FLIGHT INTERNATIONAL

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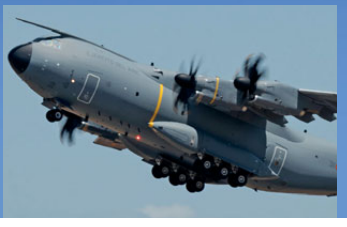

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While CFM International has set out its plan to deliver a 20% fuel saving from its next engine, only the entire aviation ecosystem working in concert can speed up decarbonisation

John Slattery, the GE Aviation chief executive, has many undoubted skills, but perhaps the least heralded is his ability to speak in soundbites while simultaneously sounding natural.

It is a talent that politicians yearn for, but which few can master; frequently the individual simply sounds stilted, as though they were reading from an autocue.

What to make, then, of Slattery's exhortations during the launch of CFM International's RISE engine demonstrator? There he called on the engine manufacturer's rivals to "engage now and compete with us" as "ultimately the planet will be the beneficiary".

Was it simply a rhetorical flourish or an expression of genuine hope? Sure, he was speaking from a position of strength – the first of the narrowbody engine manufacturers to reveal its likely future direction – but the new GE Aviation boss is correct: to stay competitive, Pratt & Whitney and others will be forced to match the 20% fuel-burn saving promised by CFM, leading to aviation as a whole reducing its impact on the climate.

These are extraordinary times, of course: thanks to Covid-19 travel restrictions, the RISE launch event was the first time that Slattery and his Safran counterpart, Olivier Andries, had met face to face since they took up their new positions. It was also just a week before what would have been the first day of the Paris air show – the likely launch venue for the RISE programme.

However, out of the havoc wreaked by the coronavirus crisis has blossomed a drive to accelerate aviation's decarbonisation.

RISE offers great promise in that respect – assuming the myriad technical hurdles can be overcome – but is unlikely to enter service until the mid-2030s. In the meantime, the thrust for the accelerated reduction of carbon emissions must come from somewhere else.

The most likely short-term hope is sustainable aviation fuel (SAF). For example, Rolls-Royce, as part of its net-zero roadmap, has committed that its in-production engines will be fully SAF compliant by 2023.

But cost and availability remain significant impediments to the widespread uptake of biofuel.

Launching R-R's roadmap, Warren East, the engine firm's chief executive, pointed out that governments have a key role to play here through incentivising the production and use of SAF; aviation must influence policy, he said.

He also noted that the engine manufacturers cannot do it alone: airframers must also drive through aerodynamic and efficiency improvements for their next-generation products.

Indeed, Andries estimated that a 10% fuel-burn gain could be derived from airframe enhancements; new powerplants are but "one component of the overall efficiency", he noted. That becomes even more true when novel architectures such as RISE's open rotor design are proposed – ever-closer integration with the airframe is vital to achieve its full potential.

The underlying message from all this? No single strand of the aerospace industry can act in isolation: airlines, engine and aircraft manufacturers, and regulators and governments must all work in concert to deliver an environment in which decarbonisation efforts can be accelerated. Or, to leave the final word to Slattery: "There is no one technology or company that can do this alone."

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In focus

Hitting the barrier Aerion's AS2 programme runs out of time

AirTeamImages

In depth

Open rotor design features single rotating fan stage followed by static guide vanes

CFM International

CFM ascends with RISE engine

Joint venture reveals open rotor demonstrator programme aiming to deliver 20% fuel-burn saving for aircraft in 2030s

Dominic Perry London

CFM International has launched RISE – a new engine demonstrator programme featuring an open rotor architecture that promises to deliver a 20% fuel efficiency gain compared with today's narrowbody powerplants.

Flight tests under the RISE – or revolutionary innovation for sustainable engines – effort are scheduled for the middle of the decade, maturing the technologies required to enable a new powerplant to enter service in the 2030s.

Programme goals include reducing fuel consumption and carbon dioxide emissions by more than 20% compared with CFM's current Leap engine, which itself delivered a 15% improvement in fuel burn over the preceding CFM56.

RISE builds on decades of research into open rotor designs at GE Aviation and Safran, CFM's joint owners, including the mid-1980s GE36 – which made an appearance at the 1988 Farnborough air show aboard a McDonnell Douglas MD-80 – and the French firm's more recent Sage2 demonstrator.

However, improvements in materials technology and digital modelling have enabled the partners to eliminate the significant size, weight and noise penalties inherent in those earlier designs, says Arjan Hegeman, general manager, advanced technology operation at GE Aviation.

Keep it simple

An open rotor architecture provides "huge propulsive efficiency" but is able to "fly at the speed of today's turbofans", says Hegeman.

Fan diameter has been significantly reduced, to 144-156in (365-396cm) – in line with the external diameter of a current-generation single-aisle engine – meaning the engine can be installed on a narrowbody-size aircraft.

In addition, the partners have chosen to "simplify" the overall architecture compared with previous open rotor engines, says Delphine Dijoud, executive manager, CFM RISE programme, systems engineering at Safran Aircraft Engines.

RISE features a single rotating fan, with variable pitch carbonfibre blades, behind which sits a row of static guide vanes. Safran's earlier Sage2 demonstrator featured a contra-rotating second fan stage, but that required "complicated internal structures which were very heavy", says Dijoud.

The turbomachinery of the system is contained in a booster, comprising a high-temperature and high-speed core and a high-speed low-pressure turbine. Dijoud says it is "too early" to specify the number of stages across each, however.

Temperatures and pressure ratios in the core will exceed those that are seen in current Leap engines, says Hegeman, while declining to offer specifics.

That step-change in performance will be enabled by the use of advanced materials, an area which has been "our strength and focus" across all generations of engines, he says. That includes the ceramic

matrix composites already in use in the shrouds of Leap-family engines, plus the use of 3D printing to produce novel structures – stator vanes featuring internal channels to provide better cooling properties, for example.

These will "proliferate further" into the core design, he says, where they will be joined by other technologies that "we are not at liberty to go into detail on".

Crucially, the RISE engine will be fuel source agnostic – able to run on either 100% sustainable aviation fuel or hydrogen – providing flexibility for future applications.

And, as Hegeman points out, the 20% fuel-burn improvement may be crucial to counteract the likely higher weight of hydrogen fuel tanks, allowing airlines to maintain current routes. Multiple electric generators will also be installed on the engine, able to extract or provide energy, as required.

"The design allows power to be transferred from one spool to another, depending on the flight phase to optimise the spools," says Dijoud.

In addition, the extra generative capacity looks forward to other new architectures. "Clearly, we envision generations of this platform where not only the engine itself benefits, but the generated power also provides distributed propulsion opportunities for the airframer," says Hegeman. "It's a foundation to allow that to happen. It secures the real estate for the airframers to continue to build on."

Although the mid-2020s flight-test goal is just four years away, Hegeman points out that CFM is building on decades of research by its partner companies, whether into the overall open rotor concept or individual components. "We are not starting now – our work started a while back," he says.

Quiet progress

GE has been "trying to solve some of the problems we ran into" since testing open rotor designs in 1980s, he adds. As a result, the architecture has "matured from decades ago" but is "an improvement without sacrificing performance".

Those tests in the late 1980s proved the efficiency of the open rotor concept, but showed that noise remained a significant issue.

However, continued research and "advanced engineering tools, refined over decades of open fan testing, and our latest state-of-the-art computer design tools" have allowed optimisation of the aerofoil shape for "both performance and acoustics", says Hegeman. This will allow RISE to "meet, with margin, future acoustics regulations".

The RISE demonstrator engine will be sized to deliver 30,000lb of thrust (133kN), says Dijoud, but "we have flexibility on that". Cruise speeds equal to current levels "and even a little bit further" will be achievable with the open rotor design.

Although CFM is initially targeting the short- and medium-haul segment, it says the design "can be adapted to customer need", even potentially scaling up to widebody applications.

But near-term demand is likely to be for a new narrowbody; potential customer Airbus has indicated a possible A320neo successor could enter service in the 2030s.

Hegeman stresses that a new aircraft will have to be designed around the new powerplants. "For propulsive efficiency to be achieved, it makes no sense to put a next-generation engine on yesterday's airframe and expect to get good performance," he says.

Meanwhile, GE and Safran have extended their partnership in CFM by a decade, with the agreement – which began in 1974 – now running until 2050.

'Closer integration' with airframe key to unlocking powerplant's potential

CFM is confident that the performance improvements likely to be delivered by the next generation of narrowbody airliners can combine with the potential fuel-burn saving from its new RISE technology demonstrator engine to deliver an overall efficiency gain of about 30%.

Unveiling the RISE programme on 14 June, Olivier Andries, chief executive of Safran, said that the engine, which promises to cut fuel consumption by 20%, is only "one component of the overall efficiency".

That saving would "be complemented by additional improvements on the aircraft side", he says. "I'm sure a combination could bring up to a 30% improvement by 2035."

Work on the RISE design, which features an open rotor architecture, began in 2019 and by the end of the year there will be 1,000 engineers working on the development across CFM's two partner companies, Safran and GE Aviation.

An open rotor engine will require CFM to "work closer than ever with our airframe partners" to optimise the integration of the powerplant, says John Slattery, chief executive of GE Aviation.

He says that both Airbus and Boeing have been briefed on the RISE demonstrator and "they are looking forward to the innovations that are going to rise out of what we are going to do".

Safran

Slattery (*left*) and Andries also extended the GE Aviation-Safran joint venture until 2050

Andries stresses that CFM is "not targeting [any] specific programme" with the 30,000lb-thrust (133kN) RISE engine; industrialisation will require an airframer to select the engine for a new aircraft, he adds.

"We want to position ourselves by that timeframe to be able to offer the best possible option with the required maturity for that technology."

While CFM is the first engine supplier to have outlined its technology roadmap for the 2030s, Slattery called on rivals to "compete with us" because "the planet will be the beneficiary".

Boeing

Twinjet landed at Boeing Field after a 2h 31min debut sortie

Max 10 clears first flight hurdle

Boeing is targeting 2023 service entry for largest variant of re-engined 737 family, as certification testing gets under way

Jon Hemmerdinger Tampa

Boeing has commenced flight testing of the 737 Max 10 – the largest and final member of the re-engined narrowbody family – but still faces a battle to regain ground lost to the rival Airbus A321neo.

Lifting off from Renton Municipal airport at 10:07 local time on 18 June, the Max 10 (N27751) landed at Boeing Field 2h 31min later after a flight that included a touch-and-go manoeuvre at Moses Lake airport in the eastern half of Washington state.

"The airplane performed beautifully," says 737 chief pilot Captain Jennifer Henderson.

"The profile we flew allowed us to test the airplane's systems, flight controls and handling qualities, all of which checked out exactly as we expected."

New targets

A few hundred Boeing staff members were on hand to watch the departure from Renton – the 737's home – among them Boeing Commercial Airplanes chief executive Stan Deal.

The first flight kicks off the Max 10's certification programme, with Boeing targeting first delivery in 2023. The company had previously expected to deliver the first Max 10 in 2020 but delayed the timeline amid the Max grounding and the Covid-19 pandemic.

Boeing launched the CFM International Leap-1B-powered Max 10 in June 2017 at the Paris air show – almost exactly four years before the first flight.

The jet can carry 188-204 passengers in two classes – or 230 passengers in a high-capacity layout – and has 3,300nm (6,100km) range.

It is 1.6m (5ft 3in) longer than the next smallest 737 variant, the Max 9. As a result of the stretched fuselage, Boeing needed to extend the Max 10's main landing-gear.

To avoid redesigning the wheel-well, Boeing added a lever to the gear that lets it extend 241mm (9.5in) during take-off rotation. When pilots retract the gear, a "shrinking mechanism" pulls in a cylinder, letting the gear fit into the standard wheel-well.

Boeing rolled out the first 737 Max 10 in November 2019.

Max 10 sales have been relatively muted, however, despite an initial flurry of orders around the variant's Paris launch.

Boeing holds orders for 431 Max 10s, with the top customers including United Airlines (88 orders), Vietjet Air (80), Lion Air (50), Flydubai (50) and Gol (30), according to Cirium fleets data. The longer-range but lower capacity Max 9 has taken 168 orders, Cirium data suggests.

The Max 10 is seen as a competitive response to the A321neo, the largest of Airbus's single-aisles.

Range finders

While the baseline A321neo is broadly similar to the Max 10 in capacity terms, holding 180-244 passengers depending on configuration, two additional variants, the LR and XLR, have significantly longer ranges, at 4,000nm and 4,700nm, respectively.

The XLR is in development and will, like the Max 10, make its commercial debut in 2023.

Airbus has taken orders for a total of 3,472 A321neos, according to the airframer's order and delivery data, of which 426 are XLRs. However, it does not break out detail on orders for the LR.

The maiden sortie of the Max 10 means that all members of the narrowbody family are now flying. The Max 8 and Max 9 are in service, while the smallest version, the Max 7, remains in flight testing after first taking to the skies in 2018; Boeing aims to hand over the first Max 7 in 2022.

Belarus 'hijacking' sparks discord

Repercussions triggered by incident involving Ryanair jet threaten agreements underpinning international air travel

David Kaminski-Morrow London

Ryanair chief executive Michael O'Leary is objecting to prohibitions on overflying Belarusian airspace, despite the apparent forced diversion to Minsk of a Boeing 737-800 operated by the budget carrier's Polish division, Buzz.

O'Leary described the 23 May event, involving the Athens-Vilnius flight FR4978, as a "state-sponsored hijacking" during testimony to the UK parliamentary transport committee on 15 June.

"There's no other way to explain it," he said, given that passengers of political interest to the Belarusian government were subsequently detained.

'Fabricated' threat

ICAO is investigating the incident after evidence emerged that the 737 crew had been informed of a bomb threat and advised not to proceed to Vilnius but instead to land at Minsk, a scenario which O'Leary believes was "fabricated" by Belarusian air traffic control.

"The pilot was put under, I would say, considerable pressure – not overtly but covertly – with the suggestion that he really should divert and land in Minsk," says O'Leary. "He wasn't instructed to do so. But he wasn't left with any great alternatives."

Belarus's ministry of transport released a purported transcript of the exchange between the crew and air navigation service Belaeronavigatsia in a bid to demonstrate that the pilots were "not pressured, threatened or coerced".

The transcript indicates the crew was notified of a threat as soon as the flight was transferred to Belarusian control after entering the Minsk flight information region, via the SOMAT waypoint on the Ukrainian border, at 39,000ft.

It suggests the crew queried the diversion recommendation, asked to contact Ryanair operational control, and were given a radio frequency for Vilnius ground personnel before deciding to divert, declaring an emergency and setting the transponder to squawk "7700".

Minsk controllers had tried "several times" to contact Ryanair's office in Lithuania, the ministry claims, but could not reach its representatives.

O'Leary is highly sceptical about this effort. "Various excuses came back from Minsk air traffic control [as to] why they couldn't reach us – 'Ryanair wasn't answering the phone' – all of which was completely untrue," he says.

Mindaugas Kulbis/AP/Shutterstock

Activist Roman Protasevich was detained when the flight landed

The European Union Aviation Safety Agency (EASA) responded to the incident by informing national regulators that they "should ensure" that operators will not conduct flights through Belarusian airspace.

"There is no full confidence in the ability of the current Belarusian authorities to manage the Belarusian airspace in accordance with international agreements," it says.

But IATA has condemned EASA's pressure on carriers, accusing it of overstepping its role and politicising air safety by shifting away from its "proportionate" advisory – which left risk assessment to airlines – to a restrictive measure.

"Politics should never interfere with the safe operation of aircraft and politicians should never use aviation safety as a cover to pursue political or diplomatic agendas," says IATA director general Willie Walsh.

While one of Ryanair's own flights was caught up in the incident, O'Leary similarly believes that a long-term ban – either on European carriers overflying Belarus or Belarusian airlines flying to Europe – should not be supported.

"It's not the way forward for air travel," he says, pointing out that air transport "fundamentally depends" on airlines' freely being allowed to overfly all countries.

"We cannot have a situation whereby airline customers run the risk of being hijacked but, equally, far more UK citizens will be disrupted as a result of long-haul flights having to fly around Belarus. This is not in our long-term interest."

'Unfortunate' suspension

Belarus's ambassador to the UK was unable to attend the parliamentary hearing. But he informed the committee, via a 9 June letter, that "all relevant information" had been conveyed to UK authorities.

This information, he wrote, proves that the Belarusian authorities took "all necessary measures" to ensure the safety of passengers on board the aircraft. He expressed concern over the "unfortunate" decision to suspend permission for flag-carrier Belavia to operate flights to the UK, a sanction which "goes far beyond the spirit of co-operation".

"Unlike most airlines, Belavia kept operating flights between Minsk and London even amid the coronavirus pandemic, in complete accordance with highest international standards, bringing British nationals back to the UK safely," he added.

"This arbitrary act of pressure on a trusted airline – which was in no way involved in the incident with the Ryanair [aircraft] – results in a direct punishment of ordinary people in both Belarus and the UK."

USAF moves to bridge tanker gap

Service may require up to 160 refuelling aircraft in period between KC-46A production completion and future platform

Jon Hemmerdinger Tampa

The US Air Force (USAF) is seeking industrial partners to deliver up to 160 examples of a so-called "Bridge Tanker" after Boeing ends production of new KC-46As for the service by the end of this decade.

On 16 June, the Air Force Life Cycle Management Center issued a sources sought request soliciting names of potentially interested companies, with a deadline of 23 June for responses.

The service seeks to acquire "140-160 commercial-derivative tanker aircraft – at a rate of 12 to 15 per year – to supplement the air force fleet at the end of KC-46A production, and bridge the gap to the next tanker recapitalisation phase," the document says. The latter effort is referred to as its future Advanced Air Refuelling Tanker project.

"As a commercial derivative aircraft, the Bridge Tanker will be based on existing and emerging technologies, with a full and open acquisition competition," the USAF says. "Neither developmental stealth nor unmanned capability is planned," it adds.

The USAF is now defining requirements and capabilities, and intends to issue a final request for proposals to industry before the end of 2022. The aircraft's "baseline capability will be based on the requirements from phase one of the tanker recapitalisation programme", it says.

Boeing was selected to deliver 179 767-based KC-46As to replace the oldest of the USAF's Boeing KC-135s through 2029. The service has a requirement to continue phasing out the legacy model – examples of which will at that point be about 70 years old – along with its 58 larger McDonnell Douglas KC-10s, via a process also referred to as KC-Y.

Airbus alternative

Before acquiring the KC-46A, the USAF also considered the rival Airbus Defence & Space A330 multi-role tanker transport. The European company has a teaming agreement in place with Lockheed Martin to pursue future opportunities, such as the Bridge Tanker. With production of its baseline A330-200 likely to end around mid-decade, it could potentially pitch a development of its re-engined A330neo for such a need.

Meanwhile, a late-May report from the US Department of Defense's Inspector General says that by overlooking design changes made by Boeing to the KC-46A's refuelling boom, the USAF missed an opportunity to catch problems early and stave off a $100 million redesign effort.

The service also "did not ensure that critical technologies for the tanker's refuelling boom were demonstrated in a relevant testing environment" prior to the type entering production, it states.

The refuelling boom is too stiff, preventing it from being extended or retracted while transferring fuel, the report says. As a result, the pilots of receiver aircraft must make large engine power corrections to adjust position forward or backward to maintain contact.

"The large engine power corrections could result in potentially unsafe flight operations during the process of disconnecting the receiver aircraft from the refuelling boom," says the report. "It caused pilots of receiver aircraft to inadvertently use excess engine power or not use enough engine power, which, upon disconnecting from the refuelling boom, could cause the receiver aircraft to rapidly accelerate toward or away from the tanker," it adds.

As a result, the KC-46A could not refuel the Fairchild Republic A-10 close-air support aircraft – which

Red Hawk schedule hit by pandemic

Garrett Reim Los Angeles

Boeing's T-7A Red Hawk advanced jet trainer has fallen more than a year behind its programme schedule, owing to parts shortages, initial design delays and the discovery of an aircraft wing rock issue.

In development for the US Air Force (USAF), the T-7A was scheduled to undergo its Milestone C pre-production programme review in the third quarter of fiscal year 2022, according to budget proposal documents. However, the service says it now anticipates this schedule being subject to a potentially 15-month delay.

"The T-7 [Advanced Pilot Training] programme has inherent schedule risk because of the aggressive nature of the programme's schedule," the USAF notes.

Model-based systems engineering tools helped to pinpoint the T-7A's wing rock issue early

"The Bridge Tanker will be based on existing and emerging technologies, with a full and open acquisition competition"

US Air Force

Shortcomings have restricted performance of 767-based type (*right*)

US Air Force

lacks the thrust necessary to push into the boom – or several variants of the Lockheed C-130 transport.

The USAF also has imposed operational limitations on the KC-46A supporting many of its bomber, fighter and transport types, restricting them to receiving fuel in limited conditions only, and with the boom's range of motion reduced. They also are forbidden from refuelling from the type in covert or lights-out scenarios.

Initially, the KC-46A's boom design was based on the KC-10's structure, and its control laws on those used with KC-767s flown by the Italian and Japanese air forces. As those technologies were deemed well-proven, it was thought that a further review was not needed.

However, during the programme's preliminary design review in 2012, Boeing presented a new boom design that "differed significantly", and should have been further reviewed, the Inspector General's report says. This was computer-controlled, versus the hydromechanically-controlled boom on the KC-10.

However, the design changes did not receive the review or testing required, the report says.

"Had programme office officials effectively managed the development and testing of the refuelling boom for the KC-46A tanker, the air force would not have had to spend an additional $100 million for the redesign to achieve the required performance," the report says.

Retrofit work is not likely to start until January 2024 and will cost the service even more, it adds.

"This delay limits use of the KC-46A for its refuelling missions," says the report. "The commander of US Transportation Command identified the aerial refuelling fleet as the most stressed of air mobility forces and stated that any delay of the KC-46 production puts the joint force's ability to effectively execute war plans at risk," it adds.

Additional reporting by Garrett Reim in Los Angeles

Boeing

"The programme office is continuously analysing methods to improve schedule and remains committed to working with Boeing to enable the T-7 programme to achieve [Milestone C] in Q4 FY2023."

General Charles Brown, USAF chief of staff, acknowledged the programme delay in a hearing before the House Armed Services Committee on 16 June. The service remains committed to introducing the trainer, he says.

The discovery of a wing rock issue while the single-engined type is flown at a high angle of attack will be fixed using a flight software update, requiring additional testing, the USAF says.

For its part, Boeing confirms that the programme is seven months behind schedule, but says that much of the delay has been caused by Covid-19-related disruptions affecting its supply chain.

The USAF will replace its aged fleet of Northrop T-38 jet trainers with 351 examples of the T-7A, with its total acquisition valued at $9.2 billion, also including 46 ground-based simulators.

By using model-based engineering during its design and development, the T-7A "moved from computer screen to first flight in just 36 months", the USAF notes.

"Through the use of high-fidelity model-based systems engineering methods and early prototyping, the air force and Boeing team was able to identify the wing rock issue substantially earlier in the testing phase than would have been possible using traditional systems engineering processes," the service says. "Traditional [Department of Defense] acquisition processes would not have identified the issue for another 24 months, during operational test and evaluation."

Attributing the programme's issues "to global supply chain challenges, due in part to Covid-19" and "initial delays in contracting suppliers", the USAF notes: "Digital model-based engineering would not have alleviated these concerns".

End in sight to WTO row

Agreement between EU and USA outlining co-operative framework should see end to 'lose-lose' tariffs

Airbus

Airbus has warned of 'disrupted' marketplace

David Kaminski-Morrow London

Airbus and Boeing have said they are encouraged by plans to end the long-running transatlantic dispute over subsidies for large civil aircraft programmes through a series of steps outlined by a co-operative framework.

European trade commissioner Valdis Dombrovskis has reached an "understanding" with US trade representative Katherine Tai intended to address bilateral issues through a collaborative platform.

The understanding sets out a framework under which financing to large civil aircraft manufacturers and programmes would be provided on market terms.

Research and development funding will be supplied through an "open and transparent" process, the Commission adds, with the results of government-funded research made "widely available", within the law.

Protecting competition

Such funding and other specific support, including particular tax breaks, that harm competition would not be permitted.

The two sides will also set up a working group on large civil aircraft, headed by one another's trade ministers, and collaborate on addressing harmful non-market activities by third parties.

Airbus says it "welcomes" the agreement, stating that it will "provide the basis to create a level playing field".

"It will also avoid lose-lose tariffs that are only adding to the many challenges that our industry faces," it adds.

Chief commercial officer Christian Scherer, speaking during an Airbus briefing on 15 June, said the decision "seems to indicate convergence" between the US and European representatives, describing the progress as "good news".

"Just ask our customers. Ask airlines whether they are in favour of tariffs," he adds.

Scherer claims Airbus has not lost orders as a result, but the dispute has "certainly disrupted the marketplace and upset a number of customers".

"An upset customer... is never a good thing to have," he says.

Under the US-European proposal, the current suspension of retaliatory countermeasures – which were authorised by the World Trade Organization (WTO) – will continue for a five-year period, enabling importers of various products, including civil aircraft, to avoid tariffs.

European Commission president Ursula von der Leyen says the agreement is a "major step" towards resolving the dispute, which has run since 2004.

"Our transatlantic partnership is on its way to reaching cruising speed," she adds. "This shows the new spirit of co-operation between the EU and the USA and that we can solve the other issues to our mutual benefit."

Dombrovskis adds that the agreement amounts to "grounding the Airbus-Boeing dispute".

"It proves that the transatlantic relationship is now moving to the next level, and that we can work with the US [government] on tackling long-running disputes," he says.

"We now have time and space to find a lasting solution through our new working group on aircraft."

Tai says that "weeks of intense diplomacy" were required to reach the agreement. "Our goal was clear – to forge a new, co-operative relationship in this sector so our companies and workers can compete on a more level playing field.

Model deal

"The agreement includes a commitment for concrete, joint collaboration to confront the threat from China's non-market practices, and it creates a model we can build on for other challenges."

