

FLIGHT INTERNATIONAL



Pilot training:
too soon to
start?



Stealthy switch

UK sets course for F-35 cuts, as Tempest advances **p6**

How Mitch Snyder revived Bell **p18**

Sustainable fuel to surge **p42**



Team player
Australia funds loyal wingman fleet boost **p22**



Volting ahead
Wideroe picks Rolls-Royce in electric push **p14**



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Will the UK's plans to take 138 F-35s be scaled back in 2025?



Into battle

Although long awaited, the UK's defence review has left many unanswered questions when it comes to future capability

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In military circles, the mantra “proper preparation prevents poor performance” rings true every bit as much during peacetime as in times of conflict – get your plans wrong today, and the consequences will be dire many years down the line.

When UK defence secretary Ben Wallace presented the nation's delayed spending plans for the period to 2025 on 22 March, he did so with the shock revelation that such documents are not always worth the paper that they are printed on.

“Previous reviews have been over-ambitious and under-funded, leaving forces that were overstretched and under-equipped,” he said.

Indeed, in a January estimate, the UK's National Audit Office pegged the funding “black hole” in the Ministry of Defence's (MoD's) equipment programme at £7.3 billion (\$10 billion) until 2030.

The UK government late last year approved a 14% increase in defence spending for the coming four years, taking the total allocation to £188 billion. Sufficient, says Wallace, “to turn hollow forces into credible ones, modernising for the threats of the 2020s and beyond”.

In line with the UK's strategic objectives, this process is also designed to “amplify UK global influence by deepening our alliances in the Indo-Pacific, Middle East and Africa [and] developing a global network of adaptable basing with

key allies and partners”, according to the report.

But for all this, the review – titled *Defence in a competitive age* – does not feel to have shaken off suspicions that its contents are cost-, rather than capability-driven.

True, this is a time of unprecedented pressure on the UK's finances because of Covid-19, but will it strike the right balance in meeting future threats?

For aviation watchers, the future make-up of the UK's combat aircraft fleet is the standout issue which will define its global capability for the next half-century. While around two dozen of its oldest Eurofighter Typhoons will be retired, the Royal Air Force (RAF) will get to invest more in its more recent examples and maintain a strength of seven frontline squadrons.

But it is the growing battle between the nation's commitment to the Lockheed Martin F-35 and development of a Future Combat Air System (FCAS) where the greatest interest – and lack of detail – lies.

For years, the UK's programme of record requirement to take 138 F-35s over the life of the programme has looked jarringly out of balance with its apparent need. The new document makes no mention of that figure, committing only to “increasing the fleet size beyond the 48 aircraft that we have already ordered”.

While it does not say so in as many words, this surely sets the

scene for cuts to be confirmed at the time of the next defence review, in 2025.

But viewed a different way, the current lack of clarity around numbers affords the MoD future flexibility, should its FCAS and Tempest fighter ambitions prove out of touch with financial reality, or change because of a shifting strategic picture.

Many other questions remain, such as whether the Airbus Defence & Space A400M airlifter can finally hit the mark in its delivery of long-overdue tactical performance? If the UK is to maintain capability in this area once its Lockheed C-130J fleet retires in 2023, then the answer must be yes.

Equally important is that a future airborne early warning fleet now slashed to just three Boeing 737-based E-7A Wedgetail aircraft arrives for duty in 2023 as expected – closing a glaring capability gap which will appear when the RAF's last E-3D Sentry retires later this year.

Also apparent is that the MoD remains in a spin about the direction of its future medium transport helicopter requirement, even though it has opted to remove its Airbus Helicopters Puma HC2s by 2025, with no current replacement in the pipeline and industry still in the dark.

A plan, yes. But time will tell about the rest of the saying. ▀

See p6

In focus

UK to reform its defences **6**

A fuel's errand **8**

Shutdown inquiry criticised **10**

Tensions ease in WTO row **12**

Trio get connected for electric aircraft project **14**

ATR confident of demand **15**

Bell's unlikely revolutionary **18**

ATS has the Wright stuff **22**

Leonardo eyes reset **24**

Fuelling uncertainty **26**

Fix nears for PW1500G **28**

Pipistrel bats for hydrogen **29**

Engines stay core for NASA **30**

Friction in fighter pact **32**

A greater lesser **33**

Aeralis on the up **34**

Powering a revolution **36**

22



Regulars Comment **3** Best of the Rest **38** Straight & Level **74** Letters **76** Jobs **81** Women in aviation **82**

In depth

SAF bet 42

The pace of sustainable aviation fuel's development is speeding up

Flying solo 48

The UK government is backing its own environmental schemes

Air Trafficking Control 52

Clamping down on illegal wildlife smuggling

Right time to train? 56

Despite the industry crisis, flight schools say they are continuing to enrol students

The year the sims stood still 62

CAE's grip on the market

Training evolution 66

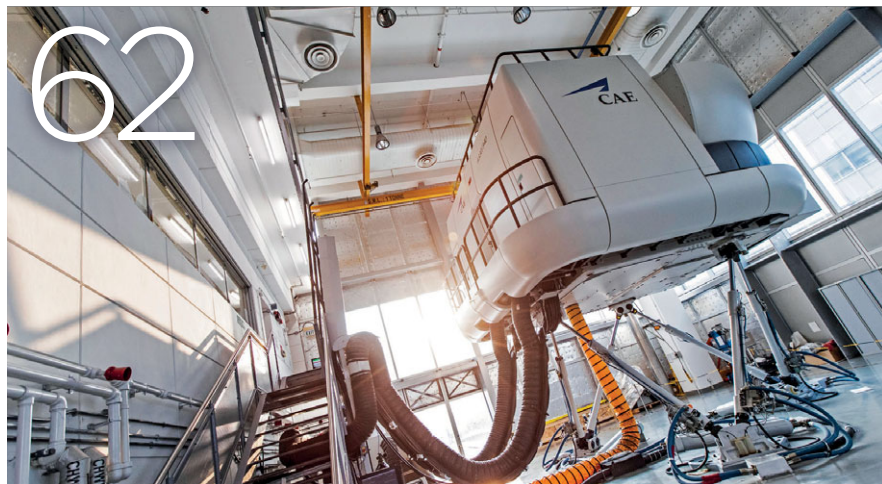
The case for simpler devices

Orbital hero 72

Remembering Yuri Gagarin's historic flight 60 years on



Welcome to the team, mate
Australia's autonomous 'loyal wingman' takes off



Platform cuts set to reform UK's defences

Ministry of Defence outlines future plans, with C-130J and Puma fleets to retire – and ambiguity around Lockheed's F-35

Craig Hoyle London

The UK will retire its Tranche 1 Eurofighter Typhoons, Lockheed Martin C-130J tactical transports and Airbus Helicopters Puma HC2 rotorcraft by the middle of this decade, as the Ministry of Defence (MoD) targets a range of capability updates.

Detailed within its *Defence in a competitive age* publication, released on 22 March, the MoD's plan for the period to 2025 also includes major new investment in a Future Combat Air System (FCAS) project, but provides only vague details on its total commitment to the stealthy Lockheed Martin F-35B.

The four-year plan has a total funding allocation of £188 billion (\$258 billion), including £6.6 billion for research, development and experimentation work, after the MoD late last year secured a 14% spending boost worth £28 billion.

"Previous reviews have been over-ambitious and under-funded, leaving forces overstretched and under-equipped," says defence secretary Ben Wallace. The measures in the new plan will enable the UK "to turn hollow forces into credible ones, modernising for the threats of the 2020s and beyond", he adds.

According to the report, the process will also "amplify UK global influence by deepening our alliances in the Indo-Pacific, Middle East and Africa [and] developing a global network of adaptable basing with key allies and partners".

Around 24 of the Royal Air Force's (RAF's) oldest Typhoons will leave service by 2025, with the money saved to be channelled into upgrades for its Tranche 2 and 3 jets. This will include integrating an active electronically scanned array radar and MBDA's Spear 3 air-to-surface missile.

The plan also commits to "grow the [F-35B] Lightning II force, increasing the fleet size beyond the 48 aircraft that we have already ordered". Lockheed has so far delivered 21 of these aircraft.

The USA's sole Level 1 industrial partner on the F-35 programme, the UK has a long-stated commitment to eventually acquiring 138 of the type. However, unlike its Strategic Defence and Security Review (SDSR) document of 2015, the new report makes no reference to that figure.

Credible capability

"We welcome [the] commitment to growing the F-35 fleet beyond the 48 jets currently contracted," Lockheed says. This "will ensure the UK can deliver a credible Carrier Strike capability", it adds, referring to the operational combination of the short take-off and vertical landing type with the Royal Navy's two Queen Elizabeth-class aircraft carriers.

"With aircraft currently contracted [for delivery] through to 2025 there simply was no need for an additional commitment to buy at this stage," the company notes. "Contrary to recent speculation, the

[UK's] F-35 programme of record has not been cut and remains at 138 through the life of the programme."

Despite the ambiguity, the MoD says it will "integrate more UK weapons onto Lightning II and invest to ensure that its software and capability are updated alongside the rest of the global F-35 fleet".


Further clarity about the nation's total offtake of the fifth-generation fighter is unlikely to emerge until its next defence review is completed in 2025. Factors likely to influence its thinking will include the success or otherwise of the FCAS activity.

More than £2 billion will be invested in this project by 2025, including new investment worth £1.2 billion. Also involving Italy and Sweden, it is expected to produce an optionally-manned or unmanned Tempest fighter, an unmanned Mosquito 'loyal wingman'

Carrier Strike F-35B fleet will rise beyond 48, but 138-unit total appears in doubt



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Fourteen stretched-fuselage Hercules will be retired in 2023, with larger A400M to assume tactical duties

£188bn

Total funding allocation in four-year plan, following 14% increase secured last year to address major shortfall

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and what the report refers to as “swarming drones”. Service entry is planned by 2035.

Michael Christie, director of FCAS at BAE Systems Air, says the project is on track to enter its concept and assessment phase later this year. The Team Tempest industrial group – a joint venture involving BAE, Rolls-Royce and the UK units of Leonardo and MBDA – is anticipating a decision in “the next few weeks” to progress to the next phase, he says, with work likely to come under contract and begin “as we go into the summer”. An initial technology development phase concluded last year.

Christie says multiple system configurations will be considered until the MoD defines its formal requirements later this decade.

“We are still looking at multiple options, and the balance between the various components,” he says. “We will be keeping our options open for a while yet.”

Meanwhile, a project to replace the RAF’s Boeing 707-based E-3D Sentry airborne warning and control system aircraft with five 737-derived E-7A Wedgetails has been cut back to just three airframes. The MoD had ordered a pair of second-hand 737NGs for UK conversion into the surveillance type, plus three new-build examples. The first used airframe arrived at STS Aviation Services’ Birmingham airport facility in early January, and the fleet reduction is believed to affect the previous commitment to new aircraft.

The 2015 SDSR had pledged to upgrade the Sentry fleet, extending operations until 2035, but the RAF’s last examples are now due to be retired this year – only to be replaced by the trio of Wedgetails from 2023.

Also in 2023, the RAF will retire the last of its 14 remaining stretched-fuselage C-130J-30s, more than a decade sooner than previously expected.

Attractive proposition

Support provider Marshall Aerospace and Defence Group (MADG) believes the transports will represent an attractive proposition for secondhand buyers. The company has previously prepared five short-fuselage C-130Js deemed surplus to UK requirements for delivery to Bahrain, Bangladesh and the US Navy.

“We had been anticipating that the MoD would bring forward the out-of-service date for the C-130 fleet. However, we had not expected such a short timeframe,” says MADG chief executive Gary Moynihan.

“We expect to support the RAF in the successful resale of the C-130 fleet in order to maximise return for the UK economy, and in turn reduce the risk of significant job losses,” he adds. “We remain confident that our C-130 MRO business can continue to grow.”

Introduced from 1999, the tactical transports have been worked hard through their operational lives, including supporting UK military activities in Afghanistan and Iraq.

Marshall last August returned to use the first RAF C-130J to have received a replacement centre wingbox via a July 2017 contract worth £110 million. This project had been intended to enable operations with the type to continue until 2035.

The MoD says retirement of the C-130Js will enable the Airbus Defence & Space A400M Atlas force to “increase its capacity and capability”. Cirium fleets data shows that the RAF has so far received 20 of its eventually 22-strong fleet of the larger type.

A pair of BAe 146 transports acquired second-hand to support operations in Afghanistan will also leave use in 2022.

The RAF’s Puma fleet will be retired in the 2023-2025 period, with a replacement medium-weight helicopter to be acquired.

“Investment in a new medium-lift helicopter in the mid-2020s will enable a consolidation of the army’s disparate fleet of medium-lift helicopters from four platform types to one,” the report states.

Airbus Helicopters earlier this year voiced interest in a Puma replacement opportunity, with potential candidates including the H175, H225M and NH Industries NH90, while Leonardo Helicopters has pitched its AW149.

Several of the RAF’s longest-serving Boeing CH-47 Chinooks are also to be replaced with new-build examples.

In the training sector, the RAF’s remaining BAe Hawk T1s are set to leave use – reportedly by 2023 – although those examples assigned to its Red Arrows aerobatic display team will fly on until the end of the decade.

“We will enhance the new military flying training system with further investment in synthetic training that will deliver more capable pilots more quickly and more efficiently,” the report says.

“The development of novel technologies, and a step change in how we use simulators for mission rehearsal and training, will enable the Royal Air Force to be among the most technologically innovative, productive and lethal air forces in the world,” it adds.

This process will also be supported by the development from next year of an intelligence, surveillance and reconnaissance satellite constellation. ▶

Fuel's errand

EasyJet chief executive says low-carbon propulsion systems will remove need to invest in SAF for short-haul operators

Lewis Harper London

Short-haul carriers have little reason to invest in the development of sustainable aviation fuels (SAFs) when new propulsion technologies are on the horizon, in the view of EasyJet chief executive Johan Lundgren.

Speaking at a Eurocontrol event on 22 March, Lundgren suggested that while SAFs are “absolutely the right thing for long-haul” operators, short-haul carriers can look forward to a “hydrogen and electric environment” in the next decade or so.

His remarks are based on the assumption that new propulsion technologies are likely to be viable on intra-European flights within that timeframe, but not on longer-haul sectors.

SAFs are therefore “definitely not something we as a short-haul operator would look to as part of our end-game, at all”, he says of the carrier’s sustainability strategy.

For EasyJet, investing in carbon offsetting is “much better for the environment than putting in huge development costs for sustainable aviation fuels that actually will be obsolete if you’re a short-haul operator here in 10 to 15 years’ time”, he says.

He describes carbon offsetting – which EasyJet does for all of its flights – as “an interim solution before you get on to ground-breaking technologies”.

Lundgren’s views on carbon offsetting contrast sharply with those of United Airlines chief executive Scott Kirby, who recently described the concept as a “fig leaf for a CEO to check a box [and] pretend that they’ve done the right thing for sustainability”.

Regarding the development of hydrogen and electric propulsion technologies, Lundgren says that “for all the bad things that happened in 2020, one of the encouraging things was that the technological advances in this field were quite remarkable”.

Hydrogen technology

He cites the development of lithium-sulphur batteries as an example, alongside advancements with hydrogen technology, including progress towards using it in “fuel cells or even a normal internal combustion engine”.

With those developments in mind, “there’s no doubt that it’s a matter of time when you’re going to see large-scale, 150-, 180-seaters operating and flying”, Lundgren says.



The question is then no longer “technical”, he continues, adding: “It’s how we transition to that, what is the business model going to look like?”

