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Forming up

Apparent accord between three European nations on their future fighter project is positive, but a lack of detail on the agreement's practicalities leaves many unanswered questions

For a while it had seemed doubtful that an accord might ever be reached between France, Germany and Spain to allow their Future Combat Air System (FCAS) to progress to the next stage of development.

There had seemed too many obstacles to progress, notably the thorny issues of workshare and intellectual property.

Dassault Aviation was particularly outspoken about the potential dilution of its role in the process.

When originally conceived, FCAS and the New Generation Fighter (NGF) at its heart was a marriage of equals; France and Germany and their various industrial champions would divide the work on an even basis.

But the formal inclusion of Spain in late 2020 upset the balance of power. While the overall FCAS project is now a tri-national effort, on the NGF, airframe activities continue to be divided between Dassault and Airbus Defence & Space, with the latter representing both Berlin and Madrid.

In other words, although the French manufacturer remains the NGF's prime contractor, it has seen its share of the project fall from 50% to 33%, while its rival's has risen to 66%.

Although the defence ministries of the three nations say that their differences are resolved, it is so far unclear how that translates to the industrial level.

Further hurdles remain, of course: the Bundestag still needs to give its assent to this next step; elections in Germany this year and France in 2022 have the potential to sabotage the process; and possible future discord between the various parties is virtually a given (Berlin's continued misgivings about defence export sales look likely to cause friction, and a French requirement for a carrier-borne NGF may also prove to be challenging).

Success for the FCAS programme is by no means guaranteed. But the mantra of European sovereignty – from two of the EU's staunchest advocates – that underpins the whole initiative is likely to overcome this rocky beginning.

Meanwhile, over on the other side of the English Channel, the UK-led Tempest future fighter programme continues to go quietly about its business.

In contrast with its FCAS rival, the Tempest effort, which also includes Italy and Sweden, has so far has been notable for a lack of public discord.

It is hard to pinpoint the reason for that apparent harmony – and it may well not last for the duration of the programme – but perhaps it is simply that all the parties are currently in alignment.

To succeed, multinational procurements require a tight formation and common goals, rather than simply common interests. A desire for European sovereignty is an admirable ambition, but smacks strongly of politics trumping all other concerns.

Principles are fine, but unless tempered by practical considerations they can threaten the underlying product.

In both cases, the partner nations would do well to remember what they are fighting for: is it to build the best aircraft, or to satisfy an abstract political aim?

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In focus

Keeping pace: Airbus Helicopters' Racer is set to make its first flight next year

Dassault Aviation

In depth

Bell's V-280 Valor cruises at 280kt

NATO outlines attributes for next-generation rotorcraft

Alliance details desired characteristics for medium-class helicopter project, but speed may be lower than US options

Dominic Perry London

NATO members driving the development of a next-generation rotorcraft appear to be prioritising range and capability – including use as an optionally piloted aircraft – over very high speed, according to documents released by the Alliance.

In addition, two new countries, Spain and the USA, are considering joining the five nations that signed up to the Next Generation Rotorcraft Capability (NGRC) initiative last year: France, Germany, Greece, Italy and the UK.

In an invite to a September industry day, the Alliance's NSPA procurement body details the required attributes of the NGRC.

It should, the document says, have a range in excess of 900nm (1,650km), a maximum take-off weight of 10-17t, capacity for up to 16 troops in full combat gear or mission equipment, and endurance of more than 5h, or up to 8h with additional fuel tanks. Combined internal and external payload should be greater than 4t, with at least 2.5t carried internally.

Additionally, it should be capable of being used in as an "optionally unmanned/remotely piloted vehicle", it says. Maritime and land variants should use a common airframe and have a footprint no larger than the NH Industries NH90 or Leonardo Helicopters AW101, including a folding tail and main rotors.

While the NGRC is intended to be faster than a conventional helicopter, where cruise speeds are around 150kt (280km/h), its intended cruise speed – "optimally 220kt or more but not less than 180kt" – is less than that of the 250-280kt currently envisaged by the US Army for its Future Long-Range Assault Aircraft. One contender for that requirement, the Bell V-280 Valor, cruises at 280kt and has been taken to speeds above 300kt.

Affordability and availability are also key metrics: the NGRC should have a fly-away cost of no more than €35 million ($42 million) and a cost-per-flight-hour of "optimally" €5,000 but no more than €10,000. Meanwhile, availability rates for forward deployed fleets should hit 75%.

Mission equipment

Under the heading "desired attributes", the document reveals that the NGRC should use "novel/hybrid powerplant[s]" producing at least 3,000shp (2,240kW), feature "fly-by-light/fly-by-wire" controls, be capable of being transported in an Airbus Defence & Space A400M or Boeing C-17 with minimal disassembly, of undergoing air-to-air refuelling, and feature an array of mission equipment and weapon systems, including air-launched effects.

In addition, it should be able to conduct manned-unmanned teaming, including managing a swarm of unmanned air vehicles, launching small "expendable" drones, and recovering small drones in flight.

The NGRC is due to enter service in 2035. Its development is being driven by the forecast retirement of around 1,000 medium-lift helicopters operated by NATO members other than the USA in the 2030-2040 period.

A letter of intent covering co-operation on the NGRC development was signed by five nations in October 2020, but the document notes that "Spain and [the] USA are also considering joining".

Separately, the US Air Force Research Laboratory (AFRL) has contracted Bell to research a high-speed vertical take-off and landing (VTOL) aircraft.

No details of the specific research were disclosed in the contract notice titled "Bell's High Speed VTOL".

However, patents filed by the manufacturer over the preceding years have revealed a number of concepts that could be of interest as it investigates an aircraft able to operate at speeds above those of the V-280.

These include the use of jet engines, or powerplants that can double as turbofans and turboshafts, proprotor blades that fold to reduce drag or that are optimised to acted as a wing during cruise.

The research contract came several months after the US Air Force Special Operations Command said it was looking ahead for a VTOL aircraft with "jet speeds" to replace its Bell Boeing CV-22 Osprey tiltrotor.

Additional reporting by Garrett Reim in Los Angeles

Bell

Partners push ahead with FCAS

Agreement between France, Germany and Spain clears way for Future Combat Air System to move towards demonstrator

Craig Hoyle London

French defence minister Parly (*left*) with German counterpart Kramp-Karrenbauer

Phillip Guelland/EPA-EFE/Shutterstock

France, Germany and Spain have completed negotiations covering the next phase of their Future Combat Air System (FCAS) activity, advancing it towards the first flight of a demonstrator by 2027.

The step was confirmed on 17 May, in a joint statement from the defence ministers of all three partner nations: Florence Parly, Annegret Kramp-Karrenbauer and Margarita Robles.

Conducted over recent months, negotiations between the nations' defence procurement agencies "made it possible to reach a balanced agreement between the different partners for the next step in the demonstration phase of the programme", they say. "The corresponding government agreements are now ready for national processes to begin for formal validation."

However, there is no detail on how concerns around workshare or intellectual property have been assuaged. Germany also previously called for two demonstrator aircraft to be built, but the statement refers only to a single example.

Launched at the Paris air show in 2019, the FCAS effort aims to develop a New Generation Fighter (NGF) and supporting remote carrier vehicles, with operations to be underpinned by the use of a combat cloud communications network.

"In an increasingly challenging context where air superiority is seriously threatened by rapidly growing threats, the New Generation Weapons System [NGWS]/FCAS programme contributes directly to the national and European sovereignty and security," the nations say.

"Fully integrated into the different national Future Combat Air Systems, the NGWS will be able to achieve operational superiority in highly contested environments."

Early discussions involved only France and Germany, before Madrid's participation was formalised last year, initiating an "onboarding" process for companies including Airbus Spain, Indra and ITP Aero.

"The industrial organisation of the programme has been structured to ensure the coherence and effectiveness of the project, taking advantage of the best capabilities of each nation's industries within the framework of a balanced, broad and deep partnership," the nations say.

Best competitiveness

This "offers an unbeatable opportunity to strengthen the technological assets of the three participating countries, while ensuring the best competitiveness of the future system", they add.

Dassault is leading work on the NGF, supported by Airbus Defence & Space. The fighter's propulsion system is being developed by a team of Safran Aircraft Engines, MTU Aero Engines and ITP.

Confirmed in late April via the formation of an EUMET joint venture, the agreement gives Safran responsibility for the new engine's hot section, plus overall design and integration, and ITP for the low-pressure turbine and nozzle. MTU will handle services and support.

Describing the joint venture as a "satisfactory" construct, Safran chief executive Olivier Andries said the pact had been finalised "with no compromises at all".

The FCAS initiative is progressing at the same time as the UK's pursuit of a sixth-generation fighter via the Tempest project. Also involving Italy and Sweden, this will enter its concept and assessment phase later this year. If both projects proceed as planned, a Tempest platform should enter UK service around 2035, with the NGF to follow five years later.

Underscoring the closely entwined nature of the European defence industry, Leonardo – which participates in Team Tempest with BAE Systems, Rolls-Royce and MBDA's UK arm – recently acquired a 25.1% stake in Hensoldt, which is among German industrial participants in the rival FCAS effort.

Leonardo chief executive Alessandro Profumo says the deal "represents a long-term operation strengthening our portfolio in the strategic defence electronics business in sensor solutions".

Speaking on a first-quarter earnings call, Giovanni Soccodato, Leonardo chief strategic equity officer, said the technology being developed by both companies will be suitable for the FCAS and Tempest "whether they stay as two separate programmes or converge".

See p58

Additional reporting by Dominic Perry

In for the long haul

Widebody activity is unlikely to grow markedly until mid-2022, Airbus believes, while short-haul shows signs of rebound

Airbus

Airframer is modifying Toulouse site to allow production of A321neo

David Kaminski-Morrow London

Airbus is not expecting to see a notable upward shift in the long-haul market until the middle of 2022, as it prepares to begin ramping-up single-aisle production.

Speaking during May's Atlantic Council EU-US Future Forum, Airbus chief executive Guillaume Faury said the impact of the Covid-19 crisis had been severe – particularly given that the airframer had been engaged in hiking aircraft output at the time the pandemic hit.

"Our supply chain, ourselves, were investing for more production moving forwards, and we had to face a brutal reality of the vast majority of the commercial [aircraft] around the world being grounded," he says.

Airbus slashed production rates – bringing A320-family monthly output down to 40 aircraft – and aims to increase this later this year.

Its reduced twin-aisle aircraft rates, however, are set to remain at lower levels.

"For the long-range [aircraft] and from the long-range business for airlines, we think the tipping point will probably not be before mid of next year," says Faury.

"The different countries of the world, the different regions of the world are really managing the situation in very different ways," Faury adds. "It will take a lot of time to re-open."

Right direction

Faury says he has had "frustrations" with the European situation, whereas that in the USA is "moving very quickly in the right direction" and is "refreshing to see".

"I am quite optimistic... that Europe will follow [the USA], probably with a couple of months of delay," he says.

Faury had previously told financial analysts that, in response to a "quite bullish" market situation, US carriers were willing to start looking at "accelerating deliveries" – whereas the recovery scenarios in Europe were "much worse" than airlines were expecting.

But in a further sign of confidence in single-aisle recovery, Airbus has resumed work on an additional assembly line for A321neos.

The airframer had unveiled plans for the modernised Toulouse line in January 2020, just weeks before the pandemic crisis forced it to slash production rates and shelve the work.

> "We had to face a brutal reality of the vast majority of the commercial [aircraft] around the world being grounded"
>
> **Guillaume Faury Chief executive, Airbus**

Airbus had already signalled that A320neo-family output would start to ramp up in the third and fourth quarters, to 43 and 45 aircraft, respectively.

It says it sees a "potential return" to pre-crisis production rates for single-aisle aircraft between 2023 and 2025.

"With market recovery in sight... Airbus is resuming its activities for the [assembly line] project," the airframer states.

Airbus is only able to produce A321neo aircraft at its Hamburg Finkenwerder, Germany and Mobile, USA facilities.

But this re-engined variant has become particularly popular, with orders at 3,473, nearly double the total figure recorded for the conventional A321.

The A321neo is crucial to Airbus's single-aisle strategy post-crisis, because the airframer is enhancing the twinjet's range and capacity, with the A321LR and A321XLR, edging into territory normally occupied by twin-aisle aircraft.

Airbus's new, digitally-enhanced assembly line will replace one of the original A320 lines in Toulouse, offering the capability to manufacture the A321neo at the airframer's main base.

The line will be established at the Lagardere facility that was previously used for A380 production. Airbus expects it to be operational by end-2022.

3,473

Orders for the re-engined A321neo, which Airbus produces at plants in Germany and the USA

Industrial flow

"The modernised [line] in Toulouse will help improve the working conditions, the overall industrial flow as well as the quality and competitiveness," says Airbus.

It says the additional production capability at Toulouse will provide flexibility to ease the initiation and ramp-up of A321XLR assembly at the Hamburg Finkenwerder site from 2023.

The airframer recorded orders for 48 aircraft in April, including 25 A321neos for Delta Air Lines and 22 for lessor Avolon.

But the Avolon order – for 14 A321neos and eight A320neos – appears to be a rejig of a previous agreement. Airbus listed 22 cancellations for the month and the overall number of aircraft ordered by Avolon remained unchanged from March.

170

Total deliveries of commercial aircraft recorded by Airbus for the first four months of 2021

Airbus also recorded an order for a single A319neo coming from a private customer.

These agreements reduced the negative net order figure to 35 for the first four months of 2021.

Airbus delivered 45 aircraft in April – including six A350s, two A330neos, and 37 single-aisle jets – taking the total deliveries it has recorded for this year to 170.

Four of the A350s were delivered to Chinese carriers, while the other two aircraft were handed over to Air France.

Delta and Corsair received the A330neos, both of them being -900 variants.

See p46

Faury predicts narrowbody triopoly by decade's end

Guillaume Faury, Airbus chief executive, believes its single-aisle duopoly with Boeing could transform into a three-way competition by the end of the decade if China progresses strongly with its Comac C919.

Faury said such a development was "not an unlikely scenario".

Comac has already secured substantial domestic orders for the C919, although the aircraft has yet to enter service.

"It's still difficult to say at what stage and what level of competitiveness Comac will be able to introduce the [C919] in the market," says Faury.

"We believe they will start with China, because the Chinese airlines are state-owned companies and it's easier to do it. It takes a lot of time to demonstrate the maturity of a product, to make it reliable, trusted, and economically viable.

"But we believe it's not unlikely [that] on the single-aisle, by the end of the decade, Comac will have taken a certain share of the market."

The C919 will compete in the same sector as the Airbus A320neo, and uses the CFM International Leap-1C engine – a version of one of the A320neo's powerplant options.

Faury says China has been an important market for the airframer – accounting for some 20% of Airbus deliveries last year – but Comac will "progressively come with domestic products".

C919 represents China's domestic entry into the single-aisle market

"It will start slowly, probably reaching at the beginning only the Chinese airlines. But we believe [that Comac] will progressively become a decent player," he says.

"So we will grow probably from a duopoly to a 'triopoly', at least on the single-aisle, by the end of the decade."

Chine Nouvelle/SIPA/Shutterstock

Material benefits

Boeing is on the hunt for efficiency and environmental improvements driven by design and manufacturing advances

Pilar Wolfsteller Las Vegas

Boeing chief executive David Calhoun believes that the next generation of aircraft will distinguish themselves by the way they are engineered and constructed, rather than through increasingly efficient engines alone.

Calhoun says new designs will take advantage of advances in materials technologies – improvements to composites, for example – thus reducing the aircraft's cost and overall environmental footprint, rather than just through using engines with a lower fuel burn.

"I expect the next product will get differentiated in a significant way on the basis of the way it's engineered and built," Calhoun says. "Less dependent on the propulsion package that goes with it.

"Most often a new airplane is developed around a propulsion package that offers 15-20% improvement with respect to efficiency" over the aircraft it is designed to replace, he adds. For instance, Boeing achieved around that level of fuel burn improvement when switching from the 737NG to the 737 Max, the bulk of which came from the performance of the jet's CFM International Leap-1B engines versus the CFM56-7Bs of its predecessor.

Diminishing returns

"I don't believe the next generation of engine can deliver that kind of performance [improvement]," says Calhoun.

A narrowing of propulsion efficiency gains can perhaps be seen on the 777X: Boeing promises a 10% improvement in fuel burn efficiency over the GE Aviation GE90-powered 777, with the new GE9X engines delivering half that increase. But production advances have seen the manufacturer also grow the amount of automation used in the 777X's assembly.

BlueBarronPhoto/Shutterstock

777X will be more efficient to manufacture – and to fly

With pressure growing on the aerospace and aviation industries to make meaningful strides to fight climate change, airlines and airframers are trying to find ways to make flying cheaper and more efficient and to cut greenhouse gas emissions significantly.

These efforts include developing new aircraft designs, increasing production and use of sustainable aviation fuel made from biodegradable waste, and experimenting with alternative power sources such as electricity and hydrogen.

Calhoun offers few clues about Boeing's future direction, but

Max fix allows delivery restart, but sceptical Ryanair doubts deadlines

US regulators have approved Boeing's fix for the electrical issue that grounded more than 100 in-service 737 Max and paused deliveries of new aircraft, a move that should allow the airframer to inject renewed momentum into the programme.

But a resumption of shipments may not come soon enough for Ryanair, which has voiced doubts about the manufacturer's ability to meet deadlines.

Boeing shipped just four 737 Max during April, far lower than required as the manufacturer attempts to push inventory stockpiled out of the door.

Its attempts to return the Max programme to an even keel were scuppered in early April, when the electrical problem was revealed. However, on 12 May Boeing said that it had issued service bulletins relating to the fault and that repairs should begin shortly after gaining final approvals from the US Federal Aviation Administration (FAA).

The issue was related to the "potential degradation of bonds associated with electrical grounding of equipment that could affect the operation of certain systems", says the FAA. Affected Max systems include standby power control units, "P6" circuit breaker panels and main instrument panels.

Boeing paused deliveries of new 737 Max aircraft after it also advised airlines to pull the aircraft from service. The problem affected 106 examples of the 737 Max 8 and Max 9, predominantly with US carriers. Affected jets have line numbers between 7,399 and 8,082. Boeing built them after making design changes in "early 2019", the FAA says.

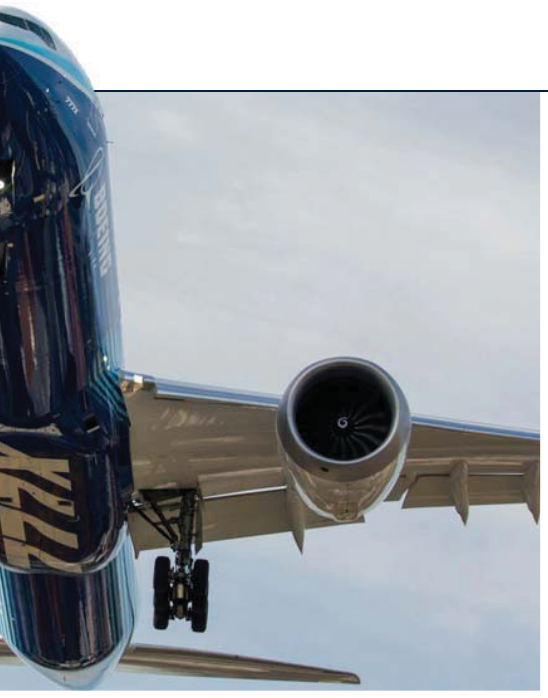
But in a sign that the programme has yet to fully recover, major customer Ryanair says it is beginning to doubt that its first 737 Max 8-200s will arrive before this summer's peak travel months.

Group chief executive Michael O'Leary said on 17 May that even though Boeing was now suggesting its first Max aircraft will be delivered in late May, "I'm not sure we necessarily believe that". Instead, he says: "There is a real risk now that we will not see any of these aircraft in advance of summer 2021".

Ryanair had already downgraded its Max delivery outlook in late March, when it said it expected to take 16 aircraft in time for Europe's busiest travel months, down from the maximum of 24 that it had previously hoped to receive.

In early April, the FAA and its European counterpart had certificated the high-density

Vladdon/Shutterstock



maintains that the company has the means to make aircraft cheaper, more efficient and less polluting without the need for double-digit efficiency gains from new engines.

"Whatever cost efficiency or performance advantages are derived from the next airplane, in my view, it's going to come from the way it is engineered and the way it is manufactured, all with a focus on a lower cost per seat when we get it out to the marketplace, and a more sustainable package with respect to the environment."

Calhoun adds that Boeing's research, especially in composites manufacturing, has provided a better understanding of how to use such materials in aircraft designs.

"We have invested in composites in our platforms for a very long time," he says. "The learning curves associated with getting efficient are significant: how we bring that engineering modelling and the composite development work [to production stage] and then develop quick, simple assembly, like we have demonstrated with the [T-7A Red Hawk] trainer airplane and other defence programmes."

Boeing has used this model-based systems engineering approach – a common set of digital designs for engineering, manufacturing and maintenance, as well as flight simulations – on its aircraft designs for the defence industry, including the T-7A advanced jet trainer and the Airpower Teaming System "loyal wingman" unmanned air vehicle, both of which have advanced rapidly from design to prototype.

Despite the lack of clarity on the airframer's next commercial aircraft, the delayed launch has allowed Rolls-Royce to reinstate itself as a possible propulsion provider.

The UK manufacturer in 2019 withdrew from the race to supply a powerplant for Boeing's then-proposed New Mid-market Airplane, believing that it could not develop its UltraFan engine in time to meet the airframer's entry-into-service target of early this decade.

But R-R has now disclosed that it is once again "in dialogue" with Boeing about possible applications on a new aircraft.

UltraFan club?

Chief executive Warren East suggests that once again the talks cover a potential application for the UltraFan. "Time has marched on for a couple of years, our UltraFan has continued in that time as we maintained investment in it, and therefore it is a different situation today."

While R-R has indicated that the UltraFan architecture is scalable, East acknowledges that the design lends itself primarily to twin-aisles. "Below widebody long-distance travel... we totally understand that UltraFan isn't necessarily the right power and propulsion answer."

But the fact that UltraFan is potentially under consideration suggests where Boeing's focus may lie.

Meanwhile, UltraFan development continues, with R-R in early May taking delivery of the first engine demonstrator's intermediate compressor case. The structure has been produced by GKN Aerospace at its Swedish facility.

See p50

Additional reporting by Cirium

Low-cost carrier has orders in place for 210 examples of high-capacity Max 8

737 Max 8-200 variant that Ryanair is the launch customer for, appearing to give the green light for deliveries to begin.

Since then, O'Leary claims that "the management in Seattle have constantly missed promised deadlines for the first delivery", leaving the airline "quite upset".

Although Ryanair may be sceptical of promised delivery dates, it retains a firm belief in the aircraft itself. Describing it as a "game-changer" for its cost base, the low-cost carrier notes that the Max 8-200 variant boasts four more seats and lower fuel burn than older-generation 737s.

The group's carriers "are all very keen to get their hands on these new, efficient aircraft", chief financial officer Neil Sorahan says. Ryanair has orders in place for 210 737-8-200 Max jets, having firmed up 75 more units in early December 2020.

While Boeing's backlog for the type inched higher by three units in April – taking in 20 orders which were offset by 17 cancellations – the Max received a fillip in early May when long-time customer Alaska Airlines announced it would exercise 13 options for the Max 9 variant, with deliveries in 2023 and 2024.

Additional reporting by Lewis Harper in London

Dassault's big bet

French airframer unveils Falcon 10X, a 7,500nm-range business jet which will be powered by Rolls-Royce Pearl engines and feature the largest cabin in its class

Dominic Perry London

Dassault Aviation has revealed the Falcon 10X, its largest-ever business aircraft, as the French airframer looks to take on Bombardier and Gulfstream in the market for ultra-long-range jets.

Although the Falcon 10X, which is scheduled to arrive in 2025, will be the last to the party – Bombardier's Global 7500 entered service in 2018 and the Gulfstream G700 will follow in late 2022 – Dassault believes a focus on innovation, plus the widest cabin in the category, will give it a leg up on its rivals.

Dassault's decision to enter the new sector was based on demand from customers, who "asked us to have an ultra-long-range Falcon", says chief executive Eric Trappier. "It will put us at the top of business jets," he adds.

"We already have two contenders [in the segment] and they are good contenders. What we wanted to do was not to do the same thing, and provide added value compared with the others," says Carlos Brana, executive vice-president of civil aircraft at Dassault.

Dassault Aviation

Both engines are controlled with a single throttle lever

Powered by twin Rolls-Royce Pearl 10X engines, the $75 million Falcon 10X will cruise at Mach 0.85, have a top speed of M0.925, and be able to access airports with steep approaches, such as London City.

Range is pegged at 7,500nm (13,900km) – matching that of the G700, but 200nm short of the Global 7500 – with a cabin for eight passengers, plus four crew.

Dassault Aviation

Cabin will seat eight passengers in highly customisable configurations

To achieve a combination of efficiency at high speed and predictable low-speed handling to allow access to short runways, the Falcon 10X has a high-aspect-ratio, 33.6m (110ft)-wide carbonfibre wing – almost 8m wider than that of the Falcon 6X – which also features retractable high-lift devices.

Composite was chosen to avoid a weight penalty from the larger structure, but it is the first time Dassault has employed a carbonfibre wing on a production business jet. Such a design is "a challenge – and it is also not, because it is something we have already done on the Rafale [fighter]", says Brana.

New dimensions

Measuring 33.4m from nose to tail, the Falcon 10X is significantly longer than the next-biggest aircraft in Dassault's range, the 25.6m-long Falcon 6X. The cabin is also wider and taller than its stablemate's: 2.77m wide by 2.03m high, against respective dimensions of 2.58m and 1.98m. Combined with a 16m-long cabin, which translates to an impressive cabin volume of 78.7cb m (2,780cb ft).

Falcon 10X will cruise at Mach 0.85, and have a top speed of M0.925

Dassault Aviation

In comparison, the Global 7500's cabin is 2.44m wide by 1.88m high and 16.6m long, while the G700 measures 2.49m by 1.91m and is 17.3m long.

Conscious that at maximum range, both passengers and crew will be subject to flights of 15h or more, Dassault felt it needed to "rethink and reshape" the experience.

Customers should be able to enjoy the flight so "they can exit the aircraft and start their working day as if nothing had happened", says Brana. Workload for the pilots is alleviated so they can "be alert at critical times of the flight".