A separate agreement between the USA and the UK – required because of its exit from the EU – was also struck.

For its part, Boeing also welcomes the pact. "The understanding... commits the EU to addressing launch aid, and leaves in place the necessary rules to ensure that the EU and the USA live up to that commitment, without requiring further WTO action," the airframer says.

"Boeing will fully support the US government's efforts to ensure that the principles in this understanding are respected."


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Net-zero heroes

UK propulsion specialist Rolls-Royce outlines its route to cutting carbon emissions by 2030, with SAF approval for in-production engines a key pledge

Dominic Perry London

Rolls-Royce believes that the development and application of advanced technologies will allow "the benefits of flying while having it at net zero", according to its chief executive.

The UK propulsion specialist on 17 June revealed its strategy for achieving net-zero carbon emissions by 2050 at the latest. "Wholesale transformation of the systems that make up the backbone of our global economy is required to achieve net zero," it says.

"We believe that air travel is a great thing and has brought a huge amount of benefit to society. You can see the benefits that travelling around the world bring to international business," Warren East said during a media call to discuss its Pathway to Net Zero roadmap.

Back to business

While the disruption to travel caused by Covid-19 has prompted reflection on the degree to which business flights are necessary, East argues that, on balance, "people were doing it because they thought that it delivered real benefits to them and typically it does in terms of competitive benefits".

As such, R-R expects to see business travel return in the post-pandemic world. "That is the reason we are putting a lot of emphasis of decarbonisation of flight," East says. The propulsion and power systems being developed by the company will mean "that you can have the benefits of flying while having it at net zero".

A key initiative for aviation will be to ensure that all its in-production civil engines – both those for commercial aircraft and business jets – are compatible with 100% sustainable aviation fuel (SAF) by 2023.

That includes the majority of the current Trent family, including the 700 and 7000 for the Airbus A330 and A330neo, the XWB for the A350, and the 1000 TEN for the Boeing 787. However, the A380's Trent 900 and earlier iterations of the Trent 1000, including the Package B and C versions, will not meet that 2023 deadline.

Combined, the fleets of Trent 900s and early Trent 1000s account for a substantial pool of nearly 750 engines, according to Cirium data. However, R-R stresses that it is simply prioritising in-production powerplants and will probably certificate those models for full SAF compatibility a later date.

R-R says that the modifications required to ensure engines can run on 100% SAF are minor, identifying

Rolls-Royce

"Wholesale transformation of the systems that make up the backbone of our global economy is required to achieve net zero"

Rolls-Royce

'Societal imperative' drives innovation across the business

David Kaminski-Morrow London

Rolls-Royce's sustainable aviation fuel plan is part of a comprehensive strategy that will enable its products to be "used in a way that is compatible" with net-zero carbon.

All new products will be compatible with that goal by 2030, it says, while all products in operation will be compatible by 2050.

R-R adds that it can "accelerate" this transition to net-zero by using next-generation technologies to advance its engine portfolio, improving the economics of sustainable fuels, and by introducing new low- or zero-emissions products – such as microgrids, hybrid-electric and all-electric systems and fuel cells.

The manufacturer says its target "aligns" with UN ambitions for 10% of all aviation fuel being sustainable by 2030.

"We will work with our customers in the armed forces to achieve the same goal for the Rolls-Royce engines they use,"

Manufacturer has already tested Pearl 700 business jet engine for 100% SAF compatibility

changes to control systems and seals as areas for attention.

Flight tests of the Trent XWB using 100% SAF took place in March this year in conjunction with Airbus, alongside ground tests in 2020 of a Trent 1000, but the manufacturer declines to say which engine will be certificated first.

The Pearl 700 business jet engine for the Gulfstream G700 was in February run on 100% SAF. It will be approved for full biofuel use alongside the Pearl 15, BR710 and BR725 turbofans. The developmental Pearl 10X, due to enter service in 2025, will also be compliant with 100% SAF.

This means two-thirds of its Trent large jet engines and three-fifths of its business jet engines – based on the pre-pandemic in-service fleet at the end of 2019 – will be compliant within three years.

2023

Target for all R-R's in-production civil engines to be compatible with 100% sustainable aviation fuel

But despite all R-R's efforts, a significant barrier to SAF uptake remains its cost and availability. East says that governments will have a "huge role" to play in policy terms, for instance "stimulating the use of SAF". As a result, the manufacturer will "have to influence" decision making.

In the short term it continues to work with fuel providers on production of SAF from food waste, for example, but is hopeful that in future it will be able to create fully synthetic fuel – what it terms "e-fuel" – using the small modular reactors being developed elsewhere in the business.

Paul Stein, R-R chief technology officer, sees that technology maturing at some point in the "middle of next decade". He says the company continues to investigate the potential for hydrogen power, through both fuel cells and direct combustion, though this does not feature significantly in its Pathway to Net Zero presentation.

Starting small

"We are in the process of discussing hydrogen with Airbus now," he says, with the initial focus "a compressed hydrogen solution for smaller aircraft" using fuel cells. But it is also in the "early stages" of assessing liquid hydrogen to "understand the combustion characteristics".

Although civil aerospace is a significant focus of R-R's decarbonisation strategy, its military engines business is also working to ensure 100% SAF compatibility on current and future powerplants.

Tom Bell, president of its defence unit, says that military customers are "very much leaning into these conversations" about becoming net zero, not least that it helps "untether them from fossil fuel supply chain worries".

R-R says it is also "engaging with its partners" in the Eurojet and Europrop International consortia – which build engines for the Eurofighter Typhoon and Airbus Defence & Space A400M, respectively – to assess SAF usage.

the company adds. "As the use of [sustainable fuels] increases, we will ensure that our future combat systems are compatible with net-zero carbon."

R-R's measures will also cover other sectors to which the manufacturer supplies systems, including shipping and energy; the company points out that its products power "some of the most carbon-intensive parts of the economy".

"We pioneer power that is central to the functioning of the modern world. To combat the climate crisis, that power must be made compatible with net-zero carbon emissions," says chief executive Warren East.

"This is a societal imperative as well as one of the greatest commercial and technological opportunities of our time."

R-R is increasing the proportion of research and development expenditure – around £1 billion ($1.4 billion) annually – aimed at lower-carbon technologies from 50% to 75% by 2025.

As part of the strategy, the company is decarbonising its operations, intending to eliminate emissions by 2030 – it claims its Bristol production site will achieve net-zero carbon status next year. Its executive remuneration policies are tied to achieving all its 2023 targets.

F-35 faces toughest fight

The pandemic hit Lightning II output at a time when its manufacturer is under extreme pressure to reduce burden of stealthy type's operating and sustainment costs

Garrett Reim Fort Worth

Lockheed Martin plans to manufacture between 133 and 139 F-35 stealth fighters this year – about the same as in 2019 but lower than previous projections, as the lingering effects of the pandemic continue to impact the programme.

A reduction in planned deliveries is part of the "process of recovering from the disruption of Covid", Bridget Lauderdale, vice-president and general manager of the F-35 Lightning II programme, said at Lockheed's final assembly facility in Fort Worth, Texas on 10 June.

Lockheed describes the process as "production smoothing", whereby it is trying find the most efficient way to again ramp up output.

"We're in the midst of working with our Joint Program Office [JPO] customer on defining what that rate looks like going forward," says Lauderdale, who was in April appointed to lead the programme.

Lockheed delivered 120 F-35s in 2020, down from its initial objective of 141 jets. Last year, coronavirus health and safety restrictions impeded production at the company and its suppliers at times. Related financial difficulties experienced by many of its small business vendors also created delays.

"The line is stabilising and the supply base [is] stabilising," Lauderdale says. "We expect to be able to ramp back up."

But at what production level the Joint Strike Fighter ultimately peaks remains an open question. Before the pandemic, Lockheed talked about producing 155 fighters in 2022 and more than 170 in 2023.

"What we've been looking at with the customer community is, what is the optimal rate, from an efficiency, from a cost perspective, from ensuring absolutely the quality we stand behind each and every delivery?" says Lauderdale. "There are choices to be made there."

To make up for production lost in 2020 and 2021 – projected to be between 37 and 43 jets – Lockheed is talking to the JPO about ways to spread out the backlog over the next four to five years.

"Think of that as levelling out the peaks and troughs year-by-year in the production quantities, which will bring a lot of benefits to our factory, to our workforce, to our supply chain, to get that stability over the next four or five years," the company says. "The exact quantities, that is pre-decisional. We're in the final phases of working that out with the [JPO]."

Operating cost

However, Lockheed indicates that the number might be just below 169 aircraft per year.

The negotiations come as the F-35 is being targeted by some in the US Congress over its high per-hour operating cost, which currently equates to $33,000 (in non-inflation adjusted 2012 dollars).

Lockheed has the objective to reduce that to $25,000/h by fiscal year 2025, but F-35 programme executive officer Lieutenant General Eric Fick told the House Armed Services Committee in April that there does not yet appear to be an established path to achieve that figure.

The programme is also dogged by sustainment costs that are projected to reach $1.27 trillion over its 66-year lifecycle, and by hundreds of unresolved deficiencies, prompting some to favour spending money on other projects.

In March, Representative Adam Smith, House Armed Services Committee chairman, said at a Brookings event that he wants to "stop throwing money down that particular rathole". Countering this view, the Joint Strike Fighter Caucus, a group of 132 Republican and Democratic members of Congress, proposed in May that the US Air Force (USAF) increase its acquisition of the F-35A to 80 per year.

Lauderdale notes that the programme has made improvements in flyaway cost and mission capability rate performance in recent years.

F-35As produced in Lot 14 are to cost $77.9 million each, down 12.8% from Lot 11. The conventional take-off and landing variant's mission capable rate also rose from 61.6% in FY2019 to 76.1% in FY2020, according to the USAF. However, the service's minimum requirement is 80%, with an objective performance target of 90%.

US Air Force

Israeli air force

Further export deals could enable programme to pad out backlog and protect unit costs

The US Air Force's 'cornerstone' fighter is under attack from opponents in Congress

Lauderdale recognises fiscal constraints for the programme. "We realise the budgets are not unlimited," she says.

There is a debate about how many F-35s the USAF, US Marine Corps and US Navy should buy. In 2020, the air force ordered an initial batch of eight Boeing F-15EX Eagle II fighters from a planned total of 144, rather than take some F-35As – a type it has called the "cornerstone" of its fleet.

In February, USAF chief of staff General Charles Brown also said the service is studying a future fighter fleet that might include a clean-sheet 4.5th-generation platform capable of handling lower-end fights.

In its FY2022 budget request, the USAF asked for 48 F-35As; a dozen fewer than it ordered in FY2021. While the service has not formally cut its overall requirement for 1,763 examples, there is suspicion that it is slow-walking its acquisition of the jet until the Next Generation Air Dominance (NGAD) fighter comes around. To enter service in the early 2030s, this is expected to replace the Lockheed F-22.

However, Will Roper, former assistant secretary of the USAF for acquisition, technology and logistics, said during his final days in the role in January that the Joint Strike Fighter's costs may make it vulnerable to being replaced.

"The F-35 programme is a long way from being at a sustainment point that we need," he said. "It's a long way from being an affordable fighter we can buy in bulk.

"[The NGAD] doesn't just represent a next-generation fighter with bells and whistles that we need in warfighting," he said. "It doesn't just represent a completely different acquisition paradigm. It also represents a chance to design an airplane that is more sustainable than the F-35 if, in fact, the F-35 cannot get its cost-per-flying-hour down."

Order quantities

Lauderdale will not comment about the possibility of the US Department of Defense buying fewer F-35s, but acknowledges that lower overall order quantities could impact the aircraft's unit price.

Lockheed believes that foreign military sales should help to pad out the backlog. It is currently offering the Lightning II in contests in Canada, Finland and Switzerland.

"With the interest internationally, we believe there will be a strong demand that will allow us to continue to keep moving forward at the kind of quantities we're talking about," Lauderdale says.

Lockheed claims it is only directly in control of 39% of operation and sustainment costs, with F135 engine maker Pratt & Whitney responsible for 14% and service customers 47%.

Lauderdale says the company has reduced its portion of the cost by 44% over the past five years and can cut it by another 40% over the next five years.

But with the majority of the F-35's operating costs out of its direct control, Lockheed is in the awkward position where it has to suggest cost-saving ideas to the JPO.

The service has experimented with several such ideas, including the Blended Operational Lightning Technician programme at Hill AFB in Utah, which uses fewer maintenance personnel to service the F-35 by cross-training crew members. The USAF has said the experiment took five fewer man-hours to produce one F-35A flying hour, compared to traditional aircraft maintenance unit processes. Its Air Combat Command has yet to commit to the concept, however.

Lockheed had also proposed playing a more direct role in the F-35's maintenance via a performance-based logistics contract, but initial interest from the JPO appears to have cooled, as the company is now negotiating longer-term deals for spare parts instead.

Despite the challenges, Lauderdale has a sunny view of the programme, saying that the F-35 is "by all accounts doing a fantastic job".

"I'm very encouraged by where we are today and will continue to advance the ball, will continue to take on challenges that arise," she says. "But, from a warfighter perspective, I think the feedback we're getting is exceptional."

Putting the SAF in Safran

Helicopter engine manufacturer launches test effort with aim of securing approval for use of higher biofuel concentrations

Dominic Perry London

Safran Helicopter Engines believes it can achieve regulatory approval by 2023 to allow its powerplants to be run on 100% sustainable aviation fuel (SAF) on the back of a test campaign with German rotorcraft operator ADAC Luftrettung.

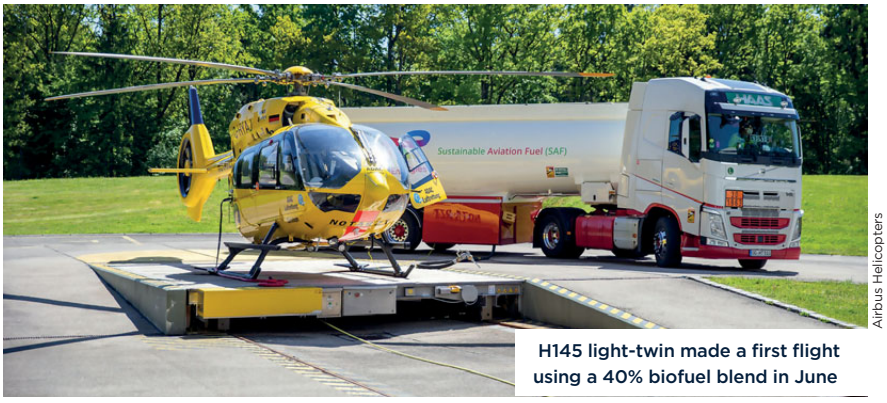
In June, the pair announced the first flight of an emergency medical services helicopter using SAF in a project also involving Airbus Helicopters and fuel firm Total Energies. That saw an H145 light-twin, which is powered by Safran Arriel 2E engines, run on a 40% biofuel blend.

But Bruno Bellanger, executive vice-president of programmes at the French propulsion specialist, says the ambition is to increase the proportion of SAF used in the near future under a long-term agreement with ADAC.

All Safran's engines are approved for blends of up to 50% SAF. While the initial tests with ADAC will run using the current maximum, "in the coming weeks and months we will explore up to 100%", he says.

He adds that the manufacturer "does not expect strong modifications" of engines will be required to gain regulatory approval for 100% SAF operations.

Bellanger says the trials will take 100% biofuel operations to technology readiness level 6 by 2023; if no changes are required to the engine, certification should be that year, or 2024-2025 "at the latest" if minor alterations are needed.



Airbus Helicopters

H145 light-twin made a first flight using a 40% biofuel blend in June

Emissions of carbon dioxide (CO_2) are cut by around one-third when 50% SAF is used, he says; if that blend was rolled out across ADAC's entire fleet, which flies around 50,000 missions annually, its CO_2 output would be reduced by 6,000t each year.

Enabling the increased use of SAF is part of a broader decarbonisation strategy across Safran's helicopter engines business.

A new "disruptive" ultra-efficient gas turbine engine is in the early stages of development, says Bellanger. This will be ready to enter service by the end of the decade, aligning with research and development part funded by the French state to develop a successor to the H125 light-single.

Safran also plans to conduct trials of an "electric boost" system, which will use a battery to provide additional power for a short duration, for example in the event of an engine failure.

Meanwhile, the firm continues to mature the "EcoMode" stop-start system for the Aneto-1X engines that will power Airbus Helicopters' Racer high-speed demonstrator. This will allow one of two engines to be idled – and rapidly restarted – during cruise to cut fuel burn.

Lastly, Safran is also pursuing a hybrid-electric distributed propulsion system, which it hopes will be flying by 2023.

MC-21 in certification push

Russian twinjet moves closer to service entry, with evacuation trials planned and software improvements introduced by Irkut

AirTeamImages

Approval for PW1400G-powered version is expected to be gained by year-end

David Kaminski-Morrow London

Irkut has identified evacuation and electrical discharge protection among outstanding tests for its MC-21-300 twinjet, as the aircraft edges towards certification.

Assessment of take-off and landing characteristics is also being finalised, following the evaluation of flight performance and aircraft systems, and noise measurement. The MC-21 has also completed runs on wet and snow-contaminated runways and undergone icing tests.

"Flight and ground tests continue," says Kirill Budaev, Irkut director of sales and marketing. "In many ways our efforts today are aimed at improving the software."

Evacuation tests are planned for the "near future", he says, as well as flight in various climatic zones.

Travel restrictions

Budaev says the pandemic has affected the work of "almost all" project participants, both in Russia and overseas, owing to travel restrictions.

"Enterprises temporarily stopped work and delayed deliveries of components," he says. "In particular, during the tests, even with the extensive use of advanced information technologies, the direct work of specialists on the aircraft is regularly required."

The continuing impact of the health crisis means the overall effect on the MC-21 programme is "difficult to determine", he adds.

Irkut is aiming to secure Russian certification for the Pratt & Whitney PW1400G-powered version by the end of this year.

United Aircraft (UAC) chief executive Yuri Slyusar states that serial production is under way, with the delivery of wings for initial customer aircraft.

"The production rate will be gradually increased," he says, but adds that the output will "depend on the market situation". Irkut's facilities will be capable of manufacturing 72 aircraft annually.

Irkut's primary modification to the aircraft so far has been the introduction of domestic Aviadvigatel PD-14 engines.

"Creation of a new generation of Russian systems is primarily associated with the evolutionary development of the industry and allows us to offer the customer a wider choice," says Budaev. "The MC-21 initially enters the market with two types of engine and this increases the stability of the programme."

Along with the PD-14-powered -310 version, the airframer says documentation has been released for the shrunk -200 variant of the twinjet, which is centred on a 165-seat configuration at 29in pitch.

"Further development of the project will be related to the market situation," says Budaev.

Irkut has taken over the Sukhoi Superjet 100 programme, which is also undergoing modification with the aim of fitting Russian engines and more domestic components.

Among other refinements developed for the Superjet are winglets – known as sabrelets – but Budaev says nothing similar is planned for the MC-21.

He says the aerodynamic development process considered a layout with winglets, but opted instead for a higher-weight wing, of greater length, without them.

"We made sure that the MC-21 with an [elongated] wing has the best fuel efficiency indicators on typical routes for this class of aircraft," he states.

Central purpose

Bringing the Superjet and MC-21 programmes together is part of a "substantial corporate transformation" and an "important stage" in UAC's development, says Slyusar, pointing out that the long-term aim is for half of the company's revenues to come from civil aviation.

"Centralisation will go further to eliminate duplicate administrative functions, create general corporate centres of competence and service, and expand co-operation of production plants," says Slyusar. "The goal is obvious – to improve the efficiency of the corporation as a whole."

Slyusar says a unified administration for Irkut, the Superjet design team and the associated Yakovlev engineering centre is being "gradually formed".

"Consolidation of Russian aircraft companies is why United Aircraft was established," he adds. "The world has changed, and competition is no longer between different design bureaus within one country but between large global players."

See p44

Tests will be carried out using a 737-9 due for delivery to Alaska Airlines in 2022

Boeing

Green to the Max

Latest ecoDemonstrator aircraft will allow Boeing to evaluate technologies that will help minimise environmental footprint

Jon Hemmerdinger Tampa

Boeing will continue its ecoDemonstrator programme in 2021, using a 737 Max 9 to evaluate cabin sidewalls made from recycled carbonfibre waste, 3D-printed cabin air vents, noise-reducing engine nacelles and a new fire-fighting chemical.

The company will also use the twinjet – which is earmarked for delivery to Alaska Airlines in 2022 – to evaluate flight-control technology, atmosphere-measuring equipment and the use of biofuel, the US airframer says; in all, nearly 20 innovations will be studied.

Boeing's ecoDemonstrator programme – now in its 10th year – offers the airframer the opportunity of examining technologies that could make their way onto in-service jets.

Testing of this year's ecoDemonstrator should begin early in the second half and wrap up in December; flights will be conducted from Seattle.

The 2021 programme will see Boeing evaluate the noise-reducing effects of changes to engine nacelles, particularly the use of advanced acoustic liners.

The airframer says it will carry out the analysis over Moses Lake, Washington, where it will use an acoustic array system to collect data.

"These refinements will also help address the different noise footprint of next-generation ultra-high-bypass engines and compact nacelles," it says.

Boeing will also use the Max 9 demonstrator to study, in partnership with aerospace company Meggitt, the use of trifluoroiodomethane (CF3I) as an onboard firefighting chemical. CF3I could potentially replace the currently used firefighting chemical Halon 1301, which has "ozone-depleting properties", says ecoDemonstrator programme technical leader Doug Christensen.

Certification data

Tests of CF3I will be carried out on the ground, not in the air, and will let Boeing collect "certification data for future airplanes", he says.

In collaboration with the US National Oceanic and Atmospheric Administration, Boeing will use the Max 9 to evaluate technologies that measure atmospheric greenhouse gases. Boeing's role will primarily involve evaluating how to integrate sensors "into a commercial airplane in the most effective way", Christensen says.

Equipping large fleets of commercial jets with such measuring systems could help scientists collect data needed to advance climate models and forecasting, Boeing says.

The company will also use the 2021 ecoDemonstrator to study the use of cabin sidewalls made from waste carbonfibre left over from production of 777X wings. It will perform acoustic tests to ensure the components meet noise and other requirements.

Additionally, Boeing will outfit the Max 9 with cabin air vent nozzles designed to prevent "airborne particles from travelling throughout the cabin", says ecoDemonstrator programme director and chief engineer Rae Lutters.

Produced using additive manufacturing – better known as 3D printing – the vents will "blow the air down into the individual's lap", creating a "curtain of air between rows", she says. Boeing's existing onboard air systems circulate and clean cabin air every 2-3min, it says.

In addition, the 2021 programme includes collaboration with the University of Washington to develop models related to "next-generation flight-control" software and hardware, Boeing adds.

The 737 Max 9 dedicated to the 2021 ecoDemonstrator programme has already been manufactured by Boeing.

Over the past decade, the ecoDemonstrator programme has evaluated nearly 200 technologies using aircraft including a 737-800, 747-8, 757, 777, 787 and Embraer 170.

Jet performance at turboprop costs

M-345

Leonardo's M-345 is the latest-generation jet trainer; ideally-suited to the entire military pilot training syllabus, from basic to advanced phases, it is also ideally-suited as an effective light combat solution in evolving operational scenarios.

The new generation M-345 benefits from more than 60 years of Leonardo's experience at the leading-edge of jet trainer aircraft design and manufacture. All essential systems are designed for maximum safety and reliability, with minimum maintenance; delivering the high performance of a turbofan jet trainer with the acquisition and life-cycle costs of a heavy turboprop trainer aircraft.

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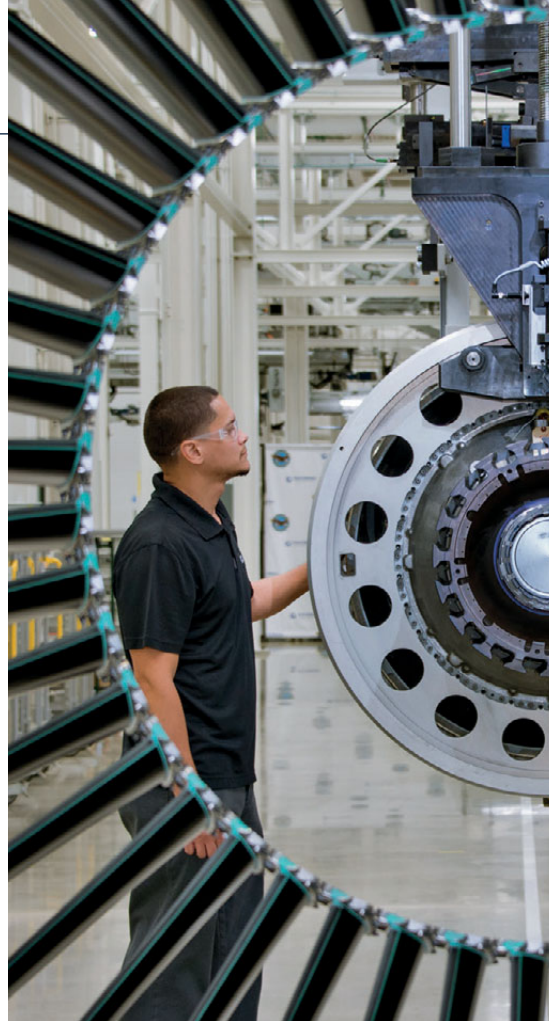
Big fans

While research is ongoing into future technologies, Pratt & Whitney continues to put its weight behind GTF engines

Jon Hemmerdinger East Hartford



Pratt & Whitney's near-term focus remains squarely on improving the architecture of the geared turbofan (GTF) engine, and possibly developing larger variants, while waiting for future low-emission technologies to mature.

But behind the scenes, a cadre of engineers and scientists from the engine specialist and other companies within the Raytheon Technologies group – P&W's parent - are busy advancing next-generation technologies, like electric propulsion and the use of hydrogen fuel.