Describing his considerations when imagining that future business model, Lundgren highlights several factors, including ensuring the performance and availability of aircraft powered by the new technologies; ensuring the availability of “the renewable energy to support the equipment”; and working out how the jet kerosene-powered fleet would be phased out.

EasyJet is “starting to think about” phasing out kerosene and “how this will take place”, he says.

Among the recent developments in the field of new propulsion technologies, Airbus – EasyJet’s

Airbus, Rolls-Royce plan for flight tests

David Kaminski-Morrow London

Airbus and Rolls-Royce are participating in a study to examine in-flight emissions from commercial aircraft powered entirely by sustainable aviation fuel.

The study will monitor emissions from an Airbus A350-900 on the ground and in the air. Sustainable fuel will be supplied by Neste and the study will include German aerospace research centre DLR.

Airbus has already carried out an initial flight check in Toulouse to ensure that the fuel is compatible with the A350’s systems and its R-R Trent XWB engines.



A350 has been used to check fuel's compatibility



Markus Mankka/Shutterstock

Low-cost carrier is “starting to think about” how it can phase out kerosene

current aircraft supplier – unveiled conceptual designs for a potential hydrogen-powered commercial aircraft last September, a technology that it believes could be developed for service entry within the next 15 years.

Earlier in 2020, US firm Wright Electric said it was aiming to conduct ground tests in 2021, and flight tests in three years’ time, of a motor intended to provide propulsion for an electric airliner. EasyJet is a partner on the programme to develop the 186-seat electric aircraft, known as Wright 1.

The UK-based budget carrier was also among a coalition of short-haul airlines, other aviation organisations and environmental groups that earlier in March called on the European Commission to

ensure that long-haul flights are included in a forthcoming EU mandate on the use of SAF.

The group – which also includes low-cost carriers Ryanair and Wizz Air – called on the Commission to urge that fuel suppliers be made responsible for ensuring that SAF is included in jet kerosene supplies, ensuing equal treatment for long- and short-haul carriers.

Policy proposals

It follows concern that policy proposals from the Commission could limit the ReFuel EU Aviation initiative to intra-European Economic Area (EEA) flights, and oblige airlines to ensure a percentage of SAF is included in kerosene-based fuel.

In a letter sent to Commission vice-president Fran Timmermans

and transport commissioner Adina Valean, the coalition cites recent Eurocontrol data showing that long-haul services account for just 6% of flights but half of the sector’s emissions.

“Increasing the supply of sustainable aviation fuel to cover just 10% of the needs of long-haul would do more than can ever be done in short-haul to reduce net CO2 emissions,” according to Eurocontrol.

The coalition argues that flights outside the EEA are already exempt from environmental policies such as the EU’s Emissions Trading System.

It also points out that there is an expectation that green propulsion systems will be available for short-haul aviation in the foreseeable future. “These new, zero-emission technologies, however, are not available for long-haul aviation in the foreseeable future; therefore SAFs continue to be key for long-haul aviation to mitigate its carbon emissions,” they write.

“The EU’s SAFs mandate will only have a sizeable impact on aviation’s emissions if we all do our part, including the long-haul operators who are the largest source of emissions, and who need this technology for the long run,” says Lundgren.

“There is no logic in excluding long-haul flights from SAF usage obligations, as this is their only possible way to decarbonise,” adds Ryanair group chief executive Michael O’Leary. “We fully support the EU’s initiative to decarbonise aviation but all carriers, including long-haul, must play their part for this to be achieved.” ▶

See page 42

Airbus will commence flight-emissions tests in April. A DLR Dassault Falcon 20-E chase aircraft will be used to conduct emissions measurements.

Airbus new energy programme manager Steven Le Moing says the collaboration will provide insight into how turbine engines function using 100% sustainable fuel, with a view to certification.

“[It will also] identify potential emissions reductions of using such fuels on a commercial aircraft,” he adds.

The work will be carried out using the initial A350 flight-test aircraft MSN1.

“Sustainable aviation fuel is essential to the decarbonisation of [long-haul] travel and we actively support the ramp-up of its availability to the aviation industry,” says R-R civil aerospace director of product development and technology Simon Burr.

The fuel will be sourced from hydroprocessed esters and fatty acids. Emissions will be compared with those from fossil kerosene and low-sulphur fossil kerosene.

“Further ground tests measuring particulate-matter emissions are set to indicate the environmental impact of sustainable aviation fuel use on airport operations,” adds Airbus.

It says this will aid preparation for use of such fuels at blend ratios above the currently permitted 50%.

Neste vice-president for Europe, renewable aviation, Jonathan Wood, says there is evidence that using 100% sustainable fuel could provide a reduction of up to 80% in greenhouse gas emissions, when all life-cycle emissions are taken into account. “This study will clarify the additional benefits,” he says.

737 shutdown inquiry criticised

Ukrainian and Canadian authorities say Iranian investigation into target misidentification fails to address wider failings

David Kaminski-Morrow London

Ukrainian and Canadian authorities have lambasted Iran's investigation into last year's fatal missile attack on a Boeing 737-800 shortly after take-off from Tehran.

Kiev submitted dozens of comments to Iranian investigators, many highly critical, regarding multiple aspects of the inquiry.

The Iranian Civil Aviation Organisation has formally attributed the destruction of flight PS752 to the misidentification of the jet as a hostile target by an air defence unit.

Amid heightened tension with the USA, this unit had been locally relocated "according to the tactics" of such mobile air defence systems, says the inquiry, and been placed on standby until it was made operational at 06:07 on 8 January 2020, about 5min before the Ukraine International Airlines 737 took off from Imam Khomeini airport.

Alignment error

But during the relocation the unit's heading changed, owing to the operator's "failure in conducting north realignment properly", introducing a 105° error in the calculated bearing of detected targets.

When the unit detected the 737 the operator transmitted the details over a co-ordination centre communication network, but the message was not relayed to the centre, says the inquiry.

"Without receiving a response from the co-ordination centre, the operator came to the conclusion that the observed target was a threat and fired a missile," it adds.

Although the radar-guided Tor-M1 surface-to-air weapon launched by the unit detonated and caused "cascading" damage to the aircraft, the air defence unit "observed the continuity of the detected target trajectory" and fired a second missile 30s after the first.

Recorded data in the unit indicated this second strike failed, but the aircraft crashed with the loss of all on board - including the three cockpit crew who had survived the initial missile detonation.

"Mitigating measures and defence layers in risk management proved to be ineffective due to the occurrence of an unanticipated error in threat identification," says the inquiry, adding that this meant the flight's safety was not protected from the alerted defence forces.

Ukrainian investigation authority NBAAI submitted dozens of comments on the draft report to the Civil Aviation Organisation, asking for them to be appended to the final document.

The inquiry says any comments that enhanced the accuracy and effectiveness of the final report have been included, but it also listed some 100 comments from NBAAI that were not adopted.

These include remarks arguing that the cause was not the detonation of the missile but the attack on the aircraft, and that the inquiry "ignores" systemic failure on the part of the Iranian state - including lack of control of defence systems and officials' non-observance of duties.

Ukraine's comments dismiss as "incorrect, and certainly not accurate" the statements that the inquiry was conducted in accordance with ICAO's Annex 13 procedures.

"The accident scene and all the evidence were not preserved, the on-board recorders were not decoded at the first opportunity and the decoding thereof was unreasonably delayed for more than six months," the NBAAI adds.

Its comments even describe some of the factual information in the report as "incorrect and far-fetched" and says they "do not correspond with the evidence available".

Second strike

The authority is also not satisfied with the finding that the second missile did not strike the 737.

The NBAAI accuses the inquiry of failing to investigate a number of aspects fully, particularly in regard to the operation of the air defence system and attempts to identify the aircraft before the missiles were fired, and points out that the conclusions do not reference any violation in the Iranian civil-military air traffic management system.

Canada, which had 55 citizens and 30 residents aboard the aircraft, has offered similar criticism.

Kathy Fox, chair of Canada's Transportation Safety Board, says the report does not examine Iran's underlying failure to prevent its military from firing at the 737. "The report says what happened, but doesn't address why," Fox says. "It does not explain the underlying factors behind why the missiles were launched at [flight] PS752."

Fox says the report frames the incident "in the context" of Iran-US military tension. But it fails to describe Iran's missile-defence supervision and oversight practices, address "underlying deficiencies", or to say what actions Iran has taken to prevent such incidents in future.

"[Iran] says that military activities fall outside of the scope of" ICAO's accident investigation guidelines, Fox says. "We do not agree."

Iran also failed to warn airlines of military hazards, contrary to ICAO advice, Fox adds. ▀

"The report says what happened but does not explain the underlying factors behind why the missiles were launched at [flight] PS752"

Kathy Fox Chair, Canadian Transportation Safety Board

Additional reporting by Jon Hemmerdinger in Tampa



Iranian military launched two missiles at the twinjet shortly after it took off from Tehran

Rouzbeh Foujadi/ZUMA Wire/Shutterstock

Simulation of events shows ‘flight operation did not play a role’ in fatal error

Judicial investigators simulated the air defence system error which, according to an Iranian inquiry, led to the missile launch that destroyed a Ukraine International Airlines (UIA) Boeing 737-800 over Tehran.

Two air defence units were placed at the same location as that involved in the shootdown on 8 January last year, says the Iranian Civil Aviation Organisation.

“All the processes in the military, civil sector, and the co-operation between them were [recreated] just as [they were during] the events on the day of the accident,” it says, using records from the various agencies.

One of the air defence units replicated a misalignment with the north compass point, believed to have occurred during a repositioning after an Iranian military attack on the USA’s Al Assad base in Iraq. The attack took place early on 8 January, a few hours before the 737 was brought down.

The other unit in the simulation corrected the misalignment, and the inquiry examined the way each unit detected, on two occasions, a 737 flying from Tehran’s Imam Khomeini airport on a similar trajectory to that of the UIA aircraft.

These results “indicated the aircraft flight operation did not play a role in the occurrence of the error made by the air defence unit operator”, the inquiry says.

Both times the misaligned unit showed the aircraft approaching from the west while the correctly-aligned unit tracked it coming from the direction of the airport.

The investigation submitted a request to examine the events leading to the missile launch “in order to realise what happened on the military side”, says the inquiry. “The military sector and the judicial authority responsible... provided the information required to the investigation team accordingly,” it adds.

Investigators found the military unit was not responsible for monitoring targets, but only “obliged to perform the actions planned”, within a command hierarchy, if the command centre assigned a target to it.

This procedure broke down, it says, because after the air defence unit detected a possible target – the 737 – inbound from an unexpected direction, it launched missiles “without receiving a go-ahead or response” from the command centre.

Investigators state that this possibility had “not been predicted [or] considered” during the assessment of the risks of misidentification, and the event shows that the consequences of human performance errors can be “serious with a far-reaching consequence”.

Iran analysed how and why the narrowbody was targeted, but few details on the immediate effect of the surface-to-air missile strike itself have emerged.

Although investigators published the flight-data recorder traces from the UIA jet, French investigation authority BEA – which extracted the information – says the data instantly became invalid after the initial missile detonation. The jet’s transponder also simultaneously ceased transmitting.

As a result little is clear about the damage to, and dynamics of, the aircraft following the attack. The last recorded information shows the aircraft in stable flight at 250kt (463km/h), pitched 9.6° nose-up, at an altitude of 7,950ft – equivalent to 4,380ft above ground.

Investigators retrieved wing surface parts and a component from the air-conditioning system some 5nm (10km) northwest of the crash site. The inquiry says the underside fuselage adjacent to the wing – in the area where the air-conditioning component would have been fitted – showed traces of burns.

This, along with the cockpit’s escaping the initial explosion, suggests the strike occurred in the vicinity of the aircraft’s lower mid-section.

Although the engines were found to have been functioning, with “no [sign of] explosion or severe fire”, the inquiry says the aircraft sustained “cascading” damage and one of the integrated drive generators – which are located in each engine – began to slow about 16.5s after the detonation. The cockpit-voice recorder ceased operating 2.5s later.

“Evidence from the wreckage, videos and images suggested the occurrence of a fire in parts of the aircraft before the ground impact,” says the inquiry. “Fire was observable in the front cabin and on its left side.”

No explosives contamination was found on objects inside the passenger cabin and tests on metal fragments in some passenger seats showed they were from aircraft alloys and not missile shrapnel.

Tensions eased in WTO row

Both sides of transatlantic spat over civil aircraft subsidies move to de-escalate situation and spur negotiated settlement

David Kaminski-Morrow London

One of the aerospace industry's longest running trade disputes may finally be nearing an end after both sides in the transatlantic spat over civil aircraft subsidies moved to defuse tensions in the row.

The quarrel was initiated by the US government in 2004 complaining on Boeing's behalf about EU subsidies to Airbus. But, with the spat having shifted from a legal battle at the World Trade Organization (WTO) to a real-world trade conflict under former US president Donald Trump, including import tariffs implemented by both parties, there had been calls in recent months for a de-escalation.

First to move was the USA, where the administration of President Joe Biden on 4 March agreed with the UK – which although now outside the EU is still part of the subsidy row – to suspend tariffs for four months.

The measure follows the UK's unilateral suspension of tariffs at the beginning of January.

Both sides say the joint four-month suspension – effective from 4 March – will “ease the burden on industry”, adding that the intention

is to take a “bold” step towards resolving the Airbus-Boeing dispute.

“This will allow time to focus on negotiating a balanced settlement to the disputes, and begin seriously addressing the challenges posed by new entrants to the civil aviation market from non-market economies, such as China,” they add.

\$7.5bn

Tariffs US government was authorised to levy on EU exports by WTO; EU was granted counter-tariffs of \$4 billion

Under WTO rulings the US government had been authorised to impose \$7.5 billion of tariffs on European exports, including civil aircraft, while the EU had subsequently been granted a counter-authorisation for \$4 billion worth of tariffs.

Suspension will benefit these industries and “allow for focused settlement negotiations” in an effort to end the spat.

The US move was replicated the following day by the EU, which also agreed to a four-month

suspension of tariffs on aircraft and non-aircraft imports.

European Commission president Ursula von der Leyen says she held a phone call with President Biden on 5 March, stating that she considers the suspension of tariffs a “symbol of [a] fresh start”.

“We both committed to focus on resolving our aircraft disputes,” she adds. “This is excellent news for businesses and industries on both sides of the Atlantic, and a very positive signal for our economic co-operation in the years to come.”

Trade commissioner Valdis Dombrovskis describes the measure as a “reset” in the EU's relationship with its “biggest and economically most-important partner”.

“This suspension will help restore confidence and trust, and therefore give us the space to come to a comprehensive and long-lasting negotiated solution,” he adds.

Necessary steps

Airbus has long argued that a negotiated settlement is necessary to end the dispute, with chief executive Guillaume Faury reiterating this point at the airframer's full-year results briefing in February.

“We welcome US Trade Representative's decision to suspend tariffs for allowing negotiations to take place,” says Airbus in response to the new measures.

“Airbus supports all actions to create a level playing field and continues to support a negotiated settlement of this long-standing dispute to avoid lose-lose tariffs.”

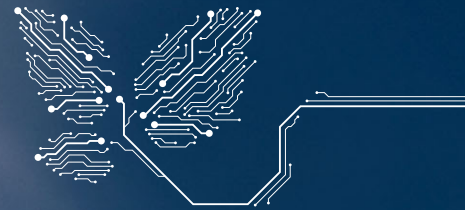
Boeing is similarly encouraged by the thaw in relations. “A negotiated settlement will allow the industry to move forward with a genuinely global level playing-field for aviation,” the airframer says.