Indeed, while the cabin has been designed from the ground up to maximise passenger comfort and convenience, arguably more significant innovation has been lavished on the flightdeck.

Here, a single throttle lever – which Dassault calls the Smart Throttle – controls both engines, with the reverse thrust and airbrake controls also integrated into the lever. This offers "vastly simplified thrust management", says chief pilot Philippe Duchateau.

A new digital flight control system (DFCS) derived from the Rafale is also added, combined with fly-by-wire sidesticks which feature flightpath stability, removing the need to trim the aircraft, an action which Duchateau describes as "something from the past".

33.6m

Span of jet's high-aspect-ratio carbonfibre wing

Level best

The DFCS will additionally be able to control the engines – for instance, increasing thrust as the sidestick is pulled back.

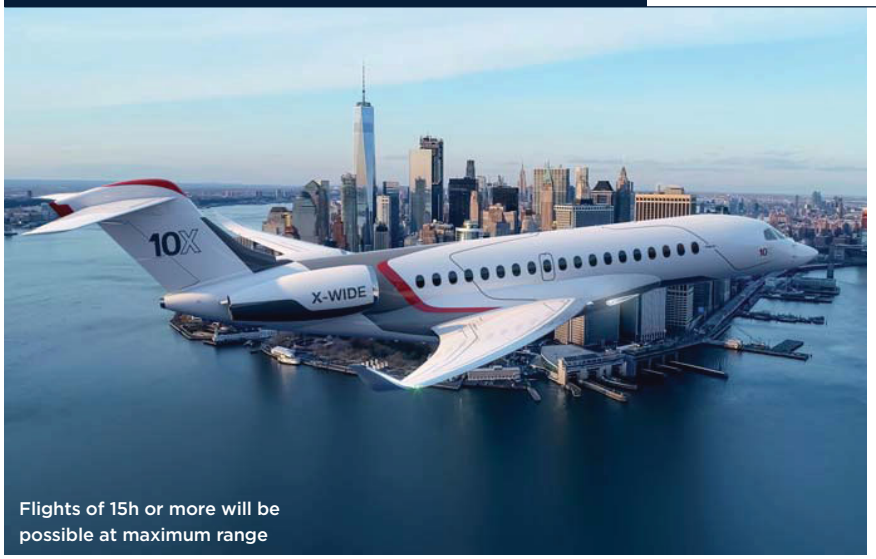
An upset recovery function also features – activated via a button on the main console – which will return the jet to straight and level flight. That system, another carry-over from the Rafale, has already been trialled on the company's Falcon 7X testbed, with "great success", says Duchateau.

A simplified digital checklist is incorporated, while enhancements have been made to the head-up display-based FalconEye combined vision system, enabling its use as "primary instrumentation", he says. The overhead panel is slimmed down, with many switches now "virtualised" on touchscreen displays.

Advanced autothrottle and autopilot modes have been added, such as "soft go-around", which will "avoid smashing everyone back into their seats". Others include emergency descent mode, reduced take-off thrust and noise abatement modes.

Although current regulations call for three pilots for a 15h flight, Brana notes that "this aircraft is designed to fly not just today but for the next 40 or 50 years" and therefore anticipates possible regulatory changes. He says it is "not absurd" to think that with higher levels of automation on the twinjet "the regulation could be changed to allow two pilots to fly for 15h".

Improvements in technology are "leading us to a significant workload reduction," says Duchateau, which "will allow us to postulate for one pilot [during cruise]". Meanwhile, the other would be able to take a "fortifying rest" in the fully reclinable pilot seat.



Dassault Aviation

Flights of 15h or more will be possible at maximum range

How ultra-long-range rivals compare

	Dassault Falcon 10X	Bombardier Global 7500	Gulfstream G700
Range	7,500nm	7,700nm	7,500nm
Cabin height	2.03m	1.88m	1.91m
Cabin width	2.77m	2.44m	2.49m
Cabin length	16m	16.59m	17.35m
Wingspan	33.6m	31.7m	31.39m
Length	33.4m	33.8m	33.48m
Engine	2x Rolls-Royce Pearl 10X	2x GE Aviation Passport	2x Rolls-Royce Pearl 700
Thrust	>18,000lb-thrust	18,920lb-thrust	18,250lb-thrust

Source: Manufacturers

"This will nicely contribute to fatigue management and being in best shape for approach and landing. [Technology] will make it possible for one pilot to manage all the tasks associated with cruise."

Initial dialogue on the topic has begun with the European Union Aviation Safety Agency, he adds.

Meanwhile, for R-R, winning a position on the Falcon 10X – its first time on a Dassault business jet – is the third in a series of victories for the Pearl family of engines.

The Pearl 15 was initially selected by Bombardier for the Global 5500 and 6500, followed by the Pearl 700 for the G700.

Right fit

Trappier says: "We strongly believe that Rolls-Royce has the right competencies and the right technologies needed to design this engine for us."

Dr Dirk Geisinger, chairman of business aviation at R-R Deutschland, says the company is "honoured" that the Pearl 10X has been chosen to power the Falcon 10X. It will, he says, offer "a market-leading combination of power and efficiency".

The selection also serves to "reinforce our position as the leading engine supplier to the business jet market".

Based on the Advance2 core, Pearl-family engines offer a 5% reduction in specific fuel consumption over previous-generation engines. In addition, the powerplants are capable of operating on 100% sustainable aviation fuel.

Dassault describes the engine as the "largest and most powerful" Pearl variant, which R-R indicates is rated at more than 18,000lb-thrust (80kN). Comparatively, the smaller Pearl 700 offers 18,250lb-thrust at take-off. The propulsion specialist does not offer a precise figure for the Pearl 10X, simply noting that it is "more powerful" than the other variants and sits in the 18,000-20,000lb-thrust range.

At the front of the engine sits a titanium fan blisk, leading to a 10-stage high-pressure compressor, low-emission combustor, two-stage shroudless high-pressure turbine and four-stage low-pressure turbine.

An ultra-slimline nacelle will be provided by Spirit AeroSystems, creating streamlined laminar flow for enhanced aircraft performance. Improved acoustic treatment will also ensure quiet operation.

Testing time

More than 1,000 test cycles and over 500 test hours have been accumulated on the Pearl 10X, says Geisinger. The new powerplant will also be the first R-R engine to be flight-tested aboard the manufacturer's newly acquired Boeing 747-400.

The Falcon 10X is large enough to accommodate four cabin zones of equal length but is endlessly customisable, Dassault says. Space is sufficient for a full queen-size bed or an enlarged master suite with a private stand-up shower.

Pressure altitude in the cabin will be 3,000ft at 41,000ft, while a next-generation filtration system will enhance the overall experience. Light will flood in through 38 windows, which are 50% larger than those on the Falcon 8X.

Cabin systems will be controlled via an app on a mobile device, simplified switches or zonal touchscreens. Minimal hardware was integrated in the cabin to avoid obsolescence issues.

Pearl 10X is most powerful variant in new engine family

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New converts

With cargo one of the few profitable areas for airlines at present, the market for passenger-to-freighter modification programmes continues to grow

Dominic Perry London

News that Singaporean firms ST Engineering and investment company Temasek are joining forces to create a new leasing venture for converted freighters is the latest in a series of recent announcements focused on the booming market for passenger to freighter (P2F) modifications.

Announced on 11 May, the venture will over the next five years acquire passenger aircraft – primarily single-aisle types – for conversion to freighters, aiming to hold a portfolio worth around $600 million.

Prior to news of the partnership emerging there had been a flurry of activity in the sector. For instance, Boeing revealed it will in 2022 set up a P2F conversion facility for 737-800s in Costa Rica – the first such operation in South America – while Israel Aerospace Industries (IAI) will in 2024 establish a modification line in Seoul, South Korea for 777-200LRs and -300ERs.

That facility will augment IAI's initial line in Tel Aviv, where the first aircraft under the 777-300ERSF programme it launched in 2019 with lessor GECAS will soon be inducted.

Meanwhile, US-based 321 Precision Conversions is close to delivering its first Airbus A321 converted freighter, and plans to begin work on a second aircraft in June. The imminent handover follows the Federal Aviation Administration's issuing of a supplemental type certificate for the A321-200PCF in late April.

Strong demand

And on the other side of the Atlantic, Ireland-based lessor GTLK Europe is to acquire four A321 converted freighters, induction for which will commence this year. The aircraft will undergo modification by the EFW joint venture which is run by ST Engineering and Airbus.

EFW says the air cargo market has experienced increasing demand. "Interest in our A321P2F conversion solution has been on a significant rise over the past year," says chief executive Andreas Sperl.

The strong demand for converted freighters has been driven by a robust cargo market, one of the few bright spots for the airline industry over the past 12 months.

While the loss of belly-hold capacity, typically around 54% of total capacity, through the collapse of long-haul passenger demand has presented a logistical challenge which has required some creative solutions, both demand and rates are now higher than they were as the pandemic took hold last year.

Widebody sector has bigger concerns

Single-aisle operators have little choice but to turn to converted freighters, given the absence of line-built models. That is not currently the case in the widebody space, however, where Boeing continues to assemble its dedicated 747, 767 and 777 freighters.

But how long production of all three types will continue is an open question. So far, the only certainty is that 747-8F output will end in 2022.

Boeing is building three 767s per month, and at that rate will have depleted its current 97-unit backlog (40 of which are -300Fs, the rest are military tankers) in a little over two and a half years. But with the US Air Force having an eventual requirement for 179 KC-46 tankers, the orderbook will be periodically topped up over the coming years. Of course, whether Boeing continues to offer the -300F is not guaranteed.

The picture is even less clear on the larger 777: including a recently announced deal from Silk Way West Airlines, of the current 57 orders for the 777

GECAS

IAI and GECAS have launched 777-300ER conversion programme

AirTeamImages

Converted 737s dominate smaller narrowbody market, with -800s increasingly prevalent

In fact, IATA data for March shows a record for air cargo, with cargo tonne kilometres (CTKs) flown 4.4% above the same month in 2019 – well before Covid-19 appeared. CTKs have climbed consistently over the last 12 months, save for the annual post-Christmas slump.

Higher rates

Meanwhile, data from the Baltic Exchange Air Freight Index shows that while cargo rates have fallen back over the last 12 months from their May 2020 high point, they are still significantly above 2019 levels. Indeed, in April this year rates on the Hong Kong-North America lane spiked to $8.48/kg, higher even than the $7.73/kg seen in May last year, driven upwards by reduced capacity due to stricter quarantine regulations in Hong Kong.

Clearly it is the absence of belly-hold capacity that has continued to keep rates buoyant. "Overall air cargo rates remain at elevated levels because of stronger demand and an ongoing capacity crunch caused by a reduction in belly-hold services," says Damian Brett, editor of FlightGlobal's sister publication *Air Cargo News*.

Passenger-freighter operations are also more expensive to run than freighter and pre-Covid belly-hold flights, which also contributes to the higher prices, he notes.

Figures released in early 2021 by consultancy IBA show the stark contrast between passenger and freighter aircraft operations. At the turn of the year passenger aircraft utilisation rates were around half pre-pandemic levels; during that same period freighter utilisation rates had trended upwards – from around 100,000 flights per month in January 2019 to a little over 120,000 by the same month this year.

Such has been the demand for cargo capacity that even aircraft thought to be long retired have been returned to service: Georgian start-up Geo-Sky has re-activated a 1987-built 747-200 converted freighter (4L-GEN) that was last ❱

family, 45 are for the -200LR-based freighter variant. Boeing is this year cutting output to two aircraft per month, including an unknown number of 777Xs. Depending on demand and build rates, the current-generation jet could continue in production for up to six years, observers estimate, although at low output levels, near-term slots appear hard to come by.

No freighter variant of the 777X is presently offered, and even if it is launched it is likely to carry a "hefty price tag", argues one industry watcher.

In the absence of new-build 747-8Fs and a lack of clarity on the 777F, operators seeking a suitable 747-400F replacement may well turn to P2F conversions, where price, availability and the high capacity of the -300ER are likely to make the Israel Aerospace Industries/GECAS product a compelling prospect.

The 777-300ERSF "will produce a significant impact on the market", the observer says; "It will not be a three-figure million number to put that on the ramp", and it "can do what the 777F does, at lower cost and with much more volume".

While no figures are officially available, IBA estimates the conversion cost of a 2005-built 777-300ER to be around $32.5 million. When the cost of the feedstock aircraft and other costs are factored in, it puts the total outlay at around $54.5 million for an aircraft that will be able to carry a little over 100t. However, others put the price tag at around $55-65 million.

In addition, the partners involved, plus the support of engine provider GE Aviation, lend credibility to the effort, industry watchers say, despite the engineering challenges involved.

The conversion will include implementation of a main-deck cargo door, reinforcement of the fuselage, fitting of window plugs and a full freighter interior – including 9*g* rigid barriers and a loading system – together with modification work on the crew compartment.

Kalitta Air is set to be the launch operator of the aircraft, receiving its first example on lease from GECAS in 2023. The identity of the launch customer further strengthens the case for the programme, according to one industry insider: "I don't think its owner has put a foot wrong in all the years it's been in operation."

Airbus

The EFW A321 P2F conversion programme was launched in 2015

operated in 2012, according to Cirium fleets data.

Of course, growing demand for conversions pre-dates the pandemic, driven by the need of the big integrators – express parcel carriers such as FedEx, DHL and UPS, and Amazon, to a degree – to update their fleets of smaller freighters. For instance, the EFW A321 P2F conversion programme was launched in 2015, with its first order secured two years later.

But the pandemic has undoubtedly added fuel to this fire. Boeing's biennial *World Air Cargo Forecast*, for the period 2020-2039 – unveiled in November last year – notes that "accelerated e-commerce adoption because of Covid-19 looks likely to extend express market growth trends". Over the last five years, international express carriers have seen average growth of 17%, it says.

Boeing sees the cargo market as a whole growing at an annual rate of 4% over the next 20 years, resulting in the need for a freighter fleet 60% larger than today's, rising from 2,010 to 3,260 units. 2,430 aircraft will be delivered, around 50% of which will replace current inventory. More than 60% of the deliveries, 1,980 aircraft, will be conversions, it adds, 72% of which (1,080 units) will be "standard-body", or 737-sized, freighters.

Consultancy Ascend by Cirium broadly shares Boeing's outlook for the next two decades. It predicts a 70-30 split in favour of conversions, with total demand for more than 3,300 aircraft, including around 600 turboprops.

Forecast factors

"Conversions are being driven by the growth of e-commerce, which has been boosted by more online deliveries during lockdowns," Cirium notes.

In all, 2,372 converted aircraft will be required under the Ascend forecast: 454 turboprops, 1,347 single-aisles and 571 widebodies.

Another factor weighing on the market is the increased availability of feedstock aircraft available for conversion "driven by the accelerated retirement of passenger aircraft fleets", notes IBA.

Indeed, one of the strategies underpinning the ST Engineering/Temasek venture is an intention to benefit from falling passenger aircraft values as the air transport crisis generates overcapacity pressure, enabling it to acquire feedstock.

In IBA's view, the 737 will continue as the mainstay of the smaller narrowbody market, with conversion activity shifting to the -800 as feedstock availability of earlier 737 Classics dries up. Between May 2020 and January 2021, a total of 30 converted 737-800 freighters were added to the global fleet. 2021 is "looking to be an even stronger year" for the type, it says, with nearly 40 aircraft pending.

The 757 continues to dominate the larger narrowbody space, says IBA; an additional 20 examples are pending conversion having been retired from passenger roles, it says, adding to the 298 units in operation as freighters at February 2021.

A well-placed industry executive believes that although the "757's story is not finished", the number of freighter examples will decline by around one-third over the next 10 years, largely replaced by converted A321s, alongside 737s, 767s and potentially A330s. The prospects for the Airbus narrowbody will be aided by a choice of engines, allowing operators to avoid over-reliance on one manufacturer.

> "Conversions are being driven by the growth of e-commerce which has been boosted by more online deliveries during lockdowns"
>
> **Ascend by Cirium**

Not so convenient

Politicians in the USA are again attempting to pass legislation preventing the arrival of foreign low-cost carriers in the country

Peter Krocka/Shutterstock

Norwegian Air International was granted a foreign air carrier permit in 2016

Pilar Wolfsteller Las Vegas

US lawmakers have introduced a bill that would prevent cut-price airlines that have been established under "flags of convenience" from operating into the USA.

The chairman of the House Committee on Transportation and Infrastructure Peter DeFazio said on 11 May that the "Fair and Open Skies Act" is designed to force foreign airlines to "play by the rules" rather than offer services under conditions that would be illegal in the USA.

"In the past, we have seen foreign airlines set up under a flag-of-convenience business model to exploit weaker labour laws outside their home countries in order to save money, undercut competition, and skirt important labour standards to get a leg up," DeFazio says. "By preventing such an airline from serving the US this bipartisan bill protects American jobs from predatory and unfair competition."

The proposal would require the US Department of Transportation (DoT) to ensure that, when issuing new foreign air carrier permits, it remains "consistent" with the labour and competition provisions laid out in the US-EU-Norway-Iceland Air Transport Agreement. The requirement would apply only to non-US airlines seeking to begin USA-Europe flights that fall under that treaty.

This is the third time DeFazio has introduced such measures, in an effort to stop low-cost carriers who may skirt labour laws and safety standards in the name of offering cheap transatlantic fares.

Short-term contracts

In December 2016, the DoT issued a foreign air carrier permit to Norwegian Air International (NAI), a subsidiary of Norwegian Air Shuttle. Launching legislation at the time, DeFazio said NAI was "Norwegian in name only", as its domicile was actually Ireland, in order to avoid Norway's labour protections, and the airline employed crews on cheap, short-term contracts governed under Singapore law. In 2019, he made a second attempt at passing such legislation.

"The controversial decision to grant NAI a permit only encourages future opportunistic airlines to continue this race to the bottom in international civil aviation," the committee now says.

NAI permanently ceased long-haul flights in March 2020, but more recently, Norse Atlantic Airways, another start-up airline co-owned and led by NAI's founder and former chief executive Bjorn Kjos, has said it aims to replicate that transatlantic model.

In a letter to transportation secretary Pete Buttigieg on 2 April, DeFazio wrote that the new administration of President Joe Biden must make good on its commitment to protecting US jobs and promoting fair competition across borders.

"If Norse Atlantic Airways' business model is predicated on the same flag-of-convenience concept that we saw in the case of Norwegian and its various alter egos, the public interest demands that the department deny the carrier's application for a foreign air carrier permit," DeFazio wrote. "All the elements are in place for a repeat of the Norwegian debacle."

ITAR breach costs Honeywell

US company fined after multi-year transfer of military technical drawings sent to potential suppliers in China and other nations

US Air Force

Engineering prints included the geometries and layouts of Lockheed Martin F-22 parts

Garrett Reim Los Angeles

Honeywell has reached a $13 million settlement with the US Department of State following alleged multiple violations of the Arms Export Control Act and International Traffic in Arms Regulations (ITAR) rules.

Between 2011 and 2018, the company repeatedly sent drawings of US military aircraft parts to suppliers in foreign countries, including China, asking for price quotes, according to the Department of State's charging letter.

The engineering prints showed layouts, dimensions and geometries for manufacturing castings and finished parts. These included components for the Lockheed Martin F-22 and F-35 stealth fighters and the latter's Pratt & Whitney F135 engine, the Boeing B-1B bomber, and other hardware and weapons.

In addition to China, Honeywell allegedly also sent the drawings to suppliers in Canada, Ireland, Mexico and Taiwan.

The company voluntarily disclosed the violations. The Department of State agreed to suspend $5 million of its fine, on the condition that the funds are used "to strengthen Honeywell's compliance programme".

The civil penalty highlights an increasingly complex relationship between Western aerospace manufacturers and China – a country many invested in heavily a decade ago, in the hope of tapping revenue growth. Now, those same firms are caught amid a new geopolitical rivalry between Washington and Beijing.

US companies now face a growing list of potential suppliers with which they can no longer deal, due to concerns around the export of sensitive technologies. Last December, the US government released its Military End User list, a compilation of dozens of Chinese and Russian companies with links to military programmes.

Military developments

The list includes Xian Aircraft, a subsidiary of state-owned Aviation Industry Corporation of China (AVIC), which is developing the MA700 twin-turboprop airliner. The project includes several US suppliers, among them Collins Aerospace (avionics), Eaton (fuel system components), Honeywell (auxiliary power unit) and Parker Aerospace (fly-by-wire flight control actuation systems, and hydraulic system).

Xian's inclusion on the Military End User list stems from its military developments, including the Y-20 strategic transport and H-20 stealth bomber.

As the MA700 illustrates, the tricky industrial relationship with China and the US Department of Defense (DoD) is by no means just a Honeywell problem.

Boeing, for example, is heavily reliant on Chinese airlines to drive business for its commercial products. In partnership with state-owned Comac, the company in 2018 opened a completion facility for the 737 in the country, anticipating demand for thousands of new narrowbodies in the decades to come.

Honeywell's example illustrates the cybersecurity challenges that can be associated with doing business in China.

Boeing is betting part of its commercial future on the adoption of model-based systems engineering design software developed for US DoD programmes like the T-7A Red Hawk advanced jet trainer. The company believes that its next generation of airliners will set themselves apart by the way they are engineered and constructed, rather than solely via the use of more efficient engines.

Such model-based systems engineering software tools allow aircraft builders to create a digital twin of a design and then explore its total lifetime cost through various simulations.

For companies like Boeing, which want to do business with both the US DoD and China – and in some cases transfer detailed know-how from the military world to the commercial sector – regulatory compliance is certain to become a growing area of concern and focus.

The AW609 marks milestones towards entering the market

The AW609, despite Covid-19 challenges, had a year of crucial landmarks as it progresses towards anticipated commercial operation. Leonardo is focused on the industrialization process of the AW609 program, which includes the manufacturing of the first batch of production aircraft, the establishment of a comprehensive customer support and training services package, and the securement of new hangar space to house and enable AW609 production.

Steps were taken in both the United States and Italy to move the program forward. “With the global pandemic, the aerospace community had to learn an entirely new way of doing business,” said Bill Sunick, Leonardo’s senior marketing manager for the AW609. “But we are close to getting to market, in large part due to the moves we made while still under the specter of Covid-19.”

In late April, Leonardo formally opened a new, $80 million training academy with the ability to train pilots to fly the AW609. It includes a virtual enhanced training device, a full-flight simulator, multi-media classrooms and a customer service facility. In keeping with the Leonardo commitment to providing full-service, 360-degree capabilities to customers, it will also house an AW609 maintenance trainer to train maintenance personnel. The academy is located right on the existing Philadelphia campus.

On that same site, Leonardo expanded AW609 capabilities even further by acquiring a new, 32,000 square foot hangar that will allow the AW609’s transition from test to production, and is specifically designed to support the AW609 program, production and flight testing in its entirety. This acquisition also supports the growing production needs of Leonardo in Philadelphia, heightened by the securement of two U.S. Department of Defense contracts, including one for the U.S. Navy’s TH-73 training helicopter.

And in February 2021, the fourth AW609 (AC4), fully representative of the final production configuration, was shipped from its Philadelphia production line to Genoa’s harbor in Italy, where it was then offloaded and later flew to Leonardo Helicopters’ headquarters in Cascina Costa di Samarate. The aircraft will remain there for the final stage of program testing ahead of civil certification. Th AC4 transfer allows Leonardo to maintain production aircraft on both sides of the Atlantic and will allow potential European customers access to the same demonstration activities. This brings the entire program to the crucial market-oriented next step.

A true multirole tiltrotor, the AW609 is not only perfectly suited for commercial operations but also for public services including surveillance, patrol, search and rescue, emergency medical service, VVIP transport, for example. Leonardo anticipates significant interest in the world market for a tiltrotor with these specific characteristics in terms of weight/size category and features.

LEONARDO

IAI broadens horizons under new leadership

Israel's state champion is emerging from the pandemic relatively unscathed and prepared to develop emerging markets

Murdo Morrison London

Boaz Levy, a 30-year Israel Aerospace Industries (IAI) veteran, has graduated to the top job at the state-owned group at one of the most promising periods in its seven-decade history. The once-turbulent business has just notched record revenues and healthy profits for 2020, despite the pandemic, and seen the emergence of a lucrative market in the Gulf following a landmark US-brokered peace accord with the United Arab Emirates (UAE) and Bahrain.

This year IAI has also deepened long-standing ties with South Korea, one of its historically strongest export markets. In March, IAI signed a memorandum of understanding (MoU) with Korea Aerospace Industries to develop loitering munitions for the country's army.

Under another South Korean partnership, IAI will expand its Tel Aviv-based Boeing passenger-to-freighter (P2F) operation with a new 777 conversion facility at Seoul's Incheon airport, which it plans to open with local firm Sharp Technics. Due to the shortage of belly hold capacity with the grounding of thousands of flights since March 2020, the P2F sector has been one of the few bright lights in commercial air transport, and IAI has benefited.

Levy, who succeeded Nimrod Sheffer last November after running IAI's systems, missiles and space division since 2013, is reluctant to claim too much credit for what chairman Harel Locker calls the company's "180° transformation" in recent years. "I am part of that change," he concedes. "And I will be continuing that plan, by continuing to focus on our customers and bring them the wonderful capabilities of IAI."

As a result of last August's Abraham Accords, one of these customers could soon be the UAE. Since last year, the Gulf nation has been establishing direct flight and trading connections with the Jewish state for the first time. From an economic point of view, the UAE's large defence and security budget makes it a prize target for Israeli industry. It also brings closer the prospect of a deal with Saudi Arabia and its even larger market.

Strategic agreement

In March, IAI announced a "strategic agreement" with Edge, the UAE's recently-established national defence house, to co-operate on an "advanced" counter-unmanned aircraft system for the federation and the wider Gulf region. IAI has been developing and marketing such technologies for decades, but Edge subsidiary SIGN4L has created its own suite of electronic warfare capabilities. The two companies say they will exchange know-how.

Levy, who began his career with IAI as an aerospace engineer, hopes the partnership with Edge will lead to more co-operation with the Arab state and its burgeoning domestic aerospace and defence sector. "This MoU serves as a stepping stone for further business and strategic alliances between our countries, and will enhance co-operation for research and development and technological innovation," he says.

Although circumstances are very different, the two states face similar threats. Like Israel, the UAE is wary of "asymmetric" attacks by hostile forces in the region using weaponised drones, and both, together with Saudi Arabia, share a common enemy in Iran. "These deals give us a great potential to enlarge our business, but also to contribute to peace," says Levy. "We have capabilities that meet their needs in a way that makes us all safe."