Perfecting plans

But do not expect hydrogen- or electric-powered airliners to be carrying passengers any time soon – the industry needs years to perfect those designs, executives say.

But the research happening today will ensure that P&W and other sister companies within Raytheon Technologies can both update existing engines and potentially offer a clean-sheet powerplant when Airbus, Boeing or other airframers come calling, they say.

Among the group's many facilities, the Raytheon Technologies Research Center along the Connecticut River in East Hartford is where much of its aircraft powerplant R&D activity takes place.

Workers at that facility, which dates back to 1929, evaluate technologies including "complex integrated systems", advanced materials, model-based digital engineering tools, autonomy, machine learning and electrification, says Andreas Roelofs, Raytheon Technologies vice-president of research and development and director of the Research Center.

The site houses a "compressor test facility" – a room in which massive, looping ducts carry fast-moving air through a test chamber. P&W uses the site to study low- and high-pressure compressors, including smaller, higher-pressure and faster-spinning cores. These can boost efficiency but can require advanced high-temperature-resistant materials.

"It's almost like a windtunnel for compressors," says the company's Scott Kearney, who helps oversee the facility. The equipment can simulate altitudes of 30,000ft, and will soon have ability to test components whirling up to 35,000rpm.

"This facility focuses on thermal efficiency, where maybe competitors have a step up," Kearney says.

2.06m

Diameter of fan on PW1100G powerplant for the A320neo, contributing to a 12:1 bypass ratio

An engine's total efficiency depends on both thermal efficiency (how well it converts a fuel's chemical energy to mechanical power) and propulsive efficiency (how well it converts mechanical power to propulsive output).

In developing the GTF – which powers Airbus A220s, A320neo-family jets, and Embraer E-Jet E2s – P&W optimised propulsive efficiency. It did so with a gear that decouples the fan and turbine, allowing for a larger, slower-turning fan that can send more air around, rather than through, the core. Because that bypass air generates most of a turbofan's thrust, the design improves propulsive efficiency. The A320neo's PW1100G has a 2.06m (81in)-diameter fan and 12:1 bypass ratio.

CFM International's line of competing Leap turbofans – variants of which power A320neo-family jets and the Boeing 737 Max – lack such a gear. But CFM, a joint venture between GE Aviation and Safran Aircraft Engines, instead opted to optimise thermal efficiency. It accomplished that through use of high-temperature materials like ceramic matrix composites (CMCs), which are made from silicon carbide, ceramic fibres and resin.

CMCs can withstand temperatures up to 1,320°C (2,400°F),

Pratt & Whitney

P&W believes GTF architecture could be scaled up for widebody applications

meaning less of a turbofan's air must be diverted for cooling, which boosts thermal efficiency.

Both companies say that their engines are roughly 15% more efficient than comparable previous-generation turbofans.

P&W president Christopher Calio confirmed during the company's 18 May investor day that it is now focusing on improving thermal efficiency. "Thermal efficiency is next in the efficiency space," Calio says. "It's developing materials to make engines even more capable."

Composite solutions

He cites use of "high-temp composites" like CMCs, noting P&W recently opened a site in Carlsbad, California to advance such technology.

"This will enable us to both retrofit the existing fleet when it's ready, and then also, in the future, we can design around it for those applications where we need to drive more heat through the core," Calio says.

The aviation industry faces huge pressure to curb carbon output and has committed by 2050 to slash emissions to half of 2005 levels.

Also in East Hartford, Raytheon is advancing additive manufacturing, better known as 3D printing. The company's additive manufacturing machines can "print" components using metals including aluminium, titanium and high-temperature nickel-based super alloys, it says.

The process can manufacture, as single units, complex components now made from multiple parts, thereby reducing weight and complexity. Raytheon Technologies is producing prototypes of components that could find their way onto engines, such as heat exchangers and fuel pump assemblies, it says.

Raytheon executives also view wider use of sustainable aviation fuel (SAF) – known as biofuel – as key to reducing carbon output. Burning biofuel releases carbon that had previously been absorbed from the atmosphere by plants, making the fuel's CO2 impact "almost neutral", according to IATA.

Regulations permit commercial jets to fly on fuel blends composed of 50% SAF, but Calio says P&W is assisting regulators to achieve approval for 100% biofuel.

"We think that can reduce emissions [by] up to 80%," he says. "We don't think it will cause us to have to do tremendous modifications to the engine."

Other companies have put weight behind SAF, including Boeing, which this year committed that all jets it produces by 2030 will be capable of burning 100% SAF. Additionally, US lawmakers recently introduced a bill that would subsidise production of the fuel.

The research facility has also been advancing high-power electric and hybrid-electric technologies, evaluating the use of 1MW electric motors.

Calio views hybrid-electric propulsion as "an opportunity in the short-to-medium range", particularly for general aviation aircraft, turboprops and helicopters. Such systems could deliver 30% efficiency improvements, he says.

Applications for larger aircraft could include a GTF engine paired with a 1.5MW "electric assist" system, according to a P&W diagram.

How soon such technology will be viable remains unknown. In 2020, Raytheon slowed Project 804, an effort to equip a De Havilland Canada Dash 8-100 with a supplemental 1MW electric system.

P&W is also evaluating potential future use of hydrogen, which, when used to generate power in fuel cells, emits water vapour.

"There's absolutely potential there," Calio says of hydrogen fuel. "But that's a 2035 prospect."

That timeline aligns with Airbus's target for potential development of hydrogen-powered commercial aircraft. The Toulouse airframer unveiled three concepts last year – all using hydrogen as a power source - saying such technology could be ready in 15 years.

But using hydrogen is not as simple as a like-for-like replacement for jet fuel. "We are talking about re-engineering the entire airplane" to accommodate hydrogen, says Raytheon Technologies fellow of strategic technology Jeff Cohen, who helps oversee the "jet burner test stand" at the East Hartford site.

There, engineers work to evaluate low-emission fuels such as SAF and hydrogen.

Hydrogen "burns easy" in turbofans but has "mass and infrastructure limitations", Cohen says, citing hydrogen's "volumetric energy-density problem".

While 1kg (2.2lb) of hydrogen has better energy density than the same mass of jet fuel, that quantity of hydrogen takes up much more space – meaning larger and likely heavier fuel tanks will be required.

Existing architecture

But during Raytheon Technologies' recent investor day, executives stressed that the group's near-term priority is improving the existing GTF architecture, saying step-change technologies remain insufficiently mature for prime time.

"We think [the GTF is] the architecture of future," says Calio. "We are working on packages to [improve] the fuel burn. Also working on a way to scale it up, to the extent that engine bypass ratios get larger, applications get larger [so] we are in a position to offer the GTF."

He does not mention potential future applications for GTF derivatives, but P&W has previously said the design could possibly be scaled to power widebody aircraft.

"The outlook does not contemplate a new centreline engine," Raytheon chief financial officer Neil Mitchill told investors. "However, it does contemplate enhancements to the gear, and geared-turbofan engine performance improvements."

Executives note that major airframers, likewise, seem unlikely to launch a new jet in the near term. "We don't see a major clean sheet on the immediate horizon," says Stephen Timm, president of Collins Aerospace, P&W's sister company.

eSTOL market sparks into life

Airflow has secured a launch order from Anchorage-based airline Ravn Alaska

Airflow

Two start-ups with strong links to aerospace industry aim to prove potential of electric short take-off and landing designs

Jon Hemmerdinger Tampa

While much electric aircraft development activity has centred on vertical take-off and landing (eVTOL) designs, two US-based manufacturers are instead promoting concepts that can depart from ultra-short runways.

San Francisco-based Airflow and Falls Church, Virginia-headquartered Electra Aero both have strong links to existing aerospace firms, particularly in the eVTOL segment.

Airflow was started in 2019 by five executives who previously worked on Airbus's now-shuttered Vahana electric aircraft demonstrator, while Electra was set up by the founder of aerospace innovator Aurora Flight Sciences.

At least two electric short take-off and landing (eSTOL) variants – the Model 100 and Model 200 – are being worked on by Airflow.

The aircraft will be able to land on traditional runways, which differentiates Airflow from the many competing companies that are developing eVTOL aircraft.

Airflow says its design faces fewer regulatory and technical challenges than eVTOL designs, which typically require somewhat novel architectures involving either a tiltrotor-type concept or a mix of forward- and downward-facing propellers. Also, many developmental eVTOL aircraft will require a new infrastructure of landing sites equipped with charging points.

"Airflow's hybrid-electric aircraft are able to enter into service with no new infrastructure requirements and limited certification hurdles compared to other electric aviation market entrants," the company says.

It has also secured a launch order from Anchorage-based airline Ravn Alaska, which has signed a letter of intent to acquire up to 50 of Airflow's aircraft. Ravn currently flies De Havilland Canada Dash 8-100s on regional routes within Alaska.

Service entry

Neither company discloses whether Ravn has put any money down as part of the deal. Airflow intends for its aircraft to be in service in 2025.

While Airflow confirms it is working on passenger variants, its website only lists specifications for cargo configurations.

According to the firm's provisional specifications, the Model 100 will have capacity to carry 227kg (500lb) of cargo, a range of 217nm (402km) and ability to take off and land within a runway distance of 46m (150ft); the larger Model 200 will have 907kg of cargo capacity, 805km range and a required take-off and landing distance of 61m.

The aircraft can "supplement existing cargo feeder routes" and will enable operators to benefit from the e-commerce market. It says they will cost one-third less to operate than helicopters or eVTOL aircraft.

Airflow expects its aircraft will initially have a single pilot, though the company expects to bring autonomy to future variants.

Airflow's founders include chief executive Marc Ausman, formerly Vahana chief strategist, chief technology officer Peter Kalogiannis, formerly Vahana aircraft integration and test lead, and former Vahana employees Don Fung, Geoffrey DuBridge and Robbie Bunge.

Airbus shuttered its Vahana project – driven by its A3 Silicon Valley start-up – in 2019 after successfully flight testing an experimental eVTOL aircraft.

Meanwhile, Electra has revealed its design for an eSTOL aircraft.

It is developing a fixed-wing type that will have a single pilot, carry up to seven passengers, cruise at 174kt (321km/h) and fly 434nm.

The aircraft will have a "blown-lift" design – meaning the distributed electric motors on its wing will blow sufficient air over the structure to enable the aircraft to get airborne at speeds below 27kt, it says.

"A combination of batteries and a small, quiet turbo-generator" will power the eight motors, the company says. The batteries will charge during flight, meaning Electra's aircraft will "not need to rely on special charging infrastructure".

Electra has disclosed few other details, although computer-generated images of its design show an aircraft with a T-tail and tricycle landing gear.

The company is now "building technology demonstrator aircraft" and aims to achieve US Federal Aviation Administration certification in 2026 under Part 23 rules, which apply to utility and commuter aircraft.

Electra founder and chief executive John Langford helped develop the human-powered aircraft Daedalus, which flew in the 1980s. In 1989, he founded Virginia-based Aurora Flight Sciences, which specialises in autonomy and was acquired by Boeing in 2017.

Aurora went on to develop an autonomous eVTOL aircraft, which, in partnership with Boeing, it flew as a prototype for the first time in 2019.

A number of Electra executives have experience at other blue chip aerospace companies: chief financial officer Jilinda Crowley formerly worked at Rolls-Royce, and senior technical fellow Marty Bradley came from Boeing.

Other former Aurora employees include director of strategy Diana Siegel, programme manager James Stewart, and lead engineer of flight physics Chris Courtin.

EcoPulse electric motor passes windtunnel test

Airbus has completed windtunnel tests of an integrated propulsion unit – the electric motor, propeller and nacelle – that will be used to power the EcoPulse hybrid demonstrator it is developing alongside Daher and Safran. Conducted at the airframer's Filton, UK facility over a two-week period, the evaluations allowed Airbus to analyse the performance characteristics of the propeller and the electric motor's cooling system.

For the trials, the 50kW Safran EngineUs motor was assembled with an Airbus-built nacelle and DUC Helices propeller. With the engine running at different speeds, measurements of the thrust and force on the propellers were taken. The propeller wake was also evaluated.

"This gave us experimental data to better understand the interaction between the propeller and the wing," says Tim Axford, head of the windtunnel facility at Airbus UK. Engine and air temperatures were also taken to assess the effectiveness of cooling technologies, he says.

Data collected during the tests will "allow Airbus and its partners to better estimate the power consumption of the propulsion system, and so the final energy performance of the aircraft demonstrator", it says.

Having passed the preliminary design review milestone in December 2020, the critical design review process is now under way. That should allow production of the EcoPulse demonstrator to begin later this year, with ground testing in early 2022 followed by a first flight next summer.

Launched in 2019, EcoPulse is supported by France's CORAC civil aviation research council and the country's regulator, DGAC. Based on a Daher TBM airframe, the design features six electric motors on the wing, plus a conventional turboprop engine in the nose, which doubles as a turbogenerator.

Atlas ready to soar

Airbus has reached 100 deliveries of its A400M tactical transport. With full capability now expected during 2023, can it at last attract export buyers?

Craig Hoyle London

With its 100th operational aircraft delivered and several key development hurdles cleared within the past 18 months, the A400M is now "at a turning point", the Airbus Defence & Space official in charge of the programme believes.

Speaking exclusively to FlightGlobal, Clive Schley, A400M programme head at the company's military aircraft unit, also voiced his optimism about further sales of the Atlas – both to existing operators and new international customers.

Europe's airlifter programme was launched in May 2003, with partner nations Belgium, France, Germany, Luxembourg, Spain, Turkey and the UK committing to a combined 170 examples, and export buyer Malaysia four.

On 24 May, Spain's 10th of an eventual 27 A400Ms was ferried to Zaragoza air base from Airbus's San Pablo final assembly site in Seville. This airframe – MSN111 – took total deliveries into three figures, just under eight years after the French air force had received the first.

For Schley, the 100th delivery milestone was worth celebrating, but given the project's considerable travails since launch and its remaining challenges, there was no sense of euphoria at Airbus.

"For the last 10 years the programme was heavily challenged. Being late, our customers were challenging us a lot about the achievement of capabilities," he says. "We have not yet fully finished the development, [and] we are not where I want us to be on supportability, fleet availability and maturity."

These challenges aside, utilisation rates for the tactical transport have soared since the start of the Covid-19 crisis: flight hours in 2020 were up 40% on the previous year. This spike contributed to another milestone being reached in late May, as the global Atlas fleet topped a combined 100,000 flying hours. Some 40% of this total has been accumulated since late 2019.

"The aircraft flies more than before, and we see it more or less everywhere around the globe," he says. This ranges from its strategic-type use in delivering supplies urgently needed to counter the coronavirus outbreak, to frontline operations, like supporting France's peacekeeping activities in west Africa.

Fleet availability

"The customers start to rely on and utilise this aircraft – despite all the challenges on fleet availability, materiel support and investment on the nations' side," says Schley. He notes that the Spanish air force retired its Lockheed Martin C/KC-130H transports last December, while the UK will cease operations with its remaining 14 J-model Hercules in 2023.

The past 18 months have also seen what he describes as "incredible progress" in flight-testing related to some of the A400M's long-overdue promised tactical capabilities. This has included proving the ability to deploy 116 paratroopers from its side doors in a single pass, performing automatic low-level flight in instrument meteorological conditions, and completing certification trials for the air-to-air refuelling of French air force Airbus Helicopters H225M Caracal combat search and rescue rotorcraft.

"We have achieved capabilities that even two or three years ago were judged as not achievable", or only "borderline feasible", he notes.

In mid-2020, the partner nations also approved the A400M's NSOC 2.0 certification standard, marking its first major capability update since service introduction in October 2013.

"The challenge [to Airbus] from the nations related to capabilities is completely off the table – this is not giving me a headache at the moment," Schley says. "There has been a huge advance in the capabilities of the aircraft, which the nations are now working on." He notes that once new clearances are made by the company, national flight trials and approval processes can take a further 12-18 months to complete.

With operational use having increased markedly, availability and affordability are key focus areas for customers: a maturity drive will run until 2023 to address shortcomings. "It takes time – the nations and operators know that, and are working with us," he says.

One of the A400M's biggest problems has been around the performance and reliability of its Europrop International (EPI) TP400-D6 turboprop engines. Schley says a propeller gearbox (PGB) replacement activity performed on part of the fleet means that "for those aircraft that have been retrofitted, they have no problems anymore".

But with airworthiness directives having been issued by the European Union Aviation Safety Agency

Recertification of TP400 engine will cut maintenance burden

Airbus Defence & Space

Richard Whitcombe/Shutterstock

UK intends to boost its airlifter fleet's 'warfighting capabilities'

related to the PGB flaw and the TP400's low and high pressure turbine discs, Airbus is working with EPI and the regulator to certificate a new standard for the powerplant.

Expected to conclude in July, this process will enable operators to establish new maintenance schedules, using what Schley describes as "less conservative assumptions". This is of great importance, he notes, because: "the engine still places a burden on the shoulders of our clients".

NH90 parallel

An aerospace engineer by trade, Schley has been in his current post for two years. His prior experience included leading the Airbus Helicopters Tiger attack helicopter programme and the company's involvement in NH Industries' NH90 transport rotorcraft.

He sees a clear parallel between the A400M's difficulty in achieving export success and the NH90's troubled early days. He notes that following its European launch order, the NH90 encountered a 12-year wait before securing an international buyer.

But since that time – and despite ongoing support challenges and industrial complexity – the type has become a major sales success. Cirium fleets data shows that there are 427 NH90s in service, with another 163 on order.

"When you look into the complexity of the [A400M and NH90] programmes and especially the customers you can transfer it one-to-one," he says.

So, what of the A400M's international prospects, some 18 years after programme launch?

"I hope that in the coming two to three years we will see significant momentum," Schley says. Prospects exist in Africa, the Asia-Pacific region and the Middle East – and for follow-on purchases among the type's existing users, he adds.

Indonesia, which in early 2018 expressed interest in taking two aircraft, is yet to advance with procurement plans.

Schley notes that the comparison with the NH90 again holds true, with countries opting to observe the A400M's progress before committing.

"Over the last two years, their main message has been: finalise your development, improve the maturity of the aircraft and [then] we will speak to you, but also to your launch customers, to see whether they are happy with you and your performance. If, at that moment in time you have made it for your launch customers, then we will express our serious interest. We have several nations around the globe that are in this observing position."

While the pandemic has seen demand for the type's services soar, it also has brought fresh challenges for the programme.

Full operational capability had been scheduled for approval before the end of this year, but Schley says that work supporting the certification of design for the NSOC 3 standard now should be completed in the second half of 2022, leading to type acceptance during 2023. Part of this slip relates to disrupted access to government-owned test facilities used for airdrop and self-protection equipment trials, which have been responsible for a six- to eight-month wait.

A "rebaselining" contract signed with the launch nations in 2019 reduced final assembly of the A400M to its current rate of eight to nine per year, safeguarding manufacturing until 2030. There is, however, flexibility to increase this to 11 or 12 – or further – if there is demand.

Schley says the UK Ministry of Defence's (MoD's) March decision to retire its C-130Js and boost the operational capabilities of its Atlas fleet comes "at a point when the Royal Air Force [RAF] and the UK government are reasonably convinced that the A400M has reached a maturity level that it can serve the nation and its commitments".

"The next phase of A400M development will be to build upon the aircraft's proven ability to operate in warfighting and humanitarian and disaster relief scenarios," the MoD tells FlightGlobal. "This will see an expansion of its warfighting capabilities such as land-operating on natural surfaces, dispatch of parachuted supplies as well as paratroopers and their fighting equipment, both day and night."

The RAF has received 20 of its contracted 22 Atlas aircraft, with the rest to follow in July 2022 and June 2023. London's pre-programme launch commitment had been for 25.

"We are constantly assessing the needs of our armed forces and no decision has been made on any changes to the size of our A400M fleet," the MoD says.

Repeat orders

"Among our launching customers, we have more than one nation that is thinking about enlarging their fleet," Schley says, without identifying the nations concerned.

"There is a life beyond the development and production contract," he says, adding that securing a repeat order from one of the partner nations "would be a fantastic message to the market".

With government departments and army and navy personnel having witnessed the type's operational capabilities, he says: "Other services see the A400M as an asset". The type could perform additional duties, such as maritime patrol work, he believes.

Airbus has already conducted modelling work on the A400M's ability to air-deploy remote carrier vehicles, which will form part of a Future Combat Air System (FCAS) planned for introduction by France, Germany and Spain by 2040.

Discussions about flight trials have taken place with one of the nations, he reveals, adding: "We are very closely embedded into this FCAS initiative."

USAF launches rocket cargo study

Service identifies technological leap made by commercial players such as Blue Origin and SpaceX as fuelling its vision for 90min global deliveries

US Air Force

Concept would also support disaster relief activities

Garrett Reim Los Angeles

The US Air Force (USAF) has named Rocket Cargo as its fourth so-called "Vanguard" programme, making the concept one of its top science and technology development priorities.

Following the decision, the Air Force Research Laboratory (AFRL) will study the viability of using large commercial rockets to deliver US Department of Defense (DoD) cargo anywhere in the world within 90min or less.

Recent advancements in large, reusable commercial rockets have made the concept seem feasible, the laboratory said on 4 June.

The USAF wants to piggyback on commercial rocket cargo efforts via "service leases", but declines to name potential partners. However, private companies Blue Origin and SpaceX both have developed reusable rockets that might be retrofit candidates.

Early adopter

"Under the new Rocket Cargo Vanguard, the Department of the Air Force will seek to leverage these commercial advances and position the DoD to be an early adopter of the new commercial capability," the USAF says. "This approach is a marked departure from the past, where the US government led rocket technology development and bore the brunt of the cost."

The AFRL says it will conduct research and development into unique technologies needed for military rocket cargo missions.

"This includes the ability to land a rocket on a wide range of non-traditional materials and surfaces, including at remote sites," it says. "In addition, AFRL scientists and engineers will research the ability to safely land a rocket near personnel and structures, engineer a rocket cargo bay and logistics for rapid loading and unloading, and air drop cargo from the rocket after re-entry in order to service locations where a rocket or aircraft cannot possibly land."

Delivering cargo via rocket is not a new idea, notes Greg Spanjers, the AFRL's Rocket Cargo programme manager. But in the past, rockets' high cost and small payload capacity have made the concept impractical. However, the development of large, reusable commercial rockets that return to – and land on – Earth has again made the concept worth considering, he says.

In particular, SpaceX has brought down the cost of launches by using reusable rockets. Most recently, the company test launched its Starship rocket to an altitude of 32,800ft before relanding the spacecraft. SpaceX says its Starship is capable of lofting a 100,000kg (220,000lb) payload into orbit.

The AFRL is eyeing rockets capable of carrying a payload of between 30,000kg and 100,000kg. Spanjers notes that the USAF's Boeing C-17 strategic transport can carry a maximum of 77,500kg.

The Rocket Cargo programme also aims to benefit from NASA's Human Landing System programme, says Spanjers. The administration in April awarded SpaceX a contract, worth up to $2.89 billion, to land US astronauts on the surface of the moon using a version of its Starship.

Moon mission

Spanjers says he sees potential in rocket technology proposed by all three bidders on the NASA programme: moon landing system bids were also received from Blue Origin and Dynetics.

"These rockets have to have the capability to do an austere landing and unload the cargo," he says. "If they can land in those places, we are interested in knowing to what extent we can extend that to a larger range of terrain so that we can do immediate cargo transports to basically anywhere on the planet."

While reusable booster rockets and moon landers have similar missions to point-to-point rocket hops across Earth, the AFRL says its particular mission will require additional technology development. For example, its Aerospace Systems Directorate is exploring rapid weather characterisation, in order to clear rockets for rapid launch. It is also looking at new rocket trajectories and windtunnel testing.

"Scientists in the AFRL Materials and Manufacturing Directorate will help research the feasibility of landing the rocket on non-traditional surfaces, such as naval platforms, or even in austere locations for disaster relief," the laboratory says.

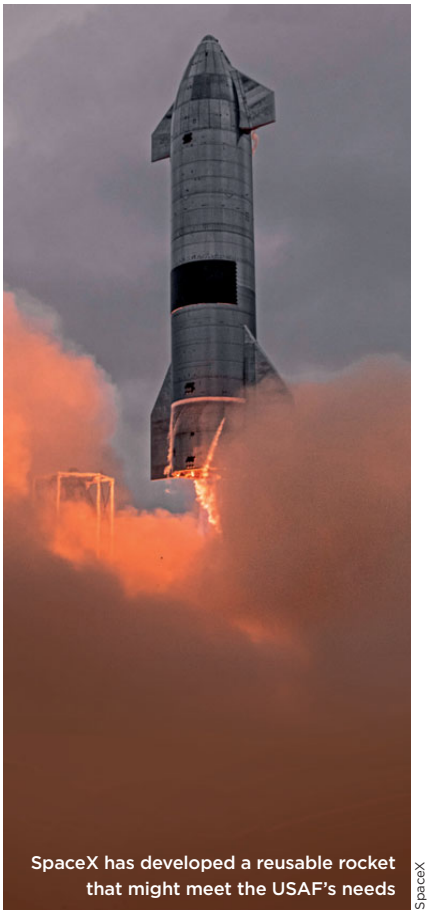
"The AFRL Airman Systems Directorate will explore human factors, such as potential toxicity issues and clouds of dust when rocket plumes impinge on those non-traditional materials, and also characterising the plume environments to assess whether we can use the rocket near populated areas."

But even if such potential hurdles could be cleared, basic loading and unloading represents a major challenge. The AFRL is researching ways to quickly load and unload cargo from a rocket more than 30.5m (100ft) tall, potentially in areas with limited ground equipment, such as during disaster relief operations, it says.

Generally, the USAF aims to lean on the use of commercial launch and landing sites, however.

The AFRL also aims to integrate standard DoD cargo into a rocket payload fairing with minimal changes to its logistics system.