If the hiatus leads to a broader settlement of the Airbus-Boeing dispute, the UK government says it will benefit the country's aerospace industry as well. “The government reserves the right to re-impose tariffs at any point if satisfactory progress towards an agreeable settlement is not made,” it says. ▶



F. Lancelot/Airbus

Airbus exports to US carriers have been affected by tariffs in WTO dispute



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Trio get connected for electric aircraft project

Norwegian carrier Wideroe joins forces with Rolls-Royce and Tecnam to bring zero-emission flight to domestic market

David Kaminski-Morrow London

Norwegian regional carrier Wideroe has linked up with Rolls-Royce and Italian manufacturer Tecnam to develop an all-electric passenger aircraft within the next five years.

The aircraft would be suited to the commuter air transport market and enter service in 2026.

Wideroe has previously expressed interest in electric regional aircraft projects such as a 19-seat model proposal from Heart Aerospace.

Norwegian authorities have been pushing forward electric aircraft programmes with the country's air navigation service and civil aviation administration, seeking domestic operations with such types by 2030 and a complete domestic transition to electric air travel by 2040.

R-R says its tie-up with Wideroe will expand on its prior research with the airline on sustainable aviation, while it already has a partnership with Tecnam on an all-electric programme called the P-Volt.

The P-Volt is a twin-engine, high-wing aircraft based on Tecnam's P2012 Traveller, which will be

capable of carrying nine passengers and serve commercial, cargo or medical evacuation roles.

Wideroe chief executive Stein Nilsen says the short take-off and landing airports in Norway are "ideal" for zero-emission technology.

"This aircraft shows how quickly new technology can and will be developed, and that we are on track with our ambition of flying with zero emissions around 2025," he says.

Chief strategy officer Andreas Aks says the regional carrier is "humble" in the face of the obstacles it will

need to overcome in putting such an aircraft into service.

"Our mission is to have all-new capabilities, processes and procedures required for a zero-emissions operator, designed and approved in parallel with the aircraft being developed and certified," he says.

The interest in the P-Volt, notably from regional airlines, has been "incredible", says Tecnam product development chief Fabio Russo, adding that the aircraft will "perfectly fit" the scope of the programme.

R-R Electrical director Rob Watson says the tie-up will reinforce its partnerships with both Wideroe and Tecnam, respectively focusing on airline requirements and the design and manufacturing aspects.

Separately, R-R has been appointed by UK start-up Vertical Aerospace to provide a full-electric powertrain for its VA-X4 electric vertical take-off and landing vehicle.

R-R will be responsible for the architecture of the electrical propulsion system and the power distribution and monitoring system. ▶



All-electric P-Volt is based on Tecnam's P2012 Traveller

Rolls-Royce maintains exclusivity on A350

Rolls-Royce has secured an exclusive position on the Airbus A350-900 for the remainder of the decade, ruling out any immediate prospect of a rival engine manufacturer entering the market for twinjet.

The agreement means the Trent XWB will remain the sole powerplant on the A350 until at least 2030.

R-R's chief executive Warren East, speaking during a full-year results briefing on 11 March, said there was a "huge amount of speculation" about a year ago around GE Aviation offering an engine for the A350.

"We're delighted to put that speculation to bed for the remainder of this decade," he says.

Airbus had previously played down any suggestion of a new engine option for the A350, stating that it

often held talks with powerplant manufacturers on potential developments but that there were no plans to offer an alternative to the Trent XWB.

East notes that, by the time the exclusivity agreement expires, engine technology will have evolved to a new stage.

R-R is working on the UltraFan high-bypass engine, which is progressing towards final assembly this year, and East says the 2030 date for the A350 agreement "coincides" with the timing of UltraFan and other future developments.

Airbus has 745 orders for the A350-900 and 168 for the larger -1000, which is also exclusively powered by the Trent XWB.

Airframer expects domestic and regional traffic to recover faster than other sectors



ATR confident on long-term demand

AirTeamImages

Manufacturer predicts brighter future for twin-turboprop family as it lines up series of incremental improvements

Dominic Perry London

Regional aircraft manufacturer ATR sees sustained long-term demand for its family of twin-turboprops, even if orders and deliveries will stay subdued over the next few years.

The Franco-Italian airframer is continuing to develop upgrades for its range, including both entirely new variants and incremental improvements.

Fabrice Vautier, senior vice-president, commercial, said during a 15 March media roundtable that a coming replacement cycle should spur demand: ATR forecasts that 900 turboprops in the 30-50-seat category are due for replacement in the next five to seven years.

Vautier sees additional growth from key markets such as India and Japan, and also China, where the airframer expects to achieve certification for the ATR 42-600 and ATR 72-600 in the first half of 2021.

China will require 1,100 regional aircraft over the next 20 years, around 800 of which will be in the 30-seat category that could be addressed by a lower-capacity ATR 42-600, says Vautier.

Describing 2020 as a “very difficult year” during which “ATR reached its bottom”, chief executive Stefano Bortoli says that difficulties remain.

“Air travel is still very restricted and will remain so well into this year. Airlines are still strapped for cash and many are struggling to survive,” he says.

Nonetheless, ATR’s “backlog is solid” he says, pointing out that just three cancellations were recorded last year, all from the same customer. Net orders also stood at three.

Flooded market

Joint shareholder Leonardo recently complained that a glut of used aircraft had flooded the market in 2020, hindering new sales.

Although Bortoli says it will “take a while” for this inventory overhang to fully clear, he sees the second-hand market as “vibrant”, adding: “I’m confident that this wave in the next few months will be absorbed by the market.”

Deliveries in 2020 included the first ATR 72-600F for FedEx; this will be followed by seven examples this year, says Bortoli. US approval for the freighter was obtained earlier in 2021.

Work is also continuing on a short take-off and landing variant of the ATR 42-600. The certification timeline for this model is currently “under assessment”, says Bortoli. Launching the variant in 2019, ATR said deliveries would begin in the second half of 2022.

The airframer also continues to work on incremental improvements for the twin-turboprop family, says Stephane Viala, senior vice-president, engineering. These include avionics and other upgrades designed to improve efficiency and cut maintenance costs, he says, such as a new system designed to analyse hard landings in order to reduce aircraft on ground situations.

C Check intervals will also shortly be extended from 5,000h to 8,000h, he adds.

While ATR continues to investigate ways of lowering the carbon emissions from its aircraft, Viala notes that disruptive technologies such as hydrogen power “are not yet mature” and will likely not arrive much before 2040.

Instead, the airframer is asking “what are the technologies that are mature enough to be onboard our aircraft in an incremental manner to bring these rapidly to our customers along this period.”

Sustainable aviation fuels (SAFs) are seen as one possibility. ATRs can operate with a 50% SAF blend and the airframer will look to increase this figure as supplies improve.

Airbus, ATR’s other shareholder, has been a vocal champion of hydrogen, last year unveiling a design for a hydrogen-powered turboprop as part of its ZeroE initiative. However, Bortoli declines to say whether ATR will be brought into this effort. “It is a question that Airbus can answer,” he says.

Last year, ATR delivered only 10 aircraft as the coronavirus pandemic caused demand to nosedive. Although the airframer hopes to double that figure in 2021, “we see delivery rates recovering gradually”, says Vautier.

Shipments will be “consistently over 20 aircraft for the next couple of years”, and could rise to “40-50 aircraft per year, as soon as the market recovers”, he says.

Domestic and regional traffic should show the fastest improvement of any sector, says Vautier, noting that around 85% of the ATR fleet is currently in service. ▶

See page 24



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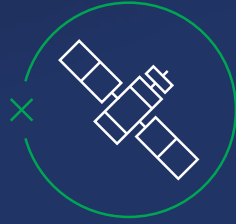
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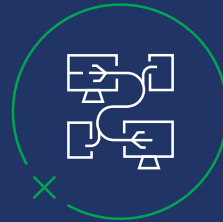
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Bell's unlikely revolutionary

Dominic Perry London

Mitch Snyder appears relaxed, confident even. Of course, it is hard to be sure over a blurry web meeting, but the Bell chief executive, now into his sixth year in charge, definitely seems upbeat.

That sunny outlook comes despite the pressures of the coronavirus, which saw deliveries slip at the US manufacturer last year – albeit that its civil and parapublic market share increased. Orders, while reduced, did pick up in the final quarter, he says.

But Snyder argues that what he saw from his company in the face of the Covid-19 pandemic is in part responsible for his positivity.

Lockdowns, working restrictions, and all the other attendant disruptions have been handled with aplomb. Maybe this was a manifestation of the “don’t mess with Texas” attitude of Bell’s home state, or simply a determination to support its customers, the “warfighters and first responders” as Snyder puts it.

Equally, there appears to be a degree of paternalism in Snyder’s management style. He is a long-term Bell veteran, joining in 2004, who had seen employee numbers effectively halve from a high of 12,000 down to around 6,000 when he took the reins.

In his five years as CEO, Mitch Snyder has been attempting to spark a cultural shift at the rotorcraft manufacturer

“When I took over, it was in kind of a tough place,” he says. “We had had so many reductions in force.”

Yet the first meeting he had on taking the top job was with representatives of the company’s four main workforce unions. “They said it was the first time they had been in the CEO’s office,” he remembers.

That rapprochement with the unions was part of a broader attempt to change the company’s culture, he says – for example, instituting a working pattern that sees employees have every other Friday off, and introducing an on-site health-care clinic. He describes the moves as fostering “a culture of empowerment, a culture of caring”.

Open for business

All that meant that when Bell said it was an essential business and was allowed to stay open through the pandemic, the workforce was on-side with the decision. “Everyone bought into what we were doing. We have been building that trust and respect over the last four to five years,” he says.

Snyder is loath to criticise the approach taken by his predecessor,

John Garrison, simply noting that the relationship between management and workforce in the 2009-2015 period “may have caused some hard feelings”. But he says that fostering a more inclusive atmosphere is “something I care very much about”, part of showing that he is “a different leader”.

“For me there is no difference between salaried workers and factory workers,” he says. “I knew the culture I wanted and how I wanted [Bell] to be.”

There was no formal interview process for the top job: the succession planning at parent company Textron saw Snyder simply offered the role on Garrison’s resignation.

“But having been here [since 2004] it was very clear in my mind what direction I wanted to take the company in when given the reins.”

But hand in hand with the changes to the workplace, Snyder was also keen to bring back Bell’s boundary-pushing spirit: “I wanted our company to go back and get excited about the future: we are pioneers and innovators.”

Bell’s list of accomplishments is legion, of course – the supersonic



Air taxi concept Nexus was launched in 2019 as the company explores UAM designs



Snyder says Bell should have 'a culture of empowerment, a culture of caring'

X-1 being the most famous. But over the years it felt like some of that pioneering spirit had withered away. Sure, there was the V-22 developed with Boeing; but, aside from that, Bell seemed to have become a little staid. It was too cautious, too reliant on the US Department of Defense to keep sales just ticking over.

Snyder's approach has undoubtedly been different. First, an automotive industry-aping concept helicopter, the FC-X, was revealed. Then Bell became the first aerospace company to exhibit at the Consumer Electronics Show. And next came Nexus, as the company's futuristic approach to the urban air mobility (UAM) segment was unveiled.

And if that was not enough, the word "helicopter" has been erased from the company's name, part of a rebranding effort that Snyder has instituted to transform Bell into what he describes as an "innovative technology company".

So, rather than drawing comparisons with Sikorsky or Airbus Helicopters, Snyder wants to be benchmarked against tech giants such as Google or Apple: "I want to be a disruptor," he says.

"I really don't compare myself and look at those guys that much," he says of his traditional rotorcraft rivals. "We don't compare our strategy and vision against what they are doing."

Long-term outlook

While that might sound arrogant or dismissive, it is not meant as such – you know that Snyder will feel it sting like lemon juice in a cut should Bell lose a contest to one of its rivals – simply that his goal is to reposition the company for the long term.

That outlook colours Bell's product strategy too. Snyder says he wants to get away from the creative straitjacket imposed by traditional thinking about what a manufacturer's range should look like: spanning a short-light-single at one end to a heavy-twin at the other, plus everything in between.

"The days of going through each of the versions and breaking down

the whole rotorcraft business into each of those segments is not how I'm looking at it."

Spend too long trapped with this rigid mindset, he says, and all that will happen is the "disruptors will come in and take everything".

Just recycling?

Even when an airframer brings a new type to market, that generally serves as a replacement for an existing product – "recycling in the new", as Snyder puts it, rather than spurring new growth.

The real question Bell is striving to answer, he says, is "in 10 years, what will the market really look like?"

There is, he argues, potential for significant growth if demand for unmanned logistics and UAM vehicles takes off. Bell has been positioning itself for both, test-flying its Autonomous Pod Transport and working on its Nexus air taxi concept.

Nexus, launched in 2019, has yet to transform into a true development programme, however. Bell has several options on the table: full- or hybrid-electric powertrains, plus an architecture that uses four or six ducted fans, depending on the range or payload required. Further variations are also in the works as the airframer tweaks the concept.

"We are evolving that electric flying vehicle," says Snyder, "but it's not the product that is going to market. Right now, for us, Nexus is our way of saying that we have an advanced air mobility system."

Snyder is also coy as to whether Bell will actually fly a demonstrator. There is, he says, "no firm date" for a first flight and instead it is "concentrating on different aspects" of the design. He also points out that with as yet no roadmap in place from the US Federal Aviation Administration (FAA) towards certification for such vehicles, it remains difficult to finalise any design.

For all Snyder's push towards innovation and his embracing the

"Right now, for us, Nexus is our way of saying that we have an advanced air mobility system"



V-280 Valor military tiltrotor could form basis for new civil model if selected by US Army

» Silicon Valley ethos - where a willingness to fail is seen as a vital part of the development process - that sounds awfully like the sort of cautious approach a regular aerospace business might espouse.

It is a tricky line to walk, though: do you rush headlong like others are and promise service entry over the next few years, or instead adopt a more incremental, wait-and-see approach?

As Snyder views it, there is little point being first to market if your vehicle cannot actually be used for its intended purpose.

"Just think about how long it has taken and how much it has cost to get the latest rotorcraft certificated. I don't think the FAA or EASA will change much here."

And this is where Bell's pedigree and history are very much to its advantage: while start-ups may still be "figuring out" how to navigate the regulatory landscape, "we have been doing it for 85 years: we know how to talk to the FAA", he says.

Of course, the UAM market may not fully blossom for a decade or more. Snyder is under no illusion that the traditional helicopter will remain relevant for some time yet "unless there is a huge [technological] breakthrough" that allows new

vehicles to match the payload and range of current rotorcraft.

Therefore, unless Bell wants to cede market share over the next 10 years, keeping its current range up to date is still necessary.

Over the years, a product refresh has usually involved a new avionics suite or an improved engine; witness for example the iterative development of the 412, a helicopter that entered service 40 years ago but which has progressively gained a Scrabble bag of letters

after its model number - from SP, to HP, EP, EPI and EPX - and still remains relevant.

While this will still undoubtedly happen somewhere in Bell's range, there are signs that more disruptive upgrades are also being contemplated by the company.

For instance, Bell has since 2019 been flying an electrically-driven tail rotor system called EDAT aboard a modified 429 light-twin. That effort has allowed the company to prove both that the technology works and that it delivers the predicted benefits, particularly around lower noise levels.

Snyder is keen that EDAT is brought to the market, but remains tight-lipped on how this might be done, beyond teasing that "we are working on definitely incorporating that into a product."

Next to come through will be the 525 super-medium-twin. The Relentless has had a rocky time in the decade since it was launched, including a fatal crash and a schedule that has slipped ever further to the right. All things being well, it should finally enter service this year or next, although Bell is still declining to offer a firm timeline (partly because the speed of approval hinges on the FAA).



