get the first sample deliveries" to customers in 2023, Harris says.

Evolito offers motors, power inverters and batteries – the last of these thanks to its purchase earlier this year of Electroflight – whether as separate systems or as an integrated electric propulsion unit.

Its focus is on the general aviation and eVTOL markets initially, as they are "where electrification is going to have an early impact".

He adds: "It's developing the right products, the right relationships with customers to deliver what we think are highly differentiated products that will aid the acceleration of electrification in aerospace."

Evolito is trying to "dovetail" its development, certification and industrialisation timeline with those of its airframe partners, he says, potentially leading to service entry towards the back end of 2024 or in early 2025.

Industrial revolution

Industrialisation of Evolito's products will be a vital part of the plan, as it looks to hit quality, price and, crucially, volume targets, a process that should be helped by its history.

"We bring all of that kind of learning from Yasa that we can apply straight into Evolito," Harris says. "So, when the eVTOL market takes off, we will be in a good position to scale our manufacturing to volume, which might be tens of thousands, 50,000, maybe even 100,000.

"But we know how to do those kinds of numbers because we have done it before in an automotive market. And I think there are very few aerospace companies that could say they have scaled to those kinds of volumes."

A new factory to manufacture motors and inverters is set to open in Bicester, central England, next year. However, Electroflight will for the moment remain at its current facility at Gloucestershire airport in Staverton, around 1h to the west.

Acquired for £150,000 ($170,000) via a pre-pack administration process in July, the aviation battery specialist is being integrated into the wider Evolito operation.

Harris says it is formulating a longer plan for the unit, including target markets and customers. "We are in the process of putting that strategy together to define exactly what our long-term technology and product roadmap should be."

That process has given Evolito "a better appreciation of the whole powertrain and the impacts, which are significant, that the battery pack has on overall airframe design".

The two companies had previously worked together on the Rolls-Royce-led Accel project that last year set several speed records for an electric aircraft.

"We knew the team and knew what their capabilities were. It wasn't in our plan to do it [the acquisition] but the opportunity came up."

While Harris says Yasa always had a plan to develop an aerospace division, probably spinning that out over a two- or three-year period, "that just all got accelerated with the acquisition by Mercedes".

Investment has come from financial firm B-Flexion. One of its group managing partners, Cyrus Jilla, is an Evolito director.

FLIGHT UNTETHERED

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Airbus Helicopters

Spain's Guardia Civil and Policia Nacional took their first two Airbus Helicopters H135s under a 36-unit deal also including its armed forces

Leonardo Helicopters

Leonardo Helicopters conducted the debut sortie with its lead production AW609 tiltrotor, with service entry targeted next year

N509FZ/Wikimedia Commons

HAECO's Xiamen engine services unit is to provide MRO support for GE Aerospace CF34 turbofans powering Comac ARJ21 regional jets

Vertical Aerospace

Vertical Aerospace performed 14 tethered test flights of its VX4 prototype over a six-week period starting on 24 September

Seattle-based Alaska Airlines will take another 52 737 Max-family narrowbodies, as it moves toward operating a Boeing-only fleet

Boeing

Best of the rest

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

LOM Praha ordered four Aero Vodochody L-39NGs to support the training of Czech air force pilots, with options to double its purchase

Aero Vodochody

TUIfly Belgium is to introduce three Embraer 195-E2s, with lessor AerCap to deliver the 136-seat twinjets from March-May 2023

TUI Group

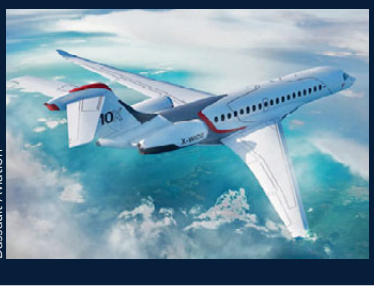
Next month

FLIGHT INTERNATIONAL

On sale
29 December

In our forecasts special: can Boeing get 737 Max soaring?

Plus...



Dassault Aviation

Twin peaks
Dassault's ultimate Falcon, the flagship 10X, gets cutaway treatment

ZeroAvia

Reality check
We assess which green technologies really have a chance of taking off

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Battle scars

The true scale of Russia's military aircraft losses in Ukraine has yet to be determined, but its invasion has spurred equipment transfers to Kyiv and a procurement spike among NATO members

Moscow had numerous Sukhoi Su-25s shot down in the early stages of conflict with Kyiv

Efrem Lukatsky/AP/Shutterstock

Craig Hoyle London / **Data by Cirium**

One story dominated world events in 2022: Russia's ill-judged and militarily flawed invasion of Ukraine. Launched on 24 February, Moscow's attempt to seize control and oust the Western-leaning government of Ukrainian President Volodymyr Zelensky followed its 2014 annexation of the country's Crimea region.

It rapidly became clear that Russian President Vladimir Putin had misjudged the fierce resolve of both the Ukrainian military and the international community, which almost unanimously moved to isolate his regime.

The early stages of the conflict saw a large number of Russian assets shot down by Ukrainian forces, including Sukhoi Su-25 and Su-34 combat aircraft, plus Kamov Ka-52 and Mil Mi-24 combat helicopters. Such acts gave rise to the urban legend "Ghost of Kyiv"; a lone Ukrainian RAC MiG-29 fighter

'Ghost of Kyiv' was an urban legend – but Ukrainian victories were real

Oleksii Chumachenko/SOPA Images/Shutterstock

ace responsible for multiple "kills" – later dispelled and attributed to its air force as a whole.

As of 14 November, Kyiv's defence ministry said its forces had destroyed 278 enemy aircraft, plus 261 helicopters and 1,509 unmanned air vehicles, since the start of the war.

The scale of Ukraine's own equipment losses remains unclear, but these have in part been offset by its receipt of replacement assets donated by NATO members and other allied nations.

With the difficulties associated with identifying individual destroyed aircraft to the serial number level solely from images taken in an active warzone, the Cirium fleets data which powers FlightGlobal's 2023 World Air Forces directory shows only minimal adjustments to the combatants' inventories versus last year's report. Russia's total of 4,182 – which ranks it second only to the USA – is in fact an increase of nine, while Ukraine's 312 marks a six-unit reduction.

Meanwhile, Moscow's invasion prompted Finland and Sweden both to request – and rapidly receive approval – to join the already 30-nation-strong NATO alliance. Ukraine wants to follow suit.

Away from Europe, years-long tensions between China and Taiwan increased after an early-August visit to Taipei by US Speaker of the House of Representatives Nancy Pelosi. Beijing responded by staging major live-fire exercises and aerial incursions into the island state's air defence identification zone, highlighting the threat of a potential future invasion.

Our new directory details some 53,265 military aircraft in active use with the armed forces of 162 nations around the globe: a net reduction of just six from 12 months earlier.

Two regions experienced percentage-scale fleet size increases during our review period: Africa (up 41, or 1%, to 4,118); and the Middle East (plus 71, or 1%, to 4,485).

Only very minor changes were recorded in the Asia-Pacific, Latin America, North America, and Russia and the Commonwealth of Independent States (CIS) regions. But Europe continued a downward trend, with its combined 8,130 aircraft marking a contraction of 196, or just over 2%.

Changes to the fleet in Africa include the Algerian air force having introduced the first two Lockheed Martin LM-100J transports – the commercial variant of its C-130J – to appear in our directory. Mali boosted its combat aircraft inventory with six Aero Vodochody L-39s, although a newly acquired Su-25 crashed on 4 October, killing both crew members.

African acquisitions

Angola ordered three Airbus Defence & Space C295s: two maritime surveillance-configured examples, and one transport, and Tunisia signed for eight Beechcraft T-6C turboprop trainers.

Retirements meanwhile included Algeria's last 13 MiG-25 interceptors.

In the Middle East, Kuwait took its first six Eurofighter Typhoons from a 28-unit order, and Qatar its first four of 24 examples of the same type. Doha also received its first four NH Industries NH90 helicopters, enabling it to retire its 11 Westland Sea Kings.

Procurement activity in the region included US Foreign Military Sales deals for Israel to acquire its lead four of a planned eight Boeing KC-46A tankers, plus four Sikorsky CH-53K transport helicopters; part of an 18-unit acquisition.

Jordan announced a planned order for eight Lockheed F-16Vs, and in a surprise step – announced almost immediately after our last directory was published – the United Arab Emirates (UAE) in early December 2021 signed for 80 Dassault Rafales, for delivery from 2027.

Global military fleet

	Country	Active fleet	Share
1.	USA	13,300	25%
2.	Russia	4,182	8%
3.	China	3,284	6%
4.	India	2,200	4%
5.	South Korea	1,602	3%
6.	Japan	1,451	3%
7.	Pakistan	1,413	2%
8.	Egypt	1,069	2%
9.	Turkey	1,065	2%
10.	France	1,004	2%
	Other	22,695	43%
	Total	**53,265**	**100%**

Source: Cirium fleets data

Some 1,223 Apaches are in use – more will follow for Australia (29) and Poland (96)

Fleet size for leading countries by role

Combat aircraft

	Country	Active fleet	Share
1.	USA	2,757	19%
2.	China	1,570	11%
3.	Russia	1,517	10%
4.	India	707	5%
5.	North Korea	572	4%
6.	South Korea	500	3%
7.	Pakistan	453	3%
8.	Saudi Arabia	364	3%
9.	Egypt	333	2%
10.	Taiwan	285	2%
	Other	5,601	38%
	Total	**14,659**	**100%**

Special mission

	Country	Active fleet	Share
1.	USA	731	37%
2.	Japan	150	8%
3.	Russia	147	7%
4.	China	112	6%
5.	India	73	4%
6.	France	44	2%
7.	Brazil	37	2%
8.	Germany	37	2%
9.	Australia	31	1%
10.	South Korea	30	1%
	Other	599	30%
	Total	**1,991**	**100%**

Tanker

	Country	Active fleet	Share
1.	USA	632	77%
2.	Saudi Arabia	22	3%
3.	France	19	2%
4.	Russia	19	2%
5.	Israel	11	1%
6.	Singapore	11	1%
7.	United Kingdom	9	1%
8.	Japan	8	1%
9.	Iran	7	1%
10.	Turkey	7	1%
	Other	78	10%
	Total	**823**	**100%**

US Army

The UAE also ordered 12 Airbus Helicopters H225Ms for its Joint Air Command, and plans to buy between 12 and 48 Hongdu L-15 advanced jet trainers from China.

In the Asia-Pacific region, Afghanistan returns to open our full report's 23 pages of fleet listings, but in the most modest form: just one MD Helicopters MD530F is listed as active with the Taliban's newly named Islamic Emirate of Afghanistan Air Force.

Bangladesh added the Grob Aircraft G120TP trainer to its air force's fleet, taking 12 of 24 on-order examples. And the Pakistan air force in mid-March received its first Chengdu J-10Cs. Its acquisition – which totals 25 of the fighters – marks the first international success for the type.

New arrivals

Other additions included Papua New Guinea's first of four Pacific Aerospace P-750 STOL transports; currently its lone military aircraft. The Philippines received its first two of six Turkish Aerospace T129 attack helicopters, and ordered another 32 Sikorsky S-70is, to augment 15 in-service examples.

Australia, meanwhile, ordered another 12 Sikorsky MH-60Rs and 29 Boeing AH-64Es, with the latter to replace its army's Airbus Helicopters Tigers. Canberra also intends to remove its 47 MRH90 (NH90) rotorcraft from use, and acquire 40 replacement UH-60Ms.

Indonesia ordered 42 Rafales, and secured US government approval for a potentially $13.9 billion acquisition of 36 Boeing F-15ID fighters. South Korea ordered up to 40 Bell 505 trainers.

Asia-Pacific retirements since our last report included the November 2021 departure of the Royal Australian Air Force's remaining 64 Boeing F/A-18A/B "Classic" Hornets, plus the Royal Australian Army's 27 S-70s. Brunei's six MBB-built BO105 helicopters also ended their service.