"For cargo accommodation we are focused on smartly integrating DoD-standard intermodal containers on to commercial rockets, so as to allow transfer between different shipping modes without slowing down to repackage," says the laboratory. "If the Vanguard is successful, we can expect DoD will be interested in shipping everything that we transport by air today, which could include volatile material such as fuel and munitions."



SpaceX has developed a reusable rocket that might meet the USAF's needs

SpaceX

$2.89bn

Contract awarded in April to land astronauts on the moon using a version of SpaceX's Starship

Handle with care

No volatile material will be carried by a rocket under the Vanguard science and technology development effort. "However, we will perform analysis to determine the compatibility of volatile materials with the rocket launch environment," the AFRL says.

Ultimately, the USAF has designated Rocket Cargo as a Vanguard initiative because it sees it as holding "game-changing" potential.

The service's Vanguard initiatives are characterised as efforts aimed at developing technologies by 2030 to gain advantage over near-peer adversaries, such as China and Russia. Its three other such programmes are Skyborg, an autonomous flight and mission control system for low-cost, "attritable" unmanned air vehicles; Golden Horde, an autonomous networked weapon system; and NTS-3, an experimental satellite navigation system.

The relatively new US Space Force is leading the Rocket Cargo effort, with the Space and Missile Systems Center to act as programme executive officer.

"Rapid logistics underpins our ability to project power," says General Arnold Bunch, commander of the USAF Materiel Command. "That is the fundamental motivation for initiating the Rocket Cargo programme. We see its initial applications in swiftly restoring operational capability for forces forward in austere environments, as well as reducing the time required to deliver crucial humanitarian assistance and disaster relief."

Aerion

Sonic gloom?

The sudden closure of supersonic business jet developer Aerion could be a worry for others in the sector

Murdo Morrison London

In some emerging technology markets, losing a rival might be seen as a good thing – a welcome consolidation that cuts competition for investors and early-adopter customers.

But the sudden collapse of supersonic business jet developer Aerion – the firm said on 21 May it did not have sufficient cash to continue its AS2 programme, so was shutting immediately – must deeply concern other start-ups promising faster-than-sound air travel in the 2020s.

It had all seemed to be going well for the Reno, Nevada-based firm. Founded in 2003, Aerion spent a decade attending trade conventions and talking up its concept. But with the 2014 launch of a new design, the AS2 trijet, actual news began to replace the hype. After flirting with Airbus and Lockheed Martin, Aerion secured an investment from Boeing and exclusive agreement with GE Aviation to develop a supersonic engine, the Affinity.

A respected industry figure, Tom Vice, former president of Northrop Grumman's aerospace systems division, was installed as chief executive. There were purchase commitments from the two giants of fractional ownership, NetJets and Flexjet, and Aerion had been lured to establish a base in Melbourne, Florida, from where it would start producing the AS2 in 2023, ahead of a first flight a year later.

While investors spooked by uncertainty around recovery no doubt played a part, Aerion hit trouble at a similar point as other would-be disruptors, from regional airliner manufacturer Fairchild Dornier to very light jet pioneer Eclipse Aviation. Start-ups can tick along for years on the small-change benevolence of a billionaire backer – in Aerion's case Robert Bass. It is when serious bills are due that cash becomes crucial.

Financial issues

"The closer you get to the finish line, the bigger you are, the harder the collapse," says Richard Aboulafia, Teal Group's vice-president of analysis. He doubts that Boeing – with its own financial issues – or a "pure-play" defence company will ride to the rescue. Boeing chief executive David Calhoun admits his company lost confidence in Aerion, noting that "we evaluated it... and we got to a decision where we didn't believe in it quite as much as we thought we could".

Despite backing Aerion for 18 years, Bass too will have run out of patience. "It is unlikely he will put [the company] back on life support now that their cash requirements have grown exponentially," says Aboulafia.

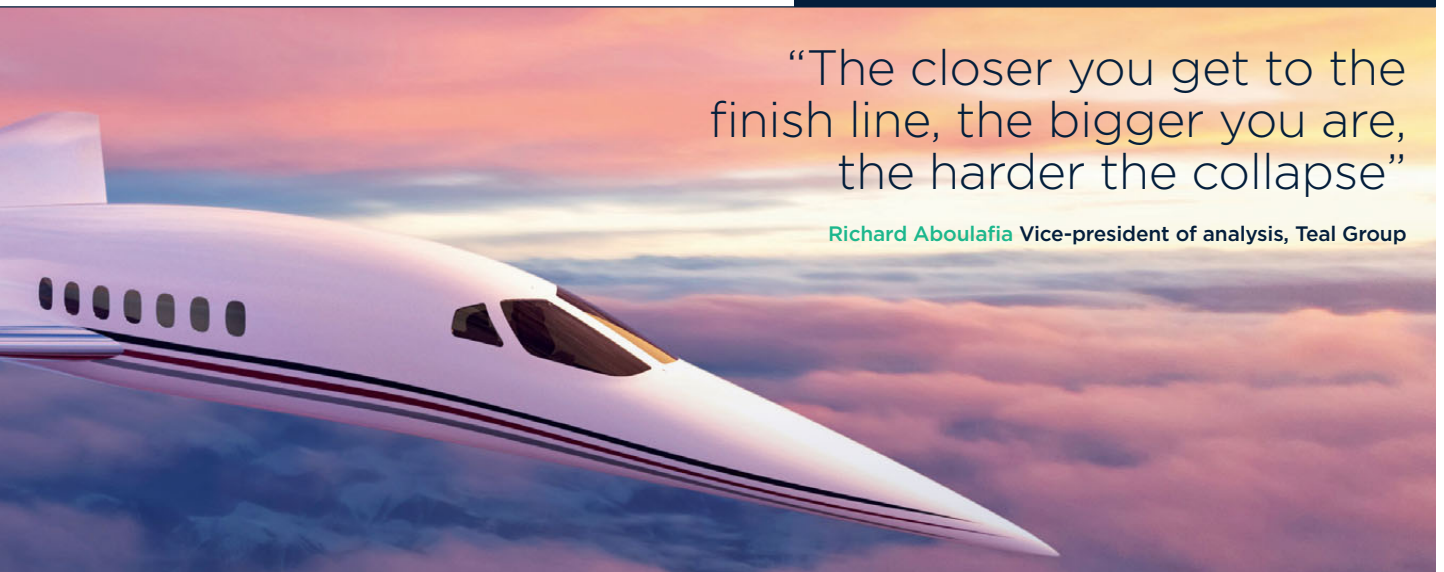
A major problem was that Aerion's $11 billion-plus backlog was fragile. As business leaders such as Virgin Group's Sir Richard Branson have long understood, simply promising to be an early customer for an innovative, high-profile product secures publicity without financial or reputational risk. NetJets' announcement in March that it had "rights to purchase" up to 20 AS2s made great headlines, but, as Aboulafia points out, "it is very unlikely that any money changed hands".

So where does Aerion's demise leave Boom Supersonic, Spike Aerospace and other market entrants? Boom's plans for an 80-seat airliner, the Overture, that can fly at Mach 2.2, are furthest advanced. The Denver-based company rolled out last October a single-pilot, proof-of-concept demonstrator, promising to fly the GE J85-15-powered XB-1 by the start of 2022. Boom will use lessons from the flight test programme to adapt the design of the Overture, which it hopes to fly by 2026.

Like Aerion, Boom has blue chip customers. United Airlines on 3 June said it had agreed to purchase

Boom Supersonic

Boom Supersonic, founded by Blake Scholl, has produced a single-seat demonstrator



> "The closer you get to the finish line, the bigger you are, the harder the collapse"
>
> **Richard Aboulafia Vice-president of analysis, Teal Group**

15 Overtures, with options for 35. The US carrier joins Japan Airlines, which has paid $10 million upfront, partly in exchange for purchase rights on 20 jets, and Virgin Group, which has "pre-orders" for 10 examples. Boom too has an engine partner, although not an exclusive powerplant; Rolls-Royce has promised to look at how it could adapt its existing Trent architecture for supersonic flight.

Of the other contenders, another US start-up, Spike, has been around the longest, although it has recently repositioned its twin-engined S-512 from a business jet to a 22-seat airliner, pitched at thinner routes between business cities where there is demand for rapid, premium travel. The company plans to fly a manned demonstrator in 2022, and have the S-512 in revenue service by the end of the decade, but has not confirmed an engine supplier, nor any potential customers.

Virgin Galactic has become the latest name in the market, last year unveiling a design for a delta-wing jet capable of carrying up to 19 passengers; where that leaves its commitment to Boom is unknown. Two other US technology firms – Exosonic and Hermeus – as well as Boom have won funding from the US Air Force to design supersonic concepts that could be used as a head-of-state transport or to redeploy missiles to forward bases at time of conflict.

With private investors or established aerospace players reluctant to bet the farm on a supersonic breakthrough, it could be left to governments to throw the sector a lifeline, just as taxpayers' money was needed to get the Aerospatiale/BAC Concorde into service almost five decades ago. "It's the best prospect for these programmes," says business aviation consultant Brian Foley. "They have the deep pockets to drive this forward."

It was something hinted at by Boom founder and chief executive Blake Scholl ahead of giving evidence to a Congressional subcommittee on aviation in March. "Supersonic flight will unlock new possibilities for human connection and for business, but this is only possible thanks to the leadership of Congress and the federal government to support emerging aviation technology," he said, before calling on the legislature to "continue supporting this important work".

$11bn

Nominal backlog of orders for AS2, although no commitments were made

So far, US public funding has been largely directed through NASA, with the development of the X-59, a project with Lockheed to build an aircraft able to overcome the sonic boom, the main factor behind the reluctance of the Federal Aviation Administration to permit overland flights by supersonic aircraft. Lockheed is hoping to fly the X-59 Quiet Supersonic Technology demonstrator in the first half of next year.

So will the big names that have invested in supersonic keep the faith? In a statement, Boeing says its "strategic investment" in Aerion – the sum was never disclosed – was "focused on research and development of the next generation of supersonic flight". It adds: "While we are disappointed Aerion could not secure additional funding... we remain committed to working with innovative, creative partners who, like Aerion, continue to push limits on ground-breaking technology."

R-R is associating itself with Boom, without seemingly committing anything in the way of risk-sharing investment. For its part, GE confirms the Affinity development has been abandoned, but insists it remains involved in the sector through the X-59, for which it supplies the F414-100 engine. "While that's not a commercial aircraft, the programme is intended to study quieter supersonic booms and translate those findings into the commercial sector," it says.

Foley says a key lesson from Aerion's demise is that "these programmes move at the speed of money". There had been hope that a SPAC (special purpose acquisition company) might save Aerion. Several of these organisations have sprung up in recent years, headed by individuals who use their reputation to attract funding with the aim of reverse-acquiring companies with promising technologies.

Emerging sectors

However, Foley believes "we are past the apex" of SPACs targeting potentially emerging aviation sectors such as supersonics and urban air mobility. Even if an enthusiastic SPAC is out there, the scale of the investment required – around $4 billion to bring the jet to production – would be beyond the means of most of them, he suggests.

However, Foley remains optimistic supersonic air travel will happen. He believes a manufacturer with technical know-how from the military world might make a move. Much depends on devising a way of flying at faster than Mach 1 over land without the sonic boom, he says. But "the technology is moving in that direction".

Fare's fair?

The developers of urban air mobility services say they have a route to cutting congestion, but will it be a service for all?

Dominic Perry London

Urban traffic congestion is already bad and will only get worse in future as cities swell: by 2050 around two-thirds of the world's population will live in cities, according to forecasts.

Aside from the time lost, fossil fuel-powered vehicles sitting in a queue of traffic are an obvious source of emissions – both those experienced locally, such as particulate matter, and greenhouse gases.

But have developers of electric vertical take-off and landing (eVTOL) aircraft found a silver bullet for congestion? Read through their mission statements and you might think so.

"We're working toward a future where you'll be able to safely soar over traffic and get to where you're going, faster," boasts USA-based Wisk.

Over on the other side of the Atlantic, Germany's Volocopter offers a similar view: "We are mobility's new dimension. Skip traffic jams and detours. Opt for advanced, predictable mobility."

The public also believe that urban air mobility (UAM) services offer the possibility of a brighter future: a recent survey from the European Union Aviation Safety Agency (EASA) showed that people saw one of the expected benefits from the advent of eVTOL operations as "faster, cleaner and extended connectivity".

51%

Proportion of respondents to an EASA survey who believed urban air mobility services would reduce traffic jams

In fact, an average of 51% of respondents living in the six cities surveyed felt that a reduction of traffic jams would be the second largest benefit of large-scale UAM services (the biggest benefit, cited by an average of 71% of people, was improved emergency response times).

As an illustration, the EASA study cites an air taxi journey from Paris Charles de Gaulle airport to the city centre which "could be two to four times faster compared to a car journey on a Thursday evening during rush hour". But it is unclear whether respondents see eVTOL aircraft as helping to cut congestion at a personal level – by allowing them to fly over it – or helping society through reducing car use significantly.

But for all their promises of a golden future, no-one should lose sight of the fact that eVTOL aircraft developers are businesses. Sure, a greener future is part of the mix, but as their investor presentations clearly state, they are in it for the money.

That is not a criticism of their capitalist imperatives. After all, Airbus and Boeing do what they do to make profits, not to further lofty goals around global mobility.

But that profit motive could conflict with wider societal aims. Noting that public acceptance will be vital to UAM uptake, EASA lists areas which may require regulators to take "preventative actions" in order to secure this.

"Ensure that UAM fits with the notion of 'public interest' by making

EASA forecasts mid-decade start of UAM operations, but full autonomy will lag

Paying passengers are likely to be flying in electric-powered air taxis in Europe by the middle of the decade, the bloc's chief aviation safety regulator believes, but fully autonomous operations are likely to be some way off.

Presenting the findings of a study into public attitudes to urban air mobility (UAM) services, Patrick Ky, executive director of the European Union Aviation Safety Agency (EASA), says that considering the "good progress being made" he believes that "commercial use" of such aircraft would likely begin in the 2024-2025 timeframe.

"We are in the process of certifying some of the vehicles that will be used for UAM and the certification target which we think is realistic is 2024," he says. "We might be late, we might be early, but we think the vehicles can be certified by this date."

Europe-based companies including Lilium and Volocopter are looking to bring their electric vertical take-off and landing (eVTOL) aircraft to the market in that timeframe.

Start-up companies

Ky anticipates the certification of each vehicle taking around four to five years, although the unfamiliarity of some start-up companies with EASA processes may delay the approval of their aircraft, he adds.

Around a dozen projects have applied for EASA certification, including several for the unmanned transport of goods – so-called delivery drones.

However, the time required to certify these vehicles is likely to be shorter, says Ky, and EASA is likely to accept "lower safety targets for goods drones", particularly if they are intended to be primarily flown over unpopulated areas.

While cargo drones will be unmanned, Ky thinks it will be several years before passenger flights will be conducted without a pilot on board.

Initial work has been conducted with UAM developers to consider the potential conditions to permit autonomous flights, says Ky, "but we have not gone too far".

Joby Aviation expects to have 963 aircraft operational by 2026

Joby Aviation

He says that "a lot of thinking" is required on the topic, notably around the integration of such services into the airspace and other safety considerations.

"There is no exact timeframe; it will take at least five more years to arrive at autonomous transport for air taxis."

Initially, pilots of UAM vehicles will be required to hold a commercial pilot licence – whether for fixed- or rotary-wing aircraft – but this will change as technology improves, says Maria Algar Ruiz, drones programme manager at EASA.

"As soon as the autonomy increases and we learn more about how these eVTOLs fly in urban environments we will start developing a new category of licence for this type of vehicle," she says.

To gain a better understanding of public attitudes to this new sector, EASA earlier this year surveyed nearly 4,000 people in six cities: Barcelona, Budapest, Hamburg, Milan, Paris, and the Oresund region on the border of Denmark and Sweden which includes Copenhagen.

Safety concerns

More than 80% of those surveyed had a positive attitude to UAM activities, with 71% ready to try out such services. Respondents' main concerns were around safety – both of the vehicles and their susceptibility to cyber attack – as well as their environmental impact and potential noise pollution.

Ky says the agency will use the findings to shape its regulations "in line with the perceptions and expectations of citizens."

He says the survey shows that the public expects passenger operations to be as safe as those of commercial air transport. "It is something that we find a challenging target, but we think we can work with that," he says.

EASA will not be responsible for licensing individual operators, determining permitted routes or the location of ground infrastructure, but Ky says the results of the study should help to guide the decision making of national or local authorities.

it affordable to all, and integrating it into the local (multimodal) mobility system/network accessible to all," it says.

EASA's findings are in line with those of previous analyses. Researchers from the Technical University Munich, University College London and Bauhaus Luftfahrt e.V in their 2020 paper *Factors affecting the adoption and use of urban air mobility* outlined that studies over the last decade have consistently shown that cost and time will be two significant factors in UAM uptake.

For instance, a NASA-commissioned report in 2019 detailed that while nearly 50% of those surveyed were "potentially comfortable" with UAM use cases, "cybersecurity, affordability and willingness to pay were perceived as barriers to the UAM viability".

In their own study, the researchers from the three universities discovered that safety, cost and trip duration, in that order, were the top three factors affecting UAM uptake.

User requirements

"If the system aims to attract a wider public, user requirements must be prioritised, notably pricing schemes must be defined, and regulated by the authorities, so that the service would not only be a niche market," the report concludes.

Ensuring affordability and accessibility will be no mean feat. While information on trip pricing is hard to come by, not least that commercial operation of eVTOL aircraft is still some years away, several companies poised to merge into stock market-listed entities have provided a little detail.

Take Blade, an Uber-like technology company in which Airbus has invested. Blade does not own any aircraft itself but buys aircraft time by the hour from operators, who provide them on an ACMI basis. Blade, meanwhile, supplies the marketing, branding, booking systems and ground infrastructure.

While offering a number of services, Blade is arguably best known for its five-minute-long helicopter flights linking the New York airports with Manhattan, for which it charges a one-way fee of $195 per person.

Blade sees its clientele as "high-income travellers", according to a recent presentation, who are willing to pay a premium to arrive in the city potentially 2h faster than if they drove.

$195

Cost of a one-way, five-minute helicopter journey from New York airports to Manhattan with Blade

It is an enthusiastic proponent of UAM and has a commitment for up to 20 Beta Technologies Alia aircraft, which carry five passengers – one fewer than a typical light helicopter. Blade sees the potential of eVTOL vehicles to "reduce pricing to expand [passenger] volumes and reduce costs".

With the start of UAM operations, the fare for a JFK-Manhattan flight could fall to around $125, according to the presentation. But the "lower cost of flying" would also lead to "margin expansion", it notes.

In other words, while it would earn less revenue from each flight, lower operating costs would make each service more profitable, even when allowing for one fewer seat on the aircraft.

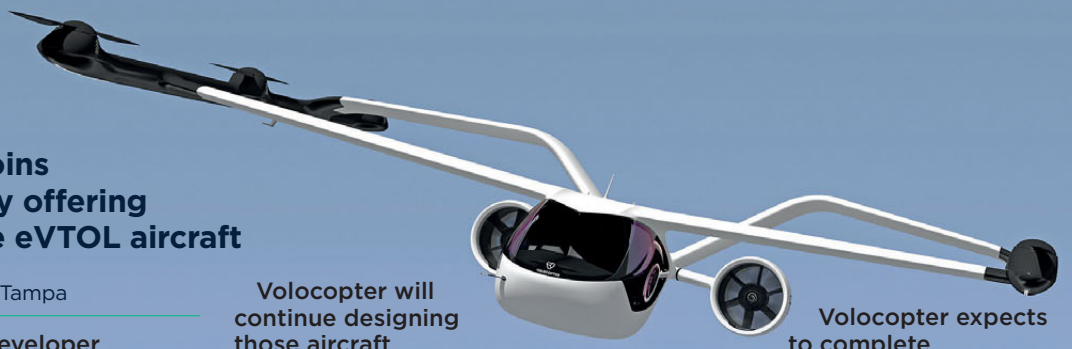
Joby Aviation, meanwhile, in its financial predictions for 2026 – when it expects to have 963 aircraft operational – lists a per-mile seat cost of $3, which, it says for an individual, "is cheaper than Uber Black" – the ride-hailing company's premium service.

Under Joby's forecasts, by that year each aircraft will be making $2.2 million in annual revenue – a little over $6,000 per day – and $1 million in annual profit, based on an average trip length of 24 miles with a load factor of 2.3 passengers in its four-passenger aircraft.

Germany's Lilium, which sees itself as a regional rather than urban mobility provider, has also given

Lilium

Lilium plans to launch as a premium service but reduce prices over time



Volocopter joins inter-city fray offering longer-range eVTOL aircraft

Jon Hemmerdinger Tampa

German air taxi developer Volocopter has launched a new, larger electric vertical take-off and landing (eVTOL) aircraft called VoloConnect, which it hopes will be in revenue service within five years.

VoloConnect will have four seats, retractable landing gear, a 52nm (97km) range, cruise speed of 97kt (180km/h) and a maximum speed of 135kt, says the company.

In contrast to the multi-rotor architecture of its short-range VoloCity design, the new model will have two fixed wings and six lifting rotors. It will also have two aft-mounted fans to provide forward thrust.

VoloCity, and the "heavy lift" VoloDrone, have 18 lifting fans, 19nm range, 52kt cruise speed and 200kg (440lb) payload, the company says.

Volocopter will continue designing those aircraft alongside VoloConnect, allowing it to address the broad spectrum of urban air mobility operations.

"This electric vertical take-off and landing aircraft is designed to connect suburbs to cities and complements the company's existing family of aircraft for the intra-city mission," Volocopter says. "VoloConnect's distinctive hybrid lift and push design is expected to achieve certification within the next five years."

Volocopter chief executive Florian Reuter says VoloConnect will provide the "next level of flight efficiency". The aircraft's "layout is ideal for smooth, fast travel experience", he adds.

"We have been working for years with a dedicated team at our Munich site," he says, noting that Volocopter has filed for a design patent.

Volocopter expects to complete VoloConnect's certification, and place the aircraft into service in 2026. It will have Volocopter's fly-by-wire flight-control system and be capable of autonomous operations.

However, initial variants of the aircraft may be piloted, depending on how quickly autonomous-flight regulations advance, says Reuter.

He declines to say when Volocopter might unveil a VoloConnect prototype or conduct a first flight, saying only that the company is currently "working fast toward flying full-scale prototypes".

Reuter insists the company has sufficient financial resources to develop three aircraft simultaneously, noting that Volocopter recently raised $240 million in funding.

Volocopter

$15,000

Estimated daily revenue generated by a single Lilium jet, based on 20-25 flights with four to five passengers

some indication of the market it hopes to tap into.

"Although we believe that we will launch our service as a premium service, with prices comparable to a road taxi on a per-mile basis, over the long term we intend to decrease prices further to match the cost of private car ownership or high-speed rail, which would make our [business to consumer] services accessible to a larger part of the population," it states.

But that emphasis on a premium service is reinforced by a recent agreement with business jet operator Luxaviation, which will help to "build out airline operations in Europe".

Luxaviation is many things, but mass market it is not. The tie-up with Lilium suggests a high-end service is envisaged, at least initially.

Lilium forecasts that once in operation, each Lilium Jet will be capable of earning revenue of $15,000 each day, assuming it can cover around 1,500 miles or 20-25 flights with an average occupancy of 4.5 people. Profit margins are estimated to be around 25%.

More generally, as consultancy Roland Berger observes, low initial production volumes of all eVTOL aircraft will "at first keep the cost of UAM services high, with only the most affluent customers using them". Scale – of manufacturing and operations – is what will drive the cost down for the consumer, although how far remains to be seen.

Reduced congestion

While eVTOL operations will clearly benefit those who can afford them, will they have a meaningful impact on congestion? Or to put it another way, how many cars will they actually take off the road, and will that be enough to make a difference?

According to the Organisation for Economic Co-operation and Development (OECD) in its *ITF Transport Outlook 2021* publication, in 2015, more than one-third of passenger trips were made by private vehicles, 2.5 times the rate of public transport. By 2050, the global fleet of private cars will have reached 1.4 billion, it says.

Based on that growth, how many trips by eVTOL aircraft would be necessary to simply keep traffic at its current level, let alone reduce it? Nobody seems to be able to offer a clear answer.

For cities keen to foster the creation of UAM services, the question therefore appears to be one of regulation. Are air taxi operators to be subject to the same fare controls as operators of ground vehicles? And if so, what are they benchmarked against? Or if not, are local authorities happy to cross their fingers and leave everything to market forces?

Ultimately, if cities wish to harness the congestion-busting benefits touted by eVTOL manufacturers there will have to be some form of price regulation and integration with existing public transport infrastructure. Otherwise UAM vehicles will – like private helicopters and business jets – remain the preserve of a wealthy elite while the rest of the population are stuck in traffic.

Embraer's regional makeover

More than 200 examples of twinjet type are in storage

Embraer

Brazilian airframer to develop STC that will allow conversion of ERJ-145 airliner into 16-seat all-premium 'semi-private' jet

Jon Hemmerdinger Tampa

Embraer has launched a programme to convert ERJ-145 regional jets into "semi-private" aircraft, to tap into the market for first-class travel and make use of the hundreds of jets left parked up by the pandemic.

Modifications planned include the removal of overhead bins – creating more "personal space" – and installation of 16 to 28 "premium seats" in a 1-1 configuration, Embraer says. In an airline configuration the ERJ-145 can accommodate up to 50 seats in a 2-1 layout.

Embraer is now developing the supplemental type certificate it needs to perform the modifications, which will be completed at manufacturer-owned service centres. "All ERJ-145s are eligible to be converted," the company says.

Embraer says the converted ERJs will appeal to "passengers who usually travel first class".

"The ERJ-145 semi-private jet allows these customers to avoid main crowded airports and save time, providing a premium experience to the passengers who will board from and disembark at a private terminal," it says.

"We have identified this opportunity given the growing number of aircraft with semi-private interiors, which have doubled in two years, from 21 in 2019 to more than 40 in 2021. With the pandemic, we believe this number will increase even more," says Marsha Woelber, head of worldwide executive jets customer support and aftermarket sales at the manufacturer.