Snyder: 'I want to be a disruptor'

“Just think about how long it has taken to get the latest rotorcraft certificated. I don’t think the FAA or EASA will change much here”

The 525 should be a hugely capable helicopter once it is finished – the first civil rotorcraft with fly-by-wire controls – but overcapacity in the oil and gas segment, one of its key target markets, raises the question of how strongly it will sell.

While Snyder says the 525 will be a “fantastic helicopter” in its own right, its genesis is enmeshed with Bell’s overhaul of its design and manufacturing processes. That change “laid the groundwork” to enable the airframer to “go fast” on other projects: notably the V-280 tiltrotor and 360 Invictus (the latter also leverages the rotor system from the Relentless).

Those two designs are competing in a pair of US Army contests

– to acquire Future Long Range Air Assault and Future Attack Reconnaissance Aircraft, respectively – as the service bids to modernise its rotorcraft inventory with high-speed aircraft under its Future Vertical Lift (FVL) initiative. As you might expect, Snyder is confident about victory in both, declining to discuss a hypothetical situation where Bell wins neither: “I don’t ever think about not winning,” he says.

Market competition

But winning one contest, let alone both, is hugely important: thousands of airframes will be required for the domestic market, with export opportunities a given, not to mention lengthy service and support

contracts. Plus, a commercial derivative of either design becomes financially so much easier when you already have an extremely strong sales base on which to build.

Nonetheless, Snyder says there are plenty of options for its next civil helicopter regardless of what happens in FVL, including the potential for a clean-sheet design – it has ideas in the works, he says – or even something in the UAM space.

“There are whole bunch of other things in development that we haven’t shown yet,” he says.

But ultimately this will be driven by what his customers want, he says. And that, in turn, may well hinge on what the public want, or “how people in the future want to move in a clean world”.

With traditional rotorcraft designs to remain relevant even as new markets for alternative architectures emerge, having both “covered off” will stand Bell in good stead, Snyder says, even if things do not pan out quite as planned.

“It could look different, but these are exciting times now.” ▶

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ATS has the Wright stuff

Boeing Australia's first flight of an unmanned combat demonstrator three years after project launch has invigorated the nation's aerospace sector

Greg Waldron Singapore

The maiden sortie of Boeing's Airpower Teaming System (ATS) 'loyal wingman' was a historic occasion for the Australian aerospace sector, and also symbolises the changing nature of aerial warfare.

Conducted at the Woomera test range in South Australia on 27 February, the debut flight happened two years to the day after a mock-up of the ATS was unveiled at the Avalon air show in 2019. More impressively, the sortie took place just three years after the programme – a joint effort between Boeing Australia and the Royal Australian Air Force (RAAF) – kicked off.

Boeing provided few details about the flight itself, other than to say that the prototype taxied autonomously, took off, conducted a pre-set flight plan, landed, and taxied back to its original parking area. An RAAF video suggests the landing gear was not retracted for the entirety of the flight, the duration of which was not stated.

RAAF capability head Air Vice-Marshal Catherine Roberts declared the flight nothing short of a "Wright brothers" moment for Australian industry. The unmanned ATS is the first combat aircraft to

have been designed and built in the country for more than half a century, following the Commonwealth Aircraft Corporation's Second World War-era piston-engined Boomerang fighter.

Initially, Canberra invested A\$40 million (\$30.1 million) in the programme and Boeing an undisclosed amount. This was to provide for the design and development of three prototypes. Immediately following the first flight, Australia announced that it would spend a further A\$115 million on three additional examples.

2,000nm

Stated range of Boeing's unmanned Airpower Teaming System – 500nm more than the Lockheed Martin F-35A

With a length of 11.5m (38ft), the ATS is roughly the same size as the McDonnell Douglas A-4 Skyhawk. The aircraft is powered by a single engine that Boeing declines to identify, referring to it only as a "commercial turbofan". The aircraft will use artificial intelligence (AI) to perform operations and team with other manned and unmanned assets.

According to Boeing, the ATS has a range of 2,000nm (3,700km) – 500nm more than the Lockheed Martin F-35A now flown by the RAAF. This endurance doubtless reflects the great distances that its combat aircraft would need to traverse should a conflict break out in North Asia, where host airfields are relatively few.

The front of the aircraft is essentially a large payload station, where different noses can be swapped in and out, depending on the mission. Applications will include intelligence, surveillance and reconnaissance (ISR).

The aircraft's wide fuselage and centre-mounted engine also hint at there being ample space for weapons bays beneath the wing, but Roberts is non-committal on priorities for weapons integration and testing.

"I think there are obvious roles [for the loyal wingman] in terms of ISR," she says. "But we do talk about this being an air combat teaming system... in terms of having levels of kinetic and non-kinetic effects. [It's] not just ISR, but weapons and non-kinetic effects will be things that we look at with this particular programme."

The aircraft has a 'digital twin' which facilitated its rapid development. According to Shane Arnott,

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Unmanned 'loyal wingman' has been developed for Royal Australian Air Force

Commonwealth of Australia

Boeing's programme director for the ATS, that virtual aircraft has already advanced far beyond its "first flight", racking up 10,000 virtual hours.

"We have been undertaking exercises, advancing the autonomous decision-making capabilities of the airplane in a future environment, and working with the Royal Australian Air Force in the classified threat environment to look at what's coming next and making sure that we're ready for that," says Arnott.

Production system

Boeing has not specified the exact location where the ATS was designed and built, but has said it is near Brisbane, where the company has an extensive presence. In addition to constructing the prototypes, the work involved developing a production system to assemble the

aircraft, which includes high levels of automation.

Arnott stresses that the ATS was not built like a typical prototype, where a team of highly skilled engineers assemble an aircraft manually.

"We've actually designed a real production system here, which includes quite a lot of automation and advanced manufacturing," he says. "The vast majority of this aircraft is assembled by robotics and advanced techniques, so we're proving out that future factory right now."

Malcolm Davis, senior analyst, defence strategy and capability at the Australian Strategic Policy Institute, contends that the ATS marks a step change for the country's aerospace industry.

"This is a potentially transformative moment for Australia's aerospace sector in the sense that Australia has demonstrated an ability to design, develop, build and fly a clean-sheet combat aircraft - not just make components, but the complete platform, in just three years," he says.

"At this point it is simply incorrect to argue that Australia cannot design and build complex military systems - be they UAVs, advanced long-range missiles, or other military combat platforms."

Some 35 other companies also are involved in the work, including BAE Systems, Flight Data Systems, Microelectronic Technologies, RUAG Australia and Sperry Engineering.

Boeing's emphasis on ATS is not just focused on RAAF requirements, but on the US Air Force's (USAF's) Skyborg initiative, experiments for

which will begin in mid-2021. Broadly, Skyborg sees the development and fielding of relatively inexpensive unmanned aircraft powered by AI, teaming with other manned and unmanned assets.

Pricing is a key metric. The USAF suggests that such aircraft will need to be priced from \$2-20 million to be deemed "attritable". The service's Skyborg effort has also attracted interest from General Atomics Aeronautical Systems and Kratos Unmanned Aerial Systems.

Formal acquisition

Should the ATS move beyond experimentation work and become a formal acquisition programme for Australia, Roberts is hesitant to state how many the RAAF might purchase, but states that a buy would be about "getting mass into our force mix". Acquisition numbers would be largely dictated by how well the platform teams with other aircraft and its effectiveness.

"Quantity has a quality all of its own, so swarms of low-cost loyal wingman-type platforms can exploit numbers (mass) to generate military effect in a more cost-effective manner than risking a small number of very expensive and very advanced F-35As," says Davis. "One of Australia's key problems is lack of combat sustainability. It has insufficient forces to sustain high-intensity operations - with all the risks of combat losses - for very long."

Davis believes that greater use of automation across all the realms of combat - air, land and sea - will greatly enhance the effectiveness of Australia's defence forces.

But much work remains to be done with ATS following its successful debut. Arnott says a full flight-test programme is planned for this year, and that trials will include not just the first prototype, but follow-on examples. A major emphasis of the testing will be teaming between the ATS aircraft, as well as manned platforms.

"[It's] the first time we've actually developed an aircraft using a collaborative capability model from an early concept to first flight in just three years, which is a remarkable timeframe," Roberts notes.

"There is no better time to be involved in a project like this," she says. "It reminds me of the Wright brothers and what they would have experienced." ▶



Canberra has so far funded the construction of six ATS vehicles

Boeing Australia

Leonardo eyes structural reset

Italian group navigated 2020 with minimal damage, but exposure to commercial aviation has hit one division badly

Dominic Perry London

Considering the chaos in the world in 2020, Italian aerospace champion Leonardo emerged from the year in relatively decent financial health, having turned in a “robust and resilient” performance.

Revenues slipped, but only by 2.7%, to €13.4 billion (\$16 billion), with orders also marginally down year on year, falling by 2.5%, to €13.7 billion. EBITA saw a sharper fall, however, down by 25% to €938 million from €1.2 billion in 2019.

But against the horrendous losses seen elsewhere in the industry, Leonardo’s staying in the black was a decent achievement.

Revenues and profits were maintained in all three of its core businesses: helicopters, defence electronics, and aeronautics.

But closer examination of the third of those segments shows that all is not well there. Aeronautics comprises two main revenue streams: military aircraft, such as Leonardo’s own M-345 and M-346, and its contribution to the Eurofighter and Lockheed Martin F-35 programmes; and aerostructures, where it has significant civil

exposure, including to ATR, Airbus and the Boeing 787.

Although revenues inched up in aeronautics, by 0.1%, all the other performance indicators went the other way: new orders were down 8.5%; order backlog was 8.1% lower; and EBITA plunged by 44.8%.

And separate out the figures for aircraft and aerostructures and it is clear where the problem lies.

€86m

EBITA loss at the company’s aerostructures arm in 2020

All the indicators moved in the wrong direction, registering double-digit falls, except for EBITA, which cratered by 682%.

EBITA performance at ATR – in which Leonardo holds a 50% stake – also plunged by 230%, to a €69 million loss. In comparison, the aircraft business saw EBITA grow by almost 11%, to €355 million.

Leonardo has been trying to turn around the fortunes of the aerostructures business for several years and was aiming to achieve

break-even in 2021. Losses in 2019 stood at €11 million, but ballooned to €86 million last year.

However, chief executive Alessandro Profumo, presenting the company’s 2020 results on 10 March, conceded that target has now been abandoned.

“We need to be realistic and recognise that due to Covid-19 our original restructuring plan working towards break-even this year is not achievable,” he said.

Operating losses are likely to worsen in 2021, says chief financial officer Alessandra Genco, as 2020’s total included a full quarter of full-rate production prior to the pandemic hitting, plus a one-off settlement related to the cancellation of the Airbus A380 programme.

The aerostructures arm is very exposed to production cuts in the ATR twin-turboprop programme and the 787, and, to a lesser extent, Airbus narrowbodies.

Leonardo builds fuselages for ATR at a plant near Naples in southern Italy, while it supplies 787 fuselage barrels and horizontal stabilisers respectively from sites in Grottaglie and Foggia in the country’s ‘heel’.

Boeing is sharply reducing output of the 787 from a high of 14 per

ATR hopes for better times after 2020 delivery crash

Turboprop joint venture ATR should hand over at least 20 aircraft this year as regional carriers begin a slow recovery from the Covid-19 crisis.

Deliveries in 2020 plunged by 85% year on year, to 10 aircraft, as the pandemic torpedoed demand. In addition, the airframer recorded just six gross orders for the twin-turboprop.

But Leonardo, a 50% owner of ATR alongside Airbus, sees a slight improvement this year: deliveries will be “at least double” 2020’s total, says chief financial officer Alessandra Genco.

However, that is well below the 68 aircraft shipped in 2019.

Losses from the programme will also be reduced this year, Genco says.

ATR’s backlog currently stands at 176 aircraft and the airframer continues to see “vibrant customer demand” despite the “very difficult context”, she says.

However, Genco notes that the closure of many smaller ATR operators due to the Covid-19 pandemic meant that a glut of used aircraft came onto the market, affecting demand for new examples.



FedEx received the first of 30 new-build ATR 72-600 Freighters last year



Company supplies fuselage barrels to the 787 programme from its site in Grottaglie

Leonardo

month in 2019 to five per month this year.

While Leonardo hopes that the Dreamliner production rate may climb again in 2022, it is in the interim analysing with Boeing the impact of the cuts on its Grottaglie plant “considering the costs we have in the site which is only devoted to the 787”, says general manager Lucio Valerio Cioffi.

But because of its position as single-source supplier of the 787’s horizontal stabiliser, more drastic action is unavailable, says Profumo.

“It is impossible to consider some of the options,” he says. “When you are sole source on the 787 you are sole source: without us the 787 does not exist.”

In Leonardo’s view, the “market for commercial aviation will not

recover quickly”, says Cioffi, an outlook which has pushed it to further restructuring of the aerostructures business.

Reduced headcount

The headcount will be reduced by around 1,000 positions – 500 through early retirement, and the balance through transfers and redeployment to other business units – and factories rationalised, says Cioffi.

In addition, production plants will also be diversified, for example building composite wings for the future multi-national EuroDrone military unmanned air vehicle at Grottaglie.

However, Cioffi notes that move will not solve the under-utilisation of the site in the short term: “We

are planning to do this even if the timing of the [EuroDrone] programme and series production will not be in our plant in the next two years,” he says.

Meanwhile, a revised agreement with Airbus on the production of vertical and horizontal stabilisers for the A220 should provide a profitability boost from the second half of 2023, says Cioffi.

That agreement has been finalised and is just waiting for the signature of both parties, says Profumo.

To support efficiency improvements promised by the revised contract Leonardo has “optimised” its Foggia site, says Cioffi.

It represents “our commitment to fix economic and financial performance issues” related to the programme, he says. ▀



Nonetheless, she says that the manufacturer’s position as “market leader” will be reinforced as “the other platforms that were competitors have somewhat disappeared from the scene”.

While Genco did not name the rival platform to which she was referring, earlier this year De Havilland Canada announced that it was pausing production of the competing Dash 8-400 at the end of the first half, once its current backlog is depleted.

Last year, however, De Havilland Canada out-delivered ATR, shipping 11 examples.

Leonardo builds the aluminium fuselage for each ATR 42-600

and ATR 72-600 at its factory in Pomigliano d’Arco near Naples in the south of Italy.

Lucio Valerio Cioffi, Leonardo general manager, says that the company is investing in automated manufacturing systems at the site, which will reduce by one-third the time taken to build each fuselage, aiding profitability.

He says ATR’s backlog is “based on strong customers”, pointing to freight carrier FedEx, which last year received the first of 30 new-build ATR 72-600 Freighters.

Leonardo also continues to work on “green technologies” that could provide “innovative solutions” for future ATR products, says Cioffi.



US Air Force

A Boeing B-1B underwent rapid 'hot refuelling' after its arrival in Powidz, Poland on 12 March

Fuelling uncertainty

Allies and adversaries should get used to the sight of pop-up bomber detachments in new locations, US Air Force says

Garrett Reim Los Angeles

US Air Force (USAF) bombers are touching down in new places. In February, for the first time ever, a Boeing B-1B landed in India, to participate in the Aero India show at Yelahanka air base near Bengaluru.

Late the same month, four of the supersonic type were temporarily deployed to Norway from Dyess AFB, Texas, for several weeks of training, which also included making a debut landing in Poland.

Expect more surprise visits from B-1Bs, Boeing B-52Hs and Northrop Grumman B-2s, General Timothy Ray, commander of Air Force Global Strike Command, said at the Air Force Association's Virtual Aerospace Warfare Symposium in February.

"We're just hitting our stride," he says. "More options are on the table. We're going to work them."

Such Bomber Task Force deployments, which typically start from air bases in the continental USA, mark a departure from the USAF's former practice of maintaining a continual presence at forward bases like Andersen AFB in Guam and RAF Fairford in the UK.