In Latin America, Chile replaced its unique but obsolete Boeing 707-based Condor airborne early warning platform, acquiring an operational pair of ex-UK Royal Air Force (RAF) Boeing E-3Ds.

Brazil's air force purchased two ex-Azul Airbus A330s for conversion into multi-role tanker transports. The first is now in use as a passenger transport, ahead of undergoing modification. The Brazilian air force and navy also will receive 27 H125 trainers.

But further cuts were made to the nation's once 28-aircraft acquisition of Embraer KC-390 transport/tankers: first to 22, and then 19 units.

Departures from the region's fleet included Argentina's two Mi-171 transport helicopters and the Brazilian air force's 12 Mi-35s.

North American developments, meanwhile, included the selection of the L3Harris/Air Tractor AT-802U as the winner of the US Special Operations Command's Armed Overwatch programme. A first US Air Force (USAF) contract covers six of the type, with the total requirement being for 75.

$13.9bn

Indonesia has secured US government approval to potentially acquire 36 Boeing F-15ID combat aircraft

The USAF, meanwhile, reduced the size of its McDonnell Douglas KC-10 tanker fleet, from 51 to 40 units. And the Royal Canadian Air Force retired its last four search and rescue-roled De Havilland Canada DHC-5s.

Limited changes in the Russia & CIS region included Belarus retiring its 10 Mi-2 transport helicopters and trainers.

European retirements

Europe's fleet size contracted due to multiple type retirements during the review period, including Belgium's five C-130H transports, Finland's 26 L-70 Vinka basic trainers, France's 27 Dassault Mirage 2000C fighters, and the last 21 C160 Transall transport and special mission aircraft flown by France, Germany and Turkey.

The Netherlands phased out its KDC-10 tanker and seven F-16B trainers, while Norway sent its remaining F-16s into retirement after 42 years of service, and moved to sell 32 to Romania. Oslo also withdrew its 13 troubled NH90s from use, and axed its two Dassault Falcon 20 electronic warfare aircraft.

Transport

	Country	Active fleet	Share
1.	USA	962	22%
2.	Russia	444	10%
3.	China	288	7%
4.	India	254	6%
5.	Brazil	125	3%
6.	France	114	3%
7.	Iran	86	2%
8.	Colombia	83	2%
9.	Turkey	83	2%
10.	Indonesia	67	1%
	Other	1,783	42%
	Total	**4,289**	**100%**

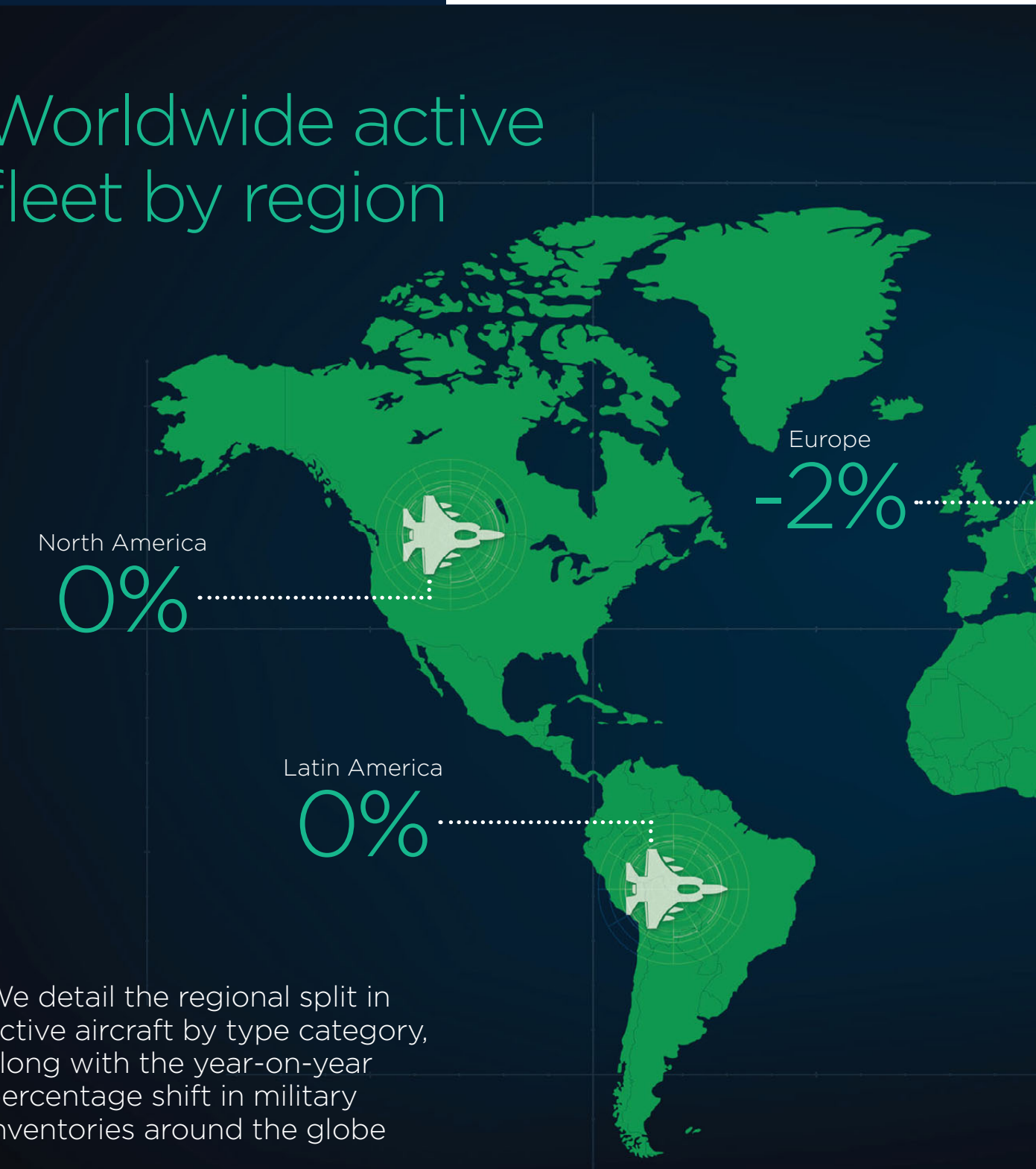
Combat helicopter

	Country	Active fleet	Share
1.	USA	5,584	28%
2.	Russia	1,531	8%
3.	China	913	5%
4.	India	807	4%
5.	South Korea	739	4%
6.	Japan	566	3%
7.	Turkey	478	2%
8.	France	438	2%
9.	Italy	404	2%
10.	Egypt	325	1%
	Other	8,308	41%
	Total	**20,093**	**100%**

Training aircraft/helicopters

	Country	Active fleet	Share
1.	USA	2,634	23%
2.	Pakistan	550	5%
3.	Russia	524	5%
4.	Japan	425	4%
5.	China	397	3%
6.	India	353	3%
7.	Egypt	341	3%
8.	South Korea	288	3%
9.	Turkey	270	2%
10.	United Kingdom	212	2%
	Other	5,416	47%
	Total	**11,410**	**100%**

Worldwide active fleet by region



We detail the regional split in active aircraft by type category, along with the year-on-year percentage shift in military inventories around the globe

North America

Sector	Active fleet
Combat aircraft	2,820
Special mission	758
Tanker	638
Transport	990
Combat helicopter	5,704
Training aircraft/ helicopters	2,766
Total	**13,676**
Year-on-year fleet change	0%

Latin America

Sector	Active fleet
Combat aircraft	463
Special mission	161
Tanker	16
Transport	518
Combat helicopter	1,114
Training aircraft/ helicopters	972
Total	**3,244**
Year-on-year fleet change	0%

Europe

Sector	Active fleet
Combat aircraft	2,008
Special mission	245
Tanker	49
Transport	588
Combat helicopter	3,328
Training aircraft/ helicopters	1,912
Total	**8,130**
Year-on-year fleet change	-2%

Africa

Sector	Active fleet
Combat aircraft	959
Special mission	59
Tanker	7
Transport	427
Combat helicopter	1,631
Training aircraft/ helicopters	1,035
Total	**4,118**
Year-on-year fleet change	1%

Middle East

Sector	Active fleet
Combat aircraft	1,556
Special mission	102
Tanker	46
Transport	260
Combat helicopter	1,514
Training aircraft/ helicopters	1,007
Total	**4,485**
Year-on-year fleet change	1%

Russia & CIS

Sector	Active fleet
Combat aircraft	1,864
Special mission	147
Tanker	19
Transport	484
Combat helicopter	1,915
Training aircraft/ helicopters	624
Total	**5,053**
Year-on-year fleet change	0%

Asia-Pacific

Sector	Active fleet
Combat aircraft	4,989
Special mission	519
Tanker	48
Transport	1,022
Combat helicopter	4,887
Training aircraft/ helicopters	3,094
Total	**14,559**
Year-on-year fleet change	0%

Note: CIS countries include Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan and Uzbekistan

Source: Cirium fleets data

Lockheed Martin

There are 729 F-35s in service worldwide, including 184 trainers

The UK RAF and Royal Navy retired all their BAE Systems Hawk T1 advanced jet trainers, bar those retained for use by the former's Red Arrows aerobatic display team. The RAF also ended operations with a pair of BAe 146-200QC transports.

Lockheed, meanwhile, furthered its European F-35 sales bonanza. Finland in December 2021 selected the type for its 64-aircraft HX requirement, and Switzerland finalised a $6.2 billion contract for 36 A-model examples. Acquisition plans were also announced by the Czech Republic (24) and Germany (35).

The F-35 continues its ascent of our combat aircraft Top 10 ranking, with the 545 now in use positioning it in sixth place. A further 184 are listed as full-time training assets, boosting the combined total to 729.

Poland ordered 48 Korea Aerospace Industries FA-50PLs, for light-attack and training duties, and also intends to buy 32 Leonardo Helicopters AW149s and 96 AH-64Es.

Other deals included contracts from Austria for 18 AW169Ms; Cyprus (six H145s); Greece (six Rafales); Hungary (12 L-39NGs); the Netherlands (five C-390s); Serbia (two C295s); and Spain (20 Eurofighters, plus 18 H135 trainers). Sweden also signed a deal with Saab for two Bombardier Global 6000-based GlobalEye surveillance aircraft, and Germany selected the Boeing CH-47F Chinook for a 60-aircraft CH-53G replacement need.

25%

The USA has a quarter of all operational military aircraft, including 28% of combat helicopters and 77% of tankers

Worldwide Top 10 active aircraft types

Combat aircraft

	Type	Active fleet	Share
1.	F-16	2,184	15%
2.	Su-27/30/34/35	1,187	7%
3.	F-15	961	6%
4.	F-18	828	6%
5.	MiG-29	822	6%
6.	F-35	545	4%
7.	Eurofighter Typhoon	522	3%
8.	Su-25	480	3%
9.	J-7	444	3%
10.	F-5	403	3%
Other		6,283	44%
Total		**14,659**	**100%**

Special mission

	Type	Active fleet	Share
1.	King Air	232	12%
2.	737	175	9%
3.	EA-18G	163	8%
4.	P-3	163	8%
5.	E-2	106	5%
6.	707	88	5%
7.	C295/CN235	67	3%
8.	C-130	66	3%
9.	Y-8	59	3%
10.	Il-18	57	3%
Other		815	41%
Total		**1,991**	**100%**

Tanker

	Type	Active fleet	Share
1.	KC-135	408	49%
2.	C-130	193	23%
3.	767	72	9%
4.	A330	48	6%
5.	DC-10	40	4%
6.	Il-78	37	4%
7.	707	19	2%
8.	747	3	1%
9.	A310	2	1%
10.	Y-20	1	1%
Other		0	0%
Total		**823**	**100%**

Source: Cirium fleets data

In terms of regional balance, Asia-Pacific operators have the largest combined fleet, at 14,559 aircraft: an in-year increase of 30. That betters North America's 13,676 – of which the USA has a 97% share – by 883 platforms.