Embraer

'First-class' cabin is configured in 1-1 layout

Although the Brazilian airframer is hoping to tap into a new market, the modification programme is also an opportunity to create a second life for the many regional jets that are now sitting in storage.

In 2020, as the pandemic strangled air travel demand, some large ERJ-145 operators shut down, among them US carriers ExpressJet Airlines, which had 95 ERJ-145s in service at the end of 2019, and Trans States Airlines, which had 46 in service, Cirium fleets data shows.

Globally, some 220 ERJ-145s are stored with roughly another 350 operational, Cirium data shows, against respective figures of 120 and 475 at the end of 2019.

Average market values for the out-of-production Rolls-Royce AE 3007-powered ERJ-145 now range from $1.1 million to $1.45 million, down by 10-17% since the end of 2019, according to Cirium.

Embraer will also compete against Bangor, Maine-based MRO provider C&L Aviation Services, which has been turning ERJ-135s and ERJ-145s into premium-only jets since 2018.

C&L recently signed a contract for a further batch of aircraft, to be converted into a 16-23-seat first-class layout. It has performed 20 such modifications to date, it says.

Embraer's all-premium airliners also seem likely to compete against corporate-converted Bombardier CRJ200s, another regional jet with declining popularity. A number of companies including Field Aerospace and Flying Colours offer premium modifications on the type.

There were no injuries and aircraft was undamaged following incident

Runway change behind WestJet 737 overrun

Crew failed to realise that altered approach to Halifax would involve tailwind component in excess of operator's limits

David Kaminski-Morrow London

Canadian investigators believe a WestJet Boeing 737-800 overran at Halifax after its crew failed to realise that a landing runway change would result in a tailwind, rather than a crosswind, during the approach.

The tailwind component exceeded the operator's limit of 10kt (18km/h) and required a lower approach speed, says the Transportation Safety Board of Canada.

Its analysis found the aircraft, arriving from Toronto on 5 January 2020, touched down on the wet, snow-covered runway 14 at 173kt groundspeed, about 365m (1,200ft) from the threshold.

Manual braking

Although the speedbrakes and thrust-reversers deployed and the autobrake system activated, the crew observed that the aircraft was not decelerating as expected and applied manual braking.

Efforts to slow the aircraft sufficiently to make a taxiway turn were unsuccessful and it overran at 26kt, coming to rest on grass 90m beyond the runway.

Its crew had originally prepared for an approach to runway 05. Wind conditions at the time would have resulted in a headwind component of 22kt. The crew calculated a target approach speed of 162kt and a required landing distance of 2,200m.

But 14min before landing the pilots were advised of a change in the cloud ceiling, putting it below the minima for the runway 05 approach, and they requested an ILS approach to runway 14 instead.

"While preparing for the runway change, the flight crew members mentally assessed that the wind for runway 05 would result in a crosswind for runway 14 because the runways were perpendicular to each other," says the inquiry.

"This mental model was likely a natural response by the flight crew to reduce cognitive effort during a time of high workload."

But the gusting winds on the ground had backed – shifting from 030° to 020° magnetic – and increased slightly during the flight's progress. This resulted in a tailwind component of 15kt for runway 14, which went unnoticed by the pilots, who did not revise their target approach speed or request new data over the ACARS communication system.

At the time the crew requested the change of runway, the approach speed selected would have required a landing distance of 2,990m for runway 14, according to Boeing calculations – a figure in excess of the distance available.

2,990m

Landing distance required at approach speed of 162kt with 15kt tailwind component; runway 14 is 2,350m long

Approach speed

While runway 05 was 3,200m long, the length of runway 14 was only 2,350m. The inquiry says the appropriate target approach speed should have been 152kt, but points out that the tailwind still exceeded the carrier's limitations.

Wind information was "not salient" to the crew during the approach, it says, following the decision to change runways and the failure to recognise the tailwind.

"The unchanged target approach speed combined with the tailwind resulted in the aircraft crossing the threshold 10kt faster than recommended and touching down at a faster groundspeed," the inquiry concludes.

None of the 178 occupants were injured and the aircraft (C-FUJR) was undamaged, although WestJet replaced the tyres and brakes before returning the jet to service.

AirTeamImages

Neil Hall/EPA-EFE/Shutterstock

Pandemic disruption has caused airlines difficulty in quantifying fuel-efficiency improvements

Measure by measure

Covid-19's impact on global passenger traffic has had a knock-on effect on the airline industry's attempts to cut carbon emissions, says **Richard Evans**

The collapse in passenger traffic due to the Covid-19 pandemic is making life more complicated for anyone wishing to evaluate progress towards carbon-reduction targets.

In 2009 the aviation industry set three global goals: improve average fuel efficiency by 1.5% per annum from 2009 to 2020; net carbon-neutral growth post-2020; and longer term, cutting net carbon dioxide (CO_2) emissions to 50% of 2005 levels by 2050.

The most obvious impact is that the fall in total aviation CO_2 emissions last year implies a huge change to the commitment post-2020. This has been addressed by the decision to change the baseline for ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to 2019, rather than the average of 2019 and 2020.

The situation also highlights the lack of clarity around what is meant by an improvement in fuel efficiency, and how progress towards these goals is measured.

The original 2009 commitment did not specify the method of assessment. However, IATA has used emissions per revenue tonne kilometre (RTK) as the metric, taking into account passengers and cargo.

In its December 2019 *Airline Industry Economic Performance* report, IATA stated that an annual average improvement of 2.4% had been achieved from 2009 to 2014. The report then quotes a 1.9% efficiency improvement in 2019 versus 2018, but in terms of fuel use per available tonne kilometre (ATK). At this point, the prediction for 2020, based on the delivery of more fuel-efficient aircraft, was for a further reduction of 2.1%, expressed as per ATK.

Metric system

The data for 2020 clearly shows the divergence between passenger demand and capacity, and that for cargo. Air freight demand only fell by 9% in 2020, and flights by full-freighter jets grew by over 30%. This highlights that efficiency metrics based purely on passenger figures would clearly give very different results from those derived from aggregate data, including cargo.

Publication of CO_2 data by airlines varies enormously, as does their use of efficiency metrics. Airlines that fly relatively little cargo have often used figures for CO_2/revenue passenger kilometre (RPK). However, on this basis, instead of showing an improvement in 2020, the drastic fall in passenger load factors resulted in an increase in CO_2/RPK of around 37%, wiping out the gains of the last 10 years at a global level. This, despite total emissions falling by 48% in 2020 against 2019.

Deciding on the metric, plus verifiable figures for CO_2 emissions is key. However, airline traffic data is increasingly difficult to source as many airlines have ceased publishing numbers, other than in annual or quarterly reports. Cirium is developing fuel burn and CO_2 models matched with actual flight data, both passenger and cargo, from the start of 2019. This provides a reference point for emissions data, but measuring aggregate industry performance remains a challenge.

Relative reduction

Alaska Airlines published its latest environmental, social and governance (ESG) report in March 2021, and commented that its own goal, set in 2013, of cutting CO_2/RTK by 20% by 2020 relative to 2009 – adjusted to a reduction of 17% when it merged with Virgin America – would have been met in 2020 if Covid had not intervened. It had achieved a 16% cut by 2016. By this metric, Alaska was 20% worse than 2012 in 2020. It has now restated its goal as being carbon-neutral against 2019 through to 2025, and a goal of net zero emissions by 2040.

EasyJet carries very little cargo, hence its efficiency is measured as CO_2/RPK. It restated its target as being a 10% reduction in CO_2 emissions per RPK by 2022, versus 2016. For the financial year ended September 2020, it noted that despite the fall in load factors, the focus on flying Airbus A320/A321neo aircraft meant only a marginal increase from 70.4g to 70.8g CO_2/RPK was seen. This represents a 4.3% fall since 2016, with the 2022 target being 68g CO_2/RPK.

Alaska and EasyJet are two of several airlines that have set goals well beyond the CORSIA target. Offsets will still be part of many airline roadmaps, but the Covid crisis implies the industry does not need these until 2024 at the earliest.

It appears there will be more focus on measurable targets for CO_2 reduction, at least in the next four to five years, rather than relying on offsets under the CORSIA scheme.

Richard Evans is a senior consultant at Ascend by Cirium

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Photographic record made by the Brazilian Air Force on one of the missions to combat COVID-19 in Brazil.

United Airlines has committed to acquiring 15 Overture jets from Boom Supersonic, and taken options to purchase an additional 35

Boom Supersonic

Best of the rest

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

Ireland's transport ministry is looking to swiftly reinstate public service obligation routes operated by Stobart Air until the carrier's collapse on 12 June

jremes84/Shutterstock

Airbus has conducted windtunnel tests of the propulsion unit for the EcoPulse hybrid demonstrator being developed with Daher and Safran

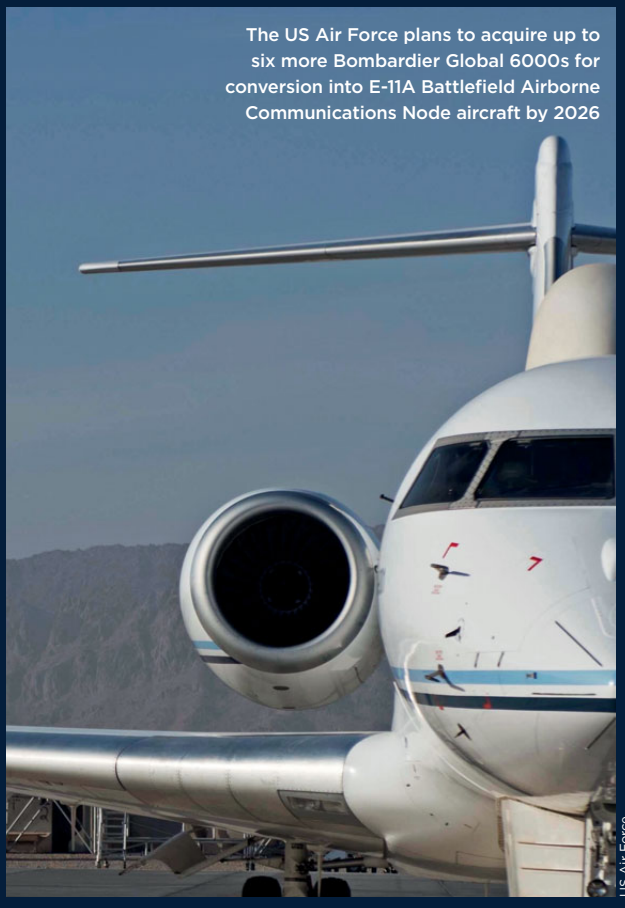
Airbus

Leonardo Helicopters delivered its inaugural TH-73A trainer to the US Navy, with another 129 examples to follow

Leonardo Helicopters

Dornier Seawings has secured over $360 million in fresh funding from Chinese backers to propel its Seastar amphibian project towards service entry in 2023

Dornier Seawings



The US Air Force plans to acquire up to six more Bombardier Global 6000s for conversion into E-11A Battlefield Airborne Communications Node aircraft by 2026

US Air Force

Boeing's MQ-25 Stingray tanker refuelled an F/A-18F Super Hornet for the first time in early June. The US Navy plans to field the new capability from 2025

Kevin Flynn/Boeing

Next month

Our review of key airliner programmes and their potential development paths

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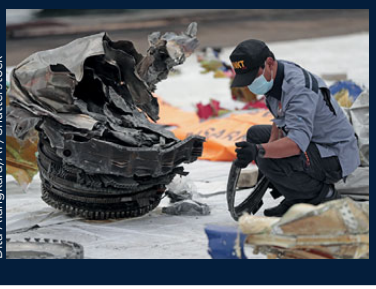
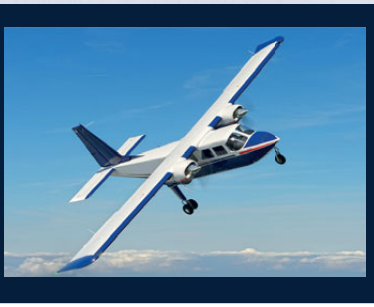


Dita Alangkara/AP/Shutterstock

Safety first
A half-year analysis of accidents, including Sriwijaya tragedy



Britten-Norman

Powering on
Britten-Norman touts green potential as venerable Islander keeps its appeal

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DASSAULT AVIATION

United Aircraft

Aviadvigatel PD-14-powered -310 variant is set to make its debut at MAKS show

David Kaminski-Morrow London

Aeroflot Group carrier Rossiya will be the first airline to operate Russia's newest commercial twinjet, the Irkut MC-21, more than a decade after Russian President Vladimir Putin queried why Aeroflot appeared intent on dominating the domestic market yet was reluctant to acquire domestically-built aircraft.

Although Aeroflot, within weeks of Putin's remarks, signed up to take 50 MC-21s, the likelihood of the flag airline's operating the type still seems distant, following a recent rethink of the carrier group's long-term business and network strategy.

Under the strategy the Aeroflot Group airlines – comprising the mainline Aeroflot operation, plus Rossiya and budget carrier Pobeda – will be assigned specific network responsibilities. Aeroflot will focus on premium long-haul international routes from Moscow, while low-yield services will be handed to Pobeda.

Rossiya will be established as a Russian inter-regional carrier to provide connections that bypass the Moscow hub by establishing a network of regional bases. It will operate Moscow feeder services for Aeroflot and conduct international flights from St Petersburg.

But Rossiya will have a particularly notable fleet role within Aeroflot Group as the strategy unfolds over the next five to seven years.

"It will establish a centre of competence for Russian-manufactured aircraft development," says Aeroflot Group strategy chief Andrei Panov. "All domestically-built aircraft of the group will be concentrated in Rossiya."

Rossiya started introducing Sukhoi Superjet 100s last year, transferred from the Aeroflot fleet, and Panov indicated in March that Rossiya already effectively had 20 of the type.

"Rossiya will receive all our [Aeroflot Superjets]," he says. The bulk of the aircraft, some 40 of them, will be moved to the carrier this year, with about 10 more following in 2022.

Significant change

But the most significant change to the Rossiya fleet will emerge once the MC-21 – now a sister aircraft to the Superjet, after the Sukhoi civil operation was brought under Irkut – is certified by Russia's federal air transport regulator.

"The first operator of the MC-21 will be Rossiya," says Russian state technology corporation Rostec, which oversees United Aircraft (UAC) and Irkut.

Certification has been a slow process, further complicated by the impact of the pandemic and the effect of US government sanctions on suppliers. As the MAKS Moscow air show opens, the single-aisle MC-21-300 – the Pratt & Whitney PW1400G-powered variant, and the first to be developed – will have spent four years in flight-test certification work, contrasting with just 15 months for Airbus's twin-aisle A350.

Serial production has edged closer and the wing panels for the first customer aircraft have been

Irkut's MC-21 is on track for first delivery this year with imported key components – but the programme is championing near-term readiness with Russian engines and homegrown composites

Domestic imperative

New single-aisle will join Sukhoi's Superjet within Rossiya fleet

Telsek/Shutterstock

shipped by road from AeroKompozit's Ulyanovsk facility to Irkutsk.

There is no firm date for initial deliveries, but the aim is to hand over the first MC-21 by the end of this year.

Five aircraft comprise the flight-test fleet after the recent addition of the first MC-21-310, the variant fitted with Russian-built Aviadvigatel PD-14 engines – and set to debut at this year's MAKS.

Rostec described the 85min maiden flight of the MC-21-310, in mid-December 2020, as the "most important event of the year" for the Russian civil aviation industry.

"Creation of such a powerful duet as a modern, medium-range aircraft and a domestically-produced engine is a serious claim to success," it added, pointing out it had been achieved during a "time of sanctions".

Rostec says the MC-21 programme is progressing "despite an attempt to disrupt Western partners" through the interruption of composite material supply at a "crucial moment".

The aircraft has about a 35% share of composite structure, but Rostec says the obstacle has forced the Russian aerospace industry to adapt "in record time" to develop a domestic alternative, with specialists devising ways to produce large-sized composite parts.

Rostec even argues that the PD-14-powered aircraft will be attractive to customers in countries "under sanction restrictions", as well as those in its main target markets.

AeroKompozit, which, like Aviadvigatel, was included on a US sanctions list, manufactures critical composite structures for the MC-21, including wing panels and spars. It says it has been working with domestic materials "within the framework" of an import-substitution programme under which Russian industry has sought to reduce its dependence on foreign suppliers, and that preparations are under way for serial production of MC-21 wings.

"The company today is capable of producing composite wings for the civil aircraft industry," says AeroKompozit-Ulyanovsk general director Anatoly Gaidansky. "Ten years ago, there was no such technology and competence."

Obninsk-based firm Tekhnologiya says it developed, under import-substitution, several new structures from domestic composites for the PD-14, including multi-layered noise-absorbing honeycombs.

"Composite materials made it possible not only to increase reliability of the components but also the weight efficiency of the engine," Tekhnologiya says. "By solving such problems, we help to ensure the independence of the domestic aviation engine industry."

United Engine's Perm Motors division is the primary manufacturer of the PD-14, but various suppliers contribute to the powerplant. Some 30% of the components, including its hollow titanium fan blades and high-pressure compressor rotor, are produced by United Engine's Ufa-based division UMPO, while Perm-based UEC-Star has developed a fully-electronic automatic fuel-management and control system.

Industrial transformation

Under an industrial transformation programme, turbine blade manufacture for a range of civil and military engines will be carried out at three specialised United Engine centres – Perm Motors, UMPO and Saturn – to position the company for PD-14 production, as well as development of other family powerplants: the lower-thrust PD-8, a demonstrator for which is under construction, and the high-thrust PD-35.

Russian civil aviation regulator Rosaviatsia had already certified the PD-14 and has newly granted authorisation for serial production of the powerplant, after evaluating quality-management systems and the processes for manufacturing, assembly and testing.

Rostec industrial aviation arm director Anatoly Serdyukov says several PD-14s will be produced as spares for the MC-21-310 flight-test programme. The company claims the powerplant, the first commercial all-Russian engine in three decades, will offer operating costs 14-17% lower than similar available engines.

Several other systems of the MC-21 are being subjected to import substitution initiatives. The Russian government has recently sought alternatives for airborne and terrain collision-avoidance systems.

Formal invitations have also been published seeking development of a radio altimeter, as well as a nosewheel steering and monitoring system.

The first MC-21-310, aircraft 73055, might be a civil centrepiece for the MAKS show, but the heavy lifting for the MC-21 programme is being done by the other four aircraft – 73051, 73053, 73054 and 73056.

Among the more high-profile tests undertaken by the fleet were spectacular water-ingestion trials using aircraft 73053 at Ulyanovsk in July 2020.

United Aircraft wants to market the MC-21 family outside of Russia

United Aircraft

But the initial flight-test airframe, 73051, also drew attention after narrowly escaping damage at Moscow Zhukovsky in January when a mishap during simulated single-engine approaches and emergency braking resulted in the twinjet suffering a runway excursion and coming to rest on snow-covered rough ground.

The aircraft returned to the test programme and was dispatched in March to Arkhangelsk for assessments of natural icing effects in flights over the White Sea.

MAKS 2021 will be the second Moscow show outing for the MC-21 after the 2019 event, and its attendance at the Turkish Teknofest a month later.

Irkut claims orders for 175 aircraft, including Aeroflot Group's 50. IrAero, Red Wings and Yakutia are among other operators to have signalled strong interest, alongside lessors including GTLK and Ilyushin Finance.

The flight-test fleet includes cabin-equipped examples of the PW1400G-powered -300, with an all-economy layout on aircraft 73056 equivalent to 211 seats, and a two-class layout on 73054 with 163 seats.

> "Development of the PD-14 [engine] has laid the foundation for Russian aviation for the coming decades"
>
> **Rostec**

Irkut ambitiously aims to assemble up to 72 aircraft annually once deliveries begin and serial production of the MC-21 ramps up. Along with the -300 and -310 the airframer intends to develop a shrink variant, the -200, with seating for 130-176 passengers.

Rostec has hinted that analysis is also under way for a previously-proposed stretch version, the MC-21-400, but says it will "require a more powerful engine". It indicates that modified PD-14 powerplants – designated the PD-14A and PD-14M – would respectively address the thrust requirements for the -200 and -400.

"Development of the PD-14 has laid the foundation for Russian aviation for the coming decades," it adds.

UAC believes the MC-21 could obtain up to 10% of the new aircraft demand in its sector over the next 20 years. Ultimately the company wants to market the type outside of Russia, and has been working with the European Union Aviation Safety Agency (EASA) with a view to obtaining certification.

This has included inviting EASA pilots to test-fly the MC-21-300 under various conditions, supported by Russian counterparts, to assess its handling across a range of altitudes and speeds, as well as specific aspects including operation at high angles of attack.

Drawing its name from the Russian for 'mainline aircraft of the 21st century', the MC-21 – with its option of an all-Russian powerplant – is the most significant development in post-Soviet civil aerospace. But convincing operators, both Russian and foreign, to break their Western-built single-aisle habit and 'buy domestic' will not be an easy task.

MC-21

TECHNOLOGIES OF THE 21ST CENTURY

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Prototype aircraft made debut flight last December

David Kaminski-Morrow London

Resurrecting a three-decade-old aircraft design whose original production run barely crept into double figures takes a certain amount of confidence and self-belief.

But Russia's United Aircraft (UAC) believes there is a market for a modernised version of the Ilyushin Il-114, designated the -300, to provide a domestically-built alternative to foreign types such as the ATR 72 and De Havilland Canada Dash 8-400.

The Il-114-300 owes its revival in part to the Dash 8-400, formerly known as the Bombardier Q400 – a final assembly line for which was the subject of discussions between the Canadian airframer and Russian state technology firm Rostec, as part of a preliminary agreement in 2013 to sell the twin-turboprop to Russian carriers.

Negotiations to finalise a deal establishing a Q400 production plant, possibly in Ulyanovsk, were unsuccessful, with the effort certainly not helped by the international political friction that followed Russia's annexation of Crimea in early 2014.

With potential customers still interested in turboprops, the Russian government turned to upgrading the Il-114 and setting up a new assembly line.

The result of that decision, the Il-114-300 programme, is part of a Russian import-substitution strategy through which the government is trying to reduce dependence on overseas suppliers and revive its own aerospace industry – a sector that suffered in the aftermath of the Soviet Union's collapse as Russian airlines opted to introduce popular Western aircraft.

"We have updated our technologies in the segment of small regional aircraft in order to develop regional transportation within the country," United Aircraft first deputy chief Sergei Yarkovoy, the head of Ilyushin, tells FlightGlobal.

Just a day after the maiden flight of Irkut's MC-21-310, with its domestically-produced engines, the prototype Il-114-300 also became airborne for the first time, lifting off from Zhukovsky airfield for initial stability and controllability tests on 16 December last year.

"Its flight-test programme is under way," says Yarkovoy. "Introducing new technologies, with high level of process automation, we are assembling the second aircraft and are ready to launch mass production."

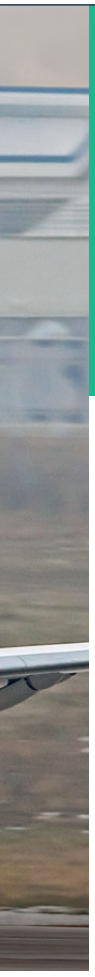
Turning point

Ilyushin's original Il-114, with its Klimov TV7-117 engines, emerged at a critical point in Soviet history, first flying from the airfield of Zhukovsky's Gromov institute in March 1990 – just four months after the fall of the Berlin Wall.

The break-up of the Soviet Union complicated the development, because Il-114 manufacture was assigned to Tashkent's aviation production organisation located in newly-independent Uzbekistan. The aircraft's test programme also suffered a setback with the fatal loss, attributed to an engine problem, of prototype 54001 during take-off from Zhukovsky in July 1993.

Foreign participation enabled creation of a modified variant, the Il-114-100, certified in December 1999 with Pratt & Whitney Canada PW127H engines and avionics from Collins and Honeywell.

Il-114s made a number of appearances at MAKS Moscow air shows, and a cargo version was developed.



Russia's Il-114 is approaching service entry in its -300 guise, almost 30 years after the Ilyushin design's emergence – and with local demand rising, it looks set to make a successful return

Local hero

But outside of Uzbekistan Airways and Russian regional carrier Vyborg Airlines, which each introduced a handful of aircraft, the type gained little traction. One of the original Il-114s subsequently served as a radar system testbed with Russian firm Radar MMS.

Dozens of Antonov An-24s and An-26s that the Il-114 was developed to replace remain in service, and the Russian government still believes the turboprop has strong potential – not just as a successor to the Soviet-era types, but as a way of addressing demand for better domestic connections. Russian government regulations on subsidised routes give preference to operators using domestically-built aircraft.

The modernised -300 is Russian-built this time, with the serial production line located at the RAC MiG facility at Lukhovitsy, near Moscow.

"We try to combine two principles in this aircraft," says Yarkovoy. "On the one hand, to make the aircraft unpretentious to service, easy to maintain, including a low level of demand for airport infrastructure – the aircraft has a built-in ramp, for example, [and] it does not require special equipment for maintenance and pre-flight preparation.

"On the other hand, it is necessary to provide passengers with a modern level of comfort and convenience in the cabin," he says.

"We understand the demand for a large amount of hand luggage, and such baggage that passengers can independently place in the cabin. The aircraft design includes three options for converting the passenger compartment and luggage compartments."

Updating the earlier Il-114 airframe has involved developing a digital flight and navigation suite from KRET, featuring five liquid-crystal display screens, with avionics allowing the aircraft to conduct landings in Category II conditions.

An original Il-114 – pictured at a MAKS show – served as radar system testbed

Fasttailwind/Shutterstock

It features TV7-117ST engines delivering 3,100shp (2,310kW), benefiting from parallel work to develop the Il-112V light military transport. The powerplant, which also has a new automatic control system and propeller, underwent four stages of tests fitted in the inboard left-hand position on an Il-76 airborne testbed.