Into the paradox

The flights are part of the Department of Defense's (DoD's) new Dynamic Force Employment strategy, which realises a paradox: US forces should be strategically predictable, but operationally unpredictable.

"Predictable in the sense that our adversaries know if they cross a certain line we will respond, and we have the will and capability to do so," says Mark Gunzinger, director of future aerospace concepts and capabilities assessments at The Mitchell Institute for Aerospace Studies. "Unpredictable in the sense that an adversary will not know how, when, or where we might respond."

"We can be present in the theatre at almost any time, and adversaries can't necessarily predict that timing," says Caitlin Lee, a political scientist and an associate director for the Acquisition and Technology Policy Center at Rand Corporation. "That may put an element of caution into an adversary's decision-making about what it's going to do in its backyard."

But while such flights could dissuade China and Russia from using so-called "gray zone" tactics - a form of aggression that remains below a threshold where the USA and its allies would be likely to react - the unpredictability of Dynamic Force Employment has potential drawbacks. Allies accustomed to the routine presence of US bombers in their region need to be reassured of Washington's commitment to their defence. And the air force also must be careful that its deployments do not accidentally escalate tensions.

“The current training with the US Bomber Task Force will increase the level of our own forces to integrate and operate with our nearest allies,” says Lieutenant General Yngve Odlo, chief of the Norwegian joint headquarters.

“Since 2014, the security situation in Europe has changed quite dramatically,” he notes, referring to Russia’s annexation of the Crimea region from Ukraine. “This is a natural part of that, to be able to operate and defend our own territory.”

The DoD’s Global Operating Model is designed to allow the US military to swiftly react to aggression anywhere in the world. Intelligence, surveillance and reconnaissance aircraft and satellites can discover suspicious activity, while forward-deployed Lockheed Martin F-22s and F-35s are capable of surviving in contested airspace.

Bomber task forces would provide support, preventing an adversary from locking in any advances they may make before the USA can mount a full response.

“When we left the continuous bomber presence, and began to operate this way, it actually built our readiness because we’re not stuck in one place without great training resources for a long period of time,” Ray says. Noting that aircrew readiness is at its highest level in the command’s history, he adds: “The morale of the team is really high. They enjoy doing this.”

Effective statements

To underscore their unpredictable nature, bomber flights to foreign countries are periodic, and sometimes extremely brief.

“Several months ago, we put a couple of B-1s on the ramp at Prince Sultan air base [in Saudi Arabia], just for a few hours. That was a very effective statement,” says Ray. The quick show of force was seemingly intended to send a message to Iran.

Aircraft do not even have to land in an allied nation’s territory to make a statement, Gunzinger notes. In May, two B-1Bs from

Ellsworth AFB in South Dakota flew over the Black Sea, just south of the Russian border, alongside Ukrainian RAC MiG-29 and Sukhoi Su-27 fighters.

A B-1B’s arrival in Powidz, Poland on 12 March saw it undergo ‘hot refuelling’ – a practice which reduces an aircraft’s time on the ground and vulnerability to potential attack.

“Proving the rapid refuelling concept in Poland, working alongside some of our closest allies, speaks for itself,” says General Jeff Harrigian, commander of US Air Forces in Europe and Africa. “Our bombers can get after the mission anytime, anywhere.”

While it is high-profile, it is unclear whether the Dynamic Force Employment strategy will deter potential Chinese or Russian aggression more effectively than the USAF’s continuous bomber deployments of old.

“The million-dollar question is, does it work?” says Lee. “Does it change how the adversary sees US capabilities and intentions?” ▶

Online crackdown underscores Beijing’s desire for secrecy

Greg Waldron Singapore

In contrast to Washington’s deliberately high-profile strategic bomber deployments, Beijing has moved to rein in discussion about its military technology advances on domestic social media.

News of the crackdown was posted on a Weibo account associated with the *PLA Daily*: the official newspaper of the People’s Liberation Army.

“If you love national defence, you need a sense of confidentiality,” it admonished enthusiasts. “Whether it is intentional or unintentional, leaking classified information on the internet will do harm to the country and potentially lead to prison terms.”

A report in the nationalistic *Global Times* was equally blunt, warning enthusiasts “not to become tools of overseas intelligence agencies”.

It cited the appearance on social media of a weapon that has yet to enter service as having offered foreign intelligence agencies an easy coup.

Last October, a video was posted showing a Xian H-6N carrying what appeared to be an air-launched ballistic missile on its centreline. This followed speculation about a previously photographed modified concave section on the underside of the bomber’s fuselage.

Over the past decade, western observers have learned of – and followed – aircraft programmes

including the Chengdu J-20 fighter and Xian Y-20 strategic transport largely through local social media platforms such as Weibo and WeChat, and Chinese-language blogs.

Several accounts have recently been suspended, including one with four million followers.

Images and video footage of the stealthy J-20’s early test campaign at Chengdu airfield emerged online from late 2010, even before Beijing had acknowledged the type’s existence.

Over the course of several years, enthusiasts also used a window in Dalian’s Ikea store to photograph the conversion of the former Soviet vessel Varyag into China’s first aircraft carrier, the CNS *Liaoning*.



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Fix nears for PW1500G problem

Redesigned bleed-valve ducts scheduled to be introduced by end-2021 in wake of in-flight failures of A220 powerplants

David Kaminski-Morrow London

P Pratt & Whitney is aiming to introduce redesigned bleed-valve ducts for Airbus A220 engines by the fourth quarter of this year, to eliminate a resonance phenomenon linked to a series of powerplant failures.

Four instances of PW1500G low-pressure compressor stage-one rotor separation, affecting A220-300s being operated by Swiss and Air Baltic, occurred in the period between July 2019 and February 2020.

Engine parameters at the time of each failure, and the resulting damage, was “consistent” for all the events, says the US National Transportation Safety Board, which has completed an investigation into the first incident, involving a Swiss A220 (HB-JCM).

The aircraft’s left-hand engine failed as it climbed through 32,000ft over Perrigny-sur-Armançon in France while en route to London Heathrow. Examination of the twinjet after it diverted to Paris Charles de Gaulle revealed a hole in the low-pressure compressor casing and the stage-one rotor was missing.

Investigators conducted multiple tests, including computational fluid dynamic and acoustics analysis to identify the cause of the failure.

These tests identified a mechanically-coupled mode excitation between the stage-one and stage-three rotors of the low-pressure compressor, driven by an “acoustic coincidence” with the 2.5 bleed-valve duct cavity.

At high engine speeds in specific operating conditions, says the



Resonance phenomenon caused cracking of rotor blades in low-pressure compressor

inquiry, the low-pressure compressor rotor blade tips could cause turbulent airflow that generated an acoustic tone as it passed over this cavity, which is situated immediately behind the compressor.

Bending stresses

This tone excited a stage-three rotor blade bending mode which was then mechanically transferred, through the low-pressure compressor module, to the stage-one rotor – generating a bending mode in that rotor which exceeded the stress limits on its blades.

The stresses created cracks in the blade root and rotor which worsened until the rotor failed from overload.

Three of the A220 engine failures involved the PW1524 variant of the powerplant, while the other occurred to a PW1521.

Investigators determined that a software revision to the electronic engine control, which altered the compressor’s variable inlet guide vane schedule, increased the likelihood of blade-flutter onset.

Operating restrictions – including a thrust limitation at high altitude – were imposed on A220s in the aftermath of the engine failures to reduce the chances of the phenomenon being initiated, and amended engine-control software was also introduced to restore the original vane schedule.

But P&W is also modifying the geometry of the 2.5 bleed-valve duct, says the inquiry, in order to increase frequency margins and eradicate the problematic resonant response. The inquiry adds that the redesigned hardware is scheduled to become available by the fourth quarter. ▀

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Pipistrel goes into bat for hydrogen

More famous for its lightweight two-seaters, Slovenian airframer is now seeking a bigger challenge

Dominic Perry London

Slovenia's Pipistrel Aircraft, best known for its range of lightweight two-seaters, is nearing the launch of a new hydrogen fuel-cell- and battery-powered 19-seat hybrid that it hopes will revolutionise the commuter-category segment.

Dubbed the "Miniliner", the aircraft could enter service by 2030, the company says, and will offer a substantial cut in operating costs against current designs.

Pipistrel says the Miniliner will be able to perform short point-to-point services between cities, boosting connectivity for underserved locations, plus what it calls "microfeeder" flights into bigger hubs.

Power from the fuel cells will be sufficient for most departures, but batteries are provided to boost short-field performance, allowing departures from runways down to 800m (2,620ft). This, Pipistrel says, will allow access to 80% of Europe's airports.

While the company sees the optimum flight length as between 160-215nm (300-400km), the Miniliner will be able to fly for around 1,000nm on a single tank of liquid hydrogen.

Return missions

"It will be able to fly three return missions before you need to replenish the hydrogen fuel," says Tine Tomazic, Pipistrel chief technical officer.

Overall, the aircraft will have around 2MW of installed power, making it "quite sporty", he says.

Operating costs should be 40% lower than current CS-23-category commuter aircraft on a per-seat basis, says Tomazic: "We want this aircraft to be a money-maker, not just cleaner than today's airplanes."

Pipistrel's participation in two EU-funded research and technology programmes, MAHEPA and Unifier - the former including flights of a hydrogen fuel-cell-powered aircraft - have helped to inform the company's design and market analysis.

"We are taking select lessons from that and are putting the knowledge into an aircraft concept that we think makes sense based on how we see the market," says Tomazic.



19-seat 'Miniliner' is envisaged as operating short point-to-point services between cities

Although other developers have already demonstrated modest range capability using hydrogen powertrains retrofitted to existing airframes, Tomazic argues that the Miniliner's clean-sheet design sets it apart.

"We are making sure the airframe has all the attributes that the powertrain and batteries need; we are building it around the best elements of the new propulsion system," he says.

"We think we will have first-mover advantages because of our understanding of the powertrain."

Three different aircraft designs are currently being evaluated - each one of which features a different engine configuration, tail

shape and use, or not, of canards. However, the composite wing and fuselage remains the same for each design.

While details are being kept under wraps, Pipistrel says the Miniliner's main suppliers have been signed up, along with a pair of undisclosed airlines - one in France, the other in Ireland - that will serve as customer advisers for the programme.

Tomazic says the optimum maximum take-off weight will be around 8,500-9,000kg (18,700-19,800lb), potentially slightly above the 8,618kg upper limit for CS-23 aircraft.

But he is hopeful that Pipistrel's relationship and experience with Europe's regulator - not least through last year's world-first certification of the all-electric Velis Electro - will enable a slight relaxation of the rules.

"Even if we are down to the category limit, it does not make or break the product," he adds.

Programme launch

A programme launch is likely later this year, leading to a first flight in 2028 and service entry in 2030 or 2031, says Tomazic, although that could be accelerated if additional research and development grants are received.

In any case, the company is likely to seek external funding to help it bring the Miniliner to market - including expanding its production facilities in Ajdovscina, Slovenia, and Gorizia, just across the Italian border.

Pipistrel's analysis suggests there is a total market for around 1,500 aircraft in the Part 23 category; Tomazic says that "even a few dozen per year would be a good outcome".

Although Pipistrel's design and development experience is on small aircraft, Tomazic believes it will be able to make the step up to a bigger size class and to an all-new powertrain.

"Take into account that we have been present in electrification for a long time - possibly longer than most people - I think we have a pretty good understanding of where the complexities are and we are confident of how we are approaching them.

"We have always preferred our challenges to be bigger rather than smaller." ▶



Blue Barron Photo/Shutterstock

Research aims to deliver efficiencies for future aircraft, including 737 replacement

Engines stay core for NASA

US aeronautics agency launches effort to mature technologies for more fuel-efficient future powerplant

Jon Hemmerdinger Tampa

NASA has launched a research effort aimed at squeezing 5-10% more fuel efficiency out of turbofan cores, with the goal of developing engines for future commercial aircraft, possibly including an eventual Boeing 737 replacement.

The agency launched the \$191 million effort, called Hybrid Thermally Efficient Core (HyTEC), about one year ago with the goal of developing a “high-power-density” turbofan core.

Such a core could benefit single-aisle aircraft entering service in the “early 2030s”, according to NASA documents.

HyTEC’s other goals include increasing an engine’s bypass ratio to 15% – up from around 12% today – and its pressure ratio to about 50%. In addition, it seeks to demonstrate

that 10-20% of a turbofan’s power can be extracted as electricity.

That last goal can enable “more-electric” aircraft, meaning traditional aircraft systems – typically those using pneumatic or hydraulic actuation – are replaced with lighter, simpler electric systems that are also easier to maintain.

Efficiency target

“We do think we can make a pretty big jump in fuel burn... by making the core smaller,” says HyTEC project manager Tony Nerone. “This is all targeted toward the future aircraft – eventually, a replacement for the 737, in 10-plus years.”

Nerone clarifies that NASA is not working with Boeing on the project. Partners will primarily include engine companies, and technology developed could benefit all aircraft makers, not just the US airframer.

NASA has, however, lined up GE Aviation and Honeywell as partners,

and in February issued a draft request seeking more industry collaborators. The agency hopes to split HyTEC’s cost with partners.

Boeing has not disclosed any firm plans to develop a new commercial aircraft but has said it is examining whether to launch a mid-sized jet. However, the timing remains uncertain owing to factors including the pandemic, though some analysts suspect the Chicago-headquartered airframer might aim to bring a new aircraft to market in the early 2030s. Airbus will also, at some point, need to develop a replacement for its A320neo-family aircraft.

The HyTEC team aims to build and demonstrate advanced turbofan cores by the end of 2026. “The engine companies would take it from there,” Nerone says.

He thinks HyTEC’s findings, combined with other engine improvements, could enable the next

turbofan to be up to 20% more efficient than current models.

HyTEC is among several projects within NASA's Advanced Air Vehicles Program. Other initiatives include the development of truss-brace wings, high-rate composite manufacturing technologies, and electric propulsion, Nerone says.

The project remains in a "formulation stage", meaning aspects could still be tweaked. But Nerone expects HyTEC will become an official NASA project this summer, following a high-level review.

Shrinking a turbofan's core increases its bypass ratio, which improves efficiency. But engine makers have already reduced core size as much as possible with available technology. They will need new materials and designs to make further improvements.

Shrinking a core is not as easy as just reducing the size of components. Smaller cores are hotter, meaning engineers must use advanced materials that are more heat

resistant and less subject to expansion. They are studying ceramic matrix composites and advanced coatings, developing cooling techniques and working to ensure smaller blades and vanes can handle stresses. Gaps within the core – such as those between blades themselves and the blades and the housing – also present challenges.

Negative effect

"If you make the blade half the height, and have the same clearance, that clearance has a much more negative effect," Nerone says. "You have to find a way to shrink that clearance the same percent you shrunk the blade.

"This is going to take some pretty significant technological jumps to make it happen," he adds.

HyTEC's work with Honeywell includes low-pressure turbine technology development, followed by turbine tests to take place in 2022 at NASA's Glenn Research Center in Ohio, Nerone says.

Those tests will help NASA build models and other tools that will aid demonstrations with GE that are scheduled to take place in about three years, also at Glenn. The GE work will involve testing how an engine operates with 10-20% of its power extracted as electricity.

"If we can demonstrate 20% [extraction] we are opening the door for hybrid and electric technologies down the road," Nerone says.

By comparison, Boeing 787s draw approximately 5% of engine power as electricity.

NASA views HyTEC as critical to helping the USA secure an engine-technology lead amid increasing aerospace competitive threats, including those from China.