While probably every US military speech or report of the last year has highlighted the increased "near-peer" threat posed by China and Russia, Washington DC's air power assets outnumber its potential adversaries in every one of our six equipment listing categories.

Numerical advantage

The USA owns 25% of all operational military aircraft, with its numerical advantage ranging from having 19% of all combat aircraft to 28% of combat helicopters and 77% of tankers. Its 13,300 aircraft total more than the combined assets held by second- to sixth-ranked Russia, China, India, South Korea and Japan, Cirium data shows.

Available to download as a 32-page report, our annual fleet review – produced in association with Embraer – excludes those aircraft recorded by Cirium as not being in day-to-day use, such as almost 5,100 which are in storage, or involved in or awaiting upgrade. We also do not list the 709 assets permanently assigned to performing VIP, government or private duties, or those flown by the DOSAAF paramilitary/reserve organisations of Russia (118) and Belarus (11).

Other omissions include a combined 378 aircraft that are employed as dedicated experimental or research and development assets, and a further 186 that are assigned to undisclosed military operators or are used for tasks such as calibration, satellite tracking, skydiving, surveying, target towing, and weather reconnaissance.

Our directory – the initial data for which was drawn on 3 October – also includes information about firm orders for some 4,185 aircraft, and letters of intent or options for up to another 7,423 (denoted by an asterisk next to a figure in the Ordered column); including a potential 2,579 F-35s which have yet to come under contract.

Sweden has signed for two GlobalEye surveillance aircraft

Saab

Directory

Yours to download

Produced in association with Embraer, FlightGlobal's 2023 World Air Forces directory will be available to download from 24 November. To access your free pdf copy of our annual report, including 23 pages of full fleet listings, visit **FlightGlobal.com/waf**

Should you experience any difficulty with accessing the complete report online, please contact us via email at **flight.international@flightglobal.com**

To find more information about Cirium fleets data, visit **cirium.com**

Transport

	Type	Active fleet	Share
1.	C-130/L-100	858	20%
2.	King Air	289	7%
3.	C295/CN235	284	7%
4.	C-17	281	6%
5.	An-24/26	221	5%
6.	Il-76	206	5%
7.	An-30/32	141	3%
8.	Cessna 208	129	3%
9.	Y-8	116	3%
10.	A400M	109	2%
Other		1,655	39%
Total		**4,289**	**100%**

Combat helicopter

	Type	Active fleet	Share
1.	S-70/SH/UH-60	3,962	20%
2.	Mi-8/17	2,804	14%
3.	AH-64	1,233	6%
4.	UH-1	950	5%
5.	CH-47	934	5%
6.	Mi-24/35	922	5%
7.	Bell 212/412	666	3%
8.	AH-1	565	3%
9.	MD500/530	564	2%
10.	H145	454	2%
Other		7,039	35%
Total		**20,093**	**100%**

Training aircraft/helicopters

	Type	Active fleet	Share
1.	T-6	980	8%
2.	F-16	626	6%
3.	L-39	578	5%
4.	Hawk	577	5%
5.	T-38	575	5%
6.	MFI-15/17/395	477	4%
7.	PC-7	362	3%
8.	EMB-312/314	352	3%
9.	Bell 206	347	3%
10.	SF260	294	3%
Other		6,242	55%
Total		**11,410**	**100%**

Commonwealth of Australia

Australia said goodbye to its F/A-18A/B "Classic" Hornets, being replaced by a planned 100 F-35As

Fleet farewells

We highlight some of the most notable military retirements recorded since we published our last World Air Forces directory

The last 21 C160 Transalls, flown by France, Germany and Turkey (*pictured*), headed into history

EvrenKalinbacak/Shutterstock

Typhoon Photography/Shutterstock

The UK ended pilot and aggressor training activities with the Hawk T1; some remain with its Red Arrows display team

BeAvPhoto/Shutterstock

With six A400Ms now in use, Belgium stopped using its five veteran C-130Hs

Brazil withdrew its dozen Mi-35 attack helicopters from air force use, a little more than a decade after introducing the type

Brazilian air force

Bundeswehr

Germany's air force ended three decades of A310 operations, with Canada acquiring one aircraft for spare parts

The French air force removed the last Mirage 2000C fighters from its fleet

BeAvPhoto/Shutterstock

VanderWolf Images/Shutterstock

The Royal Norwegian Air Force retired its F-16A/Bs after 42 years of service. Oslo plans to sell 32 of the aircraft to Romania

GE-owned Avio Aero is becoming a champion of European defence autonomy and a leader in sustainable technologies. Its chief executive explains why independence works for the company

Power of one

Murdo Morrison Turin

One of the world's three big aero engine players has owned it for almost a decade, but Avio Aero remains a proudly independent Italian manufacturer, developing its own proprietary products and playing a key role in Europe's strategic autonomy in military propulsion.

"We want to create disruptive technologies and to do that here in Europe," says chief executive Riccardo Procacci, who has headed the Italian subsidiary since GE Aerospace's acquisition in 2013. "We don't want to just be a manufacturer of parts. We want an important seat at the GE table."

A major element of Avio Aero's business remains producing sub-systems for its parent's commercial aviation programmes such as the GE90, GEnx and CFM International Leap, as well as for GE's rivals. It is a recognised leader in gear systems, low-pressure turbines and combustion systems.

However, the company, which traces its origins to before the First World War and has a workforce of around 5,000 in three main sites, has lately been burnishing its credentials in the military field, presenting itself as part of the solution to Europe's ambitions to be self-sufficient in defence.

The company has long had a major contribution to two existing military programmes – the Europrop International TP400 that powers the Airbus Defence & Space A400M and the Eurofighter Typhoon's Eurojet EJ200 – but Avio Aero is now setting its sights on a new generation of defence products.

One of Avio Aero's most significant wins was the selection earlier this year of its Catalyst engine to power the Eurodrone twin-turboprop unmanned air vehicle (UAV) Airbus Defence & Space is leading the development of for the militaries of France, Germany, Italy and Spain. The UAV is due to fly around 2027.

While volumes and revenues from the programme will be modest compared with commercial and even large-scale military contracts, 22-year GE veteran Procacci describes the announcement as a "huge milestone" for the "growth of European capabilities and sovereignity".

The critical feature for Procacci is that – despite Avio Aero's ownership – the engine itself is free from US International Traffic in Arms Regulation restrictions because the authorities consider the technologies to be European. That potentially opens export markets not available to US players.

Military market

Interestingly, Avio Aero did not conceive the full authority digital engine control (FADEC)-equipped Catalyst for the military market; in fact, some might argue that the Italian company did not conceive the turboprop engine at all. Credit for that goes to the Czechs.

The clean-sheet engine is based on the M601 and its H80 successor made by Walter Aircraft Engines in Prague, which GE has owned since 2008. It was designed to compete with Pratt & Whitney Canada's ubiquitous PT6, which in its various guises has dominated the general aviation market for decades.

Textron Aviation chose the 1,300shp (970kW) Catalyst to power its nine-seat Denali in 2015, impressed by a claimed 20% fuel burn advantage over older turboprops. However, delays to the engine contributed to a missed 2019 first flight target. That finally took place in November last year.

Avio Aero

Avio Aero's headquarters in Rivalta, near Turin

Avio Aero

Catalyst engine is now in flight testing

Riccardo Procacci with a full-scale model of the Catalyst

Avio Aero

While Procacci will not comment on those delays, he says the engine is performing well in flight-testing and that "pilots love it". Avio is now steering the programme from its head office near Turin, with Prague still responsible for final assembly, and a unit in Poland carrying out subassembly work.

He says the fact neither Rolls-Royce nor Safran offered a turboprop engine in the 1,300shp class opened opportunities for Avio Aero in the military market once states began mulling funding the development of a European medium-altitude, long-endurance UAV, able to fly in non-restricted airspace.

There might be further potential. "It won't stop with one engine. We believe we will end up with a family of commercial and military drones," says Procacci. Another possible market for Catalyst are the hybrid-electric commuter aircraft that will require conventional engines as well as battery packs.

Avio Aero is involved in another key military development, the UK-led project designing the Tempest successor to the Eurofighter Typhoon. Avio Aero is working with R-R to come up with novel propulsion technologies, and has received a first tranche of funding from Rome.

Procacci describes Avio Aero's involvement in the Future Combat Air System initiative as "great for European industry" (rather confusingly, Germany, France and Spain are backing a rival project to develop a next-generation fighter, also known as FCAS).

"It won't stop with one engine. We believe we will end up with a family of commercial and military drones"

Riccardo Procacci Chief executive, Avio Aero

He believes that the decision of several European countries, including Italy, to opt for the Lockheed Martin F-35 as an "off-the-shelf" combat aircraft "deprived us of technology", and that "if we hadn't closed the gap with the Americans [with Tempest], it would never have been closed in the future".

He says Avio Aero's acceptance into the European Defence Fund (EDF) – "despite some competitors suggesting we were backed by US capital" – has also been critical for its reputation as a keystone of Europe's standalone defence industrial capability.

Among the EDF funding initiatives in which Avio Aero is involved is European Next Generation Rotorcraft Technologies (ENGRT), intended to mature technologies for future rotorcraft. The Italian company is working with compatriot Leonardo Helicopters, Airbus Helicopters and Safran.

Another is NEUMANN, which stands (rather awkwardly) for Novel Energy and Propulsion Systems for Air Dominance, focused on coming up with alternative propulsion or energy systems for a future combat aircraft. Avio Aero will lead a partnership of 38 companies.

Avio Aero's position at the heart of Europe's future defence projects is not something the company feels it is simply entitled to, asserts Procacci. "For us to sit at the same table as Safran and Rolls-Royce and say 'We have something you don't!' is the result of 10 years of hard work," he says.

That transition and strategic focus under GE comes after decades during which Avio Aero drifted somewhat under the various shareholdings of automaker FIAT, Finmeccanica, and private equity, with the Italian government sensitive about protecting a strategic industrial and military asset.

However, when GE bought the company (minus its space business) – beating Safran to the purchase – then-boss David Joyce said Avio Aero had to be more than just part of its supply chain: after all, wage rates and other costs in Italy were not that different to Ohio.

Instead, GE moved to protect Avio Aero's independence and reputation for innovation, as well as its status as Italy's military propulsion champion. The slogans on the workers' overalls at its plants at Turin, Pomigliano D'Arco (near Naples) and Brindisi read: "Avio Aero, a GE Aerospace company".