Test facilities

United Engine expanded its Omsk ground test facilities last year by opening a fully-automated bench for the TV7-117ST, with monitors displaying graphical operational parameters for the engine. Klimov chief designer Stanislav Konashkov says this will enable the company to carry out all the required tests of the powerplant to "ensure its certification on time", and provide a platform to support long-term development work.

Voronezh-based airframer VASO is responsible for several Il-114-300 structures, including wing and tail sections, as well as the engine nacelles, while Ulyanovsk's Aviastar is producing fuselage panels, doors and hatches. Other fuselage compartments are being

United Aircraft

Certification and initial deliveries are planned for 2022

produced by the Sokol aircraft plant, which is associated with RAC MiG, in Nizhny Novgorod.

Final assembly of the aircraft is being undertaken at MiG's Lukhovitsy facility where an automated jig-less production platform – capable of aligning structures to a precision of 10 microns – has been established to reduce complexity and costs while increasing flexibility.

MiG and Sukhoi have been operating under a unified management structure since early 2020, led by Ilya Tarasenko.

Tarasenko says the companies, which have focused primarily on military aircraft, have undergone changes – modernisation of equipment and retraining of personnel – to diversify into production of civil airframes. Use of digital technologies, previously deployed mainly during early development phases, has been expanded to aid production and product life-cycle support.

The Lukhovitsy plant has carried out joining of the fuselage sections of the second prototype -300 as well as the mating of the wing and tail structures.

"Manufacturing technologies are being developed on this second prototype which will make it possible to establish serial production of aircraft in the shortest possible time," says Rostec executive director Oleg Yevtushenko.

Yarkovoy says the -300 will use several new systems which have been specifically developed for the aircraft and will enter production for the first time. Most of the components are being supplied by various Rostec enterprises.

"We're creating a safe, comfortable, easy-to-maintain regional aircraft suitable for Russian operating conditions"

Sergei Yarkovoy First deputy chief, United Aircraft

The aircraft will have an upgraded auxiliary power unit, air conditioning system – featuring domestic composite materials – fire-protection and pressurisation systems, and a lightweight power supply network.

Rostec says the cockpit takes into account "modern standards of ergonomics".

"We're creating a safe, comfortable, easy-to-maintain regional aircraft suitable for Russian operating conditions," says Yarkovoy. He expects the second prototype to enter the flight-test programme this year.

Yevtushenko says the aircraft will be able to serve unpaved runways in remote locations, while being "easy to operate" and economical. He puts the Il-114-300's fuel consumption at about 500kg/h (1,100lb/h).

The aircraft has a length of 26.9m (88ft 3in) and a wingspan of 30m and is designed to accommodate 68 seats. It will be able to transport a maximum payload of 6.8t across a range of 755nm (1,400km), with a cruising speed of up to 270kt (500km/h).

UAC says the aircraft will be capable of providing air services to populations in the northern, eastern, and Siberian regions of Russia. It will be able to serve locations with "weak airfield infrastructure" and "difficult climatic conditions", it adds.

"The modern passenger cabin will provide a comfortable flight through the entire range of altitudes," the company states. It says the Il-114-300's design is intended to be robust, with a service life of 30,000h.

Test flight

Prototype aircraft 54114 carried out its second test flight, lasting 2h 47min, on 19 January, during which it operated at altitudes up to 2,000m (6,600ft). Its crew of three tested the navigation equipment, radio communications, and power systems.

Ilyushin is intending to increase the frequency of test flights to meet an aggressive schedule, with certification and initial deliveries planned for 2022. Under the serial production plan, the Lukhovitsy plant will ramp up output to 12 aircraft per year.

While the Il-114-300 retains much of the external design of the original Il-114, programme director Maxim Kuzmenko points out that the deadlines for the project have been "tight" and says modernisation of the aircraft's onboard systems is very significant.

UAC general director Yuri Slyusar states that the -300 will "open up new prospects for the Russian civil aircraft industry".

State lessor GTLK has signalled plans to commit to the turboprop by signing a provisional agreement for up to 50 of the aircraft, while regional carriers Kras-Avia and Polar Airlines have each expressed interest in becoming Il-114-300 operators.

UAC's latest long-term forecast for commercial aircraft, covering the 20-year period from 2020 to 2039, puts the total demand at 42,130 – of which turboprops will account for 1,960 units. The company believes turboprops with more than 60 seats will account for around three-quarters of this total, although it does not envision a significant increase in the number of operators.

Evaporation of the prospective agreement to build the Q400 in Russia might give the Il-114 a second chance at the success it was unable to achieve the first time round. GTLK's commitment alone, if exercised in full, would more than double the entire production run of its earlier variants.

The fact that MAKS 2021 is one of the few aerospace shows to proceed this year illustrates the continuing uncertainty in the aircraft sector. UAC will be hoping that the -300's presence will make a lasting impression.

UAC UNITED AIRCRAFT CORPORATION

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With famous design bureaux RAC MiG and Sukhoi gradually consolidating under United Aircraft, Russia's military aviation sector continues to target fighter exports, despite US and Chinese rivalry

Stronger together

JetKat/Shutterstock

Overseas sales of the Su-35 are picking up after type was deployed in Syria

Garrett Reim Los Angeles

Russia's United Aircraft (UAC) is still finding ways to fend off rival Chinese combat aircraft manufacturers and maintain its client base, despite a slow pace of internal structural reform and financial sanctions from the USA.

Indeed, since Russian President Vladimir Putin founded UAC in 2006, via a decree that combined Soviet brands Ilyushin, Irkut, Mikoyan, Sukhoi, Tupolev and Yakovlev into a new joint-stock company, consolidation in the Russian aerospace industry has been painfully slow. Aerospace companies have been merged in name, but do not necessarily operate as a unified corporate entity, with design bureaus and manufacturing plants maintaining a degree of separation, say analysts.

Most recently, in March, UAC parent company Rostec announced plans to push UAC, Sukhoi and RAC MiG closer together by creating a single corporate aircraft manufacturing centre, which would consolidate the management of aircraft programmes.

Yet, despite plans to co-locate design bureaus within a "Unified Engineering and Design Center" in Moscow, Sukhoi and MiG will remain independent schools. Each will receive funds for new aircraft development efforts, says Rostec. And, reforms will not be swift, but will take place over several years.

Design competencies

"We are forming in Moscow a unified management organisation and a unified centre of design competencies for all UAC companies," said Sergei Chemezov, general director of Rostec, in the March announcement. Systemic reforms should improve financial stability, he added.

1,624

MiG fighters in service around the world – including 413 operated by the Russian armed forces, and 249 by India

Plans to keep funding independent combat aircraft design bureaus come despite few foreign orders for MiG aircraft. The Algerian air force has 12 examples of the MiG-29M on order, while the Russian air force has two MiG-29UBs and two MiG-35UBs on order, according to Cirium fleets data. Since the collapse of the Soviet Union, Sukhoi has been the dominant combat aircraft manufacturer in Russia, selling large quantities of fighters to China and India, in particular.

"MiG products have struggled to find markets, which also mirrors the low recent adoption rate in the Russian air force, although some countries like Algeria and Egypt have purchased the latest variant of the MiG-29," says Derek Bisaccio, military markets analyst with Forecast International.

Notwithstanding a dwindling backlog, UAC chief executive Yury Slyusar says he is bullish on the future of MiG.

The Russian air force has 75 examples of fifth-generation Su-57 on order

"We are forming in Moscow a unified management organisation and a unified centre of design competencies for all UAC companies"

Sergei Chemezov General director, Rostec

Arkady Zakharov/Shutterstock

"We will continue the production of MiG aircraft through implementing existing orders for delivery of these aircraft and we are quite positive with our market outlook with regard to light fighters to which class the MiG-29 or MiG-35 belong," he says. "Besides, the fleet of MiG aircraft supplied in previous years is really huge, there is always need for the repair, overhaul, maintenance and upgrades, which we all can provide to our customers."

According to Cirium, there are 1,624 MiG fighters in service today – offering plenty of work for aftermarket sales. The bulk of these, some 413 fighters, are operated by the Russian armed forces. The second largest operator, India, operates 249 MiGs of various types.

Since the fall of the Soviet Union, Sukhoi has had more success. There are some 2,338 Sukhoi fighters of various types in service and 191 examples on order, according to Cirium. Yet, MiG keeps holding on.

"For the past couple of decades, it's been a pretty good series of export wins for Sukhoi, with the whole Su-30 series," says Richard Aboulafia, vice-president of analysis at Teal Group. "At times, it looks like they defeated the MiG-29 and MiG-35. But, they can't quite administer the coup de grace. The -29 and -35 are still out there, primarily the -29 in crucial markets like India and Egypt."

Ultimately, UAC hopes MiG and Sukhoi will gain from greater efficiencies after restructuring.

"The point is that the work of our design bureaus can be more optimal, that is, they can use the same

JetKat/Shutterstock

Development of a replacement for MiG-31 will test merger with Sukhoi

administrative infrastructure – lawyers, financiers, human resources," says Slyusar. "In fact, we are repeating the path of consolidation that most of the same companies have gone through including Russian Helicopters with the Mil and Kamov design bureaus. Both design bureaus are working but they have the same administrative infrastructure."

Specific specialties

He points out that Sukhoi and MiG have different specialties. Sukhoi has more experience developing heavy fighters, while MiG's strength is in the lightweight segment.

Moscow may have its reasons for keeping MiG alive, says Aboulafia.

"It could be they want some redundancy in the industrial base," he says. "It could be that there's simply a place in the market, for the -29 or whatever it is. It's not going to be industrial logic that kills it."

Time will tell if the merger of back-office functions will reinvigorate MiG, Bisaccio says.

"One project to watch moving forward is the PAK DP, a replacement for the MiG-31 interceptor, which has generally been under the purview of MiG Corporation," he says of the stealth fighter-interceptor also known as the MiG-41. "The pace of its development will be an indicator of the overall effectiveness of the Sukhoi-MiG merger."

Slyusar says UAC is focused on "traditional markets where Soviet and Russian aircraft were supplied".

TRANSPORT

Sales lift

Now in flight-testing, the Il-112V will start replacing aged Antonov transports in Russian military service – but can it also attract international customers?

United Aircraft (UAC) sees export potential for its in-development Ilyushin Il-112V light transport in former Soviet states, plus in Latin America, Southeast Asia and Africa.

The twin-engined military transport resumed flight testing in March, after an extended grounding during which time engineers sought to reduce its weight. With its flight-test programme underway again, new aircraft production is also running in parallel, says UAC.

Initially, the Il-112V will be produced primarily for Russia's domestic market. Two prototypes are scheduled for delivery to the defence ministry by the end of 2021 and production aircraft are to be delivered starting in 2023, minister of industry and trade Denis Manturov said last October, according to state-run news agency TASS.

The Russian air force has two Il-112Vs on order and 27 units on option, plus letters of intent for up to 33 more, according to Cirium fleets data.

"We plan to ensure production of more than 10 aircraft per year and to gradually increase the rate," says Sergey Yarkovoy, chief executive of Ilyushin, the transport subsidiary within UAC. "Of course, everything will depend on orders. There is a great demand for aircraft of this size in our domestic market. We hope demand will grow due to the interest from foreign customers."

The Il-112V is intended for transporting and parachuting light weaponry and equipment, cargo and personnel. It can carry up to 50 passengers or 26 armed paratroopers. Ilyushin also sees a role for the aircraft transporting cargo in commercial service.

The transport is powered by two Klimov V7-117CT turboprop engines, and is designed to carry a payload of up to 5t. With that maximum weight aboard, the Il-112V has a range of 648nm (1,200km).

Yarkovoy says the aircraft offers greater efficiencies than older transports and has a cruise speed of 254kt (470km/h).

Ilyushin says it can take off and land on runways as little as 1,200m (3,940ft) in length. Designed to fly

Likely major customers include Algeria, China, Egypt, India and Vietnam, says Bisaccio.

"Some of Russia's neighbors in the post-Soviet space, moreover, present sales opportunities as well, such as Armenia, Azerbaijan, Belarus, Kazakhstan and Uzbekistan, although typically for smaller batches of jets," he says. "With the arms embargo on Iran now lifted, it can be expected that UAC will seek re-entry into the Iranian market, given the large number of ageing jets in Iran's air force."

Forecast International projects that UAC will produce 485 fighters over the 2021-2030 timeframe, representing a 12.4% share of the global fighter market. Top sellers currently include the twin-engined, two-seat Su-30 and the single-seat Su-35.

Sales prospects

The Su-35 is pricier, but its export sales are picking up. Egypt received its first five examples in February. "Their sales prospects have been helped along by the fact that the Russian air force has procured these jets in large quantities, and also put them to use in combat operations in Syria," says Bisaccio.

Sales of the Su-57E, the export version of Russia's stealth fighter, are targeted at advanced militaries, says Slyusar. "Of course, this is a very demanding aircraft. And, countries with highly skilled air forces that understand all of its advantages are the first in line to be potential customers for its export version," he says.

Although a joint production deal for the Su-57 between India and Russia fell apart in 2018, UAC has not ruled out similar deals with other interested parties.

"We are ready to consider joint manufacturing of the Su-57 with some customers in the future," says Slyusar. "One should note that the Russian side has an excellent experience in joint manufacturing and transfer of technologies through licences to our partners. Suffice it to recall the examples of the Su-30 with India and China."

> "The Su-57 is a very demanding aircraft. Countries with skilled air forces that understand all of its advantages are the first in line to be potential customers for its export version"
>
> **Yury Slyusar Chief executive, United Aircraft**

Because Russia plans to fill orders for its own air force first, exports of the Su-57E are unlikely to begin until the latter half of the 2020s at the earliest, says Bisaccio. The Russian air force has 75 Su-57s on order.

One of the main challenges Russian aircraft exports continue to face is the USA's Countering America's Adversaries Through Sanctions Act (CAATSA), a law punishing countries and companies that do business with Russia.

Type can take off and land on runways as short as 1,200m

United Aircraft

in rough Russian weather, the Il-112V "will be able to operate in the most difficult climatic conditions in a wide range of temperatures", says Yarkovoy.

"The main advantage of the aircraft is its reliability and possibility of autonomous operation, including on unequipped airfields and unpaved runways," he adds.

The type is intended to replace Soviet-era Antonov An-26s. There are 229 examples of that transport in service, with an average age of 41.5 years, according to Cirium data. The bulk of these, 145 aircraft, are operated by the Russian armed forces. Of the about three dozen other operators of the aircraft, most fly single digit numbers of the type.

Ilyushin also sees room for joint projects based on the Il-112V.

"The most promising option for market promotion is industrial co-operation projects for the development of a light military transport aircraft based on the Il-112V," says Yarkovoy. "Similar projects have prospects in India and the Middle East."

The Il-112V may find work also as a niche platform, he says. "We see a great interest of foreign customers in special versions of the aircraft, for example, a patrol modification," says Yarkovoy. "When developing, we have initially made solutions that will allow the Il-112V to be a multifunctional platform."

Yet, the Russian government has yet to make large commitments to the Il-112V and that may hold back the transport's foreign sales.

"A lot of talk, no actual funding," says Richard Aboulafia, vice-president of analysis with the Teal Group. "Maybe part of it is that the export market for aircraft in that class just doesn't look addressable."

That might be because the Il-112V's performance requirements are unique to the Russian market or only fit a relatively elite customer set. It is not clear that countries that operate one or two An-26s have appetite for much more.

"Angola needs a squadron of fighters," Aboulafia says. "Do they need a squadron of brand-new Russian transports?"

China's Chengdu J-10 fighter relies on the Russian Saturn AL-31 engine

Fasttailwind/Shutterstock

At the MAKS air show in 2019, Victor Kladov, director of international co-operation and regional policy for Rostec, complained that Indonesia was wary of buying Russian aircraft due to the threat of US sanctions. Jakarta has yet to complete a planned purchase of 11 Su-35s for $1.14 billion, even though the deal was first announced in 2017.

"Russia has sought to circumvent CAATSA through several ways, such as switching the currencies used in the transactions to roubles or euros, or even offering barter deals," Bisaccio says. "Russia has also sought to shield its financial sector by reconstituting Promsvyazbank as the primary handler of the state defence order, and the bank may also be involved in export agreements as well."

Some countries have defied CAATSA and bought Russian equipment regardless. For example, Turkey bought and then received the Almaz-Antey S-400 Triumf surface-to-air missile system in 2019. Consequently, it was ejected by the USA from the Lockheed Martin F-35 Joint Strike Fighter programme and was sanctioned in late 2020.

India has also purchased the S-400 and is scheduled to receive the weapon system between October and December 2021. The country is an important counterweight to China for the USA and because of this analysts wonder if US President Joe Biden will sanction New Delhi.

"India is simply too important to not give them a waiver," says Aboulafia.

Although China is one of Russia's largest export customers, Beijing is pushing hard to develop a domestic military aviation industry, which will compete globally. In fact, last November, the Royal United Services Institute concluded that China has eclipsed Russia in manufacturing combat aircraft. The UK-based think tank said Chinese sensors, datalinks, weapons and low-observable technology were superior, while Russia kept an edge in aircraft engines.

Yet, China has struggled to find international customers for its combat aircraft.

"The Chinese seem to be stuck in a kind of an export rut. If we'd had this conversation 20 years ago, you would have said, Pakistan, Myanmar, North Korea and African countries [are current customers]," says Aboulafia. "Here we are 20 years later, their aircraft have gotten better, but their market position hasn't changed at all."

> "Russia has sought to circumvent CAATSA through several ways, such as switching the currencies used in the transactions to roubles or euros, or even offering barter deals"
>
> **Derek Bisaccio Military markets analyst, Forecast International**

One challenge facing Chinese fighter exports is its reliance on Russian engines. The Chengdu/Pakistan Aeronautical Complex JF-17 relies on a single Klimov RD-93 engine – the same powerplant as the MiG-29. The JF-17's export success has been modest. It is in wide use in Pakistan, which co-developed it, but only Myanmar and Nigeria have acquired the type.

The more capable Chengdu J-10 still relies mainly on the Russian Saturn AL-31, but operational J-10Cs have been spotted with the Shenyang WS-10 Taihang.

This dependence on Russian engines gives Moscow a degree of leverage over Beijing's fighter sales. Yet, as China's engine capabilities mature, it is entirely possible that Chinese fighters might secure sales that would ordinarily go to Russia.

Until then, China's most promising export fighter, the J-10, is likely to struggle. "It's not a bad plane," says Aboulafia. "And they haven't scored a single export customer."

Foreign policy

China needs to find a country willing to take a chance on its aircraft. However, at the same time, Beijing has taken up 'Wolf Warrior' diplomacy, a form of confrontational and combative foreign policy that has hardened many populaces' stances toward it.

The country's diplomatic practices may make nations wary of doing business with it, says Aboulafia.

"It's possible that their habit of working with sharp elbows abroad is hampering [aircraft sales]," he says.

It appears that Moscow keeps an edge with a sort of geopolitical customer service that Beijing lacks.

"The Russians have always been clear that they're really good when it comes to building a high-end jet," says Aboulafia. "They're never going to say, 'You need to ask to use the keys before using [the] jet'. They say 'We will always support you'."

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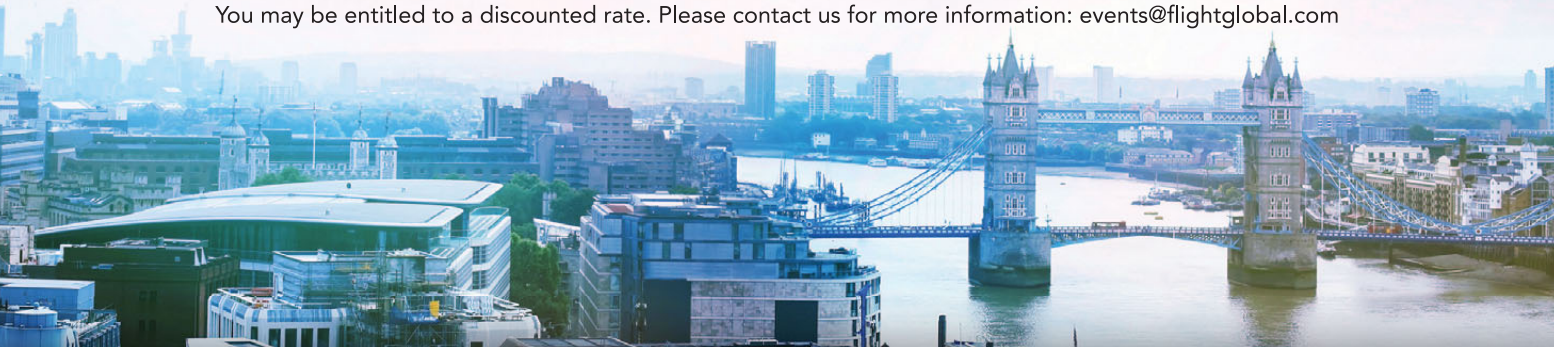

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Owner of the Kamov and Mil design houses – more famed for military aircraft – is quietly increasing its share of the civil market too as the company seeks to establish a better balance

Russia's revolutionaries

Dominic Perry London

During 2020, when the Covid-19 pandemic affected every company's ability to function normally – be that in terms of sales, final assembly, or design and development – there were just two rotorcraft manufacturers that saw their share of the civil and parapublic market rise: Bell and Russian Helicopters.

In fact, the Russian firm grew its share of the civil market by four percentage points year on year to 12%, according to figures from rival Airbus Helicopters (Bell's share jumped from 12% to 18%).

While some of the shift can be explained by its rivals shipping significantly fewer units in 2020 – production slowdowns and travel bans proved tricky to navigate – for a company better known for its military output, Russian Helicopters' civil presence was notable, particularly as its overall deliveries slid to 145, down on the previous year. But, should everything stay on track this year, then that figure will rise to about 185-190 units, says director general Andrey Boginsky, with around 40% of those heading to civil operators.

Combining forces

Boginsky, a former Russian deputy trade and industry minister with a PhD in economics, has been in charge of Russian Helicopters since early 2017. It is a sprawling concern encompassing the Kamov and Mil design bureaux (now brought together in the National Helicopter Centre), alongside start-up VR Technologies, five separate assembly and production sites (Arsenyev Aviation Company, Kazan Helicopters, Kumertau Aviation Production Enterprise, Rostvertol, and Ulan-Ude Aviation Plant), plus other manufacturing and repair facilities across Russia. In turn, it is controlled by Rostec, the state-owned holding company that owns all of the country's aviation businesses, including aircraft, engine and avionics suppliers.

There seems to be a touch of modesty about Boginsky – or perhaps it is a reflection of his time as a politician – as he seems reluctant to trumpet his achievements since taking charge. But the growth of the civil business is a definite success story. Back in the mid-teens, Russian Helicopters was delivering, at most, 15 civil rotorcraft annually; in 2020 that figure

Russian Helicopters

Ardiden 3G-powered Ka-62 could finally gain certification this year

Ansat is gaining new autopilot and anti-icing system via modernisation

Russian Helicopters

was 60, and this year it will be around 80. "We have made significant progress in this case," Boginsky says.

To an extent Russian Helicopters' growth in the civil sector can be traced back to decisions taken several years ago. For example, 33 of the roughly 80 civil deliveries scheduled this year – with a similar number to follow in 2022 - will be for helicopter emergency medical services (HEMS) operations, part of a federal government initiative to roll out coverage across the largest country in the world.

Domestic opportunities

"This is the result of previous work and we hope that the opportunities presented by the [domestic] market will lead us to support this level of production and sales [in future]," says Boginsky, who estimates that somewhere in the region of 200 more helicopters will be required to achieve country-wide coverage.

But an initiative like this is worthless if you do not have the products to meet its requirements. While around one-third of the HEMS helicopters that the company plans to deliver in the next two years will be Mil Mi-8s – the company's venerable heavy-twin – the remainder will be Kazan Ansat light-twins, a rotorcraft that has recovered from a rocky start to become a sales success. It is an outlier in several ways: it is not a product of Kamov or Mil, but the output of Kazan Helicopters' own in-house design bureau; and it is also the only Russian Helicopters model to use Pratt & Whitney Canada engines, in this case a pair of PW207Ks. And at 3.6t maximum take-off weight, the Ansat is a distinct lightweight in a range dominated by medium- and heavy-class helicopters.

80

Number of civil rotorcraft Russian Helicopters expects to deliver this year – up from 60 in 2020

Abdul Razak Latif/Shutterstock

Boginsky is a former deputy trade and industry minister

Russian Helicopters is currently modernising the Ansat, adding a new autopilot and anti-icing system. Certification of the former is tentatively scheduled for this year and the latter for 2022. The upgrades are key as they will "allow us to deliver this helicopter in the north region of Russia," he says.

A new variant is also in the works, the Ansat-M, which sees the addition of new main and tail rotor blades, updated avionics, improved handling, and a larger fuel system increasing its range to 431nm (800km), from 272nm on the baseline model. First flight of the new variant was in late 2020, with Boginsky hopeful that certification can be achieved by the end of next year. At that point, Russian Helicopters may also seek approval from the European Union

Andrey69/Shutterstock

OGP-compliant variant of Mi-171 heavy-twin is in development

Aviation Safety Agency (EASA) for the type; at present, the Ka-32A11BC is the only other helicopter it produces to be validated by the body.

"When we will come to the version Ansat-M, in my opinion, we will be ready to go to EASA," he says. The helicopter would provide "an opportunity" to take the competition to Airbus and Leonardo Helicopters on their home turf. In the Russian market, his two European rivals "come here and communicate with our customers – we should have such an opportunity too".

But Russian Helicopters is first likely to seek EASA approval on another matter. Its Helivert joint venture with Leonardo currently builds AW139 intermediate-twins for the domestic and CIS markets at its Tomilino site near Moscow. Output this year will be four units, says Boginsky, who points out that sales are hampered by the lack of EASA certification for the production line. That means AW139s built by Helivert – identical in appearance and price to those assembled at other sites in Italy and USA – cannot be operated in Europe, for example. That is fine if you know your helicopter will spend its entire life in Russia, but otherwise has a detrimental effect on residual values.