Until last year, Israelis were banned from the UAE. Now Israeli companies have begun to feature at its many trade shows, which are taking place again after a pandemic hiatus. Although a last-minute Covid travel ban put paid to IAI's plans to attend the IDEX defence expo in Abu Dhabi in February, the company did send a large delegation to April's Cybertech in Dubai, and IAI will be part of a sizeable Israeli pavilion at November's Dubai air show.

IAI, which was ranked 33rd largest aerospace business in the latest FlightGlobal Top 100, has a range of expertise befitting of a state champion that has had to over the years

Boaz Levy took over the top job at IAI in November last year

Israel Aerospace Industries

Israel Aerospace Industries

Company offers MRO services and passenger-to-freighter conversions

fulfil many of Israel's military aerospace needs as well as earn revenue from exports. Its capabilities range from munitions to maintenance, repair and overhaul, airborne radars to aerostructures, and space launchers to electronic warfare.

Sometimes that portfolio has been as much of a hindrance than a help. Successive IAI chief executives have also had to deal with both a highly unionised workforce and MPs and ministers who see it as their role to have a close interest in how the business is run day to day. It has at times made IAI a more cumbersome and bureaucratic organisation to run than its nimbler, privately owned main rival Elbit Systems.

Internal reorganisation

However, restructuring in recent years has made IAI – which makes almost three-quarters of its revenues from exports – a leaner and more outward-looking business. It now has four divisions: Elta Systems, which offers electronic warfare equipment; aviation, which includes P2F activities, the Gulfstream G280 programme and military aerostructures work; military aircraft, specialising in unmanned air vehicles; and systems, missiles & space.

The latter is responsible for the Ofek 16, a low-Earth-orbit reconnaissance satellite, which was launched last July on an IAI Shavit launcher. IAI contributes to Israel's space programme alongside Elbit and missiles house Rafael. Another important new product is the Barak ER 81nm (150km) missile interceptor, the longest-range addition to the Barak family. It underwent live firing trials earlier this year that included the interception of a ballistic target.

$4.18bn

IAI posted its highest-ever revenues in 2020, largely driven by driven by Elta Systems electronic warfare business

According to Levy, the Barak ER offers "enhanced capabilities for air missile defence" as it can be operated as a suite with the "combat proven" shorter-range variants of the interceptors from a single launch platform. The new range is crucial as 150km is the "optimal" distance to destroy an incoming missile, says Levy, who adds that IAI has secured at least one export customer for the latest version.

IAI continues to be a pace-setter in unmanned systems. While best known for its strategic platforms such as Heron, last September it upped its interests in the small tactical segment, taking a 50% stake in BlueBird Aero Systems, one of a swathe of Israeli start-ups specialising in remotely operated technologies. BlueBird's speciality is vertical take-off and landing products, of which it claims to have sold more than 70 to an undisclosed customer.

Conflicting responsibilities

Over its history, IAI chief executives have had to tread a delicate line between the often conflicting responsibilities of running a state-owned behemoth, and investing in the breakthrough technologies that, delivered at the right price, can give it the edge over international rivals. It can be a tough gig. Levy's predecessor Sheffer quit last year, after just two years. Internal disagreements over US expansion were thought to be a factor.

While IAI's financial troubles are largely behind it, not all parts of the group are performing well. IAI's 2020 revenues, at $4.18 billion, compared with $4.11 billion in 2019, were their highest ever, but the success was largely driven by defence, with the Elta unit contributing much of the increase. Sales at the aviation group, most exposed to the effects of the pandemic, fell 18%, to $1.19 billion, and its operating losses deepened.

While the return of air transport may help reverse that trend, Levy will face tough decisions, including how much to stake in attempting to boost market share in the USA, and whether to continue its partnership with Gulfstream on the G280. There has even been talk of IAI returning to business aviation in its own right for the first time in two decades. It sold its Galaxy Aerospace venture to Gulfstream parent General Dynamics in 2001.

An engineer at heart, Levy's 30 year career with IAI has been impressive – he has led the development and market launch of some of its most important and lucrative programmes, such as the Barak weapon system. He will be hoping that he can continue that track record of success during his tenure in the top job.

Super Air Jet ready to roar

Indonesia is to gain a new low-cost carrier with links to the Lion Group, but the reasons for its creation are unclear

Khafid Mukriyanto/Shutterstock

Greg Waldron Singapore

A new Indonesian airline with links to the Lion Group is in the process of building a narrowbody fleet.

Its ownership structure is opaque, but Super Air Jet appears to have links to Rusdi Kirana's Lion Group, which includes carriers Lion Air, Malaysia's Malindo, and Thai Lion.

In response to a query from FlightGlobal, Lion Group's communications team replied with a statement regarding the new airline – although it makes no mention of Lion. Further, Reuters reports that the new carrier will be run by Ari Azhari, formerly a general manager in Lion Group.

The statement indicates that the airline will commence services with Airbus A320-family jets, and that it will operate a low-cost model.

Cirium fleets data suggests that the new airline has already secured its first aircraft, a A320 on lease from CDB Aviation. The aircraft (MSN 4488) was operated by IndiGo from 2010 to 2020, and is now in storage at Batam's Hang Nadim International airport.

FlightGlobal understands that lease deals on other initial aircraft have also been finalised over recent months.

Apart from its statement on Super Air Jet, which outlines the opportunity for the new carrier in Indonesia, Lion Group has said nothing officially about the new airline, which as yet does not even have a website.

Founder Kirana has kept a very low profile since early 2020, as the group grapples with the effects of the coronavirus, including tough discussions with lessors.

Configuration change

Independent analyst Brendan Sobie notes that Super Air Jet is significant in that it marks the first time the Lion Group will operate the A320 in an all-economy configuration. The carrier's Batik Air unit has both business- and economy-class seating in its A320s.

"Lion Group intends to keep all three of its Indonesia-based airline subsidiaries, Lion Air, Batik Air and Wings Air, despite initial concerns among lessors that launching Super Air Jet could be a strategy for closing and replacing Lion," says Sobie.

"The strategy behind the new [air operator certificate] is instead more about making it harder for potential start-ups to enter and providing a platform for even lower costs by securing very cheap eight-year-old aircraft coming off lease at IndiGo."

But one lessor spoken to by FlightGlobal has a different theory: a new airline will also give Kirana extra leverage over lessors, particularly as they negotiate with the company's Transportation Partners unit regarding aircraft on lease to Lion Group airlines.

And while the idea of launching a new carrier in the midst of a pandemic may seem quixotic, Lion Group is clearly manoeuvring ahead of an eventual recovery.

In a recent forecast – compiled by Padjadjaran University (UNPAD) and commissioned by the Indonesia National Air Carriers Association (INACA) – the country's aviation sector is expected to make a full recovery by 2026, contingent on vaccines and the pandemic's retreat.

Domestic flight volumes are predicted to return to pre-pandemic levels by 2024, while international traffic will follow two years later.

However, the rate of recovery is directly linked to the speed of the vaccination programme's rollout.

The researchers' model suggests that doubling or halving the speed of vaccinations could either bring forward a full domestic recovery to as early as December 2022, when annual passenger volumes would near 75 million, or delay it to December 2025, when annual passenger volumes would hit 83 million.

Additional reporting by Cirium

JAL flies flag for A350

Japanese carrier says Airbus widebody will sit atop its fleet, as it reshapes twin-aisle inventory in pandemic-hit market

Alfred Chua & **Greg Waldron** Singapore

Japan Airlines (JAL) has picked the Airbus A350 as its future flagship, as it retires its fleet of domestic Boeing 777s by 2023, and reduces the number of large widebodies in the medium term.

In a business update released alongside its full-year financial results in early May, the Tokyo-based carrier disclosed that it will continue to introduce the A350 on domestic flights to replace its 777s, which it had already decided to remove.

Last October, JAL announced the retirement of up to 24 777s – comprising -200s and -300s used on domestic routes, and a number of -200ERs used for international flights. It will also move some -200ERs from the international fleet to operate domestic flights in the interim.

The carrier will introduce the larger A350-1000 on flights to Europe and North America from fiscal year 2023, which begins on 1 April that year. Airbus data indicates that the carrier has 13 of the big twins on order, plus is still to receive 10 of 18 A350-900s.

The move will mean that the 777-300ER, the carrier's current long-haul aircraft of choice, will lose its position as the fleet flagship.

JAL says the combined 777 fleet will be reduced to just 13 examples by FY2023, down from 39 aircraft in April 2020. The A350 fleet, meanwhile, is set to grow from five to 18 aircraft.

Underpinning the move is JAL's strategy to reduce the proportion of large widebodies in the fleet. At the group level, large widebodies, which JAL defines as the A350 and 777, made up about 18% of the pre-pandemic fleet. The carrier hopes to cut that to 14% by FY2023.

Meanwhile, the carrier swung to an operating loss of Y390 billion ($3.6 billion) in the 12 months ended 31 March.

Revenues dived 65.3% to Y481 billion, as the carrier reported a full-year net loss of Y334 billion.

Tough year

The airline acknowledges it was an "extremely tough year" for the sector, with the collapse in air travel amid the coronavirus pandemic.

"Facing a rapid and significant decrease of revenue, we implemented fundamental cost-reduction measures and investment reduction to mitigate the negative impact of the decreased revenue," says JAL.

For the 2020 financial year, operating expenses were Y885 billion, down from Y1.3 trillion in the prior period.

International passenger revenue fell 94.2% to Y27.9 billion, while domestic passenger revenue fell 67.2% to Y174 billion. But cargo and mail revenue rose 40.6% to Y129 billion.

"Severe worldwide restriction on international travel has caused the international passenger demand to almost disappear due to the rebound of infection and the spread of Covid variants," says JAL.

"We provided an international route network for returnees, expats and transit demand from Asia to North America."

Domestic travel was hurt by a state of emergency in Japan in April 2020, but then picked up again later in the year, only to be hit by another wave of Covid-19 in December 2020.

The reduction in belly-hold capacity over the year was a boon for the cargo business, however, with JAL operating 15,299 cargo flights using passenger aircraft.

"It is difficult to foresee the recovery of demand while the global spread of Covid-19 shows no sign of slowdown," says JAL.

"The recovery of international and domestic passenger demand may highly be affected by the circumstances surrounding Covid-19 and by situations of border closure and travel restrictions by governments, so that uncertainty on our further business performances, especially both our future supply plan and revenue forecast, is expected to remain."

However, in order to capture more revenue from Chinese traffic, JAL is to take a majority stake in Spring Airlines Japan, an increase on its current 5% shareholding.

China's Spring Airlines Group currently holds 48% of the joint venture. JAL does not indicate the size of the stake it hopes to acquire, but anticipates the deal closing by June.

Spring Airlines Japan will be a "China-focused" operation, to attract visitors from China, while "leveraging" Spring Airlines' brand recognition in its home market.

The investment will help JAL "capture the first inbound demand in China, which is expected to recover in the future", it adds.

Airline is still to receive 10 of the 18 A350-900s it has ordered

Viper Zero/Shutterstock

Defending across the domains

The interoperability of security assets in air, land, sea, satellite and cyber is crucial to modern military thinking. This will be a key focus of the World Defense Show next March

For millennia conflicts have been fought on land and sea, and, in the twentieth century in the air too. In the future, they are likely to also be contested in space and even on the world wide web, as new technologies and tactics are employed to probe and penetrate enemy defences.

Modern military planners now think in terms of these five domains as distinct but linked. Threats may come from one, several, or all of them at once, and those charged with maintaining safety must devise holistic and effective strategies to deter or counter them.

Today's defence show circuit tends to comprise events that concentrate either on traditional domains – aviation, naval, and land – or cyber security. The space element is often treated as an offshoot of conventions focusing on commercial spaceflight.

Rather than taking this somewhat siloed approach to the challenge, World Defense Show – which debuts in Riyadh in Saudi Arabia early next year – will stand out from the competition in that it will feature all five domains, with an emphasis on interoperability and integrated solutions.

The event – founded by the kingdom's General Authority for Military Industries (GAMI), the regulator and enabler for Saudi Arabia's defence sector, and taking place from 6-9 March – will give manufacturers and suppliers in each sector a chance to showcase their products and services in one of the most impressive industry show venues ever built.

With 800,000 sq m of outdoor space at the exhibition site, just one hour's drive from downtown Riyadh, the World Defense Show will be the only event of its kind to feature both land and air displays. It will also be the first show to have its own purpose-built runway and dedicated airspace for live military aircraft demonstrations.

Each of the five domains will be brought to life through virtual simulations and live demonstrations. For example, even though the show location is inland, state-of-the-art, interactive visual displays will illustrate how technologies can be incorporated into naval systems.

The site is even set to feature a command and control centre where visitors can experience the operational harmony across air, land, sea, cyber and space that the latest integrated systems on the market offer.

"The distinct format of the event will be a draw for any military professional keen to understand the multi-domain potential of the latest technologies"

Organisers of the World Defense Show – who spent almost two years planning the event in the run-up to its official launch in July 2020 – took into consideration a number of trends in the defence industry and global military market when devising the format.

Firstly, although the sector has survived the Covid-19 pandemic much better than its commercial counterpart, national defence budgets are likely to remain under pressure in coming years. This will prompt national and military leaders to increasingly seek efficiencies and value-for-money solutions.

Traditional "heavy metal" – ships, artillery, armour, and aircraft – are certain to remain vital assets in the defence portfolio. However, unmanned platforms – with surveillance and offensive capabilities, and across air, land, marine and sub-marine – will play a bigger security role. So too will a new generation of compact, less expensive observational satellites.

Other than perhaps in the USA, the notion of national contractors making the bulk of their revenues from a domestic customer are long gone. So another market shift is that defence companies must co-operate across borders, often partnering industrially and sharing technologies with their customers.

Finally, the interoperability of defence assets is one of the most important developments. Recent conflicts have shown how vital it is that military commanders are able to rapidly shift their focus from one domain to another to deal with security threats, while minimising casualties and collateral damage.

With its substantial military budget, Saudi Arabia is an attractive market for international manufacturers. Additionally, there are opportunities aplenty to partner with local industry, with the government in Riyadh committed to securing a 50% share of defence procurement for domestic suppliers by the end of this decade, as part of its Vision 2030 strategy.

That in itself is sure to drive interest in the show from some of the biggest players in the global defence industry – a large number have already signed up. However, the distinct format of the event, with its focus on interoperability, will also be a major draw for any military professional keen to understand the multi-domain potential of the latest technologies.

World Defense Show may be the newest name on the defence expo calendar, but its organisers are in no doubt that – with its unique offering to exhibitors and visitors, coupled with Saudi hospitality – the event will be a must-attend for thousands of industry executives and senior military personnel for years to come. ◗

World Defense Show will be held in the presence of Saudi Arabia's key leadership, international delegations and prominent industry decision-makers from around the world. To learn more about the show, visit www.worlddefenseshow.com.

US Air Force

Saudi Arabia is one of the world's most important defence markets

Marshall's star attraction

The UK Royal Air Force is now set to retire its Hercules fleet in 2023

While its domestic customer is nearing an end to almost 60 years of C-130 use, UK support specialist's boss says international business is taking off

Craig Hoyle London

Having provided in-service support to the UK Royal Air Force's (RAF's) tactical airlifter fleet for a remarkable 55 years, Marshall Aerospace and Defence Group (MADG) knew that their relationship on the Lockheed Martin C-130 could not last forever.

But the Ministry of Defence's (MoD's) March announcement that operations with the service's remaining 14 J-model Hercules would end in 2023 – 12 years earlier than previously planned – still came as "disappointing news" to the Cambridge airport-based company.

"There was always a risk the UK would retire [them] a bit earlier, so it was not a complete surprise," interim chief executive Gary Moynehan tells FlightGlobal. In fact, he says the company had been de-risking the potential for their accelerated withdrawal since the publication of the MoD's 2015 Strategic Defence and Security Review.

That planning document had set out an ambition to extend the type's use until 2030 via upgrade – later moved out to 2035, thanks to a centre wingbox replacement programme activity to be performed on each aircraft by MADG. The RAF introduced its originally 25-strong fleet of C-130Js from 1999.

One of the UK's most successful privately-owned defence companies, MADG – as with all in the industry – has faced a challenging time over the past year, as Covid-19 impacted its operations. Then, even as it was adjusting its working practices in response, then-chief executive Alistair McPhee took the surprise decision to leave.

New leadership

A 12-year Marshall executive who had most recently been the company's director of finance and strategy, Moynehan took the helm in September 2020 and is continuing a transformation activity launched on his predecessor's arrival four years earlier. Despite the upheaval, "the business has rallied around my leadership", he says.

Earlier, senior executives had strived to diversify the company's activities beyond central pillars of C-130 MRO and military land vehicle work, with only mixed results.

Such side ventures – which ranged from entering the hugely competitive commercial MRO sector, to being Northern European distributor for the Honda Aircraft HondaJet – have all now been ended. The company has also exited providing support to Cessna Citation and Gulfstream-family business jets; activities dating back to 1960 and 1974, respectively.

"The criteria that make us successful in the military market are not important in the civil sector," Moynehan says. "The people who are successful in that space have a different set of characteristics."

The company also has moved away from offering bespoke special mission aircraft conversions, which he says are "an inefficient use of that depth capability". This followed a deal to supply the United Arab Emirates with a pair of heavily-adapted Bombardier Global Express surveillance aircraft.

As an example of this shift, MADG in May 2020 withdrew its interest in modifying a five-strong fleet of 737NG-based E-7A Wedgetail airborne early warning and control system aircraft for the RAF, after failing to agree a business case with Boeing. Its executives are doubtless now relieved, since the MoD's review opted to reduce the incoming fleet size to just three airframes.

Referring to MADG's at times wandering direction prior to McPhee's arrival, Moynehan notes: "We had a strategy where we were expanding and diversifying the sectors and markets we were in, but it didn't really have a coherence – it was spreading us wider and thinner."

Instead, the company has returned its attention to supporting a growing number of C-130 operators, and also driven strong growth in its land vehicle activities.

"We have been quite successful in doing that. We've narrowed the focus a bit, but been more successful in those core markets.

"Over the past five years, we have roughly doubled the number [of Hercules operators] being supported," he notes.

The company secured international C-130 business worth more than £162 million ($225 million) in the three-year period ending December 2019. It currently supports examples operated by 16 nations: Austria, Bahrain, Bangladesh, Belgium, Cameroon, Canada, Denmark, France, Kuwait, the Netherlands, Norway, Oman, Qatar, Sweden, the UK, and the USA.

Essential support

The RAF's first K-model Hercules arrived at Marshall's facilities in December 1966 for modification work ahead of entering operational service in August 1967. The company's role in supporting the initially 65-strong fleet cannot be understated – in addition to performing maintenance tasks, it completed a fuselage extension upgrade to 29 aircraft, developed and fielded an air-to-air refuelling receiver capability within 15 days as the Falklands conflict began in 1982, and subsequently converted several airframes for tanker duties.

The RAF retired its last K-model examples in late 2013, replacing these with its Js and Airbus Defence & Space A400Ms.

Cirium fleets data shows that seven of the UK's original, now 53-year-old Hercules remain in use, with the air forces of Austria (3), Mexico (2) and Sri Lanka (2).

So, given the pending removal of its maintenance work on the RAF's Hercules – spanning forward work conducted at its Brize Norton base in Oxfordshire by a 70-strong team, and depth activities performed in Cambridge – is a crisis looming?

While there are clear potential negative implications for part of its 1,700-strong workforce, the company believes that this is not the case.

"Marshall has so far successfully acted as the resale partner for eight ex-RAF C-130Js," the company says: to Bahrain (2), Bangladesh (5) and the US Navy (1). "Marshall works in concert with Her Majesty's Government to provide the technical expertise and knowledge to the transaction, supporting the reconfiguration and entry into service of the aircraft, as well as longer term fleet support."

Describing the activity as "a well-trodden path", Moynehan notes: "The resale of the UK aircraft will be a priority, and a significant amount of work" for the company.

"There is a very strong market for used J sales," he says, pointing to both the commercial and political benefits made possible by the UK brokering such deals. "We know a number of operators who would be interested," he adds, noting that offering prospective customers blocks of three to five aircraft "is natural".

Marshall Aerospace & Défence Group

Moynehan took the helm in September 2020 and is continuing business transformation

While its close links with the RAF may be coming to an end, Moynehan says "our relationship with Lockheed is exceptional", and getting stronger. Dhaka was not a Foreign Military Sales candidate, he says, noting: "They would never have sold new Js to Bangladesh."

The status of the UK's planned £110 million centre wingbox replacement activity is an unanswered question. Three of the RAF's aircraft have returned to use since last August after receiving the life-extending modification, and discussions are to take place about whether to conduct the work on the remainder.

"The value of those aircraft is a pretty straightforward business case," Moynehan says, adding: " [the MoD] recognise the importance of not taking short-sighted decisions."

Promising opportunities also exist with the US Marine Corps (USMC). MADG and rival MRO provider Cascade Aerospace are now able to pitch for modification work on part of the service's 66-strong KC-130J tanker fleet, via a 10-year enabling contract placed with both last year.

With 10-12 such maintenance activities to be released per year, Moynehan says "securing the maximum slice of that pie will be critical". Marshall expects to complete work on its first USMC KC-130J during June, and he notes: "The significant point is demonstrating performance." Marshall already supports KC-130Js operated by Kuwait.

Relocation plans

Meanwhile, a major activity that the pandemic has not disrupted is a plan for the company to relocate from its Cambridge home by 2030. Last year it signed an option agreement to move to Cranfield in Bedfordshire and is considering Wyton in Cambridgeshire as an alternative, but has discounted Duxford.

"The requirement to relocate remains the same," Moynehan says, in part due to the need to otherwise make major investment in the Cambridge site's aged facilities.

Around half of MADG's employees have had to be on site during the pandemic, with the rest adapting to home working. "We prepared for the worst, but didn't get near it," he says: the only workers furloughed were airport operations staff.

"We are refining some of the footprint" as a result of new working practices, says Moynehan, who believes that as restrictions ease in the UK, the company should maintain its freshly proven agility, rather than "spring back to the old way".

A firm decision on the move location will need to be made in the 2023-2025 period, he says – both to give time for required infrastructure work to occur at a new site, and "to give clarity to our workforce".

So, with an expanding list of operators to support, Marshall's relationship with the Hercules will not be ending when the RAF brings operations to a halt in two years' time.

"The C-130 is far from dead," Moynehan says. "The UK [announcement] is disappointing, but if anyone thinks we'll be going away, they're in for a surprise."

"Over the past five years, we have doubled the number [of Hercules operators] being supported"

Gary Moynehan Interim chief executive, Marshall Aerospace & Defence Group

New loading procedures allow the type to carry additional weapons

US Air Force

F-15E to pack more punch

Strike platform tested carrying five stealthy cruise missiles, as US Air Force looks to spread duties beyond its bomber fleet

Garrett Reim Los Angeles

The US Air Force (USAF) has shown the ability for a Boeing F-15E to carry five Lockheed Martin AGM-158 Joint Air-to-Surface Stand-off Missiles (JASSMs), as it works to increase the strike platform's operational flexibility.

Called Project Strike Rodeo, the proof-of-concept activity was completed by the 85th Test and Evaluation Squadron at Eglin AFB in Florida.

The idea of increasing the F-15E's weapons load-out emerged from a working group in January 2021, says Lieutenant Colonel Mike Benitez, director of staff at the USAF's 53rd Wing.

"A team of expert tacticians were working through a specific scenario that relied on the ability to escort a bomber loaded with stand-off munitions to a release point in a highly-contested environment," the USAF says. "Some warfighters hypothesised that using a formation of fighters instead of a single bomber to employ the JASSM salvo could not only reduce the size and complexity of the strike package required to execute the mission, it would also distribute mission risk across the force."

Using F-15Es to carry a large number of JASSMs would give combat commanders options and create dilemmas for adversaries, who would find it more difficult to predict which types of aircraft might be used during an attack, Benitez notes.

High-value targets

Intended for use against high-value or highly defended targets, such as command and control centres and surface-to-air missile batteries, the stealthy JASSM is qualified for use on the Boeing B-1B and B-52 and Northrop Grumman B-2 bombers. The F-15E ordinarily can carry two of the weapons.

The USAF has increased its interest in cruise missiles in recent years, as sophisticated surface-to-air missile systems, such as the Russian-made Almaz-Antey S-400, have made it more difficult for non-stealthy types – such as the F-15E – to fly into adversary airspace.

In 2019, the US Department of Defense more than doubled its planned long-term acquisition of JASSM rounds, from 4,900 to a possible maximum of 10,000.

Were the F-15E to assume cruise missile launch duties in place of a dedicated bomber, its current two-round capacity would have to be increased.

"Unfortunately, the [additional] munitions would not fit on the conformal fuel tank weapons stations of the F-15E, as JASSM was designed to be loaded directly from the base of their shipping containers, which is too large to fit under the F-15E without hitting the main landing gear," says the USAF.

To address this, a team designed and manufactured a special loading tool and wrote new weapons loading procedures for the AGM-158.

"No-one told us to do this," says Benitez. "We saw the need and the opportunity, so we executed. This infectious attitude drove every unit or

office we coordinated with. Everyone wanted to see if we could do it, and no-one ever pushed back and asked for a requirement or a formal higher headquarters tasking."

Project Strike Rodeo went from idea to execution in about five months, says the USAF, and with the load test having proved successful, it is planning flight trials.

The prospect of increasing JASSM capacity on the F-15E comes after the 85th Test and Evaluation Squadron in February demonstrated the type's ability to carry six Boeing Joint Direct Attack Munitions (JDAMs) on a single side of the fuselage. In theory, this could boost the maximum number of such weapons carried from nine to 15.

"The Strike Eagle can now carry enough JDAMs for an active combat mission, land at a remote location, and reload itself and/or another aircraft – such as a [Lockheed Martin] F-35 or F-22 – for additional combat sorties," Lieutenant Colonel Jacob Lindaman, the test unit's commander, said following the proof-of-concept installation.

If such a configuration were used, the USAF says not all of the 15 JDAMs carried could be released during a mission. However, the ability to ferry extra bombs in such a way would simplify logistics in line with its Agile Combat Employment strategy, which plans to disperse combat aircraft across different airfields, including remote bases.