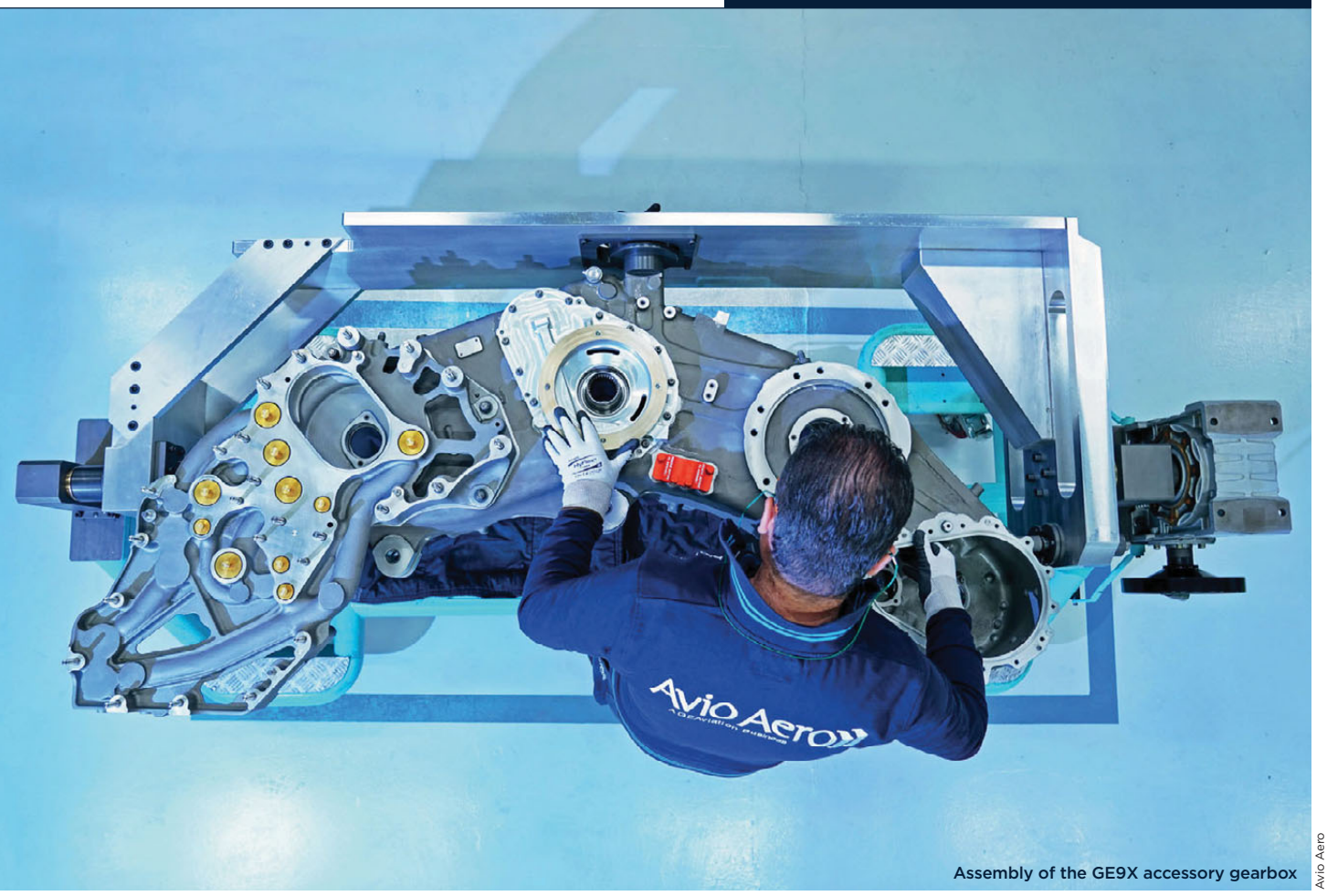
One of these areas where Avio Aero has been able to become a technology leader within GE has been additive manufacturing. The company began investing in so-called 3D printing before the acquisition, in 2009, and opened a dedicated additive manufacturing plant in Cameri in 2013.

Avio Aero

Avio Aero is adopting increasing digitisation in its factories

Avio Aero

Power gearboxes are one of the company's specialisms



Assembly of the GE9X accessory gearbox

Avio Aero

38

Number of firms Avio Aero will lead in NEUMANN project to develop alternative propulsion for future combat aircraft

Using machines made by another GE company in Sweden and electron beam melting processes with a titanium aluminide alloy, Avio Aero produces, among other components, additive manufactured blades for the low-pressure turbine on the GE9X, the engine that powers the Boeing 777X.

Another element of Avio Aero's autonomy has been its ability to continue manufacturing for GE's competitors, a legacy of contracts secured before the acquisition, including gearboxes for Safran and Pratt & Whitney. In fact, Avio Aero claims 80% of all commercial aircraft fly with its components.

Procacci believes third-party work will continue for years, insisting that Avio Aero treats all its customers – including its US parent – the same when it comes to pricing, delivering on time and quality standards.

However, he admits P&W, for instance, would "not trust us to work with them on their next generation of technologies". He adds: "We may still do some non-core components for their [Geared Turbofan] successor, but we are not going to develop disruptive technology for them."

As for almost every business, the Covid-19 crisis was difficult for Avio Aero, particularly on its commercial programmes, and the latest challenges of skilled labour and raw material shortages, together with the rising cost of energy, are likely to last into next year or even beyond.

However, Procacci says the company is prepared after using the pandemic to accelerate a process of automation and digitisation within its factories. "It is all about letting lean really drive our operations," he says. "We have used the last three years to really make a step change with this."

This has included everything from investing in technologies to allow its production machines to "communicate" better with each other to real-time data collection and using artificial intelligence to assist operators to recognise defects.

Sustainability driver

Sustainability is an additional driver for the company. Avio Aero is on the governing board of the EU's Clean Aviation initiative and working on a number of programmes, including into propulsion systems for regional hybrid electric aircraft and liquid hydrogen combustion.

Another is in support of the CFM RISE programme, collaborating with GE's CFM partner Safran on maturing technologies for open fan architecture on a future narrowbody engine, up to the ground test of an initial prototype.

Again, says Procacci, this status is the culmination of many years of dedication. "The technology we have been developing has made it credible for us to be sitting there on an equal footing with Safran. Ten years ago, that would have been arrogance. Now our technical knowledge gives us the right."

Logic's chief executive is on a mission to transform the electronic components specialist into a systems integrator and tier one supplier with a reach beyond Italy and its traditional markets

The right connections

Murdo Morrison Milan

Alessandro Franzoni is mid-way through a 10-year plan to grow fivefold the electronics specialist he became chief executive of in 2016. His aim is to turn Milan-based Logic into a tier one supplier with €100 million ($98 million) revenues and a presence beyond Italy.

So far, the former Leonardo executive is on track, after buying three Italian small and medium enterprises (SMEs) – Blu Electronic, Gelco and Gemelli – to take Logic's €20 million revenues to €50 million.

The new businesses have also given Logic new capabilities. The firm was already a player in electro-mechanical actuation, control panels and displays, as well as fuel management when in 2018 it bought 64% of power distribution specialist Blu. It raised its stake to 83% this year. The acquisition of Gemelli in 2020 added helicopter intercom and noise reduction systems. Gelco, purchased in June, makes electronic modules for engines. It has also delivered production capacity.

More investments are on the cards, including a test laboratory for hybrid-electric power generation technologies. Franzoni says it will combine research laboratories for Logic's own in-development products with a third-party maintenance, repair and overhaul facility. Based in a 2,000sq m (22,000sq ft) building next to Logic's headquarters, the centre is due to be up and running in mid-2023.

"We expect to be busy. There is nothing like this in the region," explains Franzoni.

He is also eyeing the naval market with the planned acquisition of a €15 million-turnover company in that sector. As well as inheriting a place in the supply chain of Italian shipyard giant Fincantieri, Franzoni – whose 28-year career with Leonardo included stints as chief executive of its Superjet International Russian joint venture and chief technology officer at Alenia – hopes to introduce some of Logic's aerospace electronics expertise to marine customers.

Increasing Logic's share in commercial aviation is another objective. Almost all Logic's revenues come from defence and rotorcraft, with Leonardo making up a third. Airbus Helicopters is another major customer, alongside Boeing, ATR, Korea Aerospace Industries, and Czech firm Aero Vodochody.

But Franzoni admits that breaking into Airbus's commercial supply chain is "a big jump" in volume terms.

Family business

Turning 60-year-old Logic into a €100 million concern – the revenue Franzoni told the family owners the business had to achieve to be taken seriously as a tier one supplier – will also require more funding.

"Everything we have done so far has been with our money, but now we need to refinance," he says, adding that Logic is in "final due diligence" with an Italian investment firm that intends to purchase equity in the company.

The same family that owned trainer aircraft pioneer Aermacchi before selling that business to Finmeccanica in 2003 also had Logic in its portfolio, after buying a majority stake in the late 1980s. Logic had performed a research and development (R&D) role for its sister company, including on its M-346 advanced jet trainer programme: "It became the problem-solver of Aermacchi," says Franzoni.

For 13 years, Logic continued as its parent's sole industrial asset in a "steady state", relying on "mature

"We strongly believe we have more potential for system integration. We want that force-multiplying potential"

Alessandro Franzoni Chief executive, Logic

Logic

programmes", he says. However, by 2016 the owners had decided staying still was no longer an option.

"They asked me what we should do," says Franzoni. "I said we needed to be at €50 million to be sustainable, while €100 million makes us attractive as a tier one."

Franzoni and his team began looking at acquisitions that would expand the company's reach and provide the scale that would allow it to approach aircraft manufacturers as a system integrator. The recent takeovers, together with the investment in the next-door test lab, have gone some way towards that. "Ultimately, we want to be able to offer the integration of the entire electrical system except the battery," he says.

Because of the peculiar evolution of Italy's aerospace and defence sector – it stayed largely outside the European consolidation process that created the original Airbus commercial aircraft venture in 1969 and EADS in 2000 – the country has retained its own self-contained industrial supply chain feeding Leonardo and the likes of Fincantieri in marine. Some independent manufacturers such as Piaggio, Tecnam and Vulcanair have even continued to build their own aircraft.

The legacy has been dozens of family SMEs, proud of their heritage but dependent on inter-generational commitment to continue. This could spark further consolidation in a fragmented supply chain, believes Franzoni, who thinks that only by attaining a certain size can a company such as Logic bid for higher-volume direct contracts with manufacturers outside Italy, who worry about SMEs' financial viability and ability to integrate technologies and scale-up.

Intellectual property

Franzoni describes Logic as a "design to spec" rather than "build to print" supplier. It owns the intellectual property to its products, but, because customers commission them specially, it is often difficult to adapt these for others. However, the company's winning of European Union Aviation Safety Agency Part 21 design organisation approval last year means Logic will be able to move up the value chain as a designer of original, off-the-shelf products, he says.

This depends on keeping up the pace on new product development. Logic, which employs a team of 80 engineers out of a total workforce of 260 across its four main sites, is looking at self-funded R&D to "become familiar with the latest generation of semiconductors". The company is also "investing heavily" in anti-ice systems, which it provides as a system integrator to Airbus Helicopters on the H175 and Leonardo Helicopters for the AW169, says Franzoni.

260

Logic's current total workforce employed across its four main sites, including a team of 80 engineers

Logic has also started the certification process on its first off-the-shelf launch, a back-up flight display control instrument, which will be fitted to the under development AW249 attack helicopter. Another customer is evaluating the product, says Franzoni.

Logic's rapid expansion means Franzoni and his team have their hands full integrating backroom operations and creating a group structure for the various subsidiaries. Franzoni is also looking at "rationalising the production footprint", although the direction of travel is towards expansion of the business rather than contraction.

Reaching that €100 million target will almost certainly mean further acquisitions among Italy's small supply base, as well as new product investment, and – other than the naval supplier referenced earlier – Franzoni is keeping his cards close on where these might be. However, the ambition is clear: "We strongly believe we have more potential for system integration," he says. "We want that force-multiplying potential."

Leonardo is bolstering the credentials of its M-346 thanks to an international school established with the Italian air force – and the airframer is hoping that further sales of the type will follow soon

Training Master

Craig Hoyle London

A little over a decade since the first customer example of Leonardo's M-346 advanced jet trainer was handed over, the type is now in service with six nations, and supporting the instruction of new pilots for multiple other air forces.

Orders to date have come from home nation and launch operator Italy (18), plus export buyers Israel (30), Poland (16), Qatar (6), and Singapore (12). The airframer also has delivered six of its armed fighter attack (FA) variant to an operator that it describes as an "undisclosed customer". However, online images of M-346FAs in a striking two-tone blue livery identify this user as being Turkmenistan.

The Italian air force's first service-designated T-346A made its debut flight on 31 March 2011, and was delivered late the same year, followed by a second example in February 2012.

Export success

Leonardo secured the biggest business success so far with its "Master" that same month, via a government-to-government deal which saw Israel order the type via local training provider TOR Systems, while Rome acquired two Gulfstream G550-based airborne early warning and control system aircraft from Israel Aerospace Industries. Deliveries of Israel's new "Lavi" trainers began in July 2014.