"Our goal with this project, and this subsonic strategy in general, is to really strengthen US industry in this field," says Nerone. "Working with industry, [we] can make sure that the US industry does maintain that leadership, and that our engines and our aircraft are the best." ■

Safran spools up research into 'disruptive' propulsion

Dominic Perry London

Meanwhile, Safran and GE Aviation, its partner in the CFM International joint venture, are preparing the technologies required for a next-generation commercial aircraft engine – expected to enter service in the mid-2030s – that would cut fuel burn by more than 20%.

Olivier Andries, Safran chief executive, says that the French aerospace group wants to "be at the forefront" of aviation's efforts to address climate change, directing around 75% of its research and technology spending to this topic in the coming years.

Propulsion will play a key part, he said during a full-year results briefing in late February, and work is under way on a future project.

"Together with our partner GE we are already preparing and maturing the technologies for a next-gen engine for a next-gen aircraft [to arrive] around mid-next decade – 2035."

To reach the "significant" fuel-burn and emission reductions required, Safran is working on "disruptive technologies and architectures", says Andries.

Although declining to offer details, Safran has previously demonstrated an open rotor design for a future engine, and Andries says that the company will "capitalise" on that work. The demonstrator

featured twin counter-rotating fans and was sized to deliver 10t of thrust with a bypass ratio of 30:1.

A next-generation engine will offer a fuel-burn improvement of "over 20%", he says, and be able to burn 100% sustainable aviation fuel (SAF); current CFM56 and Leap powerplants can burn up to 50%.

To encourage the uptake of SAF, the European Commission is considering proposals to mandate

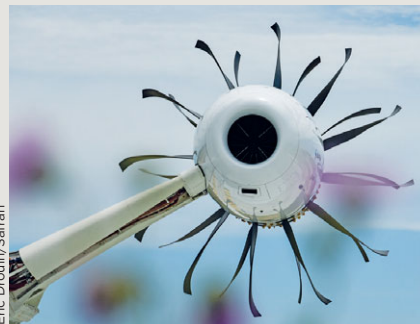
that all airlines operating flights in Europe use a "certain percentage" of SAF. However, it is undecided whether this will only apply to short-haul flights.

In addition, Safran is working on electric and hybrid-electric propulsion for smaller aircraft to enable the company to "become world leaders in this segment".

Safran has also secured a credit line of €500 million (\$600 million) from the European Investment Bank (EIB) to fund research into "innovative propulsion systems" for the next generation of single-

aisle airliners. To be carried out predominantly in France, the project has four main goals, says Safran: maximise propulsion efficiency; optimise energy management; develop disruptive technologies; and integrate them into aircraft.

The EIB credit line is available from now until September 2022 and will have a maturity date of up to 10 years. Safran in 2009 received €300 million from the EIB to help develop the CFM Leap engine.



Eric Drouin/Safran

Company has demonstrated an open rotor design featuring twin counter-rotating fans

Friction in European fighter pact

Dassault chief unhappy with workshare details after Spain's inclusion in French-German combat aircraft development

Dominic Perry London

Workshare and project management concerns are threatening to derail the launch of the next phase of the Future Combat Air System (FCAS) being developed by France, Germany and Spain.

Dassault Aviation chief executive Eric Trappier says there are a "lot of hurdles" preventing an agreement between the nations to launch Phase 1B of the FCAS programme.

In this effort, Dassault is leading the development of a New Generation Fighter (NGF), with Airbus Defence & Space as junior partner.

While initially a bi-national initiative between France and Germany, the inclusion of Spain last year has complicated the division of workshare, Trappier said during a full-year results briefing on 5 March.

France is represented by Dassault, while Airbus represents both Germany and Spain. That has led to a dilution in Dassault's workshare from an original 50% to 33%, while Airbus now has 66%.

Trappier says he has "accepted" that reduction, but believes it is essential that the "roles are distributed well" for the project to function properly.

If the one-third formula is applied to "even the strategic work packages", an agreement will be harder to reach, he cautions.

"If I am told there is no leader in flight controls it cannot work," says Trappier. If responsibilities are handed to Airbus solely to satisfy national workshare concerns "then it becomes difficult for Dassault to play the role of the prime contractor".

Intellectual property

Airbus accepts Dassault's lead role, he says, but that is not necessarily the case between the three partner nations. That also applies to demands for shared intellectual property, he adds. "It is not between Airbus and Dassault, it is between the states."

At present a single NGF demonstrator is planned, based on a Rafale fighter, but in order to preserve design capabilities German unions have called for a second aircraft to be built, using a Eurofighter.

While Trappier says he has no issue with the idea of a second demonstrator aircraft, he points out it would be built on the same production line and to the same specification as the original example.

At a technical level, the French industrial partners in the FCAS effort - Dassault, Safran, Thales and

missile manufacturer MBDA - could in theory construct their own future fighter, but "the real question, the real challenge is efficiency", he says.

"We are working together to be more effective, not for the fun of it."

Despite the challenges, Trappier remains confident in the FCAS programme: "I don't think that it is going to die soon, but I cannot say that the [project] is not at a difficult stage. That is where we are, but I still believe in it."

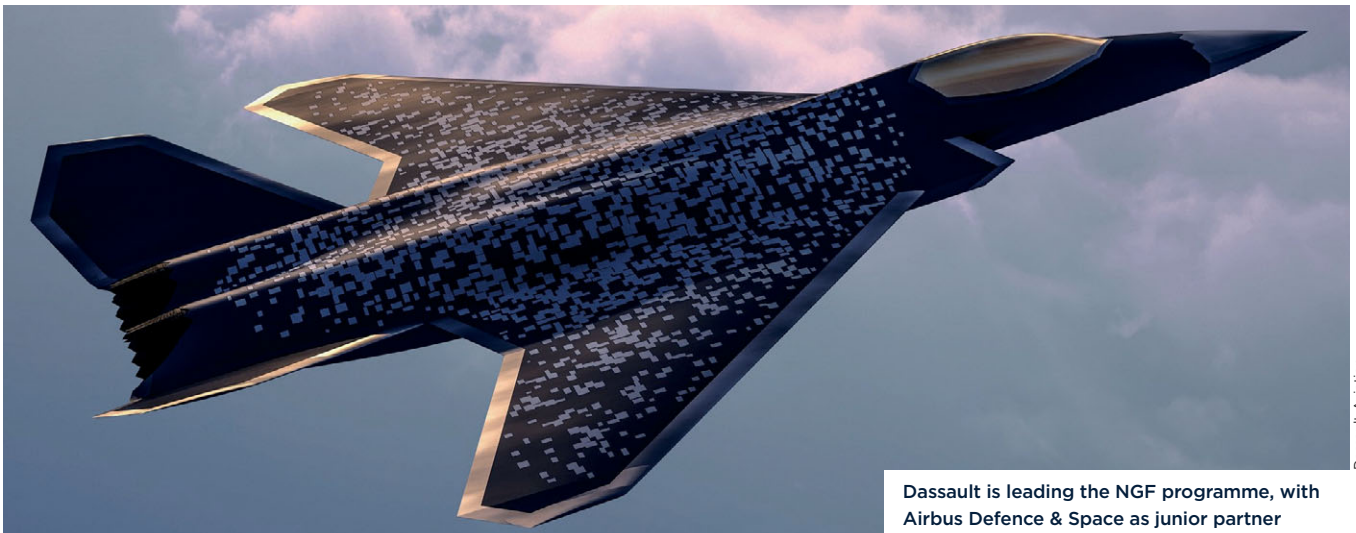
Meanwhile, propulsion system partners MTU and Safran - which signed an agreement in late 2019 to develop an engine for the NGF platform - are also working to accommodate Spanish firm ITP.

Olivier Andries, chief executive of Safran, says that now Madrid has joined FCAS, "we will have to make sure ITP has something to do".

Andries says he is "confident" the existing agreement can be broadened to admit the Spanish firm, but workshare will have to be allocated "with the principle of best athlete".

"We do not want a new partner [to] take work where they do not have competencies," he says.

Safran is leading the design and integration of the new engine, with responsibility for its hot section, while MTU will handle the cold section and engine services. ▀



Dassault is leading the NGF programme, with Airbus Defence & Space as junior partner

Dassault Aviation



A greater lessor

AerCap to acquire US rival GECAS, creating sector giant with annual revenues of \$7 billion

David Kaminski-Morrow London

Leasing giant AerCap has agreed to acquire US lessor GECAS, creating a leviathan with over 2,000 aircraft and more than 900 engines, as well as 300 helicopters through its Milestone Aviation unit.

AerCap says it has entered into a “definitive agreement” – unanimously approved by the companies’ boards – under which General Electric will receive 111.5 million new AerCap shares, plus \$24 billion in cash and \$1 billion of AerCap notes or cash.

Upon completion of the transaction, General Electric is expected to own approximately 46% of the combined company and will be entitled to nominate two directors to the AerCap board.

“This combination will enhance our ability to provide innovative and attractive solutions for our customers and will strengthen our cash flows, earnings and profitability,” says AerCap chief Aengus Kelly.

“GECAS is a highly attractive business and this transaction continues our strong track record of capital allocation. As the recovery in air travel gathers pace, this transaction represents a unique opportunity that we believe will create long-term value for our investors.”

The companies state that the tie-up will create

a leasing platform with complementary customer bases with “limited overlap”.

Single-aisle aircraft will represent about 60% of the combined fleet, with an orderbook of 493 new aircraft – of which single-aisles will account for 90%. Those orders will swell the proportion of narrowbodies to 66% by the end of 2024.

Kelly says he is “very comfortable” with a two-thirds narrowbody, one-third widebody ratio, noting that “no-one else has moved as many widebodies as AerCap has”.

New-technology aircraft will account for 56% of the combined in-service fleet, rising to 75% in 2024. This timetable is based on \$1 billion of sales per year, but there could be “further acceleration towards 75%” if annual sales increase beyond that target, says Kelly.

“Combining these complementary franchises will deliver strategic and financial value for both companies and their stakeholders,” says GE chief executive Lawrence Culp.

“Together we’re creating an industry-leading aviation lessor with expertise, scale and reach to better serve customers around the world, while GE gains both cash and upside in the stronger combined company as the aviation industry recovers.”

Kelly says the deal is about “buying the right business at the right time and at the right price”.

The motivation behind the transaction is not “getting bigger for the sake of it”, he adds, but rather providing “attractive returns for investors for years to come”.

The deal marks AerCap’s fourth aircraft leasing business acquisition, following earlier absorptions of Debis AirFinance, Genesis Lease and ILFC.

The combined company will generate \$7 billion in annual revenue and \$5 billion of operational cash flow, says AerCap chief financial officer Peter Juhas.

Easy integration

AerCap expects the GECAS acquisition will be “an easier integration” than its takeover of ILFC in 2013, says Juhas. This is because there is less of a deleveraging component and “most of the GECAS aircraft are already domiciled in Ireland”.

Kelly sees the acquisition of GECAS’s engine leasing business as “enhancing our relationship with airlines and significantly increasing the scope of the product offering we have”.

While it will “broaden” AerCap’s “long relationship” with GE Aviation, he adds that strong relationships will continue with other engine manufacturers including Pratt & Whitney and Rolls-Royce, and AerCap “won’t be captive” to one OEM.

The acquisition presents “a unique generational chance to move the business forward”, says Kelly, noting that “as we see the beginnings of recovery in the aircraft cycle”, AerCap will be “extremely well-positioned to take advantage of the cycle as it moves on”.

Additional reporting by Cirium



Deal positions AerCap for start of demand recovery, Kelly says

Aeralis on the up

UK developer aims to advance modular trainer product for nation's air force in support of future combat air system



Aeralis

Rapid Capabilities Office commitment has given project a three-year boost

Craig Hoyle London

Buoyed by a recent high-profile investment from the UK Royal Air Force (RAF), and with additional backing being sought via its latest funding drive, modular training aircraft developer Aeralis is aiming to take its concept to pre-production flying status before the middle of the decade.

In mid-February, the company secured a three-year funding commitment from the RAF's Rapid Capabilities Office (RCO), supporting its research and development activities. This was followed by an early March announcement of a formal teaming agreement with Thales Training & Simulation's UK arm.

"The RCO will support the requirements and design review process to gain an understanding of how Aeralis defines the ways in which agile, modular, commercially-driven aircraft design can develop and certify a broad range of future aircraft systems that could support the RAF's ambition to rationalise its future fleet," the company says.

Air Commodore Jez Holmes, head of the RCO, describes the company as having "an extremely

disruptive and innovative approach to design, modelling and certification processes". Their collaboration also will enable the RAF unit "to understand the exploitation potential of Pyramid, our new open mission system architecture," he adds.

For Aeralis chief executive Tristan Crawford, securing the UK military's support sets a clear timeline to advance the project, which originated in 2015 under the name Dart Jet.

Digital design

"The focus for the last two years has been on putting in place the horsepower to do the digital design fast," Crawford tells FlightGlobal. He says that as the Covid-19 pandemic took hold in 2020, "We really focused on the engagement with the Royal Air Force and the RCO, and putting in place the partnerships and the digital enterprise, to be able to assure and certify whatever we design."

The UK Ministry of Defence's commitment has been disclosed as worth £200,000 (\$276,000) until the end of the 2020-2021 financial year in early April, but Crawford declines to reveal the total sum to be provided through the enabling contract's full term.

Aeralis believes strong potential exists to create a family of training

aircraft to support the RAF's Future Combat Air System (FCAS), including a manned Tempest fighter. Via its Military Flying Training System (MFTS) project, the service currently uses Grob Aircraft G120TPs, Beechcraft T-6Cs and BAE Systems Hawk T2s for pilot instruction, and also still operates some aged Hawk T1s.



“This is a UK enterprise that has a globally-relevant product. We can offer modules of the aircraft, facilitate agreements and establish in-country manufacturing”

Tristan Crawford Chief executive, Aeralis

“It’s about preparing for the future and giving the Royal Air Force options,” Crawford says. “There is, beyond MFTS, the need to prepare pilots for Tempest and FCAS, and Aeralis is preparing a much more up-to-date solution for that.”

The company has completed its conceptual design phase activities, and is now seeking fresh private investment via its third-round funding drive.

“The phase we are in now is to raise the equity we need to do the more in-depth design of the vehicle,” says Crawford, who adds: “we have an aspiration to fly at the end of that 30-month programme.”

The company has secured patent approvals in the EU and the USA for its common core fuselage design: the heart of its modular concept. This envisions producing multiple aircraft variants, optimised for duties ranging from basic and advanced training to operational conversion and aggressor use.

Speaking about the project’s investment potential, Crawford says: “It’s a fantastic time. Most of the world’s western air forces invested in training aircraft fleets, light combat, small light jet-level aeroplanes about 40 to 50 years ago, and all those fleets are now ageing and retiring. There are a number of competitions, and that is growing every few months.”

While he declines to detail the funding target being pursued during the current investment drive, he confirms: “We are in discussion with a number of parties at the moment.”

Production facility

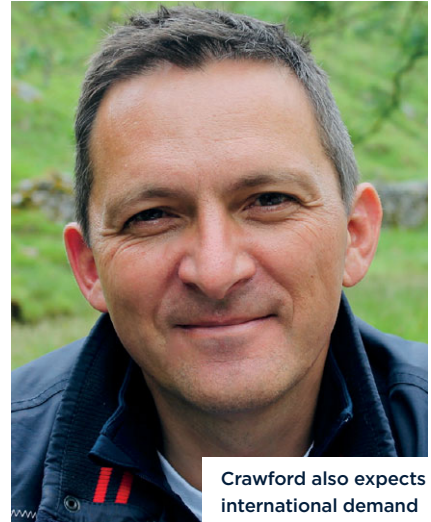
Crawford says Aeralis remains very interested in establishing a production facility for its aircraft in Wales. The company expects that such work would directly employ around 200 people, and support a further 3,800 positions through the UK supply chain.