"The combat tactic of reloading in a remote location previously took two [Lockheed] C-130s to carry the necessary munitions and personnel. Once at the location, the JDAMs had to be assembled, taking extra time," the USAF says. "The additional carriage on the F-15E allows fully assembled JDAMs to be transported, reducing the requirement to just one C-130 and saving [time by] eliminating on-site bomb building."

10,000

Maximum possible acquisition of JASSM rounds as planned by the US Department of Defense in 2019

Lindaman adds that using the F-15E to move JDAMs also could help increase the tempo of combat operations, thanks to faster weapons reloading.

The additional carrying capacity of the F-15E also may have implications for the USAF's efforts to replace its aged C/D-model fleet with 144 enhanced F-15EX Eagle IIs. The service opted to order the new model instead of some F-35As in part due to its increased weapons payload capacity.

Now entering operational test and evaluation, the F-15EX is expected to remain in operational use at least into the 2040s.

Separately, the USAF has demonstrated the ability to pass data between an F-22 and five F-35s by using an "Open Systems Gateway" communications payload carried aboard a Lockheed U-2 surveillance aircraft.

"Project Hydra marks the first time that bi-directional communications were established between fifth-generation aircraft in-flight," says Jeff Babione, vice-president of Lockheed Martin's Skunk Works advanced development programmes unit. The F-22's Intra-Flight Data Link and the F-35's Multifunction Advanced Data Link cannot directly transmit information to each other.

The airborne gateway also allowed the F-35 to pass sensor information to a US Army Integrated Battle Command System centre via a Tactical Targeting Network Terminal link.

"This next-level connectivity reduces the data-to-decision timeline from minutes to seconds, which is critical in fighting today's adversaries and advanced threats," says Babione.

Hypersonic simulation hits the spot

On 5 May, the US Air Force (USAF) demonstrated a Boeing B-52 bomber carrying out a simulated hypersonic missile strike using targeting data from sensors that were positioned more than 1,000nm (1,850km) away.

Performed during the Northern Edge 21 exercise in Alaska as part of an all-domain operations capability experiment, the activity involved a B-52 conducting a roughly 13h sortie from Barksdale AFB in Louisiana.

While en route to its simulated weapon release point, the aircraft's crew received targeting data from undisclosed sensors positioned at Joint Base Elmendorf-Richardson in Alaska. "The bomber then was able to successfully take a simulated shot of the target from 600nm away, using an AGM-183 Air-Launched Rapid Response Weapon [ARRW]," the USAF says.

Developed by Lockheed Martin, the boost-glide ARRW is expected to undergo flight testing through 2022, before becoming the service's first operational hypersonic weapon. A first free-flight rocket booster test of the missile – which is believed to have a range of up to 870nm – failed in April, due to a fault during its launch sequence.

"This was a successful showcase of beyond-line-of-sight kill chain employment – and notably, it was a success in the highly contested and realistic threat environment that Northern Edge exercise provides," the USAF says.

13h B-52 sortie replicated future operational use of ARRW system

US Air Force

Greener Vista

Charter operator VistaJet embraces environmental initiatives and targets carbon neutrality within four years

Vytautas Kielaitis/Shutterstock

Dominic Perry London

High-end charter operator VistaJet has committed to achieving carbon neutrality by 2025 as it looks to set the standard for environmental performance in the sector.

Noting that its target goes further and faster than the wider aviation industry's goal of a 50% reduction in carbon emissions by 2050, VistaJet hopes its example will be followed – or bettered – by others.

"Ultimately this is about the industry lifting up its socks and doing the best it can," says chief commercial officer Ian Moore. "I think our announcement shows what we feel needs to be the standard."

Initiatives adopted by the operator include offering customers the option of offsetting their carbon emissions, a partnership with SkyNRG to increase the uptake of sustainable aviation fuel (SAF), reducing the number of empty legs flown and the introduction of the latest-technology aircraft.

VistaJet has seen an impressive 80% take-up for its offsetting scheme, run in conjunction with environmental consultancy South Pole, far outstripping the rate seen in commercial aviation. For example, Lufthansa Group chief executive Carsten Spohr recently noted that less than 1% of its passengers use the group's voluntary scheme to buy carbon credits or SAF to compensate their flight emissions.

Moore suggests that the relative wealth of VistaJet's clientele, and pressure from their "stakeholders" – whether family members, investors or board members – has contributed to the high level of participation in the offsetting programme.

VistaJet's customers are also offered the option of using SAF in place of regular Jet-A on flights, with blends varying from 10% to 100%. Those levels have been achieved in collaboration with airframe supplier Bombardier and propulsion specialists GE Aviation, Honeywell and Rolls-Royce.

However, with SAF costing in some cases six times more than conventional jet fuel, Moore is keen that the industry "works out how to bring the cost down".

VistaJet has also been offering customers incentives to enable a reduction in empty legs flown, through, for example, lower rates to switch departure airports.

> "This is about the industry lifting up its socks and doing the best it can – this shows what we feel needs to be the standard"
>
> **Ian Moore Chief commercial officer, VistaJet**

Artificial intelligence

While 2020's disrupted travel environment means no figures are available for last year, the company achieved a 20% reduction in empty legs flown in 2019. It hopes that through the application of higher levels of artificial intelligence within its booking system, that rate can be maintained as traffic normalises.

Flying the latest generation of aircraft, such as the Bombardier Global 7500, is also contributing to the environmental performance, argues Moore. While there is also an operational cost benefit from the lower fuel consumption offered, he notes that this is more than offset by the high acquisition price of the new jets.

Other initiatives adopted by VistaJet include a move to renewable sources of electricity on the ground, the use of sustainable products on board, and an annual greenhouse gas accounting report.

Moore believes that the commitment to carbon neutrality will spur a response from the rest of the industry. "We are now looking forward to seeing how everyone follows this – or takes it further."

Single [R]evolution

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Soaring ever higher

High-altitude glider research project looks towards future missions despite founder's passing and Covid challenges

Jon Hemmerdinger Tampa

The Perlan Project proved you don't need fuel to fly to the edge of space – mountain air will do just fine.

But you probably need a man like Einar Enevoldson, the legendary test pilot behind a project that has flown gliders to altitudes exceeding 70,000ft, capturing records and advancing high-altitude scientific research.

"His primary job was being our compass," Perlan chief executive Ed Warnock says of Enevoldson, who founded the project. "Einar stayed involved day-to-day up until three days before he passed."

Enevoldson's death on 14 April at the age of 88 has left the Perlan Project in a challenging position, as it seeks to continue its high-altitude work without the man who helped make it all possible.

But Warnock says the non-profit organisation's ambitions burn bright as ever, despite the loss of Enevoldson and having scrapped two missions – in 2020 and again this year – as a result of the coronavirus pandemic.

"Next year we are hoping to go back to Argentina," he says.

Warnock remembers his first breakfast meeting with Enevoldson to discuss his joining the team.

"He was approachable, conversational," Warnock recalls. "There was nothing about Einar that, if you just bumped into him, you would say, 'Oh my gosh, I am in the presence of greatness,'."

Enevoldson was indeed legendary in aviation circles. A Seattle native born in 1932, he earned a master's degree in aeronautical engineering and embarked on a long aerospace career. He was a US Air Force fighter pilot, a test pilot for the Royal Air Force, a research pilot with NASA and chief test pilot at German airframer Grob Aircraft.

Long experience

Enevoldson logged time in many aircraft: Vought F-8s that had been modified as part of a NASA programme, Lockheed's experimental YF-12A fighter, NASA's AD-1 oblique-wing experimental jet, a "controlled deep-stall sailplane" and Martin Aircraft's experimental "lifting body" X-24B.

He also flew British jets – Hawker Hunters and English Electric Lightings and Gloster Javelins.

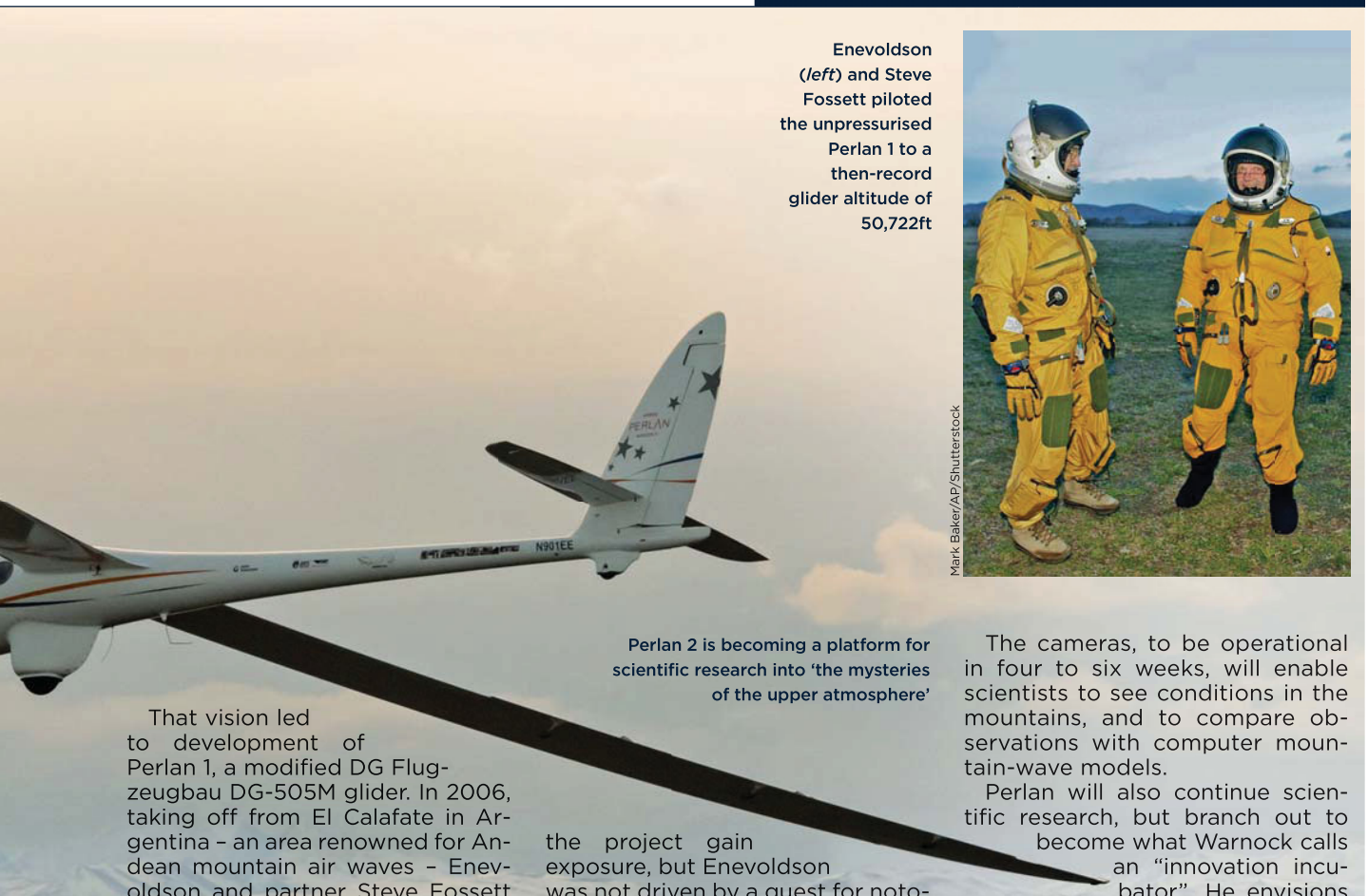
Through it all, Enevoldson fed his love for gliders, spending weekends soaring from El Mirage, California. But he wondered if stratospheric mountain air waves could lift a glider to extreme altitudes.

"He had a singular passion for this flight to the edge of space in a glider," Warnock says. "His quest was to get to 100,000ft... higher than the SR-71" – Lockheed's legendary Blackbird reconnaissance aircraft.

Airbus

NASA

Einar Enevoldson worked as a research pilot for NASA among many roles in his long career



Perlan 2 is becoming a platform for scientific research into 'the mysteries of the upper atmosphere'

Mark Baker/AP/Shutterstock

Enevoldson (*left*) and Steve Fossett piloted the unpressurised Perlan 1 to a then-record glider altitude of 50,722ft

That vision led to development of Perlan 1, a modified DG Flugzeugbau DG-505M glider. In 2006, taking off from El Calafate in Argentina – an area renowned for Andean mountain air waves – Enevoldson and partner Steve Fossett piloted Perlan 1 to a then-record glider altitude of 50,722ft.

Then came development of a higher-altitude glider called Perlan 2, and formation of the non-profit, Oregon-based Perlan Project to oversee the increasingly complex and expensive effort.

Rising ambition

Perlan 2, a pressurised two-pilot glider with a 25.6m (84ft) wingspan, was developed by Bend, Oregon glider company Windward Performance.

Airbus became a sponsor, and Perlan set out to fly higher.

In 2018, also from El Calafate, Perlan 2 ascended to 76,124ft. That flight beat the known altitude record for winged, manned subsonic aircraft and took the second place altitude record for a winged aircraft behind the SR-71, which has reportedly reached 85,000ft.

Perlan 2 is designed to fly no higher than 90,000ft; at that altitude, a 50kt (90km/h) indicated airspeed translates into about 350kt over ground, meaning shock waves can form around an aircraft.

For that reason, Perlan intends eventually to develop a glider with transonic wings for the purpose of attaining 100,000ft.

The records have highlighted Perlan's achievements and helped the project gain exposure, but Enevoldson was not driven by a quest for notoriety, says Warnock.

"Einar envisioned that the programme was not about setting a record. Once we had a stable platform – a proven platform – it would turn into a scientific research organisation," he says.

Warnock's team had hoped to deploy Perlan 2 back to Argentina both in 2020 and in 2021, but Covid-19 forced both missions to be cancelled.

76,124ft

Perlan 2 reached a record altitude for subsonic aircraft while soaring over Argentina's Andean mountains in 2018

Then came Enevoldson's passing.

Perlan's board is now tasked with maintaining the organisation's momentum and mission.

That includes getting Perlan 2, now on the ground at Minden-Tahoe airport in Nevada, back to El Calafate next year.

Meantime, Perlan is installing three "sky cams" in the El Calafate area: one in the town itself, one at the nearby airport and another about 17nm (32km) west of El Calafate, close to the mountains.

The cameras, to be operational in four to six weeks, will enable scientists to see conditions in the mountains, and to compare observations with computer mountain-wave models.

Perlan will also continue scientific research, but branch out to become what Warnock calls an "innovation incubator". He envisions Perlan partnering with researchers and for-profit companies to develop technologies that align with Perlan's high-altitude focus.

Data collection

Perlan recently launched PARTners, an atmospheric research effort that involves Canadian high-altitude unmanned glider company Stratodynamics Aviation, Nevada-based atmospheric data company WeatherExtreme and Grob Egrett operator AV Experts. The group will use data collected by Perlan 2.

Perlan's other research efforts include supporting novel methods of measuring atmospheric gas, understanding relationships between high-altitude air waves, and studying stratospheric waves over Canada.

There are also plans to measure stratospheric humidity using a radio occultation sensor that has been developed by Airbus's Silicon Valley-based innovation division Acubed.

The sensor "could be carried on every airliner in the world", giving meteorologists a wealth of new atmospheric data, Warnock says.

"The mysteries of the upper atmosphere are just beginning to be tapped," he adds. "We've only just got a glimpse."

Shock and AW

Leonardo and Kopter eye hybrid future for rebranded AW09

Dominic Perry London

Leonardo Helicopters and Kopter are already contemplating the development of a hybrid-electric rotorcraft demonstrator even as they work to bring the newly rebranded AW09 to market.

Swiss firm Kopter was bought by the Italian aerospace giant a year ago and the pair on 21 April announced the change from the previous SH09 designation, which they see as an important integration step.

While test activities continue on the 2.8t AW09 in order to achieve service entry by 2022 or early 2023, Leonardo Helicopters is keen to bring new technologies to the platform or to other products in its range.

Matteo Ragazzi, Leonardo Helicopters chief technology officer, said during a 21 April media briefing that as the AW09 closes on certification there will be an "overlapping of activities" to ensure that there is "a demonstrator out there shortly after".

This would allow it to "refine the final product for the second part of the decade".

While Ragazzi says it is too early to say what technologies it would look to implement on the helicopter, he identifies hybridisation as one avenue of interest.

That might start with simple electrification – what he describes as having "one and a half engines" – but using an architecture that could also in future "translate into other variations including fuel cells".

As regulations governing future propulsion systems are still in development, any demonstrator would allow Leonardo Helicopters to "support the evaluation process and show what is the art of the possible today", says Ragazzi.

Unconventional propulsion

The AW09 is seen as the "first platform" in a family of "new light aircraft that will have conventional [helicopter] architecture but not conventional propulsion", he adds.

Kopter has previously touted the design of its main gearbox as being uniquely suited to hybridisation and has filed patents outlining possible approaches.

Michele Riccobono, chief technology officer for Kopter, says it has not settled on any one direction, but says the patents are "going to be the foundation of this further evolution".

Although Kopter could build a new helicopter to serve as the demonstrator, Ragazzi says the company would prefer to direct its resources to validating new technology, potentially opening the door for re-use of an existing prototype.

He says it does not want to "waste energy" to "reinvent the wheel" and may instead adapt one of the pre-serial (PS) AW09s which are due to perform certification flights.

Aircraft PS4 is due to fly sometime between September and November this year, with PS5 following in 2022.

Previous test flights have used the company's P3 prototype, which has now accumulated 40h with its updated configuration, a change that was implemented at the turn of the year.

That saw the addition of an upgraded main gearbox, enhanced rotor mast – controls are now on the exterior of the structure – and a new Garmin G3000H avionics suite. Aerodynamic tweaks were also made to improve the type's handling.

The change to the mast architecture was driven by concerns around the ease of access to the controls. "We realised almost immediately that from a maintenance standpoint the burden would have been significant. Any kind of maintenance activity or inspection would have been quite complex," says Riccobono.

Leonardo Helicopters says the revised AW09 designation was selected to show the helicopter had been brought within its product family while also retaining Kopter's "strong and original history".

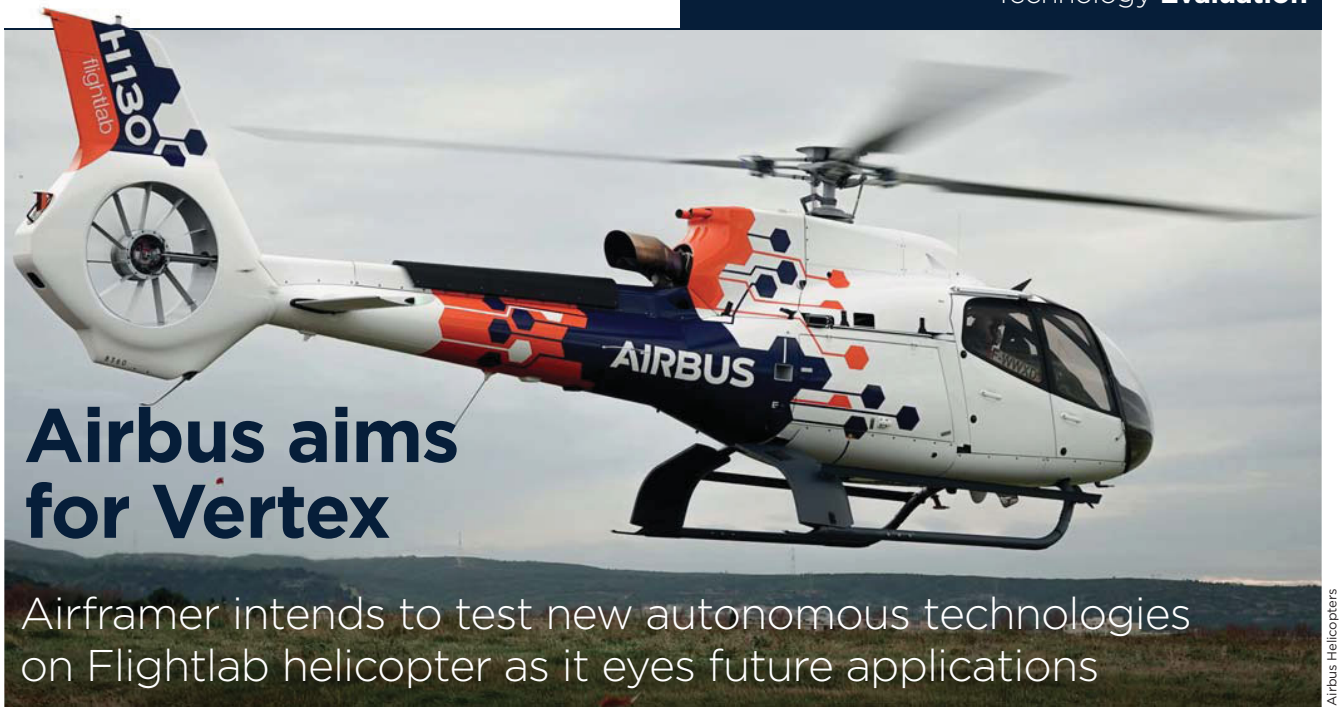
Final assembly of the AW09 will take place at Leonardo Helicopters' facility in Vergiate, Italy; a second production line is also due to be established in the USA, most likely at the manufacturer's plant in Philadelphia.

Mollis, Switzerland, which was to serve as Kopter's European production hub, will "remain a plant with a clear prototype manufacturing mission", says Marco Viola, Kopter chief executive, as part of Leonardo's strategy to use the business as a "centre of excellence for light helicopters".

Kopter has its headquarters in Wetzikon, near Zurich, plus an additional subsidiary near Ottobrunn in Germany.

Kopter/Leonardo Helicopters

Airframer is keen to introduce new technologies to the former SH09



Airbus Helicopters

Airbus aims for Vertex

Airframer intends to test new autonomous technologies on Flightlab helicopter as it eyes future applications

Dominic Perry London

Airbus in 2023 will begin flight tests of a new sense-and-avoid system integrated onto its H130-based Flightlab helicopter, as it works to mature autonomous technologies to increase operational safety on current and future platforms.

Led by the group's UpNext division, the initiative, called Vertex, will build on activities already conducted by Airbus Helicopters.

This includes previous tests of its Eagle system, which used a trio of gyrostabilised cameras, data processing and image recognition capability coupled to the autopilot to enable automated approaches.

Algorithms and advanced image processing allowed the automatic recognition of features, such as the H of a helipad, from distances of up to 2,000m (6,560ft) away at shallow approach angles.

Eagle was trialed on an H225 heavy-twin three years ago, and was due to lead to a product being available across the range by 2021.

However, advances in sensor technology and computing power should enable the "mass and cost of operation" of such a system to be cut, says head of research and innovation Tomasz Krysinski. New iterations of image processing algorithms will gain more maturity with Vertex, allowing industrial applications in the medium timeframe.

Vertex will incorporate electro-optical and infrared cameras alongside a Lidar sensor supplied by automotive specialist Luminar.

A pair of high-powered computers will be integrated into the Flightlab helicopter – one for the sensor suite and image processing, and the other for the avionics – plus fly-by-wire controls. Also forming part of the overall package is an advanced human-machine interface which incorporates a touchscreen display and smart-type glasses for the pilot to show certain parameters.

Integration activities have already begun, and flights using some of the equipment are planned ahead of 2023 in order to begin gathering data.

Third pilot

Next year will see a third pilot seat installed in the H130, the occupant of which will use a fly-by-wire joystick to control the helicopter.

Severin Dauvergne, head of the Vertex demonstrator, says that Eagle was "mature from the beginning", enabling test flights to be halted after just 10h. He anticipates a similar level of performance from Vertex: "We expect it to also be right first time," he says, which will be enabled by extensive ground-based simulations.

In all, "less than 20 hours" of flying should be required, says Dauvergne, as the manufacturer looks to take the system to technology readiness level 6.

Significant emphasis will be given to low-speed, low-altitude operations where there is "more opportunity to meet obstacles", says Dauvergne.

Airbus emphasises that Vertex does not have "autonomy as a target in itself" but instead is a means "to explore autonomous technologies alongside other technological innovations".

Grazia Vittadini, Airbus chief technology officer, says that the airframer's ambition from the project is to "significantly increase safety margins" through reducing crew workload and cognitive overload and providing enhanced situational awareness.

With the sensor suite and computing capability coupled to the autopilot, the system will be capable of managing navigation and route preparation, performing automatic take-offs and landings, as well as following a predefined flightpath.

Should an obstacle be detected, either the system will take avoiding action, while warning the pilot that it is doing so, or the pilot can initiate the manouevre through double tapping the tablet.

Airbus says the installation of a joystick and full fly-by-wire controls, using an "active trim system", on the helicopter is to enable the Vertex system to be tested on the Flightlab platform and as a "techno brick" to evaluate the flight controls of future electric vertical take-off and landing aircraft. However, "it is not aimed at developing a system that could be retrofittable".

Krysinski notes that two previous outputs from its research and technology efforts will be available to customers shortly: a Lidar-based Rotor Strike Alerting System and a digital health and useage monitoring system for small helicopters.

Airbus Helicopters unveiled the Flightlab platform in January.

Unclear approach

A UK effort to replace Puma rotorcraft will be one of its first to follow a new procurement model favouring national prosperity over capability alone

Current fleet is expected to be replaced by middle of this decade

Dominic Perry London

With the UK set to replace its Royal Air Force fleet of 23 Puma HC2 helicopters by the middle of this decade, the contenders are already lining up.

But the competition will be one of the first major procurements in the country to be conducted under new rules designed to make economic and social factors a core part of the selection process, potentially tilting the field.

At this stage, much remains unknown: the Ministry of Defence (MoD) announced the retirement of the Pumas in its Command Paper *Defence in a competitive age*, published on 22 March. That called for the twin-engined platform to be replaced by a New Medium Helicopter (NMH) by the middle of the decade.

A team has been set up within the MoD to draft requirements for the contest, but there is no indication as to when these might be released.

"Work on this programme is at a very early stage, with effort focused on developing and refining key user requirements for the new medium helicopter. Therefore, details in relation to the procurement strategy, basing locations, fleet size, delivery schedule and organisational structure are being assessed," says the British Army, to which FlightGlobal was directed for a response.

Complicating the issue slightly is the decision to also use the NMH to replace three niche fleets used by the military: understood to be army-operated Bell 212 and 412 transports, and Aerospatiale-built AS365 Dauphins which are used to support special forces personnel.

Platform size

The move to bring these within the scope of NMH will have a bearing on both the size of the platform and the quantity to be acquired. If all current aircraft are replaced on a one-to-one basis, perhaps as many as 40 helicopters could be required.