Meanwhile, Singapore's lead jet had been rolled out at the company's Venegono Superiore site in August 2012 and began supporting training activities at Cazaux air base in France the following year, and Poland's first example from an initial eight-unit order was delivered in November 2016.

Shipments under the low-profile M-346FA deal with Ashgabat commenced in 2021, according to Cirium fleets data, while Qatar's last of six trainers will be handed over before year-end.

Leonardo says the global fleet – totalling 88 customer aircraft – has exceeded 100,000 flight hours.

In what is likely to remain the programme's most ambitious sales campaign, the company's US business Leonardo DRS led a bid to produce a T-100 derivative of the Honeywell F124-powered twinjet for the US Air Force (USAF). Offered as a Northrop T-38 replacement via the T-X contest, the model would have been assembled in Tuskegee, Alabama, but the USAF instead selected Boeing's T-7A Red Hawk in September 2018 for its 351-aircraft requirement.

Current IFTS customers include students for Qatar

Leonardo

International Flight Training School operates 22 examples

Leonardo

Leonardo DRS helmed the T-100 campaign after an earlier partnership with Raytheon foundered.

Back in Europe, Leonardo and the Italian air force had used the July 2018 Farnborough air show to launch their International Flight Training School (IFTS) venture, with further support from the nation's defence ministry and Canada's CAE.

In addition to furthering the training capabilities of the Italian air force, the initiative also has at its heart a strategy to attract third-party users keen to share access. Launching the IFTS alongside Leonardo chief executive Alessandro Profumo, then-air force chief of staff Lieutenant General Enzo Vecciarelli noted: "I believe that countries in the Gulf, as well as in Africa will also be a new horizon for us."

Annual throughput

The IFTS has been designed to operate with a fleet of 22 M-346s: 18 Italian air force jets, plus four examples supplied by Leonardo. It has been scaled to deliver a total of 8,000 flight hours per year in the Phase IV, or lead-in fighter training category, enabling an annual throughput of 70 students, supported by a 40-strong cadre of military and civilian instructors.

Operations began at Lecce-Galatina air base in southern Italy – home to the air force's 61st Wing – but are in the process of being transferred a new, purpose-built campus at Decimomannu in Sardinia.

"The IFTS represents an international centre of excellence, with the aim of training military pilots to operate the latest-generation fighters, providing them with the technical and procedural skills necessary for deployment in modern, increasingly complex operational scenarios," Leonardo says.

In addition to training Italian students, the school also currently provides instruction for others from Germany, Japan, Qatar and Singapore, and Leonardo points to "growing demand for advanced training from partner and allied states".

On 18 May 2022, the company announced the graduation of the first pair of IFTS students, with the Luftwaffe pilots having completed a nine-month course at Lecce-Galatina. The school's first six Qatar Emiri Air Force (QEAF) students subsequently returned to their home nation on 1 June, after completing an almost one-year course at the same site.

"The training course, which began with an initial phase designed to bring the [Qatari] pilots (all with a turboprop background) up to speed with the requirements of the Phase IV programme, covered the standard fighter pilot training syllabus," Leonardo says.

"This allowed trainees to practice flying in every modern operating scenario, handling the most sophisticated sensors and the various types of mission systems currently in use (both in the air and on the ground)," Leonardo says. Their instruction totalled approximately 150 simulator and live flying sessions.

The QEAF, which employs a fleet of 24 Pilatus PC-21s in the basic training role, is dramatically boosting its capabilities to support acquisitions of a combined 96 Boeing F-15QA, Dassault Rafale DQ/EQ and Eurofighter Typhoon combat aircraft. This has also seen it purchase nine BAE Systems Hawk 167s.

In mid-July, "two additional cohorts of Qatari pilots" began training at Lecce-Galatina, while earlier the same month, a first course was launched at Decimomannu, involving students from Italy, Qatar and Singapore.

Supported by the Leonardo CAE Advanced Jet Training joint venture, the ground-based training system at the Sardinian facility includes two full-mission simulators and three flight training devices. By employing live, virtual and constructive technology,

Leonardo

Decimomannu site hosts five synthetic training devices

these "allow integrated training scenarios between simulated and real aircraft", Leonardo notes. "This makes for highly effective pilot training, saving flight hours that would otherwise have to be flown on board operational conversion aircraft, increasing costs."

Construction activities at the Decimomannu site will conclude before year-end. "With the building of the new IFTS campus, we are establishing in Italy a true flight training academy," Leonardo says. The facility also provides access to dedicated live-firing training areas, it notes.

While multinational training activities at the IFTS continue to develop, securing further M-346 orders remains a focus for the airframer. However, a deal to supply Greece with 10 aircraft – brokered by Israel – will see deliveries commence in early 2023, with Athens to phase out its remaining veteran North American T-2 Buckeyes.

Leonardo views multiple other nations as being potential future customers for the M-346, identifying Colombia, Egypt, Nigeria and Peru, along with a possible follow-on need for Poland.

"These markets are and remain countries of significant strategic commercial importance for Leonardo, and we strongly believe that the M-346 and its FA variant can meet all requirements of the air forces mentioned," the manufacturer says.

However, its near-term hopes of an additional order from Poland were dashed when Warsaw earlier this year opted to buy a fleet of 48 Korea Aerospace Industries (KAI) FA-50PL advanced jet trainer and light-attack aircraft. The type will replace its obsolete RAC MiG-29s and Sukhoi Su-22s in the combat role.

Launched at the Paris air show in June 2017, the Leonardo Grifo radar-equipped M-346FA is suitable for combat, counter-insurgency and aggressor training duties. The variant can be armed with air-to-air and air-to-surface weapons, and targeting or reconnaissance pods, weighing a combined maximum of almost 2,000kg (4,410lb). It also gains a defensive aids system for platform self-protection.

Meanwhile, the company also is furthering the development of its single-engined M-345, and unveiled an armed variant at the Farnborough air show in July.

Smaller sibling

So far, Leonardo counts the Italian air force as its lone customer for what it describes as the "basic to advanced" trainer. The service has already received its first two examples of the locally-named T-345A, from firm orders for 18. However, it has a stated total requirement for 45 of the Williams International FJ44-powered aircraft to replace its remaining Aermacchi-built MB-339As, including those operated by the Frecce Tricolori aerobatic display team.

"We are working on several international campaigns in Europe, Canada, Africa and Latin America" to further boost the M-345's sales, Leonardo confirms.

"Leonardo Canada is bringing this company's world leadership and excellence in the frame of the BLCAT [Babcock Leonardo Canadian Aircrew Training] joint venture, aimed at developing together with its partners an all-Canadian ecosystem in response to the FAcT [Future Aircrew Training] programme requirements," the company says.

It is also looking at Ottawa's Future Fighter Lead-In Training programme need, which will replace its NATO Flying Training in Canada-operated Hawk 115s and play a key role in preparing pilots for operations with the Lockheed Martin F-35A; its planned successor for the Boeing F/A-18.

"Both the M-345 and M-346 feature avionics and a human machine interface which is able to match that of latest-generation fighters," Leonardo notes of the potential to meet Canada's dual requirements.

It also identifies Slovakia as a potential customer for the M-345, describing its integrated training system as "the best solution to assure highly trained pilots" for the nation, which has 14 Lockheed F-16Vs on order. It is proposing that Slovakia – which also is being offered the Aero Vodochody L-39NG and KAI's FA-50 – complete its fast-jet pilot training activities by sending students to the IFTS.

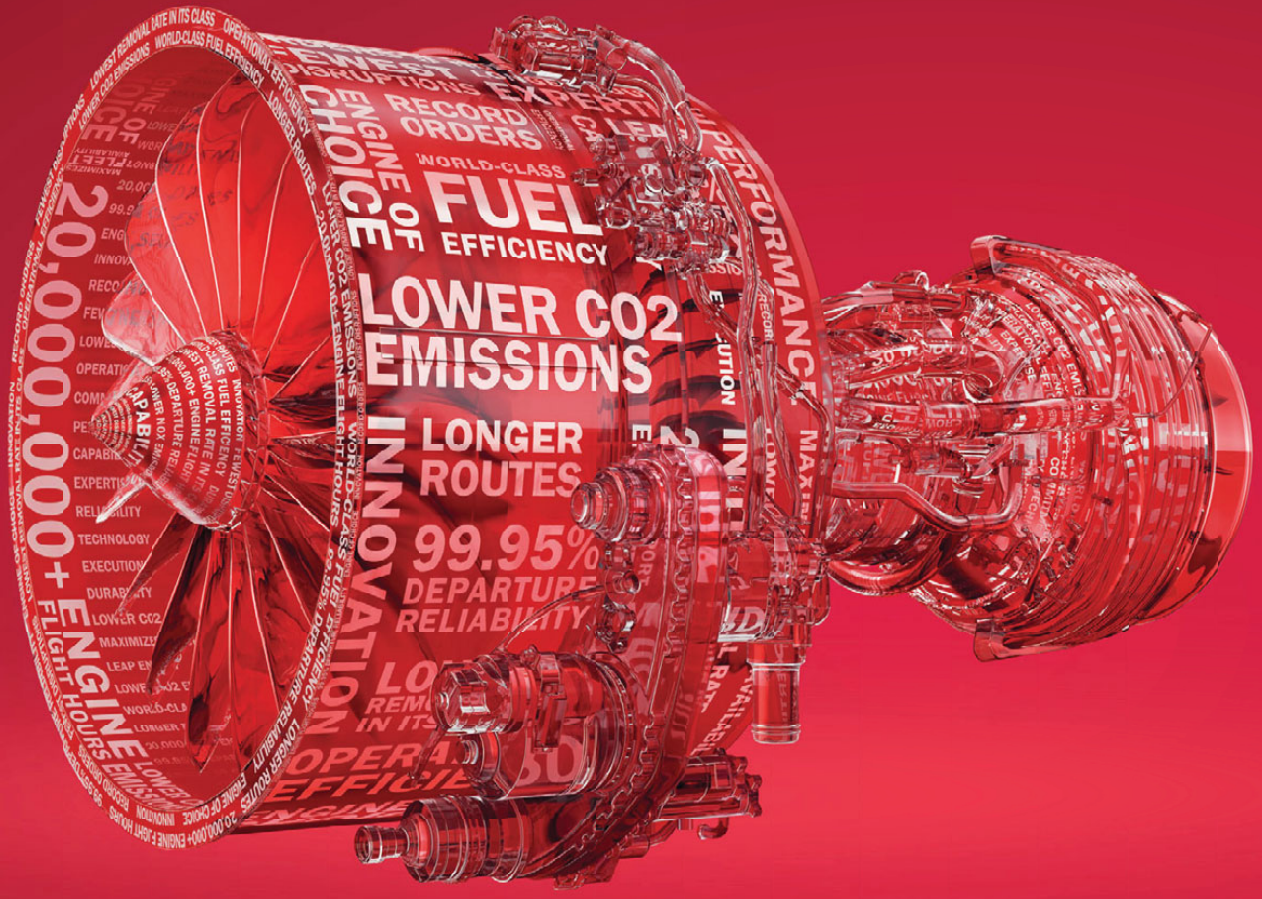
In addition to its operational benefits, Leonardo says an M-345 deal with the NATO nation would deliver "a wide industrial return both for the Slovakian defence and civil industry". Bratislava is already an operator of its C-27J Spartan tactical transport, it notes.

45

Italian air force's total requirement for 'basic to advanced' single-engined M-345s, with two examples delivered so far

Craig Hoyle/FlightGlobal

Armed variant of M-345 was unveiled at Farnborough air show



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cfm

A family-owned business that has become a reference point in its chosen sector, electronic warfare specialist Elettronica continues investing to stay one step ahead of its bigger rivals

Benign leadership

Dominic Perry Rome

In a field dominated by industry giants, Italy's Elettronica stands out. Not only is it very good at what it does – thanks largely to a pinpoint focus on everything related to electronic warfare (EW) – but it remains a family-run business.