Production certificate

Boginsky says the company has been discussing with Leonardo over the past year and a half the need to secure EASA approval for the Helivert site: "They understand that we can assemble more and sell them" once the production certificate is in place, a milestone that could be reached by late 2022. While a plan to assemble AW189s at the site appears to have been dropped due to low demand for the type, Helivert continues to offer service and support for the AW139 and AW109.

Elsewhere in Russia's aviation industry, there is a push to develop domestic alternatives to western suppliers – for instance, the Aviadvigatel PD-14 engine in place of the Pratt & Whitney PW1400G for the Irkut MC-21. To a lesser degree, this policy also exists at Russian Helicopters. "Unfortunately it is necessary for us to develop our design and production work with alternative suppliers, especially for engines," says Boginsky. Accordingly, Klimov – part of United Engine, a sister company within Rostec – is developing two new powerplants: the VK-650V for the Ka-226 and Ansat; and the VK-1600 for the Ka-62. As well as the Ansat's PW207Ks, the Ka-226 uses a pair of Safran Arrius 2G1s, and the Ka-62 Safran Ardiden 3Gs.

240

Number of test flights so far in certification campaign for delayed Ka-62, with another 195 to be carried out this year

Restrictions related to the use of these engines have prevented Russian Helicopters from selling those particular types to the Russian military, even if they are not being used for frontline tasks. With domestic engines "we understand that we have the possibility to increase the volume of deliveries to the ministry of defence", points out Boginsky.

Certification of the Klimov turboshafts is scheduled in the period to 2025, with approval for the specific variants of the helicopters following that same year. Boginsky argues that a choice of powerplants will benefit the overall operation through potentially higher sales volumes: "It is possible to avoid some space in our production schedule," he says.

But developing an alternative engine for the Ka-62 is a little surprising given that it has yet to obtain certification itself. Now several years behind schedule, the most recent deadline for Russian approval was 2020,

before Covid travel restrictions "destroyed plans to finalise certification". So far, the company has performed more than 250 flights using three aircraft, with about 180 still to be conducted this year. But Boginsky says it has "made significant progress" with the flight-test campaign, achieving a speed of 170kt (310km/h).

Should all go to plan, then could the 6.5t helicopter clear the final hurdle this year? "We hope so," says Boginsky. While sales have been another casualty of last year's pandemic disruption, preliminary agreements are in place to supply Russia's Far East region with Ka-62s for cargo and medical evacuation flights. The current production plan calls for a total of 24 examples to be built over the next three years: provisionally six units in 2022, eight in 2023 and 10 in 2024.

"The exploitation of this helicopter will demonstrate whether we were right or not to plan such a number of helicopters," Boginsky says. Export opportunities are also being pursued, for example demonstrating the type's performance to potential customers in Thailand.

Also currently in development is the new A3 variant of the Mi-171 heavy-twin, which is being specifically designed for offshore transportation. It gains a new airframe which integrates a crash-resistant fuel system into the cargo bay floor. It also features modernised avionics, which have been upgraded for offshore operations and flights in the Arctic. Widespread use of composite materials has cut airframe weight over the A2 variant, enabling range to grow by 108nm to 540nm and passenger capacity to increase from 20 to 24. Perhaps more crucially though, the Mi-171A3 will also meet international standards for transport helicopters set by oil and gas producers (OGP) - a requirement which has driven its genesis.

While Russian oil firms – Rosneft and Gazprom, for example - were happy to use previous generations of the Mi-171, foreign partners insisted on helicopters that were OGP compliant. Although Russian Helicopters did point out that statistically its products were as safe as their western equivalents, this fell on deaf ears. "Therefore, with Gazprom, we developed common requirements for such helicopters. That is why we started to develop a new helicopter. It is our answer for the requirements of our civil customers," says Boginsky.

"It is a good start because we have launch customers from the Russian Federation. It doesn't matter who it is; we understand this type of helicopter will be required by Russian companies."

JetKat/Shutterstock

High-speed main rotor blade for Mi-28 is being evaluated

> "We have launch customers [for the Mi-171A3] from the Russian Federation. It doesn't matter who it is; we understand this type of helicopter will be required by Russian companies"
>
> **Andrey Boginsky Director general, Russian Helicopters**

The initial prototype will be on display at MAKS, and first flight is scheduled later this year, leading to certification and service entry in late 2022 or early 2023.

Development of the Mi-171A3 has been enabled by a new structure imposed by Boginsky that sees different arms of the business operating closely together – in this instance three separate production plants are collaborating on the project: Arsenyev, Kazan, and Ulan-Ude. Elsewhere, Russian Helicopters has been modernising, implementing digitalisation initiatives and advancing the use of 3D-printed components. These are "small achievements" overall, says Boginsky, but necessary for the development of the overall enterprise as it looks to boost productivity and efficiency.

The resulting process improvement has enabled the rapid update of another model in the manufacturer's range, the Ka-32. The co-axial rotor-equipped fire-fighting heavy-lifter – which will also be shown at MAKS – gains uprated VK-2500 engines, a glass cockpit and a new water tank – increasing capacity

from 3t to 4t. "This allows us to increase the capability of this helicopter," says Boginsky.

Another project carried out under Boginsky's reign is the bringing together of the storied Kamov and Mil design bureaus into a single entity: the National Helicopter Centre. It has, says Boginsky, allowed the blending of the "unique experience" housed in each organisation. Plus, the combination has enabled a better allocation of resources – ironing out peaks and troughs in workload. "It has allowed us to be stable and make plans for the future." There are now, he says, "deeper communications between the design bureaux and [production] plants", which is helping to increase the overall quality of output.

While Kamov and Mil have been designing rotorcraft for decades, Russian Helicopters also encompasses VR Technologies – a start-up design house dedicated to aerial mobility, which is developing the VRT300 unmanned rotorcraft and VRT500 light helicopter, both of which use a co-axial rotor configuration. But the company is unlikely to retain full ownership of VR Technologies for much longer: at the 2019 edition of the Dubai air show, a provisional agreement was struck with Tawazun Economic Concern

> "Several years ago we looked at the investment needed to get speed above 350km/h; it's significant. Unfortunately customers are not willing to pay for this dramatic increase"
>
> **Andrey Boginsky Director general, Russian Helicopters**

of the United Arab Emirates to take a 50% stake in the subsidiary for a $400 million investment; it also ordered up to 100 VRT500s and showed interest in the VRT300.

Although the contractual basis of the deal was signed off last November, says Boginsky, Russian regulations governing the aerospace industry require that foreign investment is approved by governmental commission – a process that is currently under way. "We hope that it will make the decision to allow us to finalise a deal," he says.

Two prototypes of the VRT300 are now complete and several more will be assembled before the end of the third quarter; the certification process for the type has also started. On the VRT500, a first flight may take place later this year, while a ground-test asset will be displayed at the Dubai air show in November. A European assembly line for the VRT500 is still under consideration, says Boginsky, although a final location has yet to be determined.

At Russian Helicopters' rivals in Europe and the USA there is a focus on demonstrating future high-speed

Sale of 50% stake in VR Technologies is proceeding

BillyPix

rotorcraft for civil (Airbus and Leonardo) and military (Bell and Sikorsky) applications. But as Boginsky points out, "each 10km/h costs money", a price most civil operators are likely to shy away from. "Several years ago we looked at the investment needed to get speed above 350km/h; it's significant. Unfortunately customers are not willing to pay for this dramatic increase," he says.

However, that may be less true for military operators, where speed can confer a battlefield advantage. At present, work on the topic at Russian Helicopters is confined to the development of a new composite main rotor blade for Mi-28 and Mi-35 attack helicopters. Tests using a company-owned flying testbed have seen the helicopter achieve speeds of over 215kt and it is now awaiting defence ministry approval before launching serial production. Should a further jump in speed be sought then "we have ideas", Boginsky says.

Military priorities

As the Russian military is by far and away the manufacturer's biggest customer there are already a number of projects under way, including upgrading the Ka-52 and Mi-28, plus analysis of a possible successor to the Ka-27 amphibian helicopter for the navy. Russian Helicopters has a "clear understanding" of the work required from the design bureaux over "the next three years" and clarity over the defence ministry's future priorities, which need to be delivered "at the end of this decade". While Boginsky is understandably coy on what these are – and notes that discussions are ongoing – he expects that requirements will be finalised over the next two years, suggesting a hope that by the 2023 MAKS show "we can be a little more open".

Meanwhile, the shorter-term priority is to ensure continued equilibrium. "For us the main task is to balance production and design facilities and set up relationships with suppliers for a minimum of three years ahead. We understand what we can produce. It allows us to stabilise our production plan. This is my task for this year and next – understand how to organise it." Output for 2021 is finalised, while next year's is 70% settled, leaving some slots open based on the likelihood of orders emerging at the MAKS or Dubai shows.

But aside from the planning, the modernisation, and all the other tasks required to keep the company pointed in the right direction, a general director has an even bigger challenge: to ensure the company's engineers are sufficiently inspired for the future.

"It is very important to participate in something new and something big," Boginsky says. "For the CEO of a company their main task is to provide such kind of opportunities."

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The holding company behind Russia's aviation assets sees a bright future for its aerospace industry under effective state ownership, as it works to grow presence in civil sector

Rostec's revival

Dominic Perry London

In the aftermath of the Soviet Union's collapse and subsequent break-up, its once-powerful state-owned aerospace industry did not escape the stresses of that process. As parts of the union became independent nations again, they took with them their share of that industry – and in Russia itself, many of its aviation interests ultimately ended up in private hands.

But in recent years this trend has been reversed, with all of the country's aerospace businesses now controlled by the state-owned holding company Rostec. Within its aviation cluster sit the designers and manufacturers of fixed- and rotary-wing aircraft and aero-engines – United Aircraft (UAC), Russian Helicopters and United Engine (UEC) – plus suppliers of avionics, communications equipment, and so on – essentially a supply chain able to provide almost everything required for an aircraft.

Rostec

State ownership

There are clearly arguments for and against state ownership of an entire industry – particularly one that seeks to compete on the global stage – but, says Victor Kladov, director for international co-operation and regional policy for Rostec, the effective renationalisation of the sector was needed to allow it to recover from the disruption of the post-Soviet era.

"The reality is that only very large players survive in the global aircraft market, and the success of these companies depends mainly on how important they are for their respective state. The aircraft industry brings technology, jobs, added value and taxes to the countries where it operates. Russia is no exception here," he says.

"In our country, the state turned out to be the most interested player in consolidation. As a result, design bureaux and aircraft factories have started working more effectively [together], and will do so even more in the future. I consider this to be a positive outcome."

Consolidation is also necessary to facilitate effective competition with western rivals, he argues. While in the military market – in particular MiG and Sukhoi – Russian airframers have been "successfully competing with world leaders for a long time", in the civil sphere "we are still catching up", he observes.

"Unfortunately, there was a difficult period when our aviation industry was practically destroyed and the market was left at the mercy of foreign suppliers," Kladov says. "That was true across the entire spectrum of high-tech industries," he adds.

Domestic push

That is now changing, he says. Russia's next narrowbody airliner, the Irkut MC-21, "even uses a number of technical solutions that are not yet used by our global competitors."

With the re-emergence of a domestic industry, Russia has also been able to institute a policy of import substitution, swapping western-sourced aircraft components for those built at home. "The share of imported components in our military equipment has already been practically reduced to zero. The same will eventually apply for the civilian segment," says Kladov.

The development provides the twin benefits of being better economically for Russia, and, given the strained relations between Moscow and the West, it also mitigates against any sanctions that could be imposed by external governments.

For example, development of an updated variant of the Sukhoi Superjet 100 – the SSJ-New – sees around 97% of the imported components on the regional jet switched for those of Russian origin, "making the aircraft more cost-effective".

Most notable among the changes are the replacement of the Superjet's current SaM146 engines – which are built by the PowerJet joint venture between Safran and NPO Saturn, part of UEC – with the Aviadvigatel PD-8.

That powerplant is in turn based on the PD-14, which is being developed for the MC-21 as an alternative to the Pratt & Whitney PW1400G. While the narrowbody will enter service with US-built engines, flight-tests of a PD-14-equipped MC-21-310 version began last year.

Also on the MC-21, imported composite material has been supplanted by domestically-produced carbonfibre. "Recently, the first 17.5m [57ft] outer wing panel of MC-21-300, made entirely of Russian composite materials, was delivered to the Irkutsk aircraft plant to be installed on the aircraft this year," Kladov says.

Similar moves have been instituted by Russian Helicopters too, where domestic engines are being offered in place of western powerplants. But the word alternative is key: Kladov sees it offering customers a choice.

Kladov says renationalisation of the sector was essential for its recovery

Rostec

Customer choice

"This does not mean that we are striving to completely abandon all imports. The optimal scenario for us is to give our customers the choice to use components from different manufacturers, in accordance with the best international practices," he says.

"In general, our foreign partners are still fulfilling their obligations. But Russian new generation aviation systems are being developed simultaneously, which reduces the risk of breaches in contracts."

Additionally, Rostec still remains open to collaboration with western partners, he says, pointing to its long-standing relationship with France's Safran. "Over the decades, we have built a high level of mutual trust and understanding, and hope that in the future we will continue to develop this synergy," he says.

"We are definitely open for co-operation and ready to expand mutually beneficial relations. This will allow the cluster not only to strengthen its positions, but also to acquire relevant competencies and enter the world market for aircraft engines, components and avionics."

In many ways, the recent rebuilding of Russia's domestic aerospace industry has been enabled by its knitting together under Rostec, says Kladov – both through increased efficiency and ultimately through making its products "more attractive to the market".

Although both Russian Helicopters and UEC had been owned by the holding company for some years, a decision was taken in 2018 to also incorporate UAC.

The cluster's creation was "of paramount importance both for Rostec and for the country as a whole", Kladov claims.

"We were able to unite advanced design and manufacture competencies for engines, avionics, all necessary material components, planes and helicopters.

"The aviation cluster is doing an enormous amount of work. It covers the whole production cycle, from design and manufacturing of individual components and systems to finished aircraft," he says.

That will also extend to service and support activities, as "experience suggests that there is a strong correlation between aircraft sales and the quality of after-sales service offered throughout the product lifecycle."

Further consolidation is also taking place at company level. Russian Helicopters has, for example, brought its Mil and Kamov design houses together as the National Helicopter Centre and UAC "is undergoing an extensive corporate transformation" to centralise management, eliminate duplicate functions and "expand the co-operation between production facilities for more efficient implementation of aircraft-building programmes," says Kladov.

A unified aviation and engineering and design centre will also be created in Moscow, incorporating UAC's storied design bureaux, including Ilyushin, MiG, Sukhoi and Tupolev. Kladov insists these brands will "not disappear" but will be strengthened by the move.

"The only goal of this reform is to make our aircraft industry stronger and more competitive. We assume that the combined optimisation effect from the ongoing transformations in the next three years alone should reach 130 billion roubles," he says.

Indeed, the success of a strategy such as this is borne out in the balance sheet. In a "difficult" 2020 characterised by pandemic-driven disruption, the total consolidated revenue of all the companies in Rostec's aviation cluster stood at around Rb1 trillion ($14 billion) – representing over half of the holding company's Rb1.9 trillion total.

Financial growth

UAC increased its revenue by 23% to Rb401 billion; Russian Helicopters saw its global market share increase to about 14% and turnover hit Rb144 billion; and UEC grew revenue by 10% year on year to Rb287 billion.

At Rostec, total consolidated revenue increased by 6% to Rb1.9 trillion, with the expectation that will top the Rb2 trillion mark in 2021. Last year, net profit margin was 5.9%, against a forecast 3.9%, while EBITDA stood at 15.1% – around Rb286 billion – against a predicted 11.3%.

Crucially, however, money is being ploughed back into the business. As Kladov points out, "an industry such as aircraft construction has a long-term investment cycle".

"In order to bring breakthrough products – such as engines or aircraft – to the market in a few years, it is necessary to invest in the appropriate technological base and developments today, and this is what we are doing," he says.

Additive manufacturing has been around in aerospace for 30 years. But it is only now making the leap from niche technology to a process with the potential to transform industrial production

Printing the future

Rolls-Royce

Rolls-Royce has used additive manufacturing for years, but the switch to production parts has been recent

Murdo Morrison London

Eric Gatlin wants to make additive manufacturing mundane. That may sound strange for someone who spearheads GE Aviation's adoption of one of the most potentially transformative technologies in the production of aircraft parts. After all, scarcely a week goes by without an announcement of some new frontier being reached in the capabilities of what is also known as 3D printing – the process of constructing complex metal or plastic structures from powders, one tiny layer at a time.

But that is the point. Such is the pace of its advance, Gatlin is convinced that well within this decade 3D printing will become not just an effective way of rapidly creating one-off or low-volume parts, but competitive for volume production of even large metal components. This is because modern printers can now engineer highly complex parts in one piece, something beyond the capability of even the most sophisticated milling machines. "We are taking the physics to a different level," he says.

However, to become truly mainstream, additive manufacturing has to scale up and make the leap from lab to factory floor. "We're trying to make additive boring, and get the PhDs off the machines," says Gatlin, whose formal role at GE Aviation is additive manufacturing general manager. "We want to get the cost down and be competitive against incumbent technologies, and we're almost there. I want to make additive manufacturing just another tool in the toolbox."

70,000

Number of 3D-printed parts currently in use across Boeing's commercial, defence and space platforms

Additive manufacturing is not new to aerospace. The likes of GE Aviation and Pratt & Whitney were enthusiastically dabbling in 3D rapid prototyping in the early 1990s. However, it has largely been in the past 10 years that the technology has broken through to parts production. GE's 2012 acquisition of additive specialist and Cincinnati neighbour Morris Technologies was a significant step. Stratasys, a pioneer in 3D printing kit, has also spent the past decade targeting the aerospace sector.

The past 18 months have seen a flurry of landmark announcements in the propulsion sector and beyond. In June, GE received what is known as engineering change proposal approval from the US Air Force for an additive manufactured sump cover on its F110 that powers the Lockheed Martin F-16, among others. It is the first engine component manufactured using the technology to be qualified by any arm of the US Department of Defense.

Belgian company Materialise said in May that it had been cleared by Airbus to produce flight-ready parts for its supply chain using an additive manufacturing process known as laser sintering. Materialise was already making Airbus components using a more common type of 3D printing, fused deposition modelling (FDM), including on 100 part numbers on the A350. Adding a laser sintering qualification will allow an increase of applications on Airbus aircraft, says the firm.

Rolls-Royce

The combustor tiles on the Pearl 10X will be made using laser powder bed fusion technique

Last October, Boeing approved a new thermoplastic material made by Stratasys, called Antero 800NA, that the Israel-headquartered business says allows the airframer and its suppliers to additively manufacture higher-fatigue structural components able to withstand higher temperatures than products traditionally made using 3D printing. Stratasys builds machines that serve industries from automotive to medical supplies, but aerospace is now one of its biggest two markets.

Additive manufacturing has also been making strides in the aftermarket. In February 2020, P&W said it had achieved a maintenance, repair and overhaul first with a 3D-printed aero engine fuel system component, designed in partnership with Singapore's ST Engineering. The part would help "reduce dependency" on the traditional supply chain, said the engine maker, which described additive manufacturing as a "game-changer for the MRO industry worldwide".

Alternative solutions

Also in MRO, Airbus services arm Satair said earlier this year that it had provided a US airline customer with "what is believed to be the first certified metal printed flying spare part", a wingtip fence for the previous-generation A320. The cast-manufactured component was no longer available from the original supplier, and this led Airbus to develop its "alternative solution", according to Felix Hammerschmidt, head of additive manufacturing at Satair.

Rolls-Royce has been investing heavily in additive manufacturing since using the technology to produce a front bearing housing on the A350-1000's Trent XWB-97 in 2015 – the first flying component on one of its engines. The component did not go into serial production, but "we knew the value lay in its design complexity, and that we could industrialise it," says R-R manufacturing director Neil Mantle.

Stratasys

BAE Systems says additive manufacturing allows it to engineer more complex one-piece components

The next step for the UK propulsion firm was to set up an additive manufacturing site in Rotherham, which has engineered what will be R-R's first serially-produced additive parts, combustor tiles for the Pearl 10X – the new engine that will power Dassault's latest Falcon 10X. The 1.4mm-thick nickel alloy tiles will be made using laser powder bed fusion, the first time R-R has deployed this technique, which requires thinner layers than electron beam melting, the previous method.

Tiles form a thermal protection shield, so must withstand extremely high temperatures. They are traditionally manufactured by casting and drilling hundreds of cooling holes, but that limits the introduction of "more enhanced cooling geometries". Using additive manufacturing means "we can cool the component much better", with cooling efficiency increased by 20%, according to Philipp Zeller, senior vice-president for the Pearl 10X programme.

20%

Improvement in cooling efficiency for the Pearl 10X engine using additive manufacturing to enhance tile geometries

This requires a more complicated design than is achievable with traditional manufacturing. "We are using the ability of additive to come up with geometries that we couldn't by any other means," says Mantle. "You can produce pretty complex things with laser drilling, but everything has to be line of sight – you can't drill round corners. With additive manufacturing, all that geometrical complexity is possible."

With the Falcon 10X due to enter service in 2025, R-R plans to start manufacturing the parts for the Pearl 10X – each engine contains around 64 tiles, of six different designs – using two machines installed at Rotherham, but "based on volumes we will expand", says Zeller. R-R has been experimenting with additive manufacturing for 10 or 15 years, but he describes the move into serial production with the Pearl 10X as a "big milestone for us".

Like its two main rivals, P&W is a veteran when it comes to additive manufacturing, and made its first production part – a bridge ring bracket on the PW1500G's actuation system – in 2017. In recent years, "the pace has picked up tremendously", says Jesse Boyer, fellow in additive manufacturing. To date, the Raytheon Technologies company says it has made more than 100,000 additive manufactured prototypes, including several components on the geared turbofan family.

Design decisions

P&W claims to be a "vertically integrated additive manufacturing producer" with its own metal powder source and ability to create parts from design concept to repair. However, there is still a calculation to be made when evaluating what should be 3D-printed and what should be produced conventionally.

"We have always followed the mantra that we will look at additive manufacture for everything, but that doesn't mean every part should be additive manufactured," says Boyer.

Factors taken into consideration, he says, include: will additive-manufacturing a part reduce lead time, particularly in a repair scenario? And will the technology "optimise design" by allowing components

manufactured conventionally in multiple sections to be created in one piece? With the latest machines permitting ever-larger items to be produced and in significantly greater volumes, Boyer predicts a "bright future" for additive manufacturing: "It's just finding those right applications."

BAE Systems has been manufacturing parts for its military programmes for several years using additive FDM techniques on Stratasys printers. "Ultimately our aim is to make metal parts to substitute for those made by forgings or casting," says Greg Flanagan, additive manufacturing operations lead for BAE's air business. "Additive manufacturing gives us the freedom to make complex components – and assembly of what would have been five or six parts – in a single piece."

He gives the example of a component on the Eurofighter Typhoon's radar cooling system, made of nylon, that traditionally comprised 16 elements. "Now we print it in the northwest [of England], next to the aircraft assembly line in just two pieces, and in 24 hours." Speed and cost are the drivers. "The real challenge with next-generation aircraft is to do things in significantly shorter timescales and more efficiently," he says. "We've integrated a key disruptive technology into our business."

Stratasys

Senior Aerospace has reduced weight and lead times by adopting additive technology

"In years to come, it will become harder to source parts, and additive manufacturing will play a key role in both polymers and metals, particularly in those situations where you need one part every five years"

Scott Sevcik **Vice-president aerospace business, Stratasys**

Another Stratasys user, Senior Aerospace, recently replaced aluminium fixtures on low-pressure air ducts it supplies to a number of regional and business aircraft programmes with additive manufactured versions it prints in-house. Not only has the move reduced the component's weight, but it has cut lead times of up to 16 weeks with suppliers to "a few hours", says Darren Butterworth, chief executive of Senior Aerospace BWT in Macclesfield, the UK.

The OEMs are also driving the adoption of additive manufacturing. Boeing has more than 70,000 3D-printed parts flying across its commercial, defence and space platforms, with production on more than 200 machines at 20 sites. The CST-100 Starliner, which will transport crew and cargo to low Earth orbit, contains "several hundred" additive parts that have reduced "mass, cost and cycle time" on the spacecraft's interior, says Dr Melissa Orme, vice-president of additive manufacturing.

Boeing has been a "leader" in additive manufacturing for two decades, she claims, with its first metal experience a titanium part on a space vehicle in 2001. In the commercial aviation sphere, its first structural titanium component was a 787 aft galley fitting in 2017. While reducing cost and shortening design times are crucial, Orme notes that additive manufacturing is also a step towards sustainability for the industry, as the process requires less material to be used.

Overcoming obstacles

She believes the technology still has its challenges, although "none are insurmountable". Materials suitable for additive manufacturing are not always commercially available, and the supply chain is small because of the investment needed in machinery "making it difficult for small businesses to enter this space", she says. However, the biggest obstacle, she believes, is training, with few universities teaching additive techniques, "requiring the incumbent workforce to learn on the job".

MRO is a crucial growth area for additive manufacturing because it allows original manufacturers or repair specialists under approval to make replacement parts quickly and as single items or in low volumes. "We have seen a tremendous surge of interest from the aftermarket," notes Scott Sevcik, vice-president of the aerospace business segment at Stratasys. "For us it is the sector that is growing quickest."

Satair's Hammerschmidt believes an ageing airliner fleet will open the door to additive manufacturing in MRO. "Aircraft are a long-lasting product and need to be supported for safety reasons, but more and more programmes are going out of production," he says. "In years to come, it will become harder to source parts, and additive manufacturing will play a key role in both polymers and metals, particularly in those situations where you need one part every five years."