So far, the only two manufacturers to declare a definite interest are Airbus Helicopters and Leonardo Helicopters. US airframers Bell and Sikorsky, meanwhile, are waiting for more detail before deciding whether to propose their respective 525 and UH-60M Black Hawk.

Leonardo Helicopters' participation – as the UK's only rotorcraft manufacturer – was a nailed-on certainty: it has been touting the credentials of its AW149 as a Puma replacement for several years and clearly views the jobs that such a contract would support as weighing heavily in its favour.

But despite being on the market since 2006, sales of the AW149 have been underwhelming: it has been selected by just two customers, the Royal Thai Air Force (5) and Egypt (24); deliveries to the latter are ongoing.

Airbus Helicopters, meanwhile, has indicated that it could offer the H175 or H225M, depending on the exact requirement, or even the NH Industries NH90, in which it has a majority 62.5% stake, alongside Leonardo Helicopters (32%) and Fokker (5.5%). These span the weight range from 7.8t to 11.5t.

None of these helicopters are without issues, however. No military version of the H175 has so far been developed, largely due to Chinese involvement in programme. The civil version of the Super Puma carries significant reputational baggage, even if the underlying causes

of a fatal 2016 crash are now fully understood. And the NH90, while an advanced platform with fly-by-wire controls, seems unable to shake off a problematic reputation.

There also remains the question of whether the UK would really seek to rejoin a programme it left in 1987 while still in its very early stages. And there would need to be an agreement with Leonardo Helicopters to include it in any offer.

Leonardo's approach is essentially the AW149 or bust, as it has no larger platform in its portfolio until the three-engined, 15.6t maximum take-off weight AW101.

But in its favour, the company has an existing final assembly facility in the UK and supporting supply chain. It says that an AW149 selection "would establish a cutting-edge new production line in Yeovil", and estimates that "between 60-70% of content and through-life support" will be provided by UK companies. Export potential is also clear.

The airframer is to the point when asked if it would support the NH90 being offered, or whether it has had any dialogue on the topic with its partner Airbus Helicopters.

"Leonardo's solution for the UK's New Medium Helicopter requirement is the AW149. We cannot comment further until we understand the requirements of the UK MoD," it says.

Airbus Helicopters says that should it offer the H175, there would be a big opportunity for UK suppliers – components currently sourced from its Chinese partners would need replacing – adding to the roughly 10-15% of UK content currently on the civil variant.

Final assembly of the H175M would also take place in the UK, for both domestic and export customers. While local assembly of the H225M or NH90 would also be theoretically possible, existing production lines would likely rule out any export potential.

However, the airframer emphasises the "sustainability" of its approach for itself and the UK's rotorcraft industry; sustainment activities, upgrades and supply chain participation can create more value over the longer term than a single final assembly facility, it notes.

Policy shift

The long-term effects of any purchase will be central as the MoD shifts to a new acquisition model that does not prioritise cost or capability over other considerations.

Contained in the Defence and Security Industrial Strategy (DSIS) document published at the same time as the Command Paper, the new guidance "is part of a broader, consistent, government drive to promote both our national security in its traditional sense, and the economic growth which underpins and depends on that security", it says.

It should, says the document, be viewed in the context of wider initiatives as part of the government's levelling up agenda "to promote economic growth that is distributed more equitably across the UK".

In addition, a minimum 10% weighting towards the "social value" of a contract will be applied in competitions after 1 June, to ensure that "the government takes into account the effect of different procurement options on wider policy objectives, including on the industrial base".

Although helicopter manufacturing is not among the three "strategic priorities" – nuclear, cyber and encryption – capabilities for which must be maintained onshore, it is seen as part of a wider mix that ensures operational independence.

Previous helicopter investments have benefitted the "UK industrial base" and mean "the UK is still able to design and develop new rotary-wing capabilities" or integrate new weapons and systems, it says.

"This has been enabled by the close relationship the UK MoD has with Leonardo Helicopters through the Strategic Partnering Arrangement, which ensures that together we maximise the opportunities across our current systems, future requirements and exports."

Maintenance of that capability is vital so the UK can access "the know-how to support and upgrade our fleets to respond quickly to changing threats and operational needs". Plus, an industrial footprint – the design, engineering and manufacturing skills – will allow the country to help lead the development of a next-generation rotorcraft to arrive in the 2040s. The UK is one of five countries currently involved in a NATO capability study, alongside France, Germany, Greece and Italy.

Social value

On that basis, while there are some on the operator side who would like to see the UK flying Black Hawks, the DSIS appears to rule out, or at least make harder, a straightforward purchase via the USA's Foreign Military Sales process.

With an existing European facility at Polish subsidiary PZL Mielec, would Sikorsky countenance another UH-60 production line? Perhaps more value for UK industry could be found in a long-term industrial partnership with the US manufacturer, if it could accommodate such a move.

While the combat-proven Black Hawk would offer the benefit of interoperability with London's biggest ally, if capability is not the be-all and end-all of a procurement, would participating in the supply chain do enough to maintain the UK's design and development capabilities?

Until the MoD reveals its requirements it is impossible to say whether the NMH contest is Leonardo's to lose. But for any manufacturer trying to supplant the firm's special status in the UK, the question has become: what can you offer that it does not already?

Leonardo Helicopters

Leonardo Helicopters has long touted AW149's credentials

Air Team Images

Seeking stability

As the industry emerges from Covid-19, a less volatile market will be vital in order to invest in the next generation of commercial aircraft, argues **Michel Merluzeau**

Airlines and airframers will recover from the shock of the 2020-2021 pandemic, but with varying degrees of damage to their core businesses. This episode has been the equivalent of flying across a line of tropical storms; not all aircraft OEMs have followed the same trajectory, and one in particular – Boeing – has been experiencing turbulence for some time.

As we look towards the coming decade, the market needs, first and foremost, a return to stable aircraft production rates and steady growth. That stability will be key to enabling the industry to innovate and transform; further disruption, however, could hinder the sector's ability to develop technologies needed for the next generation of commercial aircraft in the 2030s.

The Airbus-Boeing duopoly is alive but certainly not well. Boeing has been set back by 787 development troubles and the 737 Max tragedies and subsequent grounding. Those struggles have profoundly affected Boeing – its finances (debt), organisation (leadership and personnel churn), supplier management and, crucially, product development. Boeing is emerging from the pandemic wounded but standing, largely thanks to contributions from its defence and space business.

As the crisis subsides, it perhaps is best not to fixate excessively on current difficulties facing individual programmes which have generally strong outlooks over the long term. Boeing's diversified approach also helps maintain a steady ship.

However, the need for stability post-pandemic must be coupled with transformative efforts, including adopting a greater engineering-driven approach to aircraft development and a more nuanced attitude to meeting financial targets.

In the near term, Boeing depends on the recovery of the 737 Max and 787. With a narrowbody market still going strong, the outlook for the 737 Max is upbeat – assuming issues are resolved promptly. But Boeing's ability to restore the programme in the coming years will also define its product development strategy for the 2030s. The 787's recovery, which will probably take longer, owing to the pandemic's devastating effect on international air travel, will also enable Boeing's strategy in the next decade: a new 787 derivative could potentially energise the programme and support new sales.

Direct response?

Boeing will seek stability, and necessarily so. This does not, however, preclude it from planning its next aircraft. But it faces two key questions: where should it invest first? And how will it counter Airbus? While addressing Toulouse's stranglehold on the medium-lower end of the middle-market with a direct response to the A321neo might seem logical, the size of the available market is shrinking rapidly and the pace of production and engine development suggest service entry would come in 2028 at the earliest.

But Boeing might be wiser to avoid the trap of developing a similar jet that simply bests the A321neo. A better strategy might be an aircraft with more capability than the Airbus narrowbody, one that targets the upper end of the middle-market (around 240 or more seats). In that segment, Boeing could develop the transformational technologies required from both the production and customer standpoints.

Airbus has different issues to address. Toulouse is blessed, on sheer merits, with a more market-relevant portfolio than Boeing. With the A220, A321neo and A350 all delivering – both operationally and financially – the questions for Guillaume Faury's team are strategic in nature, rather than driven by near-term troubles. How will Airbus maintain market leadership? What is the acceptable degree of risk associated with development of enabling elements that the airframer needs for a transition in the 2030s?

The strategy perhaps involves new A220 and A350 derivatives. Let's face it, hydrogen can wait. It's not a 2035 solution, but rather a means to find ways to subsidise research and development.

For other OEMs, Embraer and ATR in particular, the post-pandemic decade will be one of transformational opportunities. The turboprop market will be the technology incubator for a multitude of innovations that will further enhance commercial aviation's ability to reduce greenhouse gas emissions and maintain relevance and essential services.

In China, Comac will go through a decade of learning. The only reasonable way to judge Shanghai will be in the realm of execution. Assigning Western-centric metrics or expectations to the company's performance in the 2020s would reflect poor understanding of what China seeks to achieve.

Michel Merluzeau is a senior analyst at US aerospace advisory firm AIR, where he covers commercial and defence markets

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Pilatus

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Avelo Airlines

Lufthansa ordered five Boeing 787s – and five Airbus A350s - in early May, as part of a widebody fleet modernisation

Boeing

Air Tractor and L3Harris have joined forces to offer the AT-802U Sky Warden for a US Special Operations Command light-attack requirement

L3Harris

Malaysia Airlines' parent company has indicated plans to dispose of its six stored Airbus A380s "in the coming months"

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Best of the rest

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

Kaman's unmanned K-Max Titan cargo-lift helicopter has been flown for the first time, with a safety pilot on board. It is expected to gain US certification within two years

Kaman

Nigeria's Green Africa Airways has received its first of three ATR 72-600s, for use from its Lagos base

Green Africa Airways

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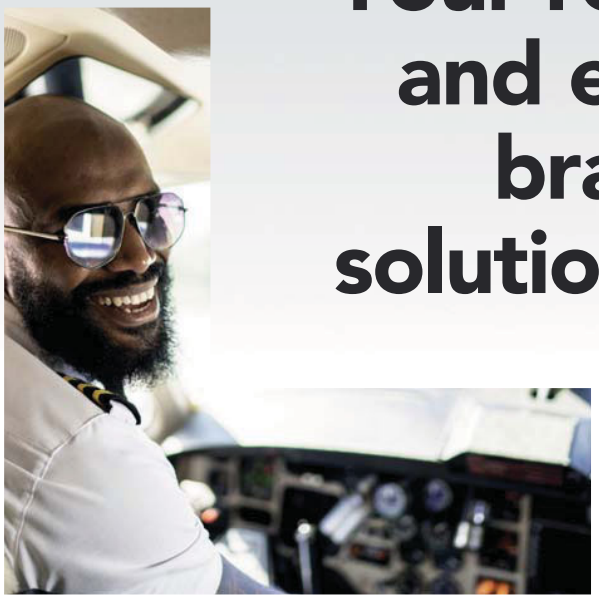

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Gold standard

Thwarted by pandemic, RIAT's 50th anniversary sparks fond memories

Airbus has used the pandemic to assess its organisational, manufacturing and development priorities, and believes it will be ready to respond fast when a recovery in demand starts

The airframer has unveiled a range of innovative concepts based on use of liquid-hydrogen fuel

A chance to rebuild

Airbus

David Kaminski-Morrow London

Even if the home-turf showcase of the Paris air show had not joined the long list of exhibition casualties, Airbus might have struggled to scrape together sufficient material around which to build the sort of upbeat media event schedule to which it has become accustomed.

Over the year since March 2020, the point at which the pandemic started to throttle the global air transport system, Airbus took orders for just 66 aircraft – only three of which were widebodies: two of them A330s for military tanker conversion.

Airbus has kept its production rates at around the same low level for the duration and, although it is looking to raise monthly A320-family output from 40 to 43 aircraft in the third quarter of this year, and 45 in the fourth, the prognosis for near-term long-haul manufacturing rates remains grim.

But while the crisis has stifled Airbus's regular activities, chief executive Guillaume Faury argues it has given the airframer a chance to prioritise an overhaul of its industrial operation and advance its "backbone" digital design and manufacturing project at a time when aerospace is embarking on the most radical shift in design considerations since the advent of jet propulsion.

Airbus

Faury aims to transform the airframer's industrial system into single unified 'digital design and production stream'

Next generation

"We've more visibility on what we want to do with the next generation of products, a better understanding of the depth of changes in architecture and the core nature of aerostructure assembly to enable digital design and production of aircraft," he said, outlining the company's priorities during an April briefing.

"[The pandemic] and the low level of production is providing an opportunity to accelerate change. This will provide [capability] to [bring] into service modern products in a much more efficient way in future. This will improve the cost base at that point in time."

Airbus has determined that aerostructures will be a core activity to be integrated with its main industrial chain, and will combine its operations in France as well as those in Germany, creating two wholly-owned and managed aerostructures companies rather than maintaining the previous supplier-client relationship.

"We aim to become more resilient toward unexpected changes that inevitably happen from time to time," says Faury. "To enable the ramp-up of more complex, innovative products faster than before, and drive our competitiveness by consolidating and simplifying our industrial set-up – which is still partly fragmented across the company, our subsidiaries and suppliers."

He says Airbus will place fuselage aerostructures assembly "at the heart" of its production system.

Stelia Aerospace, which notably builds forward fuselage and cockpit sections for the Airbus range, will be brought together with the Airbus operations managed at Saint-Nazaire and Nantes.

The Saint-Nazaire site specialises in assembling and equipping A320-family forward sections, as well as forward and centre sections of A330s.

Airbus's Nantes facilities produce centre wing-boxes for the airframer's entire commercial range, along with radomes, ailerons for A330s, A350 fairings, and other miscellaneous structures. Similarly Airbus will combine the Premium Aerotec operations at Augsburg, which specialises in fuselage sections, with those of the shell-building facility at Nordenham and the thermoplastics and sheet-metal centre in Bremen.

The re-organisation will simplify governance and interfaces, Airbus believes, allowing the French and German operations to be "more agile" and support a "stronger assembly value chain".

But the Premium Aerotec detailed parts activities will be spun off into a separate German-based entity. Faury says this will "give life" to the business and provide an opportunity to expand, "but not as a core activity of Airbus". Divestment of this entity is "one of the scenarios we'll investigate with partners", he adds.

"We believe it's the right time to transform our industrial system into one digital design and production stream, which also prepares for the next-generation aircraft that is likely to have a different architecture compared with today," says Faury.

Such architectural changes will be driven by the environmental pressure to move away from fossil fuels and towards alternative sources of power.

While Airbus and Rolls-Royce are carrying out emissions tests of 100% sustainable aviation fuels, with an A350-900 testbed, expanding their use is only part of the airframer's strategy to decarbonise air transport.

Airbus has steered away from focusing on batteries as a source of power for future commercial aircraft, believing the energy required for designs larger than regional aircraft is too great. The company views hydrogen as a more promising fuel source, but one that demands a complete rethink of aircraft architecture and airport infrastructure.

Innovative configurations

The company has been examining various aircraft configurations – from conventional arrangements to blended-wing body and propeller-driven designs – and Faury believes Airbus will be able to narrow its options over the next five years, enabling it to progress towards a formal programme for entry into service in the mid-2030s.

It is exploring a range of innovative technologies including the use of standalone liquid-hydrogen engine pods, and implementation of superconducting systems to reduce the weight of electrical power transmission components.

While Faury considers industrial preparation for the future to be a priority for Airbus, he stresses that there is "no major revolution" planned in the short term.

More immediate concerns, he says, centre on management of deliveries and the backlog of almost

Stelia Aerospace

Stelia Aerospace will be combined with operations at Saint-Nazaire and Nantes

7,000 aircraft. Having responded to cuts in production rates caused by the dip in demand, Airbus's suppliers face a tricky reversal of the process as the recovery progresses – complicated by the non-linear nature of that recovery, with China and the USA showing signs of acceleration while Europe lags.

"We fear the problems, the main risks ahead of us are on the supply chain," says Faury. "This rollercoaster situation is very difficult to manage for a long-term industry like ours."

He says Airbus is focusing on "transparency" with suppliers, running preparatory scenarios and putting "watchtowers" in place to increase the visibility on the response readiness. Faury says the company is still in the "big wake" of issues on the demand front and is starting to see "challenges" regarding supply.

Airbus expects a "steep" single-aisle ramp-up over 2022-2023 but it is still defining the precise rates, he says, and giving an estimated figure would be "premature". While it is aiming to match last year's delivery level of 566 aircraft, the path is yet to smooth. Deliveries surged to 72 in March after a weak total of 53 for January and February combined.

Stored aircraft, a symptom of delivery snags, increased in the first quarter, driving up by €785 million ($941 million) an inventory figure which Airbus had been working to bring down.

Faury hopes to have the visibility required for production decisions by the end of June, but says the company has yet to reach this "tipping point".

"We've already given indications to the supply chain outside of our firm horizon," he says, adding that the airframer is exploring "what's reasonably possible" to achieve with them. "We'll solidify those numbers and communicate at a later stage once we enter that firm horizon."

Airbus experienced considerable bottlenecks during ramp-up of A320neo production, largely relating to engine supply. While Faury says these issues were overcome, he says the powerplant supply chain is "complex", with "some specific parts always at the edge".

"It's premature to say that engines will not be a limiting factor again in the ramp-up," he cautions. "I'm more optimistic on that front than was case previously. But I would be prudent."

Government support

While Airbus has been restructuring it has taken advantage of government-finance schemes and other negotiated labour measures to retain "thousands" of staff, says Faury, and the company has the personnel it needs to hike single-aisle production.

Airbus slashed long-haul production at the same time as it lowered single-aisle rates, and Faury wants to prioritise returning its widebody production "back to break-even as soon as we can" – but signals that the long-haul sector is unlikely to recover before 2022.

This part of the market had been struggling under soft demand and global economic malaise even before the havoc wrought by the pandemic.

Airbus's order and backlog figures for the past decade illustrate the slackening interest in widebodies. FlightGlobal analysis indicates that orders for nearly 600 twin-aisle aircraft were cancelled in the 10 years to the end of 2020.

These included 116 A380s, of which 70 were struck off in the immediate aftermath of Airbus's decision to terminate the beleaguered double-deck aircraft programme in early 2019. But the A350 family accounted for over 320 cancellations, the equivalent of one

Fasttailwind/Shutterstock

The A350 logged more than 320 cancellations last decade

cancellation recorded for every two A350s ordered over the decade.

The A330 – which underwent a re-engining programme to emerge as the A330neo – fared relatively better, with a ratio of one in five, but this was still double the rate of A320-family cancellations.

While the long-haul market prior to the pandemic has been weak, Airbus's backlog has been surprisingly resilient over the course of the crisis. The airframer has engaged in deferral negotiations and avoided a heavy wave of cancellations.

Of the 115 aircraft struck from its books during 2020, more than half had been cut in the first three months of the year, before the pandemic's effects had fully begun to emerge.

The most notable impact has been the absence of orders. Airbus's total order figure, which has typically risen by around 1,000 aircraft annually over the last decade, actually fell in the 12 months subsequent to March 2020.

Airbus's tasks taking immediate precedence include concentrating on the company's cash preservation and earnings beyond 2021.

The airframer's A220 family continues to show promise, with cumulative orders of around 650 aircraft, but the programme remains loss-making with relatively high cash usage, and will probably not break even until the assembly lines at Montreal Mirabel and Mobile, Alabama, achieve a healthy loading approaching 170 aircraft per year – a position which Airbus does not expect to reach until around the middle of the decade.

> "We think it's not healthy to have only one player in the [freighter] market – a segment that is very significant, and has been resisting well in the pandemic"
>
> **Guillaume Faury Chief executive, Airbus**

Airbus

A321neo orders rose by 46 in the year to March 2021

Given the projected upturn of the single-aisle market and the prolonged stagnation of the widebody sector, Airbus believes its long-range A321XLR – intended to offer narrowbody economics on long-haul routes – is a critical part of its product strategy.

Faury says the XLR programme "remains on track", with service entry planned for 2023, even if the crisis delayed plans to set up an additional A321neo production line in Toulouse: a step confirmed on 12 May.

Although overall Airbus orders fell in the year to March 2021, the figure for the A321neo actually rose by 46 aircraft, illustrating the popularity of the twinjet, which accounts for 47% of all A320neo-family orders.

Airbus's plant in Hamburg Finkenwerder has taken delivery of the first A321XLR centre wing-box from the Nantes manufacturing facility, one of the first major sections to be handed over for the structural assembly of the XLR's centre fuselage.

Design modifications

The component has undergone substantial design modifications and reinforcement in order to accommodate the XLR's increased take-off weight, as well as the need to allow new fittings and supply lines to support the aircraft's characteristic large aft centre fuel tank. Two other centre wing-boxes for flight-test aircraft are undergoing assembly at Nantes and the first for a customer aircraft will enter production in the fourth quarter of this year.

Airbus might have to forego a big-bang Paris air show centrepiece, but Faury hints that the airframer is looking towards addressing customer requirements post-crisis – notably in the widebody freight sector, where he admits the company's presence has been "weak".

Faury promises to be "more aggressive" in this market. Airbus only offers a single dedicated freighter, the A330-200F, which has sold poorly and has no orders outstanding.

"I don't like the idea to remain weak on that segment in the future," he says. "We believe we have the products to be able to be more aggressive in the future.

"We think it's not healthy to have only one player exclusively in the market for a segment that is very significant, and has been resisting well in the pandemic."

If Airbus is considering developing the A350 as a freighter, and opening a new front of competition with the Boeing 777, it has yet to confirm such a plan and indicate a timeframe. Something for a future air show, perhaps.

Boeing

US Federal Aviation Administration lifted the 737 Max's grounding last November

Jon Hemmerdinger Tampa

Boeing executives insist the company has solid plans to address its many challenges, but those who follow the airframer are increasingly eager to understand exactly what these plans entail. They want to know how it will counter Airbus, and prevent the types of problems facing its current models recurring on future programmes.

During a first-quarter earnings call on 28 April, Boeing's senior officials said the airframer has made real progress toward improving safety and addressing production problems.

Chief executive David Calhoun cited Boeing's safety management system, more-efficient use of data, investment in "fundamental design practices" and an internal shift in its structure that now has engineers reporting to a chief engineer.

"We're doing this now so that we can emerge a leaner, sharper and more-resilient company as the market recovers and production... increases in the future," said chief financial officer Greg Smith. "We'll continue to execute a widespread set of changes over a multi-year period."

But analysts want specifics.

"He didn't explain how business transformation is going to fix this on the next airplane," says Ron Epstein, financial analyst with BofA Securities. "How is this not going to happen again?"

"They can frame this however they want to," agrees Credit Suisse analyst Robert Spingarn. "There is a recent history of design and development issues at Boeing."

Boeing reported a $561 million loss in the first quarter; a vast improvement from the fourth quarter of last year, when a $6.5 billion 777X charge pushed it to an $8.4 billion loss.

Other than a $318 million charge against the 747-based VC-25B presidential aircraft replacement programme – attributed by Smith to "Covid impacts and performance issues at our supplier" – analysts viewed the latest figures as unsurprising.

With US airlines adding capacity ahead of the summer season, Spingarn thinks Boeing's next set of results will be more telling.

"We think the second quarter is the linchpin for how to think about the rest of the year," he says. "We will have a much better idea of what 2021 will look like."

Leadership questions

As has been the case for several years, analysts think the company's recovery still depends largely on the 737 Max's return. The company also must mend the 787 programme and guide the delayed 777X through certification. Its 767-based KC-46 tanker has also suffered quality problems, and broader leadership questions remain unanswered.

If it can succeed in ramping up 737 Max production and deliveries, the model can still be a "guarantor of stability for Boeing going into the 2020s", says Michel Merluzeau, aerospace analyst with consultancy AIR. The company must "prioritise the Max over the next decade", he adds.

The Max programme successfully overcame its highest hurdle last November, when the US Federal Aviation Administration (FAA) lifted the type's 20-month grounding.

Already rocked by the grounding of its re-engined narrowbody before Covid struck, Boeing is battling to get multiple programmes back on track – but is airframer falling behind its European rival?

Recovery mode

But in April Boeing disclosed a new 737 Max issue, involving an electrical grounding of the standby power control unit on recently-produced jets. One aerospace safety expert describes the issue as relatively minor – something that, if not for heightened scrutiny following two crashes, would not have led airlines to park jets.

However, Boeing recommended that airlines pull from service the roughly 100 affected aircraft.

Boeing "paused deliveries" while it addressed the issue, reducing 737 Max shipments in April to just four aircraft.

Then on 12 May the US regulator approved Boeing's fixes for the electrical problem, allowing the airframer to begin rolling out repairs.

Boeing

Chief executive David Calhoun says airframer has made 'real progress'

Calhoun stresses that regulators in 165 countries have approved Max flights, and airlines globally have returned roughly one-third of their Max fleets to active service. Additionally, regulators recently approved the 737 Max 8-200, a higher-density variant of the typically 178-seat Max 8, for which Ryanair is launch customer.

One country, however, has so far glaringly refused to clear the re-engined type to resume operations: China, which was also the first to ground the Max after its second crash in 2019.

"We now assume that the remaining non-US regulatory approvals will occur this year, with approval in China most likely now in the second half," Calhoun says, without elaborating.

China's hesitancy to lift the grounding is viewed by analysts as fallout from the US-China trade conflict.

Calhoun stresses that Chinese customers are central to Boeing's ability to meet 737 Max production and delivery goals, noting that one-quarter of the aerospace industry's growth in the next decade will come from China.

"We're also monitoring the global trade environment, in particular US-China relations, given the importance of the Chinese market to our near-term delivery profile as well as future orders, which influence future production rates," he says.

Smith adds that China's Max approval will "affect our 737 delivery plan", and that demand from Chinese airlines will "affect our future production rates".

Boeing's goal is, by year end, to have delivered roughly half of the 450 Max jets it stockpiled during the grounding period. The "majority" of the rest should follow in 2022.

Meanwhile, it plans to increase 737 production from a current unspecified "low rate" to 31 jets monthly in "early 2022".

Spingarn reads Calhoun's comments as implying that Boeing can meet short-term Max delivery goals even without Chinese customers, by transferring those operators' delivery slots. But its ability to maintain that momentum could become more difficult over time if US-China relations do not improve.

Boeing

Boeing says the delayed 777-9 is on track for delivery in 'late 2023'

"A prolonged recertification delay in China could weaken the Max's recovery," says a BofA report.