Heading the operation is president and chief executive Enzo Benigni – the nephew of company founder Filippo Fratalocchi – while alongside him is his daughter, Domitilla Benigni, who also serves as CEO and chief operating officer, and son Lorenzo, who is director of institutional and governmental relations.

Born in 1938, Enzo Benigni has worked at Elettronica since 1966, or in other words, for all but 15 of the company's 71 years in existence. Given that long intertwined history, he is clear how the company has stayed the course.

"People ask how we have survived for 70 years. The answer is that we have never strayed from our niche," he says.

That signifies two things, he says: firstly, that Elettronica has developed incredible expertise in the segment, and secondly, there have been no distractions from attempting to move into an unrelated field.

"If you go deep into that niche the potential market is not so small," he adds.

Depending on how you view it, the company's ownership shows either the benefits of attempting to fly solo – you are so good at what you do that others need to invest in your business – or the difficulties, notably around size and scale, of such a position.

Industry giants Thales (33.3%) and Leonardo (31.3%) hold stakes in the Elettronica Group, with the remainder owned by the private family company Benigni Srl.

While the structure may be a way of ensuring some degree of independence, in a defence sector that seems perennially ripe for consolidation, how does the company ensure it is not simply swallowed up?

Enzo Benigni thinks for a moment before answering. "I'm not absolutely sure. Maybe I would like to be sure but I am not," he says.

But, he says, if there is a way, it is to maintain leadership in your niche – to make sure your technology

Francesco Militello Mirto/ZUMA Wire/Shutterstock

Defensive aids equip a variety of rotorcraft platforms

"People ask how we have survived for 70 years. The answer is that we have never strayed from our niche"

Enzo Benigni President and chief executive, Elettronica

Company is design authority for Eurofighter's Praetorian system

Giuseppe Lami/EPA-EFE/Shutterstock

is more advanced than that of your rivals. "There is a certain moment where the follower does not have enough money [to invest]. We have to create the right gap to keep this difficult... this has always been our philosophy," he says.

In practice this means Elettronica sometimes "renounces profit for quality", he says.

"It sounds crazy but it's not. What protects us is quality – quality wins everywhere, not only in a restaurant. It doesn't matter if we have to renounce some level of profit – to survive is the [best] quality."

Heavy investment

That, to no little extent, means investing heavily in research and development. Last year R&D spending was €50 million ($50 million), a figure Elettronica plans to double over the next decade, says Domitilla Benigni.

She charts the firm's growth from being a systems provider, to one supplying solutions – "a system-of-systems integrator" – ultimately becoming a "provider of multi-domain capability" focussed on "electromagnetic spectrum superiority".

Besides the classic electronic warfare disciplines – self-protection, electronic attack, signals intelligence – the company also has interests in the adjacent field of cybersecurity and has ambitions to bring its expertise into the space domain. There has also been a surprise pivot into bio-defence as a response to Covid-19 (*see box, p64).*

Elettronica Group comprises four separate businesses: Elettronica SpA (also known as Elt Roma) and GmbH, respectively the original Rome-based company and its German sister, plus CY4Gate, a cyber security software spin-out, and EltHub, a rapid prototyping and research unit in which a 70% shareholding was acquired in March this year. "We bought it with the aim of it being a small laboratory for Elt Roma," says Domitilla Benigni.

CY4Gate was set up in 2014 "to complete the concept of electronic warfare", says Enzo Benigni.

"In my opinion electronic warfare-cyber, which is a small niche today, will be very important in the future."

He points to the ongoing conflict in Ukraine, where cyberattack and defence is a constant, if unseen, battle. "The damage you can receive from a cyberattack is more than a bomb – it is not a weapon, it is not a device – it is invisible but exists probably in a heavier way than traditional electronic warfare," he says.

A 46% chunk of CY4Gate was floated on the Italian stock exchange in 2020, with Elettronica retaining a 38% stake and Milan firm TEC Cyber holding the remainder. Revenues in 2021 were a healthy €63.6 million, compared with €250 million for Elt Roma.

Despite its branching out, traditional EW solutions remain at the core of Elettronica's business. For example, it is the design authority for and manufacturer of the Praetorian self-protection system on the Eurofighter Typhoon as part of the EuroDASS consortium. Other examples of its systems equip the NH Industries NH90 and Leonardo Helicopters AW101 rotorcraft.

Additionally, Elettronica is participating in the Tempest future combat air system programme,

AirTeamImages

Elettronica supplies self-protection suite for Italian air force AW101

which seeks to deliver a manned successor to the Eurofighter after 2035, alongside uncrewed assets. Led by the UK with Italy as a participant together with Japan, Elettronica is Rome's EW champion for the development.

Enzo Benigni sees Tempest as "the future" and praises the UK's leadership, noting that it "knows how to manage this kind of consortium"; the Eurofighter programme, in which London is also a partner, has been a "miracle of organisation", he says.

And although *Flight International*'s interest in the company is clearly centred on its air capabilities, Elettronica does equally strong business in the ground and maritime domains.

Daniela Pistoia, corporate chief scientist, says the company's future technological investments stem from the knowledge that the electromagnetic spectrum on which military and non-military missions rely – "a critical enabler for all dimensions of warfare", as she puts it – will in future become increasingly "contested, congested, constrained and constantly changing".

Development work is also informed by its participation in two European Defence Agency-backed consortia. Lead by Spain's Indra, REACT (Responsive Electronic Attack for Co-operative Tasks), is developing a next-generation electronic attack capability as a podded system for escort missions, or for use by unmanned air vehicles for stand-in operations. Pistoia says a "stand-in" solution "overcomes the challenges" of a stand-off capability – notably the need for a crewed platform and the power requirements associated with operating from further away. And as with other areas of air combat, a fleet of cheaper, smaller – potentially networked – aircraft promises a step-change in performance for comparatively lower cost. Depending on a future production decision, a new system developed under REACT could be fielded by the end of the decade.

BAE Systems

Developer is Rome's electronic warfare champion for Tempest programme

Team captain

Meanwhile, Elettronica is co-ordinating a 14-strong group of companies, representing eight nations, who are working through Project Carmenta to develop the next generation of self-protection systems for fixed-wing transport aircraft and helicopters.

But are these Europe-spanning projects a sign that the continent's industry knows it must work together, or a harbinger of future consolidation?

Enzo Benigni seems sanguine either way. Europe's defence industry must collaborate to avoid duplication of effort, he says. "It's not acceptable from the point of view of cost to have many different armoured cars, or aircraft, or other weapons – the trend is commonality."

This direction of travel is "another reason" to strive for excellence, he adds, if only as a differentiator. "How many companies will remain? I don't know," he says. "Somebody will disappear... but the niche will always be important.

"We do not know what will happen but the niche will always remain," he adds, with the clear subtext that he thinks Elettronica will continue to thrive within it.

Microwave-based Covid-19 killer sanitises the parts other products cannot reach

Perhaps the most surprising item on Elettronica's stand at the ILA Berlin air show in June was a small white box, about 8cm (3.1in) square, resembling, to all intents and purposes, a wi-fi router.

Completely unrelated to the firm's traditional electronic warfare portfolio, the box – called the E4Shield – was revealed to be Elettronica's response to the Covid-19 pandemic.

The brainchild of one of its engineers after reading several scientific papers on the topic, the E4Shield uses microwaves to destroy the cell structure of the Covid-19 virus.

It is designed to 'sanitise' a space of about 3m (10ft) around an individual – with a success rate of around 90%.

Elettronica calls the development a "bio-defence" product and was the result of around two years of research.

In addition to the portable model, a larger wall-mounted version is also available, which Elettronica says has an effective radius of 50m.

Laboratory tests on live virus cultures have validated the E4Shield's performance, the company says, and it is effective across multiple Covid-19 variants. Crucially, it is also entirely safe, the company stresses.

It should be available in the business-to-business market by the end of the year, with the consumer market to be addressed later.

CAN
CORPORATE ANGEL NETWORK

Cancer Patients Fly Free

Can You Spare a Seat?

Corporate Angel Network (CAN) is a 501(c)(3) nonprofit organization whose mission is to provide cancer patients with free transportation to treatment centers throughout the United States.

CAN works closely with over 500 of America's top corporations, including half of the Fortune 100, to match empty seats with patient flights. Thanks to the generous support of these companies, CAN has coordinated more than 67,000 flights since its founding in 1981.

Contact CAN to learn more about registering a cancer patient or to donate an empty seat on an aircraft.

corpangelnetwork.org

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

-Henry Maier, President and CEO, FedEx Ground

Westchester Center Airport – White Plains, NY | (914) 328-1313

Take a break

The world changed in 2022: no sooner had the pandemic's weakened grip allowed us to emerge bleary-eyed from our living rooms and kitchens after national lockdowns and restrictions, a war in Europe, soaring energy prices and the threat of global recession made some wish they hadn't bothered. But as the year nears its end, we stand ready to raise your spirits – and maybe even a glass – with our annual festive quiz. The FlightGlobal team has compiled a true test, in the guise of 50 multiple-choice questions, cunningly crafted to check your knowledge of all things aviation, and that you have been paying attention while

Jag-cz/Shutterstock

reading *Flight International* throughout the past 12 months. Then move on to our identify-the-type section, where you'll need sharp recognition skills to name all 15 of the mystery aircraft on show. As we are ending the year packed full of cheer and in generous mood, a score of 75% or above will secure you that most coveted of prizes: Total Aviation Person status. What better way to give you a cosy feeling as we prepare to power into 2023? You'll find all the answers on p78, but make sure that you only run through the checklist after you've finished – forget worrying about Santa: it's really Uncle Roger who knows if you've been peeping!

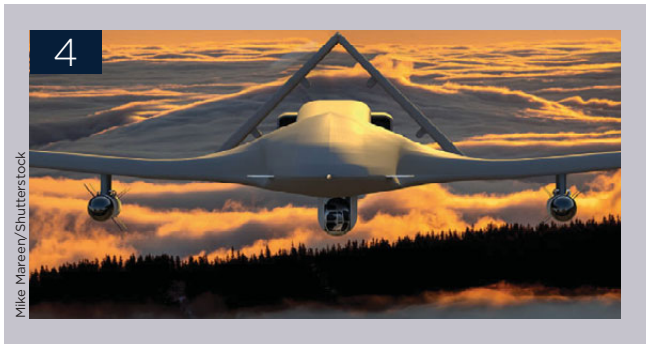
Boom Supersonic

1 Boom Supersonic redesigned its Overture, but lost its expected engine supplier: which company pulled back the throttles on their partnership?
A CFM International
B Pratt & Whitney
C GE Aviation
D Rolls-Royce

2 Which carrier was the first to receive a Boeing 787, in August 2022, following a near-20-month pause in deliveries?
A Lufthansa
B United Airlines
C American Airlines
D Air France

3 Poland picked which combination of military helicopters during 2022?
A Apache and S-70M
B Apache and AW149
C AH-1Z and AW149
D Tiger and UH-1Y

4 Which armed unmanned air vehicle achieved international notoriety in Ukraine in 2022, inspiring modern folk songs, after playing a vital role in the defence of Kyiv?
A AeroVironment Switchblade 600
B General Atomics Aeronautical Systems MQ-9 Reaper
C Baykar Bayraktar TB2
D HESA Shahed 136


Mike Mareen/Shutterstock

5 Which of these Russian-produced airliners is sanctions-struck Aeroflot not planning to obtain as part of a 339-aircraft deal?
A MC-21
B Il-96
C SSJ-New
D Tu-214

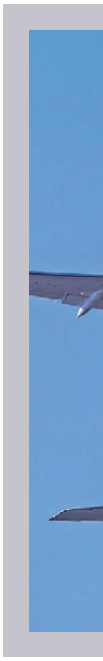
6 What is Archer Aviation's new electric vertical take-off and landing aircraft called?
A Midnight
B Goodnight
C Dark Knight
D Last Night