Back at GE, Gatlin says emerging programmes will have a higher proportion of 3D-printed parts – a third on the company's Catalyst general aviation engine, for instance. Also, the economics of additive versus conventional casting will improve as equipment grows in size and sophistication. He almost seems surprised at the pace of change.

"We started with parts you could hold in your hand," he says. "Now you have to push them around on a cart. That's in five to seven years."

Covid-19 restrictions have prevented two years of the world's biggest military air show, including its 50th anniversary spectacular. We speak to its chief executive about plans for a big comeback next July

Ready for RIAT's return

Craig Hoyle North Weald

For aviation enthusiasts, top military officials and aerospace industry leaders alike, the UK's annual Royal International Air Tattoo (RIAT) is nothing short of a must-attend event.

Each July, many dozens of aircraft from around the globe arrive at the normally quiet Royal Air Force (RAF)-owned base at Fairford in Gloucestershire, where crews participate in three days of unrivalled flying displays, or grace a sprawling static area which offers visitors unmatched variety.

The largest military air show of its kind, RIAT attracts in the order of 170,000 spectators each year. This number is capped due to local infrastructure restrictions such as the narrow rural roads around the site, which can easily become gridlocked with traffic.

Sadly, the impact of the Covid-19 pandemic and associated restrictions on gatherings has for the second year running led to RIAT's cancellation, with the loss of the 2021 event – originally scheduled for 16-18 July – a particular disappointment, in what is the Air Tattoo's 50th anniversary year.

Paul Atherton is in the unenviable position of nearing the second anniversary of heading RIAT's organising company with no event yet staged during his tenure.

Having been selected as the new chief executive of the RAF Charitable Trust Enterprises (RAFCTE), Atherton attended the last show three months before assuming his role.

"RIAT 2019 had been successful – I had spent a week here, which was a really good part of the handover," he tells FlightGlobal. Notable attractions included participation by Romanian air force Mikoyan MiG-21s, Ukrainian Sukhoi Su-27s and Spanish navy Boeing AV-8B Harriers, plus a memorable flypast involving the RAF's Red Arrows aerobatic display team and a British Airways Boeing 747, celebrating the jumbo jet's half-century of service.

Among the main themes of the last show was commemorating the 70th anniversary of NATO's formation, although – by far unheard of at such events – poor weather conditions on the first day forced a special flypast to be cancelled.

"I'd been to many, many RIATs in an official

David Allison/Shutterstock

Star attractions in 2019 included Spanish navy Boeing AV-8B Harriers

Most recent event attracted 170,000 spectators to Fairford

Royal International Air Tattoo

capacity, so I knew what it was like," says Atherton, a former RAF pilot and two-star officer with more than 5,000h accumulated on the Lockheed Martin C-130K and J-model Hercules, Lockheed TriStar and Vickers VC-10. "But I had no idea what it took to put it on. Just seeing that week before [the event] was really staggering."

Preparing the show site – ordinarily a US Air Force (USAF)-run facility, which currently houses a detachment of Lockheed U-2 surveillance aircraft and regularly hosts strategic bomber deployments made by the service – is a four- to six-week undertaking, he notes.

Public excitement

"It whet my appetite," he says of the 2019 experience, "and I was really looking forward to starting the planning phase, and seeing the whole thing evolve from an austere USAF base on MoD [Ministry of Defence] land to what we see when we all turn up on the [opening] Friday. You've got a Royal Ascot-type event, with all of the opulence and public excitement that surrounds it."

The first event scheduled under Atherton's leadership was cancelled in March 2020, as the severity of the coronavirus pandemic struck the UK. He describes the decision to axe that show as "a strategic shock".

"The saying is you get your first 90 days to have a look [in a new job] – just towards the end of my 90 days, Covid reared its head," he notes.

After the cancellation, the RAFCTE team's thoughts turned to making an immediate recovery this year, in the belief that "Covid can't last". But worse was to follow: in February, the 2021 version also was called off.

As with many major summer events in the UK, such as the Glastonbury music festival and Edinburgh Royal Military Tattoo, the financial liability associated with their running has been heightened this year, with organisers unable to secure cancellation insurance cover.

"We start to become financially exposed in about March-April time – that's when we have to start paying all of the deposits to all of our suppliers," Atherton says. "Some of those contracts involve an awful lot of money," he adds.

"The hole was just opening up in front of us, [and] a second cancellation – without insurance – would have been catastrophic. We couldn't afford to take that chance," he says. Indeed, had the organiser taken the wrong decision and hoped for the best, he believes this could have led to an "irrecoverable" position.

Despite the disappointment, Atherton says that the public and military appetite for attending RIAT remains undiminished, noting: "Everybody has missed it".

Indeed, some 90% of ticket holders have opted to retain them until next time. "We are really fortunate that the public have carried over tickets for two years, and left their money with us, which is absolutely amazing," Atherton says. This despite the organiser having offered a full refund, feeling that this was "morally right".

RIAT also offered to return money to its corporate sponsors, which provide strong support and fill the exclusive chalet line that features prominently at the ❱

British Airways

Red Arrows and British Airways jumbo marked half a century of 747 operations

show. "The support we got from our sponsors was really quite humbling as well," he says. "An awful lot said 'We will work with you', which was very positive."

The show's only other cancellation of recent years had been in 2008, when freak heavy rainfall waterlogged the site and its grass car parks. This led to the police and local authorities calling a halt, on safety grounds.

RIAT's organiser has this year sought to safeguard the event's future by using the UK government's employee furlough scheme and other support initiatives, such as obtaining a business interruption loan. It also has received considerable financial support from the charity that it raises funds for in a normal year.

The show typically raises around £1 million ($1.4 million) per year for the RAF Charitable Trust, which in 2019 approved grants worth in the region of £700,000 to help initiatives such as junior rank scholarships and others promoting aerospace engagement.

"They have taken a hit" during the downturn, Atherton says of the charity, with the Trust having been unable to run its usual programmes due to factors such as social distancing restrictions.

Atherton notes that while RIAT is hugely successful, that is in part because of its unique feel.

"We get 50 or 60 heads of air forces, and senior company executives, but it's not a trade show. It has a relaxed and enjoyable atmosphere," he notes. It is not typically a place where deals get done, but a gathering at which relationships are forged and maintained between military personnel and industry professionals.

So, with two years of events gone, where next for the Air Tattoo?

"We are going to go back to basics," Atherton says, adding: "Covid has given us the catalyst. Could it become better and more efficient, and how do we evolve going forward?" As an example, he is keen for the organiser to restructure its activities, "to spread workload through the whole year".

While it could look to offer a bigger Friday – the show was until 2018 a weekend event only – Atherton is determined that "there is no ambition for a trade show". Nor is there any desire to extend the event beyond its current three-day duration. "You'd increase your cost and lower engagement," he notes.

Areas that he feels are worthy of increased attention include sustainability, space, unmanned systems and cyber. This includes the potential to for the first time enable an unmanned air vehicle to participate in the display flying, he indicates.

> "We get 50 or 60 heads of air forces, and senior company executives, but it's not a trade show. It has a relaxed and enjoyable atmosphere"
>
> **Paul Atherton Chief executive, RAF Charitable Trust Enterprises**

However, what will not change will be the event's reliance on 1,200 volunteers and 1,000 cadets and adult supervisors, who ensure that it runs smoothly.

Another key aspect – already addressed via its Techno Zone exhibits, concerns promoting aerospace to younger visitors. "It's all about enthusing the youth of today," he says.

Despite the blow of losing the golden anniversary show, Atherton is determined that RIAT will return as scheduled, from 15-17 July next year.

"We plan to be back bigger and better in 2022, to open a new and exciting chapter in the event's history. The main thing will be putting on the show to the expected standard."

One of the key themes for the next event will be marking the 75th anniversary of the USAF's formation. A strong presence can be expected from the service's European-based assets.

Safety matters

For Atherton, running a safe show is paramount. He was director general of the UK Military Airworthiness Authority (MAA) at the time of the 2015 Shoreham air show disaster, in which 11 people were killed when a Hawker Hunter crashed on a busy road adjacent to the West Sussex airfield during a flawed display routine. He was involved in a subsequent review of display flying, which resulted in tighter restrictions being imposed on all such events.

"When I – as the regulator – looked in at RIAT, they were almost overly-compliant," he says. "Everything they did was probably in accordance with the way that we were evolving the regulation."

The show has a flight safety committee, and all display routines must be validated before permission is granted to fly during the event.

For RIAT, post-Shoreham focus areas included assessing the positioning of off-site camping areas, ensuring the safety of those outside the base, and keeping display boxes clear. "It's an incredibly controlled environment," he says.

"We work really closely with the MAA on the whole regulation suite, from ground to air traffic to air, and it's a relationship that's really strong, and that we're very proud of."

But what if coronavirus remains an obstacle in 2022 to staging such a gathering, which attracts participants and visitors from around the world?

"Whatever the new normal is, we need to learn to live with it," he concludes. "We did a lot of work on how to do a show with restricted numbers" before this year's cancellation decision, he adds.

With its reputation for attracting the best and newest aircraft – it was the first event to feature the Bell Boeing V-22 Osprey tiltrotor and Lockheed Martin F-35, for example – along with rarities from distant nations, all will be hoping for a spectacular RIAT return next year.

Organiser marks golden anniversary where Air Tattoo began

A small group of Air Tattoo veterans assembled at North Weald airfield in Essex on 31 May to mark the event's 50th anniversary milestone, where they were joined by one of the aircraft which had visited the inaugural show.

Around 12,000 people attended the 1971 event, which was staged by the Royal Air Forces Association and run by an organising team which included World War Two Bomber Command veteran Squadron Leader Jack Currie, and two air traffic controllers from Boscombe Down: Paul Bowen and Tim Prince, who would both subsequently lead the event.

"What differentiated it from previous annual air displays was the involvement of aircraft from international air arms," the Royal International Air Tattoo (RIAT) notes.

"I am reminded of all the wonderful people who volunteered their time and energies and came together to stage Air Tattoo 71," Prince says. "We all stepped into the unknown and staged an event that was to become world famous for the air forces of the world to meet annually in a spirit of friendship and cooperation whilst inspiring the next generation of aviators through the magic of flying."

The show's chief executive until 2014, Prince has a glint in his eye while recalling the challenges the team overcame during the first event – including directing a four-ship formation of Royal Danish Air Force Saab Drakens into the airfield in poor visibility while avoiding a local aerial installation.

Programme of first show, attended by around 12,000 people

Changing times

As described in Ben Dunnell's book *Air Tattoo 50 – The Story of the World's Greatest Air Show*, times have certainly changed, and air shows have become more slick, professional and safety-conscious since that first gathering. "Famously, the Patrouille [de France] didn't much care for the accommodation they were offered in a disused barrack block," he notes.

In true air show fashion, the anniversary gathering went ahead despite the last-minute withdrawal of its planned star attraction: Battle of Britain Memorial Flight-operated Supermarine Spitfire PM631. Unable to fly in from RAF Coningsby in Lincolnshire, the PRXIX-model had been among the 80 aircraft that took part in the first Air Tattoo.

Instead, a 55 year-old Jodel D140C Mousquetaire (G-ATKX), owned and flown by Phillip Petitt, took the limelight after journeying from Redhill aerodrome in Surrey.

Royal International Air Tattoo

Tim Prince (*left*) and Paul Atherton with Jodel D140C Mousquetaire

Send your offcuts to murdo.morrison@flightglobal.com

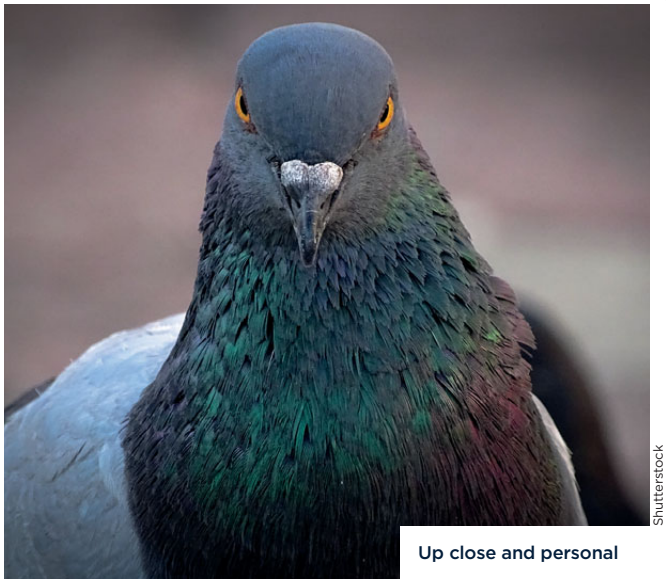
Pigeon proof

Alongside its state-of-the-art digital video systems, London City airport's new-fangled remote tower installation appears to include some rather old-fashioned air traffic control technology.

Close-up promotional images of the 50m tower, which relays a panoramic view of the airport to controllers in a room at Swanwick en route centre, suggest the camera array is surrounded by distinctive spikes similar to those on a number of other London structures – all designed to deter opportunistic landings by a primary user of the capital's airspace.

That's one advantage of a conventional look-out-the-window control tower. Just as you're juggling that steep-approach arrival with other flights queueing for the same runway, an invading pigeon doesn't pop up in high definition and scare the bejesus out of you.

Airbus Defence & Space



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Up close and personal

Lava or leave it

New Icelandic airline Play has been tempting Brits to its homeland with the prospect of glimpsing the volcanic activity on the Reykjanes Penninsula – describing it as a "must-experience for UK travellers".

It is nice that the island's seismic activity is giving a post-Covid boost to the aviation sector. Eleven years ago, ash clouds caused by eruptions from another volcano, Eyjafjallojokull, led to the previous biggest disruption to the industry since the Second World War.

Just the jab

Only travellers who have been inoculated against Covid-19 may be permitted to fly on airlines in future.

Will they be known as vax pax?

From the archive

100 75

1921 Wireless requirements

All the Instone "air liners" which are used regularly on the London-Paris service are now equipped with wireless telephones, and continuous practice in direction-finding, and the general use of the telephones, is being carried out. On several occasions, communication has been kept up between a machine and Croydon until the former—flying on its journey to Paris—has reached as far as Abbeville. It is, however, becoming apparent that, as more and more machines are equipped with wireless 'phones, a special ground station will have to be provided at Croydon to deal solely with messages from aeroplanes. At present it is impossible to keep in continuous touch with the machines owing to the number of routine messages the wireless operators have to deal with.

1946 Return of the rocket

The time may be near when diligent investigators of aerodynamic phenomena will desert their wind tunnels and laboratories for a radar tracking room, for in radar-plotted research models, with rocket or athodyd propulsion, we may hold the key to practical flight at transonic and supersonic speeds. If this proves to be so—and there is every indication that it will—the key will have been delivered into our hands by German scientists; it was they who developed the practical liquid fuel rocket and applied its tremendous thrust to high speed aircraft, research missiles and controlled weapons. American manufacturers are interested in rocket-powered research aircraft, and we in Britain must look forward to the day when the roar of the rocket is once more heard in the land.

Bringing up the rear

By the seat of your pants

From a story on the Airbus website about the A330 MRTT's trial in Singapore:

The automatic refuelling system was called A3R and the idea behind it was clear: to reduce air refuelling operator (ARO) workload, improve safety and optimise the rate of air-to-air refuelling (AAR) transfer in operational conditions to maximise aerial superiority.

Everything at the 'simple' push of a bottom.


Hatchwell Antiques

Careful wi' t'cash

Conforming to regional stereotypes, an ongoing series:

From a press release from Yorkshire Air Ambulance announcing the replacement of its two H145s with new five-bladed variants: "We have been financially planning for these replacements since G-YAAC and G-YOAA commenced their operations in 2016 and with prudent, planned savings, careful budgeting, and through building our reserves we are now in a position to move forward."

Going, going, gone

An auction house is inviting bids for a vintage Martin-Baker ejection seat, originally fitted to a French Dassault/Dornier Alpha Jet.

The aluminium Mark IV seat (*right*) is priced at £12,500 ($17,600) by Chelsea dealer Hatchwell Antiques.

The firm's Allan Hatchwell says ejection seats from the early fighter jet era rarely turn up on the market because collectors "recognise the quality of engineering and the design".

Just the thing, perhaps, for when that Zoom meeting gets too tedious.

50 25

1971 Chinese opportunities

The recently announced visit to Peking projected by President Nixon, and the diplomatic detente between the USA and the Republic of China, lend added point to current applications by US airlines for traffic rights into China. United and Northwest have applied to the CAB, and Pan American and TWA, both holders of authority before the communist revolution in 1949, are likely also to be interested. Diplomatic moves to admit China to the United Nations—US objections have been a stumbling block in the past—could bring benefits to aviation. Canada now has traffic rights to China, and CP Air, which serves Hong Kong, is the likely airline to make use of them. The US ban on trade with China, which could now be gradually lifted, has served to give British suppliers a foot in Peking's door.

1996 Eurofigher boost

The first two-seat Eurofighter EF2000 is expected to be flown by the end of July, with senior management confident that the technical difficulties affecting the project are now under control. This clears the way for the four partner governments, Germany, Italy, Spain and the UK, to commit to the production phase. Go-ahead for production investment is intended by the end of this year. Senior government and military are finalising the industry price and workshare package submitted to the NATO Eurofighter Tornado Management Agency in March. A UK commitment to the production phase would give an incentive to the other three nations to push ahead. With Germany re-examining budgetary commitments, UK industrialists are keen to extract a commitment from Bonn.

Flexibility key to improving gender balance

As both a doctor and a pilot (PPL) I have followed various trends in both medicine and aviation for many years.

In quite a number of areas, such as crew resource management, no blame incident reporting and big data analysis, aviation has led the way, with medicine often following its example.

I have followed with interest your series of articles on significant women in aviation and this is certainly one area where aviation lags.

Over the past 50 years medicine has changed from being a male-dominated profession to a majority female profession, particularly in family medicine and general practice.

Medicine has had to change to accommodate this, with a historical model where a GP was on duty 24/7 being replaced by co-operative out-of-hours cover and sessional working to accommodate working mothers. However, extremely demanding roles in medicine such as neurosurgery continue to be male-dominated.

Perhaps aviation needs to follow this lead? A friend of mine is a first officer with an airline and chooses to remain on early shifts. He leaves home at 5am while his wife gets the children off to school before going to work, and he is finished in time to collect them later.

With role-reversal, perhaps this model would work for female pilots with young children and while flying low hours, before later graduating to more demanding long-haul flights (the equivalent to neurosurgery in medicine) when their early childhood care role has diminished?

As an aviation medical examiner I meet few female pilots, and most of them fly because their father or grandfather did.

We need to encourage more female pilots, but perhaps it is aviation itself that needs to change to facilitate this.

Dr Kieran Murphy
Athea, County Limerick, Ireland

Early shift pattern could suit a pilot sharing childcare duties

aapsky/Shutterstock

National pride

The Times recently published two anti-Red Arrows letters, after its correspondent decried the team's display at the end of the recent G7 summit in the UK, saying it was highly polluting and sent a contradictory message to the poorer nations of the world.

I can't prove it, but I suggest that there are a great many people who would agree with my view that the Red Arrows are a necessary symbol of good cheer, personal commitment, national achievement, and global partnership.

I seem to remember that some parliamentarians previously tried to have them struck off, but there was a national outcry.

David Stevens
Woking, Surrey, UK

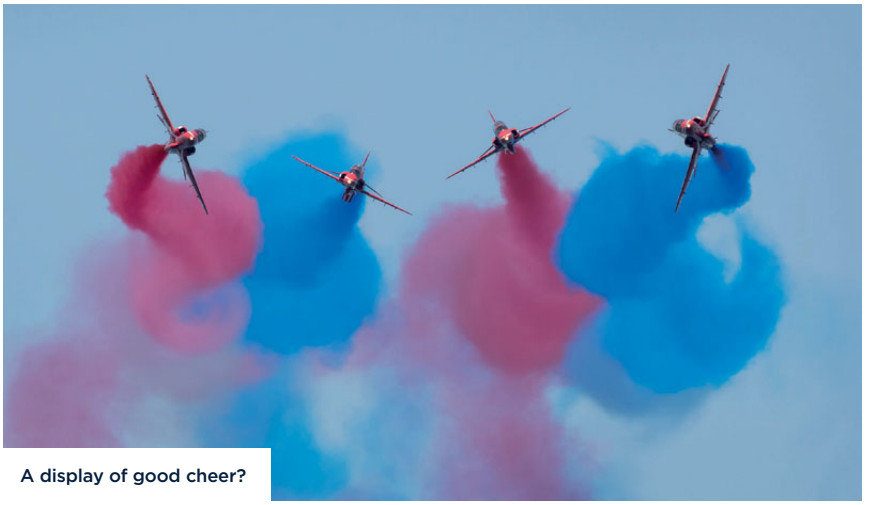
F-35 under fire

Much has been made of the F-35's ability to "kick down the door" on the first day of a conflict. But surely air-launched supersonic or hypersonic missiles could do the job with less risk to the pilot (*Flight International*, June 2021)?

Radar and other detection means are eating into the supposedly invincible F-35's lead – if it even had one to start with.

Lockheed Martin says it's building the best jet. But if that's the case, why are there new-build [Boeing] F-15s, Super Hornets, [Dassault] Rafales and [Saab] Gripens coming off the lines? All are capable of deploying cruise missiles from stand-off ranges.

Edward Philpott
Neston, South Wirral, UK



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Lieutenant **Michaela Curtis** is an observer serving on Auckland's Super Seasprite helicopter fleet, whose love of aviation was first inspired by watching accident investigation programmes

Expert observation for New Zealand

Greg Waldron Singapore

Royal New Zealand Navy (RNZN) Lieutenant Michaela Curtis has found her calling as an observer aboard the Kaman Aerospace SH-2G(I) Super Seasprite helicopter.

Curtis has served in the navy for seven years, but her early role had nothing to do with aviation. As she puts it, her job as a warfare officer was "driving ships".

Then a pivotal moment came: she was asked to take some photographs of a Super Seasprite operating from the ship on which she was embarked.

"I pretty much thought that that's exactly what I want to be doing," she says of the moment. "And so I submitted a trade change request."

Although getting close to shipboard helicopter operations was an epiphany for Curtis, it was by no means her first exposure to aviation. She recalls that in her teenage years she was hooked on the television series *Air Crash Investigation*.

The year following her decision to move from ships to aircraft was challenging. She underwent a comprehensive training course conducted by the Australian military to learn how to be an effective observer aboard the rotorcraft.

Australian instruction

Her flying during this time was mainly in a Royal Australian Air Force (RAAF) Beechcraft King Air 350 operating from East Sale, Victoria. According to the RAAF, the type plays a key role in training air force mission aircrew and navy aviation warfare officers.

"I found it the most demanding and exhausting year of my life, but I loved every minute of it," Curtis says.

The work prepared her for operating in the Super Seasprite, of which the Royal New Zealand Air Force's (RNZAF's) Auckland-based 6 Squadron has eight. The rotorcraft are operated by navy personnel, but maintained and supported by the air force.

Though she is not qualified as a pilot, Curtis has a broad range of duties as an observer within the helicopter's three-person crew, which also includes the pilot and a loadmaster in the rear cabin. Her work involves planning missions, and then using the full capabilities of the helicopter during them.

"The observer's job is to utilise aircraft sensors to act as an extension to the ship's sensors, search for targets, or conduct reconnaissance," she says. "Then, if required, utilise the weapon systems to neutralise targets. Tactical employment of the aircraft is the primary role."

When embarked, Curtis also plays an important role advising the ship's commanding officer on the optimum way to employ the helicopter. In addition, she informs the ship's crew on all aspects of aviation.

The Super Seasprite's primary weapon is the Kongsberg Defence & Aerospace Penguin anti-ship missile, but it can also carry torpedoes and a machine gun. In addition to performing anti-surface warfare tasks, other missions include maritime patrol, surveillance, search and rescue, force protection, and utility operations such as winching and load lifting.

Formerly a mainstay of the US Navy, the SH-2G is today flown only by the militaries of Egypt, New Zealand, Peru and Poland. Wellington acquired its current assets in 2015, with these replacing earlier examples of the same type.

"They are a very powerful small-ship helicopter and extremely reliable," says the New Zealand Defence Force. "They have the ability to operate from the larger seven of the navy's nine ships and have excellent range. They and their earlier-model predecessors have proven themselves in RNZN operations at home and around the South Pacific over the last 20 years."

"Aviation is my passion. I can't see myself doing anything other than a job within the industry"

New Zealand Defence Force

Michaela Curtis hopes to become a navy instructor

Asked about her most interesting experience on the type, Curtis recounts a mission called Operation Endurance, for which she was embarked on HMNZS *Canterbury*. The mission involved sailing south to resupply New Zealand's sub-Antarctic islands: Campbell Island and the Auckland Islands.

Curtis had been to the area in her pre-aviation days, experiencing them from the bridge of a ship. Initially she was not thrilled about the trip, given it would involve heavy sea states and incessant rain.

She soon realised, however, that the remote islands offer quite a different experience from a helicopter.

"The experience I had was just so different from when I was stuck on the bridge of the ship," she says. "I got to see so much more. I got to land on all the islands, I got to see all the wildlife. And then because we were transporting equipment and personnel to and from the islands every day, I felt like this time I was just a much more integral part of the mission."

As for how more young women can be brought into the aviation sector, Curtis feels that people tend to find passion on their own, but believes that women with careers in aviation can serve as role models for girls.

She also notes that the RNZAF has a programme called School to Skies, which promotes aviation to female students. It gives 40 students a chance to spend six days with the air force, learning about aviation roles such as engineers, technicians, and pilots.

Curtis is involved in educating children about the New Zealand military and aviation. From time to time, Super Seasprites land in sports fields at schools, with the crew discussing their work with students.

Curtis is keen to stay in aviation and aims to become an instructor in the navy. She is also studying for a degree in aviation management in conjunction with a diploma in air traffic services. Longer term, she aspires to work as an air crash investigator.

"Aviation is definitely my passion," she says. "I can't see myself doing anything other than some kind of job within the industry."

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