"We've got to reinstate our trade relationship in aerospace with China," Calhoun says. "It's important that we get our fair share... of that market, which historically has always been at 50%."

Boeing will "engage with leaders in both countries to urge a productive dialogue, reiterating the mutual economic benefits of a strong and prosperous aerospace industry", he says. "It's time for us to just point out the economic implications of trade with China in the aerospace industry and commercial aviation specifically."

Calhoun concedes that Boeing "can't make up for the production gap" created by the 737 Max's troubles. So, he aims to "split that market".

"I'm not going to try to regain that ground," he says. "I'm simply going to try to hold our own with respect to what I think is our rightful share going forward."

Boeing also faces the urgent need to straighten out the 787 programme, which has been beset by a "skin flatness" at the aft section of jets, where fuselage sections meet. The company says this did not meet specifications that include tolerances equivalent to the width of a human hair.

To address the issue, 787 deliveries were halted between October 2020 and March. By late April, nine aircraft had been handed to customers, Calhoun says.

"These fit and finish issues with respect to the joins in our fuselages were just nagging problems, difficult problems," he says. "We applied real engineering talent and expertise to that – new process controls, new lines of communication with our supply side – so that we're not surprised by that stuff anymore."

In the first quarter, Boeing reached its goal of reducing 787 production to five jets per month (down from a high of 14) and stopped building Dreamliners in Everett, Washington. The company now makes the type only at its North Charleston facility in South Carolina.

The delivery pause exacerbated Boeing's undelivered-aircraft problem. The company had started stockpiling the widebodies earlier in the pandemic, when demand for new long-haul jets soured.

At the end of April, Boeing was sitting on about 100 undelivered 787s, of which it expects to deliver the "majority" this year, Smith says.

BofA, however, predicts that the inventory of "excess" 787s will not be cleared until 2025, and anticipates that monthly output will be trimmed to four.

Meanwhile, Boeing says the delayed 777-9 remains on track for first delivery in "late 2023". The company disclosed that revised goal in February, when it delayed the 777X programme by a year, citing the need to tweak design aspects due to certification issues.

Rigorous testing

"We're working closely with global regulators on all aspects of development, including our rigorous test programme," Calhoun says. "Our team remains focused on executing this comprehensive series of tests to demonstrate the safety and the reliability of the airplane's design."

Emirates, an initial 777-9 customer, had expected to receive its first example in June 2020 – but the airline's president, Tim Clark, says deliveries could slip to between late 2023 and 2025. He describes the 777X programme as in a "state of disarray", due to heightened regulatory scrutiny in the wake of the 737 Max disasters.

Analysts note that the delay comes at a somewhat convenient time, as most airlines do not need more widebody jets in the pandemic-affected market.

Customers are likely "willing to wait", says Spingarn. "I think the 777X will have a renaissance in a year or two or three, when the market is back," he adds. "Then you are going to see a wave of orders for big widebodies."

Boeing also faces leadership uncertainly, not with its chief executive, but rather its financial head. The company disclosed on 20 April that Smith, who also heads "enterprise operations", will retire effective 9 July.

In announcing his departure, Boeing upped its mandatory chief executive retirement age from 65 to 70, signaling that 64-year-old Calhoun will, for now, remain in the corner office.

"We're not searching for a new strategic direction," Calhoun says of Smith's departure. "We will engage in a comprehensive and thoughtful search process for a world-class executive."

Smith has worked at Boeing for over 30 years. He became chief financial officer in 2011 and was interim chief executive between Dennis Muilenburg's departure and Calhoun's arrival in January 2020.

Leadership plans

Analysts had viewed Smith as a contender to be Boeing's next leader, and his departure raises questions about the company's leadership plans. Some analysts have suggested that more changes may be needed to help move beyond its past and ongoing troubles.

But as Boeing works to fix problems with current programmes, it must also address its future – in other words, figure out how to counter Airbus and gain back share lost to the European airframer amid the 737 Max grounding. That means developing a new aircraft.

Analysts have waited several years for details about that next jet, while Boeing has stalled, never actually committing. Prior to the Max crisis, the company had seemed close to launching its New Mid-market Airplane, a concept envisioned as having about 270 seats and a range of 4,000-5,000nm (7,400-9,300km).

Then, in April 2020, Boeing pulled out of a planned $4.2 billion acquisition of 80% of Embraer's commercial aircraft division: a deal that would have given it a line-up of E-Jets to compete against the Airbus A220.

In the meantime, Airbus has made strides. In 2019 it launched its own version of a mid-market aircraft: the 4,700nm-range A321XLR, which is expected to enter service in 2023.

Merluzeau suspects Boeing is working to blunt the A321XLR's edge by squeezing more performance from its in-development, 3,300nm range 737 Max 10. It plans to deliver the first example of its largest Max variant in 2023.

The airframer has reduced 787 production to five jets per month

United Airlines

Airbus has also acted to strengthen its A220 programme, embarking on a cost-cutting effort and opening a second production line for the type, in Mobile, Alabama.

The A220's capabilities, including its roughly 3,400nm range, have caught the attention of major Boeing customers. Delta Air Lines, for instance, is replacing ageing 717s and McDonnell Douglas MD-80s with the twinjet.

"The 220 is an aircraft that is going to become more dangerous to Boeing," Merluzeau says. "That's a big problem."

Boeing competes against the 110-130-seat A220 with its 737 Max 7, which carries 140 passengers and has a 3,850nm range, and has won notable competitions. Southwest Airlines ordered 100 in March, but that win reflects economies the carrier achieves by operating only a single aircraft type, analysts say.

Compared on operating economics, the clean-sheet A220 edges out the 737 Max, they say.

"Boeing doesn't have a competitor aircraft" to the A220, Merluzeau says.

Aside from Airbus, Boeing faces competitive threats from Chinese aerospace companies, most notably Comac, with its roughly 160-passenger, 2,200-3,000nm-range C919. That programme

> "It's time for us to point out the economic implications of trade with China in the aerospace industry"
>
> **David Calhoun Chief executive, Boeing**

remains in development, but analysts expect that, in the coming decade, China will become a competitive commercial aircraft producer.

So, when will Boeing launch its next aircraft? And what will it be?

Calhoun provided some insight during the April earnings call, but few details. He says Boeing's next airliner is likely to derive cost efficiencies through improvements in engineering and production, including the potential use of composite manufacturing.

That marks a change from past aircraft programmes, which historically have benefited from engines delivering a 15-20% improvement in fuel efficiency. However, "I don't believe the next generation of engine can deliver that kind of performance," Calhoun says.

Generally, analysts suspect Boeing will launch a new aircraft – likely a 737 replacement known as the Future Single Aisle (FSA) – in the next few years, with service entry in the early 2030s.

If that is indeed the plan then Boeing should say so, analysts say. "If Boeing doesn't start developing the FSA programme soon, it could be really hard for the company to recover market share from the continuously weakening position that we expect it to have by the mid-2020s," says BofA's report.

He may be less combative than his unpredictable predecessor in the White House, but it is unclear if the new US president will back away from aggressively promoting defence exports

Biden time

Garrett Reim Los Angeles

Meet the new boss, same as the old boss. That is more or less the conclusion of analysts watching the first few months of US President Joe Biden's arms export decisions and policy statements.

Several precedents established during the term of former president Donald Trump are likely to stand. And, export policies that stretch back to president Barack Obama will also probably continue.

To be sure, Biden has indicated he plans to depart from previous policies in a few areas. The administration is likely to be warier of selling offensive weapons to Saudi Arabia, a country which is entangled in a brutal civil war in neighbouring Yemen. And, he is more likely to lean on allies and arms control agreements to make decisions, say analysts.

How much weight Biden explicitly places on the economic considerations for arms exports is not as clear. The production run of several older aircraft types have been extended in the past via Foreign Military Sales (FMS) deals.

As US modernisation programmes crowd out the Department of Defense's (DoD's) appetite for some older models, will international sales keep those aircraft in production for years to come?

Last, the administration is also likely to face tricky new issues selling digitally-connected aircraft and weapons, say analysts. New aerospace products, including everything from bombs, in-flight refuelling tankers and stealth aircraft, are increasingly valued based on their network effect – their utility as part of a larger ecosystem of connected platforms. Who can be trusted to join this military-of-things network is a difficult question to answer.

In the short term, the Trump administration's two biggest decisions – the approval of expanded sales of large, armed unmanned air vehicles (UAVs) and the Lockheed Martin F-35 stealth fighter – look likely to go forward.

Permission granted

That is good news for the United Arab Emirates (UAE), which received approval in January from the Trump administration for a $23 billion arms sales package that included 50 Lockheed Martin F-35As and 18 examples of the General Atomics Aeronautical Systems MQ-9B UAV. The deal also included air-to-air and air-to-surface munitions.

The Biden administration acknowledged in April that it would probably allow the sale of the F-35A and MQ-9B to the UAE, marking the first time that an authoritarian state had been granted permission to buy either of the aircraft.

The sale of large UAVs, such as the MQ-9B, had prior to the Trump administration been subject to a strong presumption of denial from the US Department of State under the Missile Technology Control

Qatar and Saudi Arabia have shown interest in acquiring stealthy F-35

US Air Force

Regime (MTCR), an export control agreement voluntarily enforced by 35 member states. That limited the sale of the aircraft to only close US allies, such as NATO members France and the UK.

However, in July 2020, the Trump administration changed US policy regarding the MTCR, removing a strong presumption of denial for UAVs with a maximum speed below 430kt (800km/h). That cleared the way for the Department of State to approve the sale of four MQ-9Bs to Taiwan last November and then the 18 examples for the UAE.

$23bn

Potential value of arms package for United Arab Emirates approved in last days of the Trump administration

A sales boom for manufacturer General Atomics, which had long complained that Israeli and Chinese manufacturers were seizing market share because of the restrictions, the new MTCR policy does not look likely to be reversed in total by the Biden administration, says Bill Hartung, director of the arms and security programme at the Center for International Policy.

"However, they want to have talks among allies about some restrictions on drone exports, that would be separate from the MTCR," he says. "That may be, but that would be a lengthy process. I think for the moment, it's going to be the Trump policy – and deals Trump has already made will probably stand."

While new policies toward the MTCR may mark a precedent, it is not yet clear whether the F-35 sale to the UAE is the start of expanded sales of the stealth fighter.

"That's a very controversial deal. If they are willing to do that, it does open the question of: who else might they be willing to offer such technology to?" says Hartung. "But, I think it may be case by case."

Combat question

Qatar has requested the F-35 and Saudi Arabia may consider the aircraft if it became an option, he adds. Whether either of those two autocracies would be granted permission to obtain the type remains to be seen. Meanwhile, the F-35A is being evaluated in competitions in Finland and Switzerland.

Despite some policy similarities with the Trump administration, it does not appear that all former deals will proceed during Biden's presidency.

In January, Raytheon dropped the anticipated sale of an offensive weapon system to an unnamed Middle Eastern country, possibly Paveway precision-guided bombs to Saudi Arabia, owing to concerns that the incoming administration would not grant it a direct

US Air Force

Sales of General Atomics' MQ-9B have been aided by reinterpretation of MTCR treaty

commercial sales export licence. Biden and Democratic lawmakers have been critical of Riyadh's airstrikes in neighbouring Yemen, which is in the midst of a civil war, as the attacks allegedly have caused civilian casualties.

The Biden administration is likely to emphasise the sale of defensive weapons, say analysts. In light of that new policy, defence manufacturers are adjusting their sales pitch.

"If you think about Patriot and some of the other defensive systems, we have no issues with getting licences. But offensive weapons [are] a little bit more difficult," said Greg Hayes, Raytheon's chief executive, in the company's 2020 fourth quarter earnings call in January. The Patriot system is designed to shoot down incoming tactical ballistic missiles, cruise missiles, UAVs and aircraft.

Raytheon has not given up on the sale of offensive weapons, however.

"As we go forward, we will work with the [DoD]," says Hayes. "We will try and do these through [FMS], as opposed through direct foreign sales, to make sure we have got alignment with [the DoD] and the administration before we book any of these."

What's more, Raytheon does not see a slowdown in sales. When asked by a stock analyst in the January earnings call if the cancellation of the offensive munitions sale was a sign of declining future weapons sales to Middle Eastern countries, Hayes did not mince his words.

"No, no, no," he said. "Look, peace is not going to break out in the Middle East any time soon."

Under the Trump administration, production of Cold War-era aircraft continued to be extended, as manufacturers found ways to modernise old products with new computing and networking capabilities.

One example of that trend is the Boeing F-15, which was first delivered to the US Air Force (USAF) for testing in 1972, and now looks poised to have more than a 60-year production run. Under Trump, Boeing received a $6.2 billion contract in 2017 to manufacture 36 examples of the F-15QA for Qatar.

That jet comes with fly-by-wire flight controls, a digital cockpit, an active electronically scanned array (AESA) radar, an electronic warfare (EW) suite and what Boeing calls "the world's fastest mission computer". Those improvements were enough to convince the USAF in 2020 to buy its own version, the F-15EX Eagle II, to replace some of its ageing F-15C/Ds.

Package deal

Those new capabilities have long-time F-15 operators such as Japan looking to upgrade. The Department of State approved an FMS package for Japan in 2019 valued at up to $4.5 billion to upgrade 98 F-15Js, originally manufactured under licence by Mitsubishi Heavy Industries. As of April, Tokyo and Washington were still trying to iron out costs and scheduling disagreements for upgrading the fighters to the new "Japan Super Interceptor" standard.

For an Indian air force requirement for 110 fighters, Boeing is pitching the F-15EX, as well as its F/A-18E/F Super Hornet. Lockheed is offering its F-16V, renamed the F-21 for the same programme. The Indian navy is also looking for 57 aircraft carrier-based fighters, with the Super Hornet being offered for that contest.

More generally, the USAF is looking to see if offering new "commoditised" aircraft, including the MQ-9

and F-16, will speed up sales by reducing back-and-forth negotiations. For example, in August 2020, Lockheed was granted permission by the service to sell a base model version of the F-16 Block 70/72. That aircraft would come with a standardised price and set of features, including avionics, mission systems, an AESA radar, EW suite, automatic ground collision avoidance system and engine, and other common components.

In the coming years, if US DoD spending begins to sag on particular aircraft there might be an incentive for the Biden administration to push FMS business to maintain US jobs. That appeared to be the case when budget sequestration in 2013 crimped Pentagon spending and the Obama administration was incentivised to approve the sale of the F-15SA to Saudi Arabia, says Greg Sanders, deputy director of the Defense-Industrial Initiatives Group at the Center for Strategic and International Studies.

"One way of trying to balance that pressure had been to look for export markets, where appropriate, to allow US industry to have some of the economies of scale or other benefits that they might lose out on by reduced demand from DoD," he says.

The US Army has sought to backfill production of the Boeing CH-47 Chinook in Philadelphia, Pennsylvania, with FMS orders, as it starts to spend money on other priorities, including development of Future Vertical Lift rotorcraft. In 2020, the service said it could keep production running at a rate of 18 helicopters annually until at least 2025 with a partial reliance on export sales.

In April, the UK reportedly agreed to a $2 billion purchase of 14 Chinooks to replace the Royal Air Force's oldest in-service examples. Also in April, Australia agreed to buy four F-model examples of the tandem-rotor helicopter.

One area in which the Biden administration may set precedent is on the sale of networked weapons and aircraft. As part of the Pentagon's Joint All-Domain Command and Control initiative, US manufacturers are trying to develop aircraft and weapons that are highly networked and have open-systems architectures that allow for the plug-and-play of upgrades.

Connectivity may actually bring more countries into the FMS ecosystem, say analysts. "If you have countries that are buying a fair number of high-end systems, it makes sense to have systems that work together," says Sanders.

Countries such as Saudi Arabia and the UAE might be less inclined to consider buying aircraft and weapons from China or Russia, as it would undermine their fleets' effectiveness, he notes. That might make European aerospace manufacturers, which have interoperability with US systems via NATO standards, the alternative arms dealers of choice. Nonetheless, states such as Egypt and India, which have historically purchased mixed fleets of aircraft as a means of diplomatically balancing competing foreign interests, may still be resistant to the network sales pitch.

Boeing has enjoyed steady international orders for Chinook, including from India

Boeing

Raytheon backed out of weapons sale to a Middle Eastern country in January

Raytheon

98

Number of F-15Js due to undergo modernisation via Tokyo's $4.5bn 'Japan Super Interceptor' project

Networking aircraft and weapons with platforms controlled by other nations would also come with risks, however, including cyber security concerns.

A preview of this problem is seen in the USA's decision to refuse delivery of the F-35 to Turkey. Ankara bought and received the Russian-built Almaz-Antey S-400 air-defence missile battery in 2019, despite protests from Washington that it is technically incompatible with the F-35. Another concern was the possibility that Russia could use a cyber-backdoor in Turkish S-400s to observe vulnerabilities in F-35s flying nearby. Ultimately, the nation's decision to buy the S-400 caused Washington to eject the country from the F-35 Joint Strike Fighter programme.

That sort of incompatibility problem is likely to surface again in future FMS agreements. The Biden administration will have to carefully judge the political alignment and trustworthiness of arms recipients.

"The more things are networked, the larger the attack surface is for cyber operations," Sanders says. Buyers will have to also weigh risks, he says. "Defence technology security, I think, is going to continue to be a high point of emphasis for any high-technology buyers."

Europe's industry may be embarking on designing its next generation of combat aircraft via two rival projects, but there are lucrative near-term sales targets for its current trio of products

Flying high

Crown Copyright

Craig Hoyle London

Even as they begin the journey towards developing so-called sixth-generation platforms, the companies behind Europe's existing trio of fighters are enjoying a surge in demand for their current offerings.

If partnership models forged since late last decade remain intact, there will be two future European combat aircraft programmes, each involving three nations.

France, Germany and Spain are poised to enter the demonstrator phase of their Future Combat Air System (FCAS) activity, which should deliver a New Generation Fighter (NGF) for use by 2040. Meanwhile, the UK is leading the Tempest effort, with Italy and Sweden as partners, aiming for service introduction from 2035. Concept and assessment-phase work is scheduled to start later this year.

Opinion is very much divided regarding the duplication involved in these seemingly largely parallel projects, which appear to have similar constructs and desired outcomes. In addition to delivering a new fighter, each aims to develop supporting unmanned assets and new-generation air-launched weapons, operating within a so-called combat cloud environment.

Exponents are firmly of the view that in order for a new-generation European combat aircraft to be effective, and competitive on the export stage, only a single project can be pursued.

Speaking during the Royal Aeronautical Society's online Air Power conference last December, Italian air force chief of staff Lieutenant General Alberto Rossi pointed to the non-recurring cost penalty associated with nations having diverged to develop both the Eurofighter and Dassault Rafale.

"If we won't be able to merge in a single programme, which would be the best option for everybody from an operational perspective, then we should make those two systems as interoperable, integrated, standardised and capable to connect to each other," he said.

Speaking earlier this year, Dassault chief executive Eric Trappier voiced concern over the consequences of including Spanish firms within the FCAS effort, diluting what had originally been envisioned as a 50:50 split between the French company and Airbus Defence & Space. Once implemented, changes made solely to satisfy national workshare requirements mean "it becomes difficult for Dassault to play the role of the prime contractor [on the NGF]", he said.

At the same time, German unions complained about the lack of high-value work for the nation's

Qatar operates Dassault's Rafale and ordered the Eurofighter Typhoon in 2017

Dassault Rafale operators

Country	Active	On order
Egypt	24	30
France (air force)	102	38
France (navy)	41	2
Greece		18*
India	18	18
Qatar	23	13
Total	208	101*

Note: *Includes 12 ex-French air force examples

Eurofighter Typhoon operators

Country	Active	On order
Austria	15	
Germany	134	38
Italy	92	
Kuwait		28
Oman	12	
Qatar		24
Saudi Arabia	72	
Spain	70	
UK	119	
Total	514	90

Saab Gripen operators

Country	Active	On order
Brazil		36
Czech Republic	14	
Hungary	14	
South Africa	26	
Sweden	96	60
Thailand	11	
Total	161	96

Source: Cirium fleets data

industry, and that a planned lone demonstrator for the design will be French-built.

MTU Aero Engines and Safran recently came to an agreement to include ITP Aero as part of their propulsion partnership for the NGF, with what Safran chief executive Olivier Andries described as "no compromises at all".

Having secured a recent funding boost from the UK government, the Tempest programme is advancing well and has received strong backing from Italy and Sweden, at both a government and industrial level.

International partnerships

The UK's new Defence and Security Industrial Strategy document underscores the importance of sustaining a domiciled combat air capability, while also embracing international partnerships over traditional exports. On Tempest, London is also "exploring important co-operative opportunities with Japan", it notes.

Ultimately, the defence industry champions and governments of each nation involved in the current two efforts are determined to retain the skills and jobs associated with fighter manufacturing: all six have final assembly lines, and such security of supply seems likely to remain a prerequisite.

As such, a single, unified project seems unlikely to be capable of sustaining current activity levels at Airbus, BAE Systems, Dassault, Leonardo and Saab.

Asked during MBDA's annual results briefing in late March whether the guided weapons specialist would prefer to be supporting a single effort, chief executive Eric Beranger told FlightGlobal: "Yes, it would be easier. There are two programmes. Some people like it and some people don't like it. We are supporting our customers on both sides – we are simply doing our job."

Caution regarding a future merger is also urged by some due to the complexity of the four-nation Eurofighter construct, industrial inefficiency of the NH Industries NH90 transport helicopter project and complicated joint requirements which caused problems on Airbus's A400M airlifter. The difficulty and consequences of building in compromises to suit all players are also evident when viewing Lockheed Martin's long-term struggle to control costs and support systems for the F-35.

Arguably, competition is also a good thing.

In late April, all three current types were formally pitched to Finland, as Helsinki received best and final offers for its HX requirement. The Rafale, Eurofighter Typhoon or Saab Gripen E could be victorious later this year, if they can overcome

competition from the F-35A and Boeing F/A-18E/F Super Hornet/EA-18G Growler.

Four of these contenders – excluding the Gripen – also are pursuing an opportunity with the Swiss air force, with a selection decision expected by mid-year.

Combined, the requirements are likely to total around 100 new combat aircraft, representing a valuable income stream and supporting production continuity prior to the arrival of sixth-generation models.

Also of note in the Finnish and Swiss contests are the nations' central requirements to be able to independently support their aircraft in a time of crisis. To do so, both have requested the option to perform final assembly of part of their new fleet in-country, and to establish their own maintenance capabilities.

Additionally, direct and indirect offset programmes will help Helsinki and Bern to develop their domestic defence industrial capabilities. Such requirements appear to be at odds with the so-called "best athlete" models touted for both FCAS and Tempest, where partners will only participate if they can demonstrate top-level capability.

So, which bidder will benefit most from the pending selection decisions in the two European nations?

Arguably, Saab is the most in need of a victory, given that its most recent international success with the Gripen – a Brazilian deal for 36 E/F models – was signed in October 2014. The Latin American nation followed Sweden in ordering the type, with Stockholm to field 60 single-seat examples.

Export successes

The four-nation Eurofighter consortium's last export deal was signed with Qatar in December 2017, with the 24-aircraft buy following hot on the heels of Kuwait's April 2016 deal for 28 Typhoons. Closer to home, Germany last November approved a follow-on Project Quadriga buy of 38 Eurofighters to replace its Tranche 1 production examples.

Dassault, meanwhile, has had a spectacular 2021 to date, thanks to a pair of export successes.

In January, Greece confirmed an acquisition of 18 Rafales, including a dozen to be drawn from the French air force's inventory and transferred during the course of this year. Paris also ordered 12 replacement aircraft, with these to be delivered in the F3R operating standard during 2025.

Then, in April Egypt announced a follow-on order for another 30 examples, in a step which will boost its fleet size to 54: second only to the French air force.

Cirium fleets data shows that the three contenders are evenly matched in terms of their current order backlogs: with the Rafale (101) narrowly leading the Gripen (96) and Typhoon (90).

But in terms of current active fleets, Eurofighter leads the way, at 514 aircraft, trailed by the Rafale (208) and Gripen (161).

Developed for partners Germany, Italy, Spain and the UK, the Typhoon's international success began with Austria, which acquired 15 Tranche 1 examples via a 2007 agreement. In September the same year, Saudi Arabia signed a 72-aircraft deal with the UK. Oman also took 12, via a contract finalised in December 2012.

Beyond its current production deals for Germany, Kuwait and Qatar – all of which include the provision of active electronically scanned array radars – the Eurofighter consortium could yet secure a repeat order from Spain, which is looking at taking a new batch, and potentially yet more for Berlin.

Talks are also continuing over a long-term enhancement programme which will add further new technologies to the type. These could include some elements being pursued for the FCAS and Tempest projects.

Having long failed to attract an export buyer for the Rafale following its domestic introduction in 2001, Paris at last brokered a first sale in February 2015, when Egypt signed for 24. After barely pausing for breath, it added Qatar just three months later, with Doha to take 36.

India, which had picked the type for its ill-fated 126-unit medium multi-role combat aircraft need, signed for a more modest 36 in September 2016. Deliveries started late last year.

Recent sales successes will safeguard production for the rest of this decade, and further examples for the French military are scheduled to be added between 2027 and 2030, as part of a planned fifth production tranche.

Brazil has begun in-country evaluation of its Gripen E

Brazilian air force

The C/D version of Saab's Gripen is today in use with the air forces of the Czech Republic, Hungary, South Africa, Sweden and Thailand. Despite having delivered its last example of the model in 2015, Saab continues to offer it for export customers.

But greater prospects exist with the new-generation Gripen E, the first examples of which have been transferred to the Brazilian and Swedish air forces for evaluation, ahead of service entry later this decade.

Brazil, which ordered its locally-designated F-39E/Fs following the December 2013 outcome of its F-X2 contest, is widely expected to acquire further batches. As part of the deal, Saab is conducting a major technology transfer activity with in-country partner Embraer, including the establishment of manufacturing and final assembly capabilities.

Unusually, Saab is the only bidder in the Finnish contest to have disclosed the contents of its final offer: 64 Gripen Es, plus two Bombardier Global 6000-derived GlobalEye surveillance aircraft.

Whatever the outcome of the contests in Finland and Switzerland, along with further opportunities in nations like Canada and India, it is clear that continued solid investment in the Gripen, Rafale and Typhoon means Europe will benefit from the introduction of enhanced capabilities – even if their more ambitious sixth-generation plans fail to take off as planned.