7 What percentage of US Federal Aviation Administration-certificated pilots (excluding students) in 2021 were female?
A 7.3%
B 5.7%
C 3.9%
D 6.0%

8 Which all-Boeing operator from China placed an order for 40 Airbus A320neos in September 2022?
A China Eastern Airlines
B Lucky Air
C Xiamen Airlines
D 9 Air

9 Which fictional, Mach 10 aircraft does Tom Cruise's character fly in the *Top Gun* sequel *Maverick*?
A Darkstar
B Polestar
C Lone Star
D Wandering Star

10 In which city did Short Brothers establish an aircraft factory that is now owned by Spirit AeroSystems?
A Glasgow
B Southampton
C Cardiff
D Belfast



Lockheed Martin

11 Which of the following was the busiest airport in the world (according to passengers served) in 2021?
A Dallas-Fort Worth International
B Indira Gandhi International
C Frankfurt International
D Hartsfield-Jackson Atlanta International

12 Which new two Canadian airlines launched in 2022?
A Lynx and Jetlines
B Flair and Encore
C Jazz and Porter
D Jetlines and Swoop

Vidit Luthra/Shutterstock

13 To the nearest $10 billion, what was Boeing's latest full-year (2021) revenue?
A $120 billion
B $90 billion
C $60 billion
D $30 billion

14 Cranfield Aerospace Solutions received investment from which tier one company during 2022?
A Safran
B Rolls-Royce
C Pratt & Whitney
D GE Aviation

15 What is the service name used for two Dassault Falcon 2000LX VIP transports operated for the UK Royal Air Force?
A Buckingham
B Conveyor
C Traveller
D Envoy

Crown Copyright

16 Which aircraft programmes is De Havilland Canada (together with sister company Viking Air) considering rebooting?
A DHC-8 400 and DHC-6 Twin Otter
B DHC-2 Beaver and DHC-3 Otter
C DHC-515 Firefighter and DHC-6 Twin Otter
D CRJ regional jets and Learjets

17 Which European airline introduced an extraordinary range of coloured stripes to its fleet, drawing inspiration from "parasols, bath towels and beach chairs"?
A British Airways
B Condor
C Ryanair
D Croatia Airlines

Melidis A/Shutterstock

18 Which combat aircraft type did Poland unsuccessfully propose donating to Ukraine following Russia's invasion?
A F-16
B Su-25
C Su-22
D MiG-29

19 Which airline was the loser in the tug-of-war for Spirit Airlines during 2022?
A Frontier Airlines
B JetBlue Airways
C Sun Country Airlines
D Allegiant Airlines

Kevin Porter/Shutterstock

20 Doncaster Sheffield airport in the UK, also known as Robin Hood, was closed. From which Royal Air Force base did it emerge?
A Church Fenton
B Sherwood
C Finningley
D Ilkley Morbar-Tatt

21 Which Asian operator has brought back its stored Boeing 747-400 to service?
A Qantas
B Thai Airways International
C Singapore Airlines
D Asiana Airlines

22 Which aircraft holds the record for staying airborne the longest time without landing?
A Airbus Zephyr high-altitude pseudo-satellite
B Helium balloon
C Cessna 172
D Boeing B-52

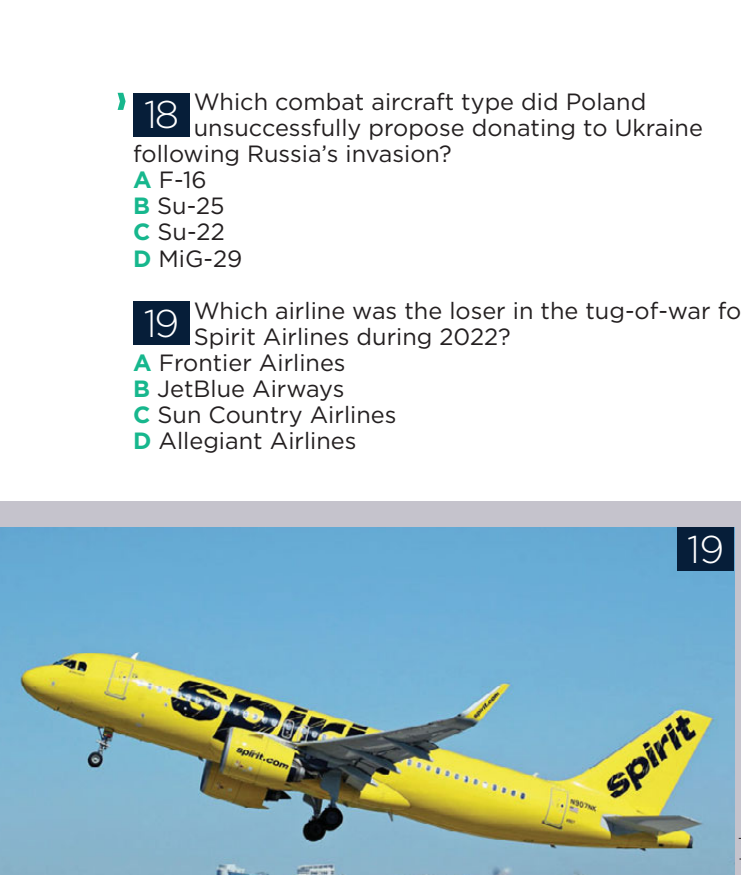
23 Heart Aerospace has settled on a hybrid-electric aircraft design featuring how many passenger seats?
A 10
B 20
C 30
D 40

24 What name did L3Harris and Air Tractor give their adapted AT-802U, ordered by the US Special Operations Command?
A SkyStriker
B SkyWarden
C SkyGuardian
D SkyWarrior

25 Irkut is focused on testing the Russian PD-14 engine for the MC-21-310, but what does 'PD-14' represent in English?
A Promising Engine, 14-tonne thrust
B Advanced Turbine, 14 blades
C High Bypass, 14:1 ratio
D Powerplant Diameter 14 decimetres

26 What effect does high density altitude, as compared to low density altitude, have on propeller efficiency and why?
A Efficiency is increased due to less friction on the propeller blades
B Efficiency is reduced because the propeller exerts less force at high density altitudes than at low density altitudes
C Efficiency is reduced as a consequence of the increased force of the propeller required in the thinner air
D Efficiency is increased because the propeller exerts more force at high density altitudes than at low density altitudes

27 Which joint US-Canadian command known for tracking Santa Claus received a large funding infusion in 2022?



Heart Aerospace

BillyPix

28

Airbus

A Northern Command (NORTHCOM)
B North American Aerospace Defense Command (NORAD)
C The Arctic Council
D Arctic Response Company Group

28 Which business jet engine will be installed on an Airbus A380 to test hydrogen combustion?
A Pratt & Whitney Canada PW800
B Rolls-Royce Pearl 15
C GE Aviation Passport
D Safran Silvercrest

29 2022 saw Indonesia order 42 fighters. What is the type?
A Boeing F-15EX
B Dassault Rafale
C Lockheed Martin F-16V
D Korea Aerospace Industries KF-21

30 In March 2022, the US Air Force said which of its stealth aircraft had encountered Chengdu J-20s over the East China Sea?
A Lockheed Martin F-35
B Northrop Grumman B-2
C Lockheed Martin F-22
D Lockheed Martin RQ-170

31 Which European regional airline plans to become the launch operator of Hybrid Air Vehicles' 100-passenger Airlander 10?
A Flybe
B Binter Canarias
C Wideroe
D Air Nostrum

32 Sustainable aviation fuels can be made out of which of the following substance(s)?
A Used cooking oil
B Municipal waste
C Wood residue and forest debris
D All of the above

33 Which carrier, in September 2022, became the latest invited to join the SkyTeam alliance?
A Air Algerie
B Virgin Atlantic
C Nepal Airlines
D Conviasa

31

Hybrid Air Vehicles

MS Digital/Shutterstock

34 What is the purpose of installing winglets on an aircraft?
A To show off airline logos
B Purely for aesthetics
C To reduce drag and increase fuel efficiency
D For storing additional fuel

35 Which "most British of French airports" is to be renamed after the late Queen Elizabeth II, according to its local commune?
A Le Havre-Octeville
B Calais-Dunkerque
C Brest Bretagne
D Le Touquet-Paris-Plage

36 Which Latin American airline brought in a new chief executive in 2022?
A Gol
B Azul
C LATAM Airlines Group
D Avianca

37 How many public airports in the continental USA are located above 2,500m (8,202ft) elevation?
A Three
B Six
C 10
D 17

38 NASA and the DLR flew their final scientific mission with a uniquely adapted Boeing 747SP in September 2022. What acronym was used for the project?
A CAIRO
B LIMA
C TOKYO
D SOFIA

39 What major UK aerospace company did Parker Hannifin acquire during 2022?
A Cobham
B Meggitt
C BAE Systems
D Marshall Aerospace

40 What is a VOR?
A A navigational aid
B An on-board coffee machine
C An engine component
D Part of an electrical system

US Air Force

42

Bombardier

44

Commonwealth of Australia

41 Which nation became the first export customer to receive a J-10C fighter from China's Chengdu?
A Pakistan
B Myanmar
C Nigeria
D Bangladesh

42 At its May launch, Bombardier's prototype Global 8000 had cleared what milestone?
A Flying 8,000nm (14,800km)
B Breaking the sound barrier
C Circumnavigating the globe
D Running on battery power alone

43 Which eVTOL air taxi developer folded in 2022?
A Wisk
B Odys Aviation
C Joby Aviation
D Kittyhawk

44 What type will the Royal Australian Air Force acquire to replace its Lockheed Martin C-130Js?
A Kawasaki C-2
B Embraer C-390
C Lockheed Martin C-130J
D Airbus Defence & Space A400M

45 The US Federal Aviation Administration requires passengers in unpressurised aircraft to be supplied with supplemental oxygen from and above which altitude?
A 15,000ft
B 18,500ft
C 14,000 ft
D 12,500 ft

46 Which armed service became the first to accept General Atomics Aeronautical Systems' new MQ-9B remotely piloted aircraft, under the designation Protector?
A US Army
B Polish air force
C US Marine Corps
D UK Royal Air Force

41 Which Asian country intends to host its own air show from 2027?
A Pakistan
B Thailand
C Vietnam
D Philippines

48 Hawaiian Airlines in 2022 agreed to operate a fleet of Boeing 767Fs for which partner?
A Walmart
B Atlas Air
C Amazon
D Alibaba

49 South Korea has decided to develop a new attack helicopter for its marines. From which platform will it be derived?
A Bell AH-1Z Viper
B Boeing AH-64 Apache
C Airbus Helicopters H155
D Korea Aerospace Industries KUH-1 Surion

50 Which of these phrases did not appear in the classic disaster spoof *Airplane!*, released in 1980?
A Clearance, Clarence
B Vector, Victor
C Duet, Juliet
D Roger, Roger

50

Paramount/Kobal/Shutterstock

Identify the type

In our annual challenge to your recognition skills, work out which 15 aircraft are on show: minus their give-away markings

4

1

5

2

3

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11

15

From yuckspeak to tales of yore, send your offcuts to murdo.morrison@flightglobal.com

Crow-th strategy

Cyprus Airways

Cyprus Airways was upstaged in its efforts to show off its new colour scheme when a real aviation expert chose to take a closer look at the livery. The bird – which looks like a Cypriot hooded crow, although we're open to ornithological re-education – perched on the fin of the Airbus A320, one of a pair being introduced under a revised strategic plan.

"Even the most experienced of flyers are hitching a ride," the airline acknowledged.

The eagle has branded

De Havilland Canada

On the subject of birds, Frontier Airlines ignored the never work with children or animals dictum when it had a bald eagle (*pictured*) on hand at an event marking the arrival of its first A321neo.

The aircraft will sport a striking special edition livery, with the bird of prey featuring on the tail. Frederick the Bald Eagle is, of course, also the emblem of Pratt & Whitney and named after Frederick Rentschler, the founder of the Connecticut engine maker whose PW1100Gs the carrier has chosen for the first time.