“We see St Athan as being an ideal site for assembling the aircraft, but also for operating it as part of a training solution in the future, because the airspace around there is extremely supportive for that kind of activity.”

A leasing operator could acquire a fleet of aircraft and deliver services via a defence aviation training business, also offering slots to international customers with a smaller throughput of students or insufficient budget to purchase their own assets, Crawford says.

Unlike current types, he says the Aeralis jets could be easily upgraded or adapted for new tasks, thanks to their modular design and the use of an open mission systems architecture.

He also sees the family of aircraft as having strong export potential. “This is a UK enterprise that has a globally-relevant product,” he says. “We can offer modules of the aircraft as part of offset, help facilitate



Crawford also expects international demand

sales agreements, and establish in-country manufacturing.”

But with full designs yet to be completed, will Aeralis be able to fly an aircraft before the end of its three-year deal with the RCO?

Crawford says discussions are under way with potential avionics and engine suppliers, and that the company already has engineering personnel in place among its 48-strong team. He also points to its use of digital design techniques and early engagement with the UK’s military regulatory body.

“I think we are unprecedented in that we are doing this from day one with the Military Aviation Authority,” he adds.

Innovative processes

Under their newly-announced agreement, Thales will “develop innovative philosophies, processes, devices and systems to operate the transformational Aeralis platforms”, the companies say. This will “ensure that the training systems required to teach pilots to fly Aeralis will be ready in conjunction with the modular aircraft system”.

Aeralis in July 2019 announced entering into a memorandum of understanding with Thales, with the activity “to evaluate concepts for a common simulator system that can be used to support all phases in a future flying training system”.

With its RCO relationship in place, Crawford says Aeralis will use September’s DSEI exhibition in London to promote its activities. “We really want to show we are providing the UK with options in the training solution space for Tempest and FCAS.” ▶



Multiple variants could perform roles from training to aggressor duties

Powering a revolution

The case for public-private co-investing in next-generation technology is proven and compelling, argues **Paul Everitt**

In the UK there are few sectors as capable as aerospace of driving high-value, high-impact, productive activity across the country.

But the future of this vital manufacturing sector faces significant challenges. Securing the ability of UK aerospace to generate future long-term growth will depend on successfully competing for the investment in advanced green aircraft technology that will be developed in the coming years.

International competition is fierce; for every business looking to invest, there will be multiple governments laying out the red carpet.

Plus, without state support, R&D projects will either not happen or occur at a much slower pace, harming the UK's competitive position.

With the race now on to replace old technologies and achieve net-zero aviation, government backing is key.

As businesses invest millions to research and develop the future solutions we need, they are also casting their eye to find the best possible home to bring these technologies to market. A long-term commitment is essential.

Aerospace manufacturing often leads directly from R&D. With that in mind, the UK must offer a strong incentive for companies to conduct their research activities here.

Fostering a sectoral environment that is internationally competitive, agile in decision-making, attractive fiscally and with clear long-term commitment is critical to that. Remember, our international competitors are doing exactly the same.

The UK is now taking some important steps towards making our aerospace sector a major player in the international challenge of

delivering net-zero aviation, notably the launch in 2020 of the Jet Zero Council and the FlyZero initiative from the Aerospace Technology Institute (ATI).

Both major international manufacturers and our network of hundreds of smaller, but no less innovative and dynamic supply chain companies have an essential role to play. Beyond the powerful match-funding agreement between the UK government and industry, the economic case for state investment is extremely compelling: every £1 of government funding generates at least £12 of private investment.

Supply chain

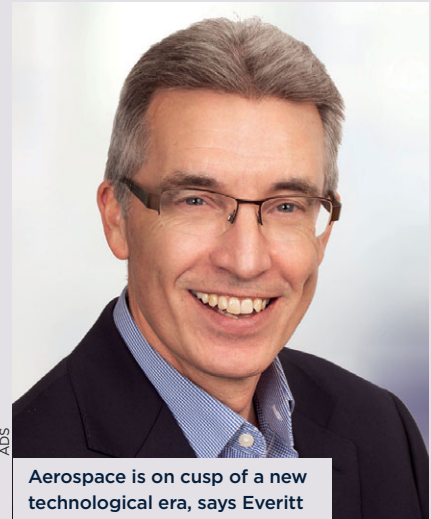
The regional spread of the supply chain means co-investment by public and private sectors in aerospace immediately supports the government's levelling up agenda.

As a result of maturing technologies and the need to tackle climate change, the aerospace industry is on the cusp of a third generational technology evolution, which supports broader sustainability goals.

However, while the ATI has so far been hugely successful due to its unique nature and the public-private partnership, the joint funding commitment underpinning that success is likely to be insufficient over the next 12-18 months.

Although the investment to date has been substantial, it has not been enough to dictate an ambitious push into these third-generation technologies.

Without increased funding we are in danger of losing out to other rival nations and ceding our existing competitive edge. If that is allowed to happen we will have to



Aerospace is on cusp of a new technological era, says Everitt

accept that the UK's supply chain will reduce in size.

With a joint commitment to 2036 or beyond and extra funding, the ATI can help retain and grow aerospace in the UK.

The country is showing great ambition in driving the international climate agenda, culminating in its hosting the COP26 climate change conference later this year. The aerospace industry has the potential for a golden future in the UK, helping to deliver on the green vision that has been outlined.

Messages sent now around joint funding commitments are already affecting company decisions, so we must seek to firm up the UK's position over the next six months.

The economic case has been proved beyond doubt and now we need the financial backing to maintain the momentum that the ATI has generated.

The UK aerospace sector is looking to the government to offer the international industry a strong signal that we aim to be a global leader in achieving net-zero aviation.

As one of the top four countries in the world for aerospace manufacturing, the challenge and the opportunity facing us today is to compete as fiercely as our rivals will to be the home of new technology development. That will secure thousands of the high-value jobs for our manufacturing centres across the UK. ▶

See p48

Paul Everitt is chief executive of ADS, the UK trade association for the Aerospace, Defence, Security and Space sectors





“Without state support, R&D projects will either not happen or occur at a much slower pace”

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Israel has picked Sikorsky's CH-53K King Stallion to replace its fleet of 22 D-model 'Yasur' heavy-lift helicopters

US Navy



Rolls-Royce is poised to fly project ACCEL's 'Spirit of Innovation': an electric-powered adaptation of the Nemesis NXT

Best of the rest

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



Dassault performed the first flight of its Falcon 6X business jet on 10 March. Service entry is scheduled for late 2022

V. Almansa/Dassault Aviation

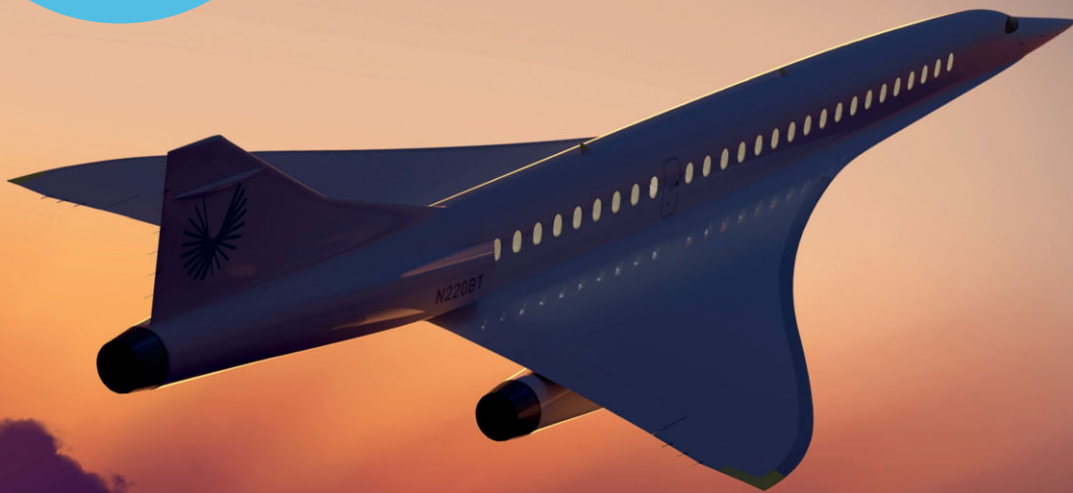
Rolls-Royce

Next month

Will supersonic business jets accelerate from development phase?

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

-Henry Maier, President and CEO, FedEx Ground

The pace of sustainable aviation fuel's development is speeding up as airlines, producers and regulators see it as a critical tool enabling aviation to make progress with cutting its carbon emissions

SAF bet

Mark Pilling London

T rue or false? Garbage, cooking oil, old clothes and woodchips are some of the raw materials that can be used to make aviation fuel.

All true. And not just fuel, but sustainable aviation fuel. These so-called SAFs are being touted as an elixir that will offer aviation a way out of a big carbon problem. SAFs have the potential to become a significant part of new approaches to enable an industry that relies entirely on fossil fuels today to lower carbon pollution tomorrow.

Historically, fuel has not been a big strategic issue for commercial aviation – it is simply a costly essential, representing 30% or more of an airline's total cost base. It is also a volatile cost, skyrocketing and plummeting in response to wars, global crises or, as we are seeing today, a pandemic.

But that is changing. Fuel is turning into a strategic asset as the aviation industry, with varying degrees of enthusiasm and reticence, joins the global movement to lower its carbon emissions and play its part in tackling climate change.

Most estimates say aviation produces about 2% of total global greenhouse gas emissions – but this may be magnified by other factors, with research pointing toward the significance of the non-CO2 climate impact from aviation, such as NOx, soot and contrails.

The industry's common target is to reach net zero emissions by 2050, with many airlines having

announced their commitments to achieving net zero, and many more set to follow.

Scott Kirby, the chief executive of United Airlines, is prominent and outspoken on this topic. In a LinkedIn post in December, he said: "We're embracing a new goal to be 100% green by 2050 by reducing our greenhouse gas emissions 100%. And we'll get there not with flashy, empty gestures, but by taking the harder, better path of actually reducing the emissions from flying."

The problem for aviation is this is easier said than done. Today, the only fuel source is fossil-based and there is no obvious way of quickly slashing emissions. Carbon offsetting is one option – and although this does something, many see this approach as no more than a temporary sticking plaster.

Electric avenue

Aircraft powered wholly by electricity are gaining prominence. This technology offers the potential to deliver sustainable short-haul flying using aircraft with up to 50 seats in the second half of this decade. Hydrogen fuel is another much-discussed candidate, but that is thought unlikely to become viable until well into the 2030s.

Most agree that the only realistic alternative power source, especially for heavier aircraft, is sustainable aviation fuel. In its November 2020 report *Blueprint for a Green Recovery*, aviation environmental coalition the Air Transport Action Group (ATAG) describes a rapid and worldwide scale-up of SAF as "perhaps



KLM 737 engineering pilot Jeroen Kok, KLM chief executive Pieter Elbers and Shell Aviation fuel operator Roland Spelt

the single largest opportunity to meet and go beyond the industry's 2050 goal".

The World Economic Forum November 2020 report, *Clean Skies for Tomorrow*, concluded that "there is no 'silver bullet' overarching approach for aviation's decarbonisation, but SAF is a necessary asset in the transition".

The key word in SAF is sustainable - because this fuel is not pollution free. The improvement comes as a result of the fact that the SAF production process itself absorbs CO₂, according to a recent report from consultancy McKinsey.

"If you look at our product the reduction is up to 80% on a life-cycle basis," says Sami Jauhiainen, vice-president, business development, renewable aviation at Finnish renewable fuel producer Neste.

According to ATAG, SAF can be described as reducing emissions on a life-cycle basis because the

"We're embracing a new goal to be 100% green by 2050 by reducing our greenhouse gas emissions 100%"

Scott Kirby Chief executive, United Airlines

CO₂ that is absorbed by plants during the growth of biomass is roughly equivalent to the amount produced when the fuel is burned in a combustion engine, which is then returned to the atmosphere.

While there are several terms used to describe sustainable or alternative fuel, the term SAF has become a catch-all for non-fossil-based aviation fuels. The first phase of SAF uptake happening now is being driven by use of bio-based waste and residue raw materials.

In time these will be complemented with e-fuels or electro-fuels. These alternatives are manufactured with captured CO₂ in a reaction with hydrogen and using renewable electricity.

Burning issue

While it is true that burning SAF causes the same carbon emissions as burning regular jet fuel, the avoidance of using fossil fuel in the first place is key, says Lauren Riley, managing director, global environmental affairs & sustainability at United. The airline has been using SAF daily on its flights at Los Angeles International airport since 2016.

"SAF and carbon capture are the two known pathways today for airlines to decarbonise," says Riley. "My vision for 2050 is 100% of our planes fuelled by SAF and significant carbon sequestration to mitigate the emissions from the past."

The industry has been quietly working on SAF development since 2006. The Commercial Aviation Alternative Fuels Initiative (CAAFI) was formed that



Fulcrum

SAF plants are identical to conventional oil refineries

year by US aviation bodies including the Federal Aviation Administration and Airlines for America to foster the development and commercialisation of SAF.

“The aim is that blended SAF is a ‘drop-in’ jet fuel, so no changes are required in aircraft or engine fuel systems, distribution infrastructure or storage facilities,” says Steve Csonka, CAAFI executive director. “As such, blended SAF can be mixed interchangeably with existing jet fuel.”

This is the case for industry-approved SAF production pathways today at blend levels of up to 50% with regular jet fuel. Work is under way on higher blend levels that will enable SAF to deliver deeper carbon reductions, Csonka says.

In recent months, Rolls-Royce has conducted tests with a Trent 1000 and a Pearl 700 turbofan exclusively powered by SAF. “Our aim is to give the industry confidence that we can continue on to 100% SAF certification,” says Simon Burr, director of engineering & technology at R-R. “The engines behaved exactly as expected.”

Demonstration flight

Boeing flew dozens of 100% SAF test flights in the late 2000s, but it was a Virgin Atlantic 747-400 demonstration flight from London Heathrow to Amsterdam – with founder Sir Richard Branson’s typical razzmatazz – that brought greater publicity to alternative fuels.

Fuelling change

This year looks like being the year when sustainable aviation fuel (SAF) production takes off. A dozen or so commercial-scale projects have been announced since the beginning of 2021, bringing a host of new names to aviation such as Fulcrum Bioenergy, LanzaTech, Neste, SkyNRG and World Energy.

Several of the traditional energy providers, such as BP and Shell, are piling in too.

SAF can be made from a variety of raw materials, called feedstocks, and several different technologies, dubbed pathways. SAF plants look identical in size and scale to traditional fuel refineries and cost the same, upwards of \$500 million each.

Today, the predominant commercial SAF makers are Boston-based World Energy and Finland’s Neste. The former is converting its refinery in California to exclusively make SAF and renewable diesel by late 2023, says chief executive Gene Gebolys.

Working with an undisclosed industrial partner, World Energy will use its experience in California to



Neste

Sami Jauhiainen says Neste has been investing to boost output

replicate it in “strategic locations around the world” to make “lower-carbon fuels”.

Neste makes SAF from renewable waste materials at its plant near Helsinki and is investing heavily to boost its output, with plants slated to come

SAF development has continued steadily throughout. The latest breakthrough, which came in February, saw a SAF produced in a “lower-carbon pathway” power the first commercial flight with an e-fuel blend. This significant move was achieved with a SAF made by Shell from synthetic kerosene (from CO₂ and hydrogen, not biomass) and powered a KLM service from Amsterdam to Madrid.