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Airbus Helicopters

Part-funded via the EU's Clean Sky 2 programme, the Racer has ambitious performance and emissions targets

Dominic Perry London

Around this time last year, Airbus Helicopters was gearing up for final assembly of the Racer – or Rapid and Cost-Effective Rotorcraft – a demonstrator it is building under the EU's Clean Sky 2 programme, setting the experimental aircraft on course for a first flight in late 2021.

Fast forward by more than 12 months, a period during which the aerospace industry has been ravaged by the coronavirus pandemic, and the project is further on, albeit much less than hoped.

Faced with Covid-19 disruption to its unusually dispersed supply chain – that complexity is a result of the Clean Sky activity's multinational framework – timelines have slipped: final assembly is nearing a start, and the Racer's maiden sortie has been pushed into the beginning of the second half of 2022.

A separate project to develop rotor blades for high-speed flight has also stalled amid the wider health crisis.

Exciting times

But after a year when frustrations were more evident than progress, a sense of excitement is finally starting to build for all those involved as the demonstrator becomes "concrete", says Brice Makinadjian, chief engineer for Racer at Airbus Helicopters.

This sense of renewed optimism was triggered by the mid-April arrival of the main fuselage at the airframer's site in Donauworth, Germany, from supplier RoRCraft – a partnership between INCAS and Romaero in Romania.

The structure was subsequently mated with the canopy – specially designed for high-speed applications by FastCan, a consortium of German motorsport specialists – which had already been shipped to Donauworth.

Elsewhere in Europe, it is a similar story as suppliers gear up to ship parts to Airbus Helicopters' facilities. By July, the manufacturer is expecting to receive major components including the tail section, fuel system, box wings, electrical harnesses and landing gear. Meanwhile, the Racer's two Safran Helicopter Engines Aneto-1X powerplants are due in mid-year.

2022

Revised first flight date for Racer after previous 2021 goal slipped on the back of Covid-19 delays for supply chain

Final assembly of the Racer will take place at Airbus Helicopters' main site in Marignane, France.

Makinadjian estimates that around 50% of the major parts had been built by early April, with manufacturing launched on all components.

There is, he says, "a very positive dynamic" across the programme partners, "because we are starting to see this baby growing". That animation was absent while the Racer remained as a digital

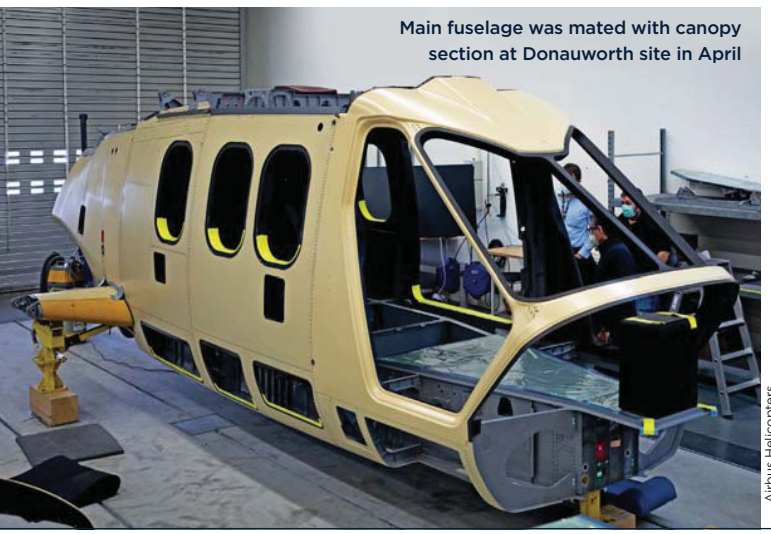
While the Covid-19 pandemic has unavoidably frustrated Europe's ambition to fly a high-speed compound rotorcraft this year, the innovative platform is finally starting to take shape

Back in the Racer

rendering – "it was not really concrete", says Makinadjian, "but now we have it and people are starting to get excited".

Released images of the individual structures do not really encapsulate the ambition or complexity of the eventual compound rotorcraft. Once complete, the Racer will feature V-shaped box-wings for additional lift, with twin pusher propellers mounted at the apex. That architecture necessitates the use of flexible driveshafts running from the main gearbox, down the upper wing to a pair of lateral gearboxes.

While it builds on research conducted with Airbus Helicopters' (then Eurocopter) X3 compound demonstrator from 2010, the Racer is built from the ground up.



Main fuselage was mated with canopy section at Donauworth site in April

Airbus Helicopters

Makinadjian is reluctant to specify the design's maximum take-off weight – it is somewhere in the 7-8t range – but he reveals that the cabin is around the same size as that of the company's eight- to 10-passenger H145 light-twin. While the design is "scalable within some limitations" – 25 passengers would require more engines, he notes – it nonetheless has "potential to grow".

"There is some margin, some room to improve in one direction or another, larger or smaller," he says.

While Makinadjian is keen not to use the Covid-19 crisis as an excuse for all the Racer's travails – even before the pandemic hit, first flight had slipped from an initial 2020 target – it is clear that numerous coronavirus-related issues have weighed on the project.

Inevitable setbacks

These have ranged from multiple cases of Covid in the fuselage assembly hangar – requiring staff to quarantine and a week-long closure each time – to small suppliers struggling with factory shutdowns before social distancing measures could be implemented, which, he says, "caused some delays to deliveries to our Romanian partners". Other small suppliers went out of business, necessitating alternatives to be brought on board. And a plan for Airbus Helicopters' prototyping staff to assist the Romanian team in the country was delayed by travel restrictions.

Despite these multiple setbacks, Makinadjian sees light at the end of the tunnel. "I think we have been able to mitigate most of the risk and topics we have faced and we now have the fuselage in house," he says.

There is better news too on the development of the gearbox, which had long been an item of concern, where delays have been "partially recovered". The first castings were made on 16 April, followed shortly after by machining of the gears by partner Avio Aero.

Two gearboxes will be shipped to Marignane during the first quarter of 2022: one for ground testing and the other for installation in the Racer.

"And so it will be at that moment we will be able to finalise the complete assembly of the aircraft," he says.

Before the Racer's first ground run the gearbox will have to be successfully validated, however, to produce "results that allow us to turn the rotor".

But in a departure from previous development programmes, the airframer will not employ its whirl tower for ground-test activities. This, explains Makinadjian, is because the Racer uses the main rotor blades from the H175 super-medium-twin, rather than developmental high-speed ones. The H175 blades – one of the few repurposed components used on the Racer – are a known quantity on which "the risks are already mitigated". However, he admits that they are "not the best design ever for high speed".

220kt

Despite the absence of bespoke blades, Airbus Helicopters is confident that the Racer will reach its target speed

Despite the absence of the bespoke blades, Makinadjian is confident that the Racer will still reach its target speed of 220kt (407km/h), although constant monitoring will take place "to ensure we are still in the domain where we have no risk for the blade and mechanical components".

Around 200h of test flights are proposed, with the team intending to advance relatively quickly towards the Racer's goal. "This is really clear for us. If we don't face any unplanned behaviour, I think within six months, we can reach the high speed [target]," he says. And, even if modifications to the helicopter are required, these will add only another six months to the timeline, he believes.

Following an initial year of development testing, the Racer will then transition to being used as a mission demonstrator – essentially proving its viability for a number of roles, including search and rescue, emergency medical services and VIP transport.

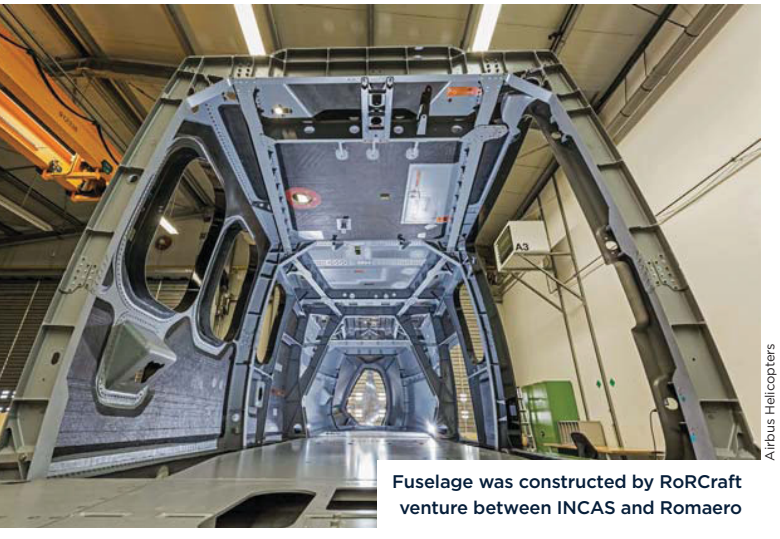
Evaluation of the "Ecomode" on the Aneto engines – the ability to idle one of the two powerplants during cruise as a fuel-saving measure – will take place only during the second phase of testing.

Aside from the simple goal of flying faster, the Clean Sky 2 programme also requires that the Racer cut by 20% carbon dioxide, nitrous oxide and noise emissions.

To address the last of those targets, the Racer's upper and lower box wings and tail are fitted with flaps. While these will not be primary control surfaces, they can be used to "tune" the aircraft's attitude, allowing "some adaptations of the trajectories to lower the noise", says Makinadjian.

The Racer's unique configuration provides a "higher degree of freedom" to tweak speed, attitude and position during approach and take-off, allowing higher rates of climb and descent than in a conventional helicopter. "Theoretically, this brings some good results [on noise]," he says.

Part of the ethos underpinning the Racer is to ensure that the pilot of a conventional helicopter will be able to transition rapidly on to the new design. So far, around 20-30 pilots have flown the Racer in the simulator – and have "confirmed it was really easy to switch between a conventional helicopter and this formula".



Airbus Helicopters

Fuselage was constructed by RoRCraft venture between INCAS and Romaero

Airbus Helicopters

X3 veteran will be at controls for debut

Airbus Helicopters has selected Herve Jammayrac as the pilot for the debut flight of the Racer demonstrator in the second half of next year – an act that will see him reprise his role on the then-Eurocopter X3 more than a decade ago.

Jammayrac was at the controls when the experimental X3 compound rotorcraft took to the air for the first time in Marignane, France, in September 2010.

A precursor to the Racer, the innovative X3 accumulated 140 flight hours by the time of its retirement from use shortly after it had claimed two unofficial helicopter speed records in June 2013. These were related to the aircraft achieving 255kt (470km/h) in level flight, and 263kt during a descent.

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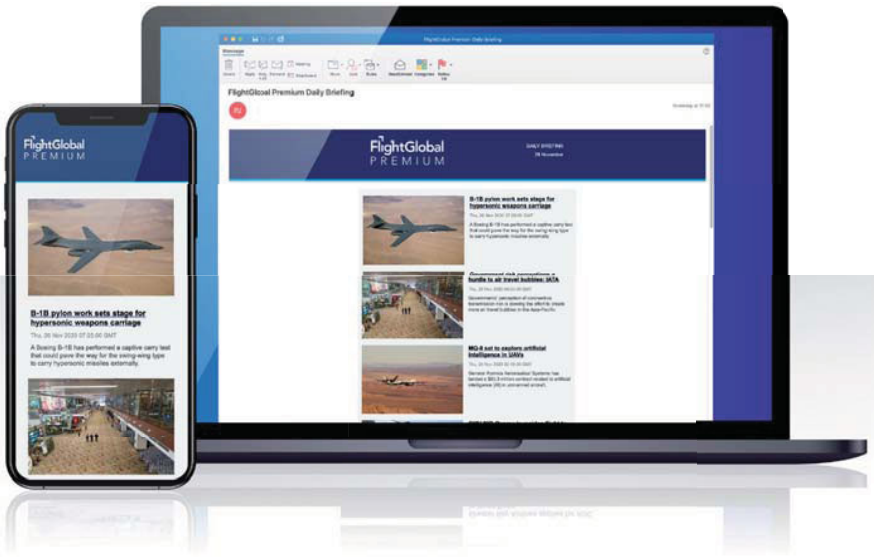

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As commercial engine MRO providers await the recovery in demand that should come with rising traffic levels, leading players are still unsure quite how deep the pandemic's business impact will be

Needing support

Mark Pilling London

In aviation's engineering, maintenance and after-market world, there is only one currency that really matters – aircraft utilisation.

The pandemic has shown how frail the aviation ecosystem is when that revenue is shut off. Aircraft in the air equal dollars flowing into flight-hour plans for engine OEMs and others, demand for airframe checks and engine shop visits, and a relatively predictable demand for new, repaired and used spares.

That demand and predictability has collapsed along with traffic levels. In its wake lies a sorry aftermarket sector reeling from its revenue source evaporating.

"Right now, airlines are not spending a dollar on MRO," said Dick Forsberg, a leading aviation finance expert and consultant to PwC Ireland, during a recent Cirium webinar.

After the initial shock of the pandemic's impact on aviation, airlines "went into survival mode, working out rapidly how to keep afloat", explains David Stewart, a partner in Oliver Wyman's specialist airline MRO consultancy.

A Raytheon Technologies financial filing of its 2020 results, explaining the impact of the crisis on subsidiary Pratt & Whitney, summed up what all carriers have been asking for: "Airlines have shifted to cash-conservation behaviours such as deferring engine maintenance due to lower flight hours and aircraft utilisation, requesting extended payment terms, deferring delivery of new aircraft and spare engines and requesting discounts on engine maintenance."

As the new year of 2020 dawned, such tactics were unimaginable. The aviation aftermarket industry had been rolling along steadily pre-pandemic, driven by a decade of strong traffic growth. The big two airframers had been striving for a greater chunk of this market via their burgeoning services businesses, either for aircraft lifetime maintenance and parts support or with digital services and products aimed at operational efficiency.

For years, the major engine makers had relentlessly sought a dominant slice of the services market for their home-built models.

The biggest were getting bigger. On 23 March 2020, Lufthansa Technik (LHT) chairman Johannes Bussmann was reporting bumper results with record revenue and earnings. At that time, he knew the crisis was going to be bad – just not how bad.

"The full extent will hit us with a delay, which means a forecast is currently not possible, but first impacts are massive," Bussmann said.

AJW Group

Parts providers have been frustrated by stalled supply deals

OEMs are keen to make up for lost time as carriers bring their aircraft back into service

MTU Aero Engines

A year later, at LHT's 2021 results presentation, Bussmann was reporting a revenue drop in 2020 of 43%, to €3.7 billion ($4.4 billion), and the industry's biggest airline MRO made a €383 million loss.

Similar incredible revenue falls and losses have been witnessed across the sector. Oliver Wyman expects the global commercial air transport MRO market to suffer a reduction in demand of more than $60 billion over 2020 and 2021 combined, according to its *Global Fleet and MRO Market Forecast 2021-2031*. This is a fall of 33% compared with pre-pandemic projections.

Grim numbers

For the engine OEMs and others with servicing deals based on flying hours, the business model has been shattered, says Phil Seymour, chairman of IBA, the global industry consultant and appraisal firm. "For them, the issue is how rapidly will flying come back – and if it will come back at all."

The huge financial impact on the engine OEMs is clear in their grim 2020 numbers. P&W's overall sales in 2020 fell by 20%, to $16.8 billion. The organic sales decrease of $4.1 billion in 2020 compared with 2019 "primarily reflects lower commercial aftermarket sales of $3.8 billion, due to a significant reduction in shop visits and related spare part sales", according to US financial filings.

Rolls-Royce reported that large engine flying hours were down by 57% in 2020, contributing to a pre-tax loss of £2.9 billion ($4 billion) for the year. The company recorded one-time charges of £1.3 billion, including a £974 million impact from service agreement "catch-ups", as a result of a forecast reduction in flying-hour receipts.

GE Aviation recorded "net unfavourable changes of $1.1 billion to the estimated profitability in its long-term service agreements", it explained in its 2020 annual reporting.

But as flying returns, the engine OEMs remain confident they can make up the lost ground.

"The services backlog in 2020 was resilient, despite the impact of Covid. As travel recovers and utilisation accelerates, we expect to capture much of that delayed spending," GE Aviation chief executive John Slattery said during an investor update in March.

There will, however, be dislocations. In its report, *Covid-19: Fleet outlook and impact on lessors and MROs*, global consultancy ICF says: "Airlines will challenge the flight-hour contract concept in the short- to medium-term. They will want to stay away from minimum-flight-hour guarantees in contracts, given the significant uncertainty around demand."

One market feature that is thought not to have changed is the annual OEM replacement parts price escalation – a yearly ritual that airlines naturally dislike but have little control over. The pandemic has not given airlines any relief, according to industry sources, with price rises of 6-7% last year as the manufacturers sought to plug their revenue shortfalls.

The priority is for aviation to restart – but when? "The industry has been in a kind of stasis, with enough money to survive but with restricted ability to 'build back better'," says Stewart.

Restart activity is intense, and Christopher Whiteside, chief executive at global parts and repair specialist AJW, sums up the frustration for many. "I have 200 deals in play at present, from Peru to Pakistan, but airlines say, 'we are not flying yet', so the inking of the contract has not really happened."

Niklas Prescher/Shutterstock

MRO revenues nosedived in 2020 as many aircraft went into storage

So, what next? And what are the recovery scenarios and strategic moves likely to be seen in the sector? The most obvious impact is that for an industry that has stalled, there will be surplus capacity and some MRO players will either fail or downsize.

"Airlines may face some challenges in terms of disruption of supply as the supplier base in certain markets or geographies comes under strain," believes Stewart.

AJW, which carries a hefty parts inventory worth $500 million, has dipped to 65% of its pre-pandemic revenue base, but has restructured and lent heavily on its diversified portfolio in addition to airline clients to weather the storm. "There will be a culling of people in our business that don't have contracted services, military or cargo business," says Whiteside.

Those that survive will be keener than ever to do whatever it takes to win. "We have been even more engaged with our customer base as a partner through the crisis – it's all about avoiding unnecessary spending," says Martin Friis-Petersen, senior vice-president MRO programmes at MTU Aero Engines.

35%

Pandemic-driven fall in revenue recorded at global parts and repair specialist AJW

Strong, credit-worthy airlines have found suppliers willing to entertain flexible payment terms, discounts on shop visits and help to use so-called "green time" engines – powerplants with life left on the clock. Higher-risk carriers will not always be offered such flexible terms.

Airlines have been outsourcing their MRO services for years, and this trend may accelerate again. The goal is to move from high fixed costs, such as in-house MRO entities, to a more variable cost base. "Boardrooms will once again be asking the question: why do we want the infrastructure?", says Stewart.

It may be attractive for some to look at partial disposals of their MRO assets as a mechanism to raise capital. A sale of a 30-40% stake in an airline MRO would be an attractive prospect for private equity, a sovereign wealth fund or pension fund seeking a secure income stream, while the airline retains operational control.

For Airbus and Boeing, there may be a requirement to temper aftermarket ambitions as they digest bigger issues for now.

"There is a need to refocus on the core business and return to a steady state. And there is the fact that the services business is even more competitive than ever because everyone is fighting for survival," says Yann Cambier, aviation principal at ICF.

While the desire to capture more aftermarket business will remain, the trend could be away from capital-intensive services and to higher-margin activities such as data services, around predictive maintenance, or via acquisitions of specialist service providers.

Alternative spares

The expected increase in retirements, aircraft part-outs and availability of green engines for some years ahead has ramifications for supply and demand across the whole services ecosystem. Manufacturers of non-OEM spare parts, which airlines can favour as they are cheaper than those bought from the original manufacturer, should be well placed, as well as companies specialising in parts repair.

MTU works in some of these areas, in addition to offering used serviceable material (USM) and green-time engines, and in-house parts repair. "The wave of retirements expected from mid-2020 has not materialised, but it will come," says Friis-Petersen. "We will be an active player where we see value."

A disrupted industry brings opportunities, and the environment is ripe for mergers, acquisitions and consolidation. Cambier says that with excess MRO supply "ICF expects that investors may buy some suppliers with weak cash positions".

Stewart agrees: "There are private equity investors that are looking for a good deal in a market that has long-term growth prospects." There is plenty of interest, he says, particularly in players that deal in end-of-life services, asset management and USM.

How the aftermarket develops in the coming years is entirely dependent on the pace and shape of the traffic recovery. A snap back to previous growth patterns could see the aftermarket arena emerge battered and bruised but fundamentally unaltered.

Analysts are cautious about predicting wholesale changes just yet, but the underlying feeling is that some business models have changed for good.

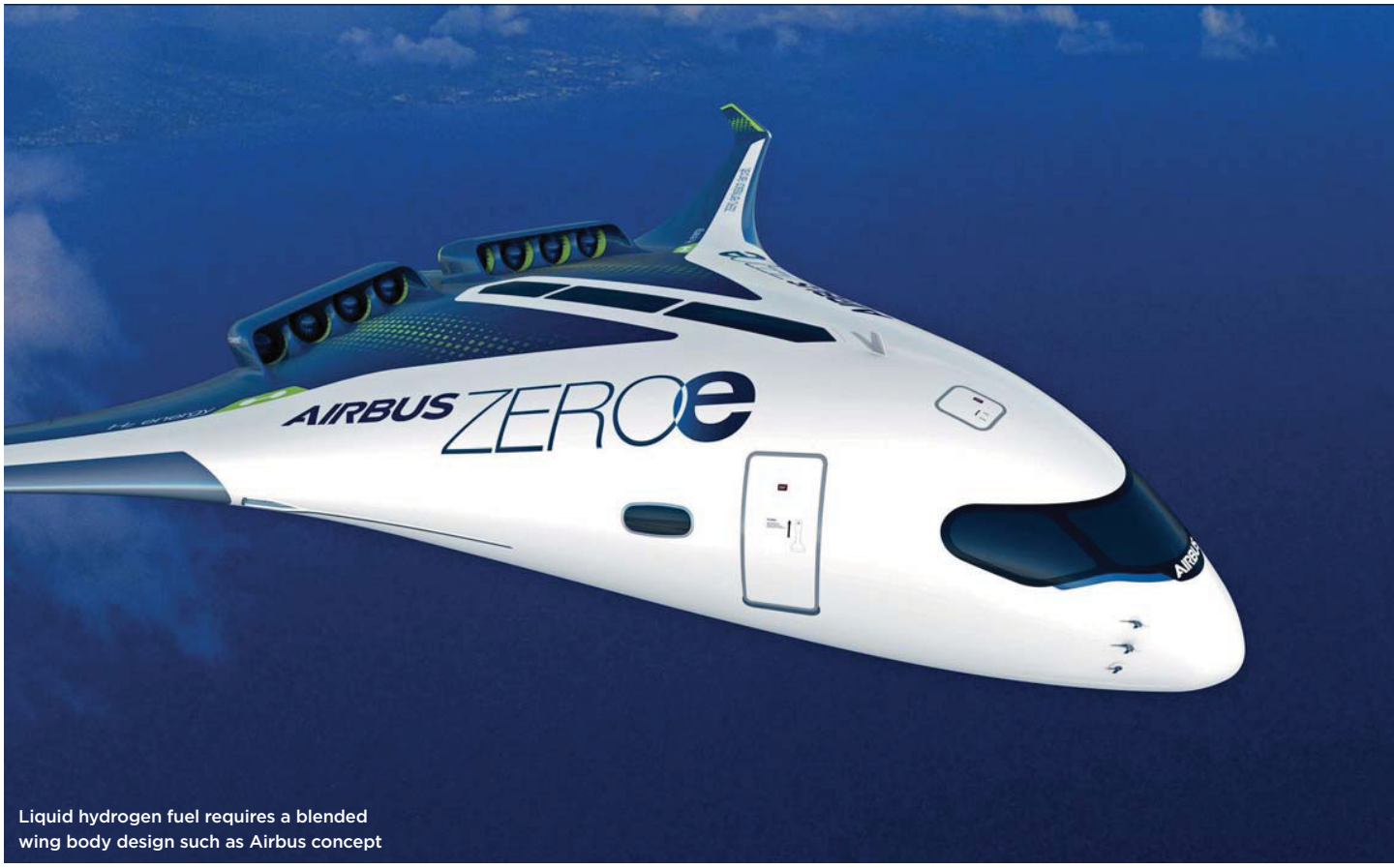
This article appeared first in our sister publication, *Airline Business*

P&W has spent $10 billion on its GTF 'benchmark architecture'

Pratt & Whitney

The great engine race

For aviation to achieve zero or near-zero carbon emissions in the coming decades, an entirely new suite of propulsion technologies is critical. The big manufacturers say they are up to the challenge



Airbus

Liquid hydrogen fuel requires a blended wing body design such as Airbus concept

Mark Pilling London

The cocktail of possible engine technologies and fuels that are going to propel an industry desperate to prove it can decarbonise becomes more extraordinary by the day.

The ingredients in this cocktail are bewildering, encompassing next-generation turbines, sustainable and hydrogen aviation fuels, hybrid, electric, fuel cells, and an intoxicating mixture of all of them.

For the engine makers researching a raft of technical solutions, a discipline that constantly absorbs millions of dollars, this is their day job. However, the task of developing the next generation of engines has arrived at the worst moment financially, with balance sheets swamped by the pandemic-induced crisis.

Nobody, however, has been tempted to take a hatchet to research and development budgets. Andy Geer, chief engineer, UltraFan at Rolls-Royce, acknowledges the challenge: "Our R&D strategy is very much unchanged by the events of the last 12 months; the only thing that has changed is the need for it to be delivered in perhaps the most cost-constrained environment that can be imagined."

Perversely, the crisis could offer industry more clarity on its priorities. Government bailouts and stimulus packages are inexorably connected with accelerating environmental progress: what some dub the "green recovery".

The manufacturers are aligning themselves accordingly. "Essentially the engine game has not changed, but it is the speed with which these technologies are going to be adopted because the industry has really changed," believes Arjan Hegeman, general manager of advanced technologies at GE Aviation.

Rolls-Royce

R-R's UltraFan should be in service around 2030

"In the past 12 months, our strategy has not changed, but rather has been confirmed by the ongoing public discussions, which are driving us to continue to intensively pursue our goals," says Stefan Weber, senior vice-president, engineering and technology for MTU Aero Engines.

Central to these goals is the all-consuming and unaltered drive for better performance. In the old days, the target was obvious: a better turbofan than the previous generation, bringing double-digit fuel burn efficiency gains for airliners to bring lower costs.

And they are good at it. For example, CFM International brought in a 20% improvement with the CFM56, while its successor, the Leap, has delivered another 15%, explains Jerome Bonini, vice-president research and technologies at Safran Aircraft Engines.