Our man on the spot reports that the eagle did not appear to be delighted about its public appearance. However, given the species' rather austere physiognomy, we are not sure how one tells when a bald eagle is happy.

Jon Hemmerdinger/FlightGlobal

GAVA

From the archive

100 75

1922 Rise of Rolls-Royce

For a great number of years Rolls-Royce, Ltd, have held a leading place in the automobile world, and during the War the firm undertook the development of aero engines with the idea of establishing a similar reputation in that branch. With what success this task was undertaken is now familiar to readers of this journal, the Rolls-Royce engines having done an enormous amount of war service as well as some of the most remarkable flights since the cessation of hostilities. Among the many famous flights made by Rolls-Royce engines may be mentioned the transatlantic flight by the late Sir John Alcock and Sir Arthur Whitten Brown in the Vickers "Vimy," the London to Australia by the late Sir Ross Smith and Sir Keith Smith, and the Cairo to Cape Town flight.

1947 Helicopter theory

The helicopter is a modern instance of practice being ahead of theory. The mathematicians have not yet caught up with the engineers, and the theoretical snags in helicopter designs are so formidable that if one took them very seriously one would not dare to build a helicopter. Yet helicopters are flying every day and doing good work, work which could not be done by any other vehicle, be it surface or air. Theoretically the helicopter is far from perfect. It may not be stable, it may be very expensive, and it may be difficult to fly. But it does fly. Flying would not be where it is today without theory. But theory should be regarded as a tool, a very valuable tool, not as the creative force. The time has not yet come when aircraft design is an exact science. It is still an art.

DHC-2 Beaver puts stamp on history

Canada has unveiled a stamp celebrating the contribution to the country's aviation history of the De Havilland DHC-2 Beaver, marking the 75th anniversary of its first flight.

Part of Canada Post's Canadians in Flight series, the service describes the all-metal, short take-off and landing type as the "best bush plane ever built" and "one of Canada's top 10 engineering achievements of the 20th century".

De Havilland Canada inherited the Beaver when it bought the rights to the DHC family trademarks and type certificates from Bombardier.

The first DHC-2 flew from Toronto's Downsview airport on 16 August 1947. A total of 1,692 were produced over 20 years.

The company's owner Sherry Brydson is pictured far left, with Suromitra Sanatani, Canada Post's chair of board of directors.

Airborne art

For lovers of aviation art, the annual Aviation Paintings of the Year exhibition is always a highlight.

The organisers of the exhibition – the Guild of Aviation Artists (GAVA) – have asked us to point out that, following a few years of Covid-19-related disruption, it has not been possible this year either to hold a physical show.

However, a digital display continues to be available to view until 4 December, with details at **gava.org.uk**.

GAVA, which plans a return to presenting an in-person exhibition in summer 2023, says the digital show is a "wonderful opportunity to view new, original art, which is for sale".

Finger trouble

Airbus chief executive Guillaume Faury found himself suffering a slight episode of mode confusion during the airframer's third-quarter media briefing at the end of October – an experience those who have become familiar with online meetings may sympathise with.

The opening question was a long and detailed query about the company's risk outlook for the Chinese market, but Faury was forced to ask the caller to repeat the first half of it.

Not because of the quality of the line, though. "I wanted to put [myself] on mute but I disconnected the call," he admitted.

"Don't let the CEO touch the buttons."

50

1972 Spacemen sleep in

At the end of the most uneventful outbound flight in the Apollo Moon programme, Apollo 17 went into lunar orbit at 19:47 GMT on December 10. The arrival was back on schedule following a 2hr 40min launch delay, the time being recovered by a slightly early departure from Earth orbit and adjustments to the flight trajectory. The only problems occurred early in the flight and included a series of erroneous alarm signals and the failure of one of the 12 locking catches to secure properly following initial docking with the lunar module. Neither of these issues threatened the safety or success of the mission. Mission control's only concern was over its inability on one occasion to wake the astronauts, who overslept by more than an hour.

25

1997 EASA takes shape

The European Commission (EC) will present plans to a meeting of European Union (EU) transport ministers this month aimed at creating a European aviation-safety authority. The new agency could be operational as early as 2000, says a well-placed EC official. Detailed work on pulling together recommendations on the role and powers of the new authority has been under way in earnest since September, after transport ministers gave the go-ahead in June for the work. Once resolved, the EU official says it is hoped that this month's meeting will agree the broad shape of the European aviation-safety authority, allowing it to take over the role of the existing Joint Aviation Authorities as early as 2000, if it is decided that the new body can operate as an arm of the European Commission.

HiFly

FESTIVE QUIZ ANSWERS

1. **D.** Rolls-Royce
2. **C.** American Airlines
3. **B.** Apache and AW149
4. **C.** Baykar Bayraktar TB2
5. **B.** Il-96
6. **A.** Midnight
7. **D.** 6.0%
8. **C.** Xiamen Airlines
9. **A.** Darkstar
10. **D.** Belfast
11. **D.** Hartsfield-Jackson Atlanta International
12. **A.** Lynx and Jetlines
13. **C.** $60 billion
14. **A.** Safran
15. **D.** Envoy
16. **A.** DHC-8 400 and DHC-6 Twin Otter
17. **B.** Condor
18. **D.** MiG-29
19. **A.** Frontier Airlines
20. **C.** Finningley
21. **D.** Asiana Airlines
22. **C.** Cessna 172
23. **C.** 30-seat
24. **B.** SkyWarden
25. **A.** Promising Engine, 14-tonne thrust
26. **B.** Efficiency is reduced because the propeller exerts less force at high density altitudes than at low density altitudes
27. **B.** North American Aerospace Defense Command (NORAD)
28. **C.** GE Aviation Passport
29. **B.** Dassault Rafale
30. **A.** Lockheed Martin F-35
31. **D.** Air Nostrum
32. **D.** All of the above
33. **B.** Virgin Atlantic
34. **C.** To reduce drag and increase fuel efficiency
35. **D.** Le Touquet-Paris-Plage
36. **A.** Gol
37. **B.** Six
38. **D.** SOFIA
39. **B.** Meggitt
40. **A.** A navigational aid
41. **A.** Pakistan
42. **B.** Breaking the sound barrier
43. **D.** Kittyhawk
44. **C.** Lockheed Martin C-130J
45. **A.** 15,000ft
46. **D.** UK Royal Air Force
47. **B.** Thailand
48. **C.** Amazon
49. **D.** Korea Aerospace Industries KUH-1 Surion
50. **C.** Duet, Juliet

IDENTIFY THE TYPE

1. **Boeing 717** Photo credit: itinut380/Shutterstock
2. **Antonov An-225** Photo credit: Arsgera/Shutterstock
3. **Airbus BelugaXL** Photo credit: Messe Berlin
4. **Tecnam P2012 Traveller** Photo credit: Tecnam
5. **Boeing 727** Photo credit: Craig Hoyle/FlightGlobal
6. **Embraer EMB-110 Bandeirante** Photo credit: Brian Ireland/Wikimedia Commons
7. **Vickers VC10** Photo credit: FlightGlobal image archive
8. **Lockheed SupersonicTransport** Photo credit: FlightGlobal image archive
9. **HA-420 HondaJet** Honda Aircraft
10. **Airbus A220** Photo credit: Renatas Repcinskas/Shutterstock
11. **Lockheed AH-56 Cheyenne** Photo credit: Lockheed Martin
12. **Piaggio Aerospace P180 Avanti** Photo credit: BillyPix
13. **Lockheed Martin F-35A** Photo credit: Craig Hoyle/FlightGlobal
14. **Douglas A-4 Skyhawk** Photo credit: Rich Cooper
15. **Blackburn Buccaneer** Photo credit: FlightGlobal image archive

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Equipment, maintenance and service

Having never professed an interest in aviation, **Angela Ng** secured a job in the sector and was hooked. She is now a director of development for the Civil Aviation Authority of Singapore

Helping prospects soar in Singapore

Alfred Chua Singapore

When Angela Ng was studying, she never thought of herself as an "aviation fanatic", or someone who might one day consider a career in the sector.

After all, as a student, she always thought aviation in Singapore was "either Singapore Airlines or Changi airport". In fact, as she pursued her undergraduate studies – in "the most generic course" of business – she was still unsure what her career path would be.

Yet the 40-year-old would be led to the aviation sector, where she has spent more than a decade with the Civil Aviation Authority of Singapore (CAAS).

Now a director at the agency's aviation industry development division, Ng oversees the growth and development of the city-state's air transport and airport industries, as well as in jobs and skills.

Ng says it was her first job after graduating – at a government manpower agency – that led her into the sector. While at the Workforce Development Agency (now known as Workforce Singapore), she was an account manager overseeing manpower development in the aerospace sector, interacting with MRO providers and other companies in the industry.

"That opened up the whole new world of aerospace to me, and from that, led to a lot of other related job opportunities," she says.

"It really shaped the direction of my career and my interests. [It] helped me realise, by some sort of serendipity, that aviation is a wonderful industry to get into, and had a lot of depth and... diversity for me to explore throughout the rest of my career."

At CAAS, which she joined in 2010, Ng would chalk up experience in departments such as industry development, safety policy – where she worked on Singapore's return to service of the Boeing 737 Max – as well as international relations.

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Changi airport is to gain a new fifth terminal

Encouraging growth

In her current role, which she took up in 2021, Ng also oversees efforts to rebuild Singapore's aviation sector, battered by two years of the pandemic.

One project that gets Ng excited is the development of Changi airport's huge fifth terminal.

She says: "[We] all feel a sense of responsibility that in the next few years, we really have to work with the sector to plan [for Terminal 5]."

As Ng talks about her work experience, she is aware of the many opportunities that have paved the way for her in the aviation sector.

One of them was a secondment to New York to support Singapore's foreign affairs ministry during the UN General Assembly. Issues she worked on were beyond simply aviation, such as women's development, and sustainability, but Ng says the stint – a career highlight – has been valuable, especially after she returned to CAAS.

The experience was "one in a million" and would not have come if "I had stayed in my comfort zone", she says. Stepping out of such comfort zones is a challenge females working in aviation must overcome, Ng says.

Ng joined CAAS in 2010, and has worked across several departments

Civil Aviation Authority of Singapore

"I'm not a technical person, but I brought a new perspective that was not the mainstream way of doing things"

"Sometimes [you are] assessed with a higher bar because you are entering an environment where you are not the norm," she says.

While she was in the safety policy department overseeing work to lift an operational ban on the 737 Max, Ng says she felt a bit daunted, as most of the agency's safety inspectors were men.

"I'm not a technical person, but [I think] I brought a new perspective... a new background and insights... that were not the mainstream way of doing things," she says.

While Ng believes more can always be done to improve diversity in the sector, she stresses the importance of starting young.

Referring to her impression of aviation in her student days, she says: "We need to offer youth more windows into seeing what aviation is like and understanding beyond the tip of the iceberg."

On 15 October, CAAS supported the Singapore chapter of the Women In Aviation association in organising a 'Girls In Aviation Day', where girls aged between 8 and 17 were invited to learn more about the sector, including meeting with female leaders.

CAAS is also working with schools in Singapore on a series of activities – including reviving the Air Scout programme – to introduce aerospace to young people.

There is also a piece of advice that Ng gives to her colleagues – including younger females – and that is to "grab whatever opportunity comes your way".

Pushing boundaries

Relating her own experiences, Ng says: "I [used to be] very hesitant to take on job opportunities or roles where I felt I could not excel because... in a way, I'm a bit of a perfectionist, and I want to do well in whatever I'm tasked to do.

"But at some point in time, you will be given opportunities, like [how] I was given the opportunity to move from looking at domestic manpower development to looking at international relations.

"I could have [chosen not to have] taken that leap, [and] stayed in my comfort zone. But if I had not taken that step... I don't think I would be where I am today," she says.

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