But when will the next step-change be required? Guillaume Faury, Airbus chief executive, offered clarity in March during a Eurocontrol webinar, saying that a 2035 entry-into-service date for a next-generation aircraft "makes sense". A formal launch would take place in 2027-2028, giving industry a lead time of five to seven years to mature the technology, he said.

Faury has also been enthusiastic that a future jet will feature hydrogen fuel in some form. Airbus is pushing hydrogen

because it offers the most significant impact on carbon emissions reduction.

So, what will the next-generation engine be? Hydrogen is firmly in the sights of all manufacturers; but whether the fuel is Jet A-1, sustainable aviation fuel (SAF) or hydrogen, the turbine engine is the starting point in each case.

"What is obvious is that, for the foreseeable future, there will be no alternative to the aero gas-turbine – in further optimised form – as a propulsion system for large commercial aircraft," says Weber.

"We have spent $10 billion on a technology that was moving in a direction we knew we had to go," says Geoff Hunt, senior vice-president engineering and technology at Pratt & Whitney, describing the US manufacturer's bet on its geared turbofan (GTF). "We have established what I think is a benchmark architecture that provides the flexibility to adjust as the industry looks towards climate change alignment."

As a matter of course, P&W expects to be able to continue the trend of annual fuel efficiency improvements of 1% on average as programmes mature. "Continuing to improve on the GTF architecture is very much the near-term drive and that is consistent with the long-term strategy if you are going into SAF or hydrogen fuel or hybrid-electric," says Hunt. The introduction of these fuels and technologies "will all base off that architecture", he adds.

"The first pillar of our strategy is to define and build an ultra-efficient engine architecture," says Bonini. Safran is working on different architectures – for example, the work it has conducted into open rotor design, in preparation for the aircraft configuration the airframers will chose.

Like P&W with the GTF, CFM joint venture partners GE and Safran have a modern-generation powerplant – in their case the Leap – as a baseline propulsive system architecture.

Alongside this work there is heavy investment in lightweight, high-performance materials as well as sophisticated cooling technologies, as the trend towards higher engine pressures and temperatures continues. "All these new technologies will work their way into the engine," says Hegeman.

The conviction that a next-generation turbine is an essential pillar for "decarbonising aviation" is the reason R-R remains committed to its UltraFan programme, says Geer. "We plan to have that engine available around the turn of the decade and as it is a scaleable technology, it is suitable for both narrowbody and widebody new aircraft programmes," he adds.

MTU Aero Engines

Focus at MTU is still on performance, says Weber

For its part, "MTU is currently concentrating on the WET [Water-Enhanced Turbofan] engine," says Weber. This employs a heat exchanger to use the energy from the engine's exhaust gas stream to generate additional power.

Eric Drouin/Safran

One of Safran's projects is an open rotor design

Efficiency drive

Whatever mix of architecture, materials or fuel is in the cocktail, the engine technologists interviewed by FlightGlobal all agree the target in efficiency terms for the next-generation engine is 20% and more.

"This generation needs to provide a major step change in efficiency to, firstly, reduce emissions by simply burning less fuel and, secondly, to enable alternative fuels spanning from SAF to electric to hydrogen by providing longer range through its increased efficiency and, as such, overcoming some of the disadvantages of alternative fuels in supply constraints and/or associated weight increases [batteries] or airframe drag increases from large storage needs [hydrogen]," Hegeman says.

The use of liquid hydrogen fuel, for example, will require an aircraft shape and size like the Airbus ZEROe blended wing body design, because hydrogen takes up about four times the volume of jet fuel.

Another clear strategic pillar to achieve decarbonisation is to develop engines that run 100% on low-carbon fuels, such as SAF and synthetic fuels, or liquid hydrogen, which would be zero-carbon, says Bonini.

Boeing agrees. It has set a target of 2030 for all its commercial aircraft to be certified to fly on 100% SAF. Today, the maximum is a 50:50 Jet A-1/SAF mix. There is work on fuel standards and the technical

> "What is obvious is that, for the foreseeable future, there will be no alternative to the aero gas-turbine"
>
> **Stefan Weber Senior vice-president, engineering and technology, MTU Aero Engines**

changes needed to run turbines at 100% SAF, but it is not a tough nut to crack and 2030 or probably earlier is achievable.

The prospect of burning liquid hydrogen in aero engines is more captivating. The first thing the engine makers point out is that hydrogen is not new to them. P&W ran a hydrogen engine in the 1950s, while GE ran one in the 1960s. Russian scientists flew a modified Tupolev Tu-154 using hydrogen fuel in the late 1980s.

"We understand the challenges and the opportunities of hydrogen. From an engine manufacturer's perspective, we do not see we are the long pole in the tent to get into a hydrogen solution at the aircraft level," says Hunt.

"Burning hydrogen inside an engine is not the issue; getting the hydrogen into the right conditions to be used is the challenge," explains Bonini. In February, Safran announced the Hyperion study, where it will work with space launch vehicle maker Ariane Group and Airbus on turbines that burn liquid hydrogen.

Yes, the combustor will be different, as is the control system – but the biggest challenge is not how the fuel is burnt, it is upstream and integrating it into the aircraft design, says Hegeman.

Questions on storing the bulky hydrogen in the airframe and the infrastructure needed to deliver it to an aircraft are harder to answer. "The bigger challenge, similar to SAF, is the need to scale it up. And the need will be for green hydrogen," explains Hegeman, referring to hydrogen produced using renewable power generation.

The view is that liquid hydrogen will be an attractive longer-term option, with advances in current turbine technology and the use of SAF both providing near-term benefits.

"An ultra-efficient engine is still the key to the future – whatever fuel you burn," says Bonini. Embedding electrical systems in such engines to create a hybrid configuration will deliver further levels of efficiency and represents the third strategic pillar of decarbonisation.

The target is to make hybrid variants of current models, such as P&W's GTF family and CFM's Leap, where electrical power is generated to help provide or save energy in the engine. The aim of this work,

"Burning hydrogen inside an engine is not the issue; getting the hydrogen into the right conditions to be used is the challenge"

Jerome Bonini Vice-president research and technologies, Safran Aircraft Engines

Why Honeywell is an eager disruptor

To help describe where it plays in the hybrid engine space, Honeywell has a nifty slide with nine boxes on it that explains the thrust source (turbine, electric, or both) and power source (fuel, battery, or both).

The important part for the US aerospace manufacturing giant is that it can tailor a solution in seven of the nine hybrid architectures to address product opportunities in civil and defence markets, from commercial airliner auxiliary power units (APUs) to helicopter engines and in unmanned air vehicles (UAVs).

"It's our view we need to be prepared for conventional and disruptive solutions," says David Marinick, president of engine and power systems at Honeywell. "We are working on improvements to conventional architecture, such as greater efficiency and better fuel burn for our APUs, including the ability of our turbomachinery to run on sustainable aviation fuels [SAFs]."

But with every passing quarter, "more of our investment is moving toward the disruptive side", says Marinick. A growing element of this disruption is the development of electric, hybrid-electric and hydrogen propulsion technology.

This is familiar territory for Honeywell, says Marinick, for "integrating gas turbines with generators and gearboxes is something we have been doing for decades. We feel we are in our core here."

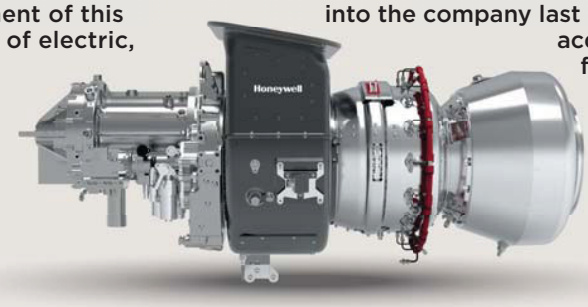
The next step on its roadmap is a recently announced plan to mate a 1MW Honeywell generator with its HGT1700 APU, which is found on Airbus A350s, to create a turbogenerator. A demonstration unit will run this year with a view to a product that could power air taxis, cargo UAVs and small hybrid-electric aircraft.

"We feel like in many ways we are uniquely suited in this space, because we have so much domain expertise," says Marinick. Part of its DNA is being a partner with the engine OEMs on a host of airframes, and the "opportunity for [further] partnerships is strong", he believes.

There will undoubtedly be new players to this market that will take on the established order, but Marinick is unfazed. "The combination of both might ultimately win the day with the best of both worlds," he says.

"We maintain a very strong interest in hydrogen, both as a fuel cell and as a fuel source," he adds.

Honeywell brought some "compelling technology" into the company last October, with the acquisition of US hydrogen fuel cell system firm Ballard Unmanned Systems, which manufactures engines for UAV applications.



Honeywell is designing powerplants for air taxis, cargo UAVs and hybrid-electric aircraft

Honeywell

says Weber, is "the most complete electrification of the drive train possible in order to be as emission-free as possible in flight".

Many believe the concerted hybrid research efforts in play will yield benefits in the short- to mid-term. "A hybrid-electric variant of GTF is certainly something that we are studying," says Hunt. Although P&W did last year slow Project 804, an effort to develop a hybrid-electric engine for a regional aircraft, starting with a De Havilland Canada Dash 8-100, this work has a "lot of merit" and is ongoing, he says. However, a flight demonstration planned for 2022 will slip.

At P&W, there is a benefit having sister Raytheon Technologies company Collins Aerospace in the family. "We work extremely closely with Collins, which has very strong capability in the electrical systems area," says Hunt.

GE has been working on a basket of hybrid research efforts for more than a decade, including a project in 2016 where 1MW of electrical power was siphoned off from a military F110 engine while also generating thrust. This much electrical energy could power a small, six- to 10-seat aircraft.

The years of foundational work spent on such research gives GE confidence it will have the answers. "We are running all of these systems towards a flight of a full hybrid propulsion system," says Hegeman. "We are very far along that journey, with a ground demonstration of a fully built-up engine and flight demonstration of a twin aircraft planned within a couple of years."

Safran

Low-carbon engines represent years of research, says Bonini

The hybrid technologies under development will have applications in turbines powering jetliners in the 100-plus seat class, and there are dozens of smaller aircraft being touted for cargo, regional airline, and urban air mobility opportunities. Further down the size class there are many working on all-electric engine applications.

Another technology with promise, which MTU advocates for the longer term, is the conversion of hydrogen into electricity with the help of fuel cells. It is studying this technology with the DLR German Aerospace Center. "These technologies could go into series production even before 2040," believes Weber.

Ultimately, all the engine makers say they will respond with a powerplant when asked. "There isn't any user knocking on our door today. When they do, we are going to have a product," says Hegeman.

Today, the product opportunities appear to centre on a new narrowbody to succeed the Airbus A320 and Boeing 737 Max families, while Boeing chief executive David Calhoun has hinted that it might still develop an aircraft with around 270 seats.

Airbus has been the most progressive and aggressive, clearly signalling a desire to speed up moves to low or zero-emissions aircraft, while Boeing has committed to its 2030 target for using 100% SAF on all its commercial aircraft.

GE Aviation

GE has invested heavily in future powerplant development

With their existing positions on the A320 and 737, CFM and P&W appear well placed, while R-R is relying on its UltraFan to force its way into the reckoning. "This is a new generation of gas turbine, with the capability to grow and adapt to become an entire engine family, designed for service around the turn of the decade, offering a 25% efficiency improvement compared with our first generation of Trent engine," says Geer.

Multiple technologies

As Bonini explains, a new class of low-carbon engine will bring millions of dollars and years of research to fruition: "This is a great challenge, a huge effort, which is why we need the construction of other technologies, including SAF, hydrogen and hybridisation, to achieve the decarbonisation goals we have."

Hegeman agrees. "I don't think there is one single solution that is going to work. All these different technologies are going to be necessary across the whole spectrum of commercial aircraft," he says.

With its open rotor technology, Safran claims it has already demonstrated a 15% fuel efficiency gain compared with the Leap. Moving away from a nacelle, as an open rotor does, is one of the options airframers will be considering as they deliberate aircraft configurations.

Perhaps an open rotor design is one of the answers. Perhaps not. Today, it is impossible to judge which technologies, in which order, or in what blend, will flourish. The manufacturers are obliged to spend big across a variety of bets, uncertain as ever if their strategy will be the one that ultimately succeeds.

The flag has truly dropped on this urgent technology race to discover a new low- or zero-carbon aviation engine nirvana. Without doubt, it is a contest the engine manufacturers are relishing. Their tradition says they almost always come up with the answer. They are convinced they will this time too.

Living fast

When mounting an attempt on an aeronautic speed record, there are, as you might expect, pages of regulations to be adhered to, set by the Federation Aeronautique Internationale. Rolls-Royce is currently working towards a bid for the title of fastest all-electric aircraft under its ACCEL programme.

Speaking during a recent Royal Aeronautical Society online lecture (while also carrying a very small baby in a papoose, in a wonderful display of multi-tasking), project director Matheu Parr described the decades-old regulations as "incredible". But among the rules governing the course to be flown, and at what altitude, is a rather important stipulation: for an attempt to be deemed successful, the test pilot must remain alive for 30min after landing.

Bad news, then, for R-R's man at the controls, Phil O'Dell. "We have taken this as meaning that when Phil lands having broken the record, we can put him in a little coned-off area and we can drink champagne and he has to wait for 30 minutes before we can let him out," says Parr. "Just in case he falls over or something."

Martin Leber/Shutterstock

Soviet Union's Tu-16 jet-powered long-range strike aircraft

Rolls-Royce

Hoping for a speed record... and to die another day

How PR works

London's Gatwick airport has just introduced a controversial charge for motorists dropping off passengers, insisting that the "new revenue stream" will "help the airport preserve jobs and recover from the significant effects of the Covid-19 pandemic".

Gatwick Airport

Either way, you pay

Difficult to argue with that, but we are pretty sure that when the scheme was mooted originally, it was because of the business's

From the archive

1921 Pictures for the press

Mr. Cobham flew his 'bus across to Aldergrove Aerodrome, where at 1 o'clock a member of *The Times* was taken aboard, together with a cargo of photographic plates exposed during the opening of Parliament procession, and a start was made for home. Flying close behind was a second D.H.9. piloted by Mr. Hatchet, with Pathe films on board. The two kept company, passing over Barrow, Preston, Wigan, Birmingham, until, near Rugby, Hatchet's machine ran out of petrol, and he had to land in a ploughed field. On missing his aerial companion, Cobham returned and landed alongside in the same field. The Pathe films were transferred to the other D.H. and she was pushed to an adjoining field, which was better for getting off from than ploughed land.

1946 American dream?

Many weeks have now elapsed since it was first reported that an American attempt was to be made on wresting from Great Britain the world's speed record of 606 m.p.h. One should not be very surprised at this, and the delay is readily explained by two simple facts: the American newspaperman's tendency to confuse possibility with accomplished fact, and the difficulties inherent in the record attempt itself. Do not let us forget that in this country we made the self-same mistake. The news that an attempt was to be made leaked out long before the machines were ready. As for the American chances, our English correspondent in the United States, in his "American Newsletter" this week, does not appear unduly worried. Indeed, there is no reason why he should be.

Russian Cold War warriors on display

More than 40 grizzled Cold War veterans and other decommissioned aircraft are on their way to museums across Russia, courtesy of state conglomerate Rostec.

They include the RAC MiG-29K, Myasishchev VM-T Atlant airlifter, and Tupolev Tu-16 strategic bomber.

The VM-T is possibly most famous for carrying the Buran prototype spaceplane on its back, while the Tu-16 was the communist superpower's first jet-powered long-range strike aircraft. The MiG-29K was developed in the last days of the Soviet Union as a carrier-based supersonic fighter.

The USSR may be long gone and largely unlamented, but many Russians remain proud of their country's military aerospace achievements that helped contain what was seen as the great NATO threat in the decades following the Second World War.

"commitment to sustainable transport by reducing unnecessary car journeys".

Given the new justification, we presume therefore that, once the airport returns to full post-pandemic operation and profitability, the dropping off charge will be... er... dropped.

Watch this (parking) space.

Launch, then dinner

From a press release about Servair's contract to develop meals for the European Space Agency: what do you call a cosmic adventurer with a taste for fine food? A gastronaut.

Bahrain drain

You know aviation has a sustainability image problem when a Formula 1 driver objects to the flying display at a Grand Prix as "a waste of fuel". Apparently Sebastian Vettel saw the Gulf Air Boeing 787 during its validation flight ahead of the Bahrain GP and complained, so the flag carrier conducted the flight with sustainable fuel.

Yuckspeak

Austin-Bergstrom International airport is launching a new "online wayfinding tool". We think it means a map.

50 25

1971 The enemy within

I found Mr L. F. E. Coomb's article "Know Your Enemy" very interesting. He has, however, once again worked on an assumption that has bedevilled the transport pattern of this country for over a century, simply this: not everyone lives in London, and nor do they necessarily wish to travel to London. I submit that this preoccupation of Londoners on all national matters with their own area is one of the biggest hindrances to the economic development of this country as a whole. There are, after all, more of us living away from London than in that city and its environs. The easier it is to travel between major cities without going through London, the better it will be for all concerned, and this applies particularly to the air transport scene.

1996 Low-cost savings

The launch of no-frills, low-fare airlines has reduced the cost of flying for US travellers by $6 billion so far, says a new study by the US Department of Transportation. In cities where low-cost US carriers operate, the average cost of a one-way ticket has dropped by $54, or $70 if a city serves as a major airline hub. Competition has led established US long-haul carriers to lower their fares, and the availability of cheap tickets has encouraged more people to fly. The study shows that low-fare carriers now compete in markets which account for almost 40% of domestic travellers, and they are rapidly expanding their operations. Most growth in recent years has been in markets where lower fares have stimulated demand.

AirTeamImages

Boeing facing European rivalry is not new: Eastern Air Lines fielded A300 from 1977

NOTAM overload

Your article on information and NOTAM overload (*Flight International*, May 2021) struck a chord with me.

I stopped flying as a private pilot a couple of years ago, but I remember similar instances of completely irrelevant information for my short flights from my local airport in southern England.

I always used the NATS AIS website to obtain my pre-flight briefing information but, despite requesting information relevant only to a circle of 50 miles surrounding the airport, I was invariably provided with NOTAMs covering other parts of the London flight information region (FIR) as well, together with the Scottish FIR and also details of hazardous airspace in places such as Afghanistan, Ukraine and other foreign locations.

Even at my modest level of operation it took a good few minutes for me to filter out the one or two pieces of information that I actually needed.

The system then was clearly not fit for purpose and it appears that nothing has changed.

Paul Baker
via email

Cranfield Aerospace Solutions

The hydrogen fuel-powered Islander might benefit from another wing

Winging it

The interesting article 'Fresson takes new direction' in the May issue had an illustration of an Islander with large hydrogen storage tanks under each wing.

If increased storage volume for the fuel is the main driver for adding these, then why not make the tanks wing-shaped?

Britten-Norman expects that the development of a green "next-generation Islander" will be an "iterative process" – maybe it could end up as a 'Bislander'?

It would be interesting for someone who knows to educate us on the impact on the Islander if it were to become a biplane.

Don't laugh at the suggestion: the Russians are developing the TVS-2DTS, a modern biplane replacement for the Antonov An-2.

Steve Gilchrist
Prestwick, South Ayrshire, Scotland

Family first

I read the letter 'An impossible dream' (*Flight International*, April 2021) with interest.

The difficulty in recruiting women into certain trades and professions is well known.

In the case of aviation, particularly the flightdeck, I expect many women are unwilling to invest in flying training for one simple

Healthy competition

Whatever the unstated – and unwise – source for W D Barbut's suggestion that Boeing "had once been promised that it would be the only airframe manufacturer for civil aircraft in the western world" (*Flight International*, May 2021), there is no sudden or recent cause for "quiet rage that Boeing not only has a competitor now, but one that is even assembling some of its aircraft within the USA".

Why the "now"?

Competition from Airbus has been around for nearly 50 years – for part, at least, of which time Boeing has been playing catch-up to the Europeans' technological lead.

The correspondent also points out that there is established Airbus final assembly in the USA, a provision that nicely overcomes any innate tendency that the Americans (rather like the French) may have to resist anything "not made here".

Who now remembers (or even noticed) the irony of former president Trump's "America first" speech ("our goal as a nation must be to rely less on imports and more on products made right here in the USA") at the roll-out of the Boeing 787-10 – a design comprising major sub-assemblies manufactured in half a dozen or more other countries?

As *Flight International* asked more than 30 years ago: "What's American for 'Fait a l'Etranger'?".

It is also worth remembering that the A300 – the world's first twin-aisle, twin-jet airliner – entered service with US carrier Eastern Air Lines in 1977. So European competition is not a recent phenomenon and did not end "suddenly" – or simultaneously – with the Vickers Super VC10 and BAC One-Eleven: production of the latter ceased in the early 1980s, more than 10 years after that of its larger sibling.

Nor has the UK given up aircraft manufacture: Airbus is the country's largest commercial aerospace activity.

Ian Goold
Cranleigh, Surrey, UK

reason – within around five years of graduation, they will be looking to start a family. An occupation involving nights away on a regular basis will be difficult to reconcile unless she has a very co-operative husband and grandparents.

Short-haul flying would make life easier, but the rewards in pilotage are in long-haul, heavy jet flying.

I can see why other occupations would be more attractive.

Dudley Newiss
Lytham St Annes, Lancashire, UK

Wasted opportunity

Your very interesting article with Sir Stephen Hillier (*Flight International*, May 2021) about the UK Civil Aviation Authority raises some important questions.

Recognising essential quality and safety issues – as well as the ability to embrace future innovations – all costs money, and one has to ask whether or not the UK government has fully committed to the changes and sustainability that will be required here.

Dealing with individual EU member states seems an expensive retrograde step, with all the mountains of implied duplicated bureaucracy that involves, when the European Union Aviation Safety Agency still lives – albeit with the UK (the best of the bunch?) now on the outside.

Roger Allingham-Mills
Burbage, Leicestershire, UK

Rich Higgins/Shutterstock

Is the UK Civil Aviation Authority duplicating effort outside the EU?

We welcome your letters about our coverage, or any other aerospace-related topic. Please email flight.international@flightglobal.com, or write to: The Editor, Flight International, 1st Floor, Chancery House, St Nicholas Way, Sutton, Surrey, SM1 1JB. Letters should be no longer than 350 words in length, and supplied with the correspondent's name and location. Letters may also be published on FlightGlobal.com, and do not necessarily represent the views of the editor.

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For materials engineer **Luciana Selmi Marques**, resilience is not only a characteristic of aircraft construction, but a key behavioural trait that has helped guide her career at Brazilian manufacturer

The right material for Embraer

Pilar Wolfsteller Las Vegas

When Luciana Selmi Marques's husband, a private pilot, takes off in his small plane, she is a willing passenger. She has considered taking lessons herself, but for the moment is more interested in the materials that help them get airborne.

An engineer for Embraer at its headquarters in Sao Jose dos Campos, Selmi Marques has blazed a career at a global aerospace leader that is also one of Brazil's most prestigious companies. She is currently head of advanced materials and structures technologies for the airframer.

Her route into the company's management ranks opened thanks to Embraer's Engineering Specialization Programme, which launched in 2001 and serves as a primary gateway for its engineers. She was a member of its inaugural class.

"I had always thought Embraer was out of reach for me," Selmi Marques says. "This programme was my way into this great company."

Master's degree

The course targets young university graduates and combines a professional master's degree from Brazil's Aeronautics Institute of Technology (ITA) with a curriculum designed to prepare engineers to work in multidisciplinary units at Embraer.

About 1,600 people have completed the highly-selective programme in its 20-year existence, with more than 1,000 students applying annually for a few dozen slots.

Two decades later, 43-year-old Selmi Marques leads a team of 27 Embraer engineers across three countries. One-third are women.

Selmi Marques became interested in engineering early, when she and her older brother joined their father in tinkering around the house. Her brother repaired electronics and electrical issues, while a young Luciana learned how to become handy in almost everything else that needed fixing.

"I was very curious about mechanics. I loved physics and I was really good at maths," she says.

When she was 10, her father started a company making prosthetics. That was when Selmi Marques felt inspired to experiment wtih making things herself, an interest that led to a materials engineering major at Brazil's Federal University of Sao Carlos.

"Materials engineering was a comprehensive course, and you can choose a lot of paths after that," she says.

Later, at ITA, Selmi Marques gained a degree in Aeronautical and Mechanics Engineering – a field that involved studying the physics and chemistry of aerospace materials.

After initial training through the Embraer programme, she spent four years working as an engineer focused on loads and fatigue. Following that, she joined the airframer's Composite Research and Development group, where she studied infusion, thermoplastic and fastened joint technologies.

She led a complex composite demonstrator project, from design to final structural tests.

Now, her job spans Embraer's aircraft programmes. She researches composites, metallic and other new materials, and develops processes to make them. "We focus on the technology and making them mature [to use on future aircraft]."

While the pandemic has fundamentally changed the way she and her team work, it has made research and learning more egalitarian, she says.

For example, in the past, she would have to decide which employees could attend a particular technical symposium, congress or workshop because it was

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Embraer

Selmi Marques emphasises agile thinking

cost-preventative to send them all. But with video meetings and webinars now the norm, more engineers can participate in educational opportunities.

In addition, members of her team who are not physically located in Sao Jose dos Campos – she manages personnel in Brazil, Ireland and Portugal – now have equal virtual access to their boss.

Her personal goal is to make sure her team's collective knowledge and talent are stretched to solve the company's engineering challenges.

"My passion is about people. So, if I can add value by bringing people into the right roles so that we can maximise their skills, and solve the technical questions also, then I am happy," she says.

Selmi Marques preaches this kind of agile thinking to colleagues and staff. It mirrors well the engineering work her group has been tasked with.

Resilience, she says, is the ability of a material to absorb energy when deformed and release that energy upon unloading. It is a critical physical trait in building aircraft, but also one she says correctly describes her journey as a woman in the aerospace industry.

"Resilience in behaviour is the opposite of anxiety," she says. "If you are resilient you can be more sensible to what is happening around you, you are more aware. And you can grab the opportunities, think in a way so that you can be more flexible."

A rigid course of action – in life, careers or in perfecting a certain aviation technology for Embraer – is rarely the best or most effective.

"It depends on the challenge you're facing. You may need more sensibility, or collaboration, or perhaps more assertiveness," she says. "In my job it's not about the gender, it's about having the skills to do the job well."

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