Regular operations

Tests and demonstration flights aside, several front-running airlines have been using SAF for five years in regular operations.

Cathay Pacific started researching the nascent SAF industry in the USA for use in its transpacific operation in the early 2010s. It was attracted to California-based Fulcrum Bioenergy’s strategy of “low-carbon fuel made from trash”. To secure access to Fulcrum’s SAF, Cathay invested in the firm in 2014. Others, like United and BP, followed suit.

Over recent months Cathay has developed a SAF deployment strategy as part of its net zero commitment, says Yee Chow, the airline’s biofuel manager.



Municipal waste can be used as a raw material to make fuel

“We are producing a roadmap of what percentage of SAF we can achieve at what cost, by when,” he says. “There are plenty of unknowns, but it is all about putting a stake in the ground.”

However, such pioneers are currently something of an exception in the industry. The adoption of SAF in air transport has been slow when compared with other sectors, which have latched on to sustainable options much faster.

“Aviation’s use of SAF has progressed a lot slower than road transport’s use of sustainable fuel – it’s 15 years behind, even though the product is not in reality any different,” says Neste’s Jauhainen.

The main barriers to SAF adoption have been high cost and limited availability. SAF is three to five times the price of jet fuel today. That will fall as SAF production rises and incentives for its use arrive.

“The aim is that blended SAF is a ‘drop-in’ fuel, so no changes are required in engine fuel systems”

Steve Csonka Executive director, CAAFI

Currently the uptake of SAF is minuscule compared with the volume of jet fuel burnt in a normal year. Airlines used about 300 million tonnes in 2019. SAF only made up about 0.1% of this.

But that is changing. Over the past year, SAF has become a hot topic. “It’s a once-in-a-century chance for an industry to develop new energy sources,” says Darrin Morgan, head of growth and investment at SkyNRG, a Dutch outfit that KLM helped found in 2010 to develop the SAF market. “We see it not as a defensive activity but as an opportunity.”

on stream in Rotterdam and Singapore in 2023, says Sami Jauhainen, vice-president, business development, renewable aviation.

At Fulcrum, municipal waste is the feedstock for its SAF. “The beauty of garbage as a feedstock is that people pay Fulcrum to take it away,” explains chief executive Jim Macias.

Macias says its first commercial-scale plant, in Nevada, will go on stream this year. Fulcrum has announced another in Chicago and the plan is to roll out SAF plants in Houston, Seattle, San Francisco, Los Angeles and New York. In February, a site was selected for its first UK plant and there are more in the planning stages in the UK, Japan and Australia.

SkyNRG was formed in 2010 with a mission to bring SAF to market and make it the “new global standard”. It has five “Direct Supply Lines” under development, consisting of local feedstock, the refinery and offtake partners. The first, in the Netherlands, will pump SAF by 2023.

In January, SkyNRG announced the FLITE consortium, a partnership with LanzaTech to make

SAF from waste-based ethanol by 2024. A month later, a consortium of Schiphol Group, the Port of Amsterdam, KLM and SkyNRG unveiled SynKero. This start-up aims to develop an e-fuel plant in the Netherlands, to go live in 2027, using so-called “green” hydrogen made from water, renewable energy and CO₂.

Meanwhile, traditional energy giants are also becoming more vocal. Shell will play a strong role as a buyer, distributor, producer and technologist in working towards the 2050 decarbonisation goals, says Anna Mascolo, global president of Shell Aviation. It has invested in Canadian firm Varennes Carbon Recycling, which will make low-carbon fuels from non-recyclable waste from 2023.

“BP and Qantas recently announced a strategic partnership to further advance their shared net zero ambitions,” says Andreea Moyes of Air BP. Qantas chief executive Alan Joyce believes SAF will play a crucial role in getting the industry to net zero by 2050. “With this deal we want to create a SAF industry in Australia,” he says.



Rolls-Royce

Rolls-Royce has tested engines powered entirely by SAF

SAF producers are using the same business models as the traditional energy industry – including renewable sources such as wind and solar power – to bring investors to the table. “Long-term offtakes facilitate project financing – it makes perfect sense,” says Morgan. Offtakes is the jargon used where airlines commit to a multi-year fuel deal with producers. However, less than a dozen airlines have taken the plunge so far with such SAF agreements.

While rising SAF production will bring the cost down and usage up, policy change will be essential too. “There needs to be a highly effective set of measures led primarily by governments,” says Andrew Murphy, aviation director at Brussels-based sustainable transport advocacy group Transport & Environment. “Aviation cannot decarbonise by itself.”

These rules, likely to specify how much SAF must be blended with regular jet fuel, and financial incentives for users, are in the making, along with the lobbies to influence them. California, the Netherlands and Norway already have SAF usage policies.

Mandated requirements

Norway became the first country in the world to bring in a mandate in 2020, stipulating that 0.5% of all fuel usage is SAF. Its target is to get to a 30% requirement by 2030.

At a recent government conference, several European transport ministers and the European Commission lined up to support the SAF drive. It was timed to influence the EC’s publication later this year of its policy – called ReFuelEU Aviation – to boost the supply and demand for SAF in the EU. This could see a SAF mandate in place by 2025.

Many other countries are preparing legislation that will compel airlines to blend a proportion of SAF into their aviation fuel use.

“The time is now for governments to come in and help scale that gap,” says Riley of United. “The focus

must be decarbonising aviation and policies should be technology, feedstock and producer neutral.”

It is a common cliché around major industry challenges, but all believe collaboration is key to making SAF a success in reducing aviation’s carbon footprint. “Our ambition at Shell is not only to fulfil industry demand but help accelerate this journey,” says Anna Mascolo, global president of Shell Aviation.

The scale of the ramp-up and this collaborative effort is illustrated by the sheer volume of SAF needed to meet aviation’s travel demand. ATAG estimates some 450-500 million tonnes annually by 2050. The

“Our ambition at Shell is not only to fulfil industry demand but help accelerate this journey”

Anna Mascolo Global president, Shell Aviation

World Economic Forum puts current output of all sustainable fuels – used by aviation, road transport and others – at just 5.5 million tonnes.

SAFs will be an important part of aviation’s decarbonisation drive, and are likely to make up more than half of the target. And most believe the current global crisis will not slow this drive down.

“We anticipate that the pandemic will accelerate the pace of transition to a lower carbon economy and energy system, as countries seek to ‘build back better’ so that their economies will be more resilient in the future,” says Andreea Moyes, sustainability director at Air BP.

By all accounts SAF is here to stay. ▶



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Project HEART includes development of advanced autonomous controls for the BN-2 Islander

Dominic Perry London

There has been a raft of announcements about new aerospace projects in recent months, all with UK government backing. Featuring snappy acronym-based titles such as HEART, HyFlyer and H2Gear (to name but three), they promise high-tech solutions to some of the industry's enduring problems. Lately, many of the announcements have – alongside the obligatory quote from a government minister – featured prominent emphasis on the decarbonisation of aviation.

On that basis, you could be forgiven for believing there was a flood of new state support in the UK, partly as a response to Covid-19's impact on the industry, for research and technology projects dedicated solely to tackling aviation's contribution to greenhouse emissions.

But the answer is not quite that simple. Government funding has been funnelled through bodies that predated the coronavirus pandemic: the Aerospace Technology Institute (ATI) and the Future Flight Challenge (FFC), both ultimately administered by UK Research & Innovation, part of the Department for Business, Energy and Industrial Strategy (DBEIS).

Additionally, neither the ATI nor the FFC is expressly tasked with the decarbonisation of aviation.

While some of the more high-profile recent projects selected by the ATI, such as GKN's hydrogen fuel-cell-based H2Gear effort, explicitly set out to foster "clean air travel", the institute equally backs projects that will improve the design, integration and

manufacturing of aerostructures or avionics and flight-control systems. More sophisticated automation, lighter parts or highly efficient wings can of course benefit an aircraft's CO2 emissions, but are not necessarily a project's primary aim.

At its core, the FFC's aim is to "encourage the creation of a new aviation system", says director Gary Cutts. "Environmental credentials run throughout this," he says, adding: "Because of the size of the vehicles [we are funding] we can get things into service and prototype zero-carbon aircraft much quicker."

But the environmental aspect – to promote technologies that will help the UK reach its carbon net zero target – is one of several objectives, which also include: increasing mobility, improving connectivity and reducing congestion for people across the UK; and driving technology investment to the country by increasing manufacturing and service opportunities.

“Because of the size of the vehicles [we are funding] we can get things into service and prototype zero-carbon aircraft much quicker”

Gary Cutts Director, Future Flight Challenge

No longer part of Europe's environmental efforts, the UK government is backing a number of its own research and technology schemes. However, how focused are they on the green agenda?

Flying solo



Aviation provides a vital lifeline for communities in the Scottish islands

Chris Noe/Shutterstock

The upshot is that technologies are not researched in isolation, but as a “system of systems”.

That holistic approach can be seen in Project HEART, or Hydrogen Electric and Automated Regional Transportation. It is an initiative led by Blue Bear Systems Research that was recently awarded £3.74 million (\$5.14 million) – with the FFC’s contribution matched by industry.

Under the project, Blue Bear and its consortium partners will demonstrate advanced autonomous controls on a Britten-Norman BN-2 Islander – technology that is sufficiently robust to allow single-pilot operations.

Additionally, the practicality of using hydrogen power for short-range flights will be examined with consortium member ZeroAvia.

But Project HEART’s approach – and by extension that of the FFC – is broader than simply looking at the changes required to the airframe, avionics or propulsion.

For example, introducing a new fuel, in this case hydrogen, needs consideration to be given to its production and distribution infrastructure – hence the presence in the consortium of green hydrogen and fuel cell developer Protium, and Highlands and Islands Airports, which runs facilities in the north and west of Scotland.

Capacity questions

Scottish regional airline Loganair is also involved, to provide operational expertise, while Inmarsat will supply the satellite connectivity for the work around automation. But additional partners include Fleet on Demand, which specialises in mobility-as-a-service solutions, architects Williamson+Partners, and the Transport Research Institute at Edinburgh Napier University.

Michael Gadd, head of airworthiness at Blue Bear, says that the project is about finding ways to build a “viable, sustainable aviation business” in parts of the country where “low-capacity” routes are providing an essential service, such as those serving the Highlands and Islands region.

That fits with part of the FFC’s remit, which is to spur the development of new markets for aviation, almost as a public service.]



ZeroAvia

ZeroAvia will conduct research into using hydrogen power for short-range flights

Although electric vertical take-off and landing aircraft developers have frequently touted the potential for air taxi services to provide better connections within cities or from a major hub airport to downtown, Cutts thinks there is a significant opportunity for larger air vehicles of between five and 19 seats to link towns which are currently under-served by rail or road links. “We could see that market becoming meaningful in the 2028-30 timescale,” he says.

But he stresses that research into the demand side is an important part of the picture. Aircraft are the simple part, relatively speaking, but “I have always been of the view that public perception will be the final enabler. The technology can do it, but whether the public wants to take it up is another issue.”

In other words, a project should look at the technology itself, how it can be utilised, the environment in which it will be operating, and the attitude of those who will fly in the aircraft: a system of systems.

The FFC has a total budget of £125 million – to be matched by a £175 million contribution from industry – to spend in the period to 2024. So far, it has

£175m

Contribution from industry – to spend in the period to 2024

committed investment of £33.5m across 48 projects: 34 sizeable initiatives to run over the next 18 months, and 14 smaller, six-month efforts mostly around the use of drones for Covid-19-related transport.

Phase III funding of around £75-85 million is due to be announced this autumn, which will select projects that can form part of a large-scale demonstration in controlled airspace in 2024, which Cutts calls a “real-world use-case demonstration”.

While many of the vehicles in development as part of the FFC will have flown “prototype missions” before that, 2024 will be an opportunity to fly as part of the wider system of systems, including advanced air traffic management and ground infrastructure.

There is, though, almost inevitably, crossover with ATI projects. While Californian start-up ZeroAvia is

bringing its hydrogen know-how to the HEART consortium, it is receiving a far greater chunk of funding, £12.3 million, to research hydrogen-powered flight from the ATI as the leader of a programme called HyFlyer II. And fellow HEART member Britten-Norman is a core part of another ATI-backed initiative called Project Fresson, which is looking to develop a zero-carbon powertrain for the manufacturer’s Islander.

A representative from the ATI sits on the FFC’s advisory board, says Cutts, enabling a “free flow of ideas”. But the distinction between the two is that the challenge will not fund aerospace technology projects, he explains.

Emission statement

But what has changed over the past 12 months is the creation of a new body that is directly charged with cutting carbon emissions from aviation. Called FlyZero, it is an ATI-backed body with a vision for “the UK to realise zero-carbon emission commercial flight by the end of the decade”.

Unveiled in July 2020, its one hundred “employees” will be seconded from industry and academia, with DBEIS providing £15 million to cover staffing and overhead costs.

Leading the effort as project director is Chris Gear, an industry veteran whose most recent role was chief technology officer at GKN Aerospace.

FlyZero is not wedded to any particular solution, architecture or segment, but is seeking to analyse the best way forward and then marshal resources behind that.

Gear says FlyZero’s remit is to “make an independent assessment of what the right solution might be”, including the business case and industrial strategy.

Due to report in December 2021, FlyZero’s first year of work is divided into two partly overlapping phases: part one, the “concept phase”, will last four to six



FlyZero

Chris Gear leads FlyZero’s efforts to cut carbon



GKN Aerospace is aiming for “clean air travel” with its hydrogen fuel-cell-based H2Gear project

months, while a “delivery phase” will have an eight-month duration.

The concept phase is intended to take the hundreds of possible solutions and “drive it down to two that we think are best for the [relevant] market sectors and desired payload and range”.

Those decisions will then inform the delivery phase where that pair of solutions – probably for two different sectors – will be further elaborated, including the operational and environmental advantages, and the potential benefits for the UK’s aerospace industry.

“My objective at the end of the process is to have two concept vehicles that we study in enough detail to show they could go to the next stage,” Gear says.

Targeted funding

Should funding for the second and third years of the project become available, the technologies outlined will be taken forward into flight testing, Gear hopes, pushing them down the road towards certification.

But the UK’s approach is in sharp contrast – in scale and intent – to that of its near neighbour, France. Under the country’s Plan Aero to support its aerospace sector, Paris has doubled its spending on research and development activities to €300 million (\$362 million) in the period spanning 2020-2022.

However, this funding increase is targeted at decarbonisation, with emphasis on hydrogen as a preferred future fuel source.

At the same time as the coronavirus pandemic has thrown the aerospace sector into disarray, Brexit also threatened to cut off another source of research funding for UK companies. However, the trade deal struck between London and Brussels preserves British firms’ ability to participate in EU-funded research and technology projects, says the ATI.

“My objective at the end of the process is to have two concept vehicles that we study in enough detail to show they could go to the next stage”

Chris Gear Project director, FlyZero

This includes the recently-announced European Partnership for Clean Aviation, which will build on the work carried out under the Clean Sky and Clean Sky 2 programmes, and will pursue “innovative and impactful research to ensure climate neutrality by 2050”.

Drawn up by Europe’s aerospace sector and the European Commission, there is now a Strategic Research and Innovation Agenda for Clean Aviation, spanning 2021-2031. This is intended to “accelerate the development of disruptive technologies through simulations and integrated demonstrations of novel aircraft and propulsion configurations and systems at the aircraft platform level.”

Three main avenues will be pursued: hybrid-electric and full-electric concepts; ultra-efficient architectures, and technologies to enable hydrogen-powered aircraft. The end goal is a “new breed” of regional, short- and medium-haul airliners for service entry by 2035.

In addition, UK companies can also benefit from funding through the EU’s Horizon Europe initiative, which was launched at the start of February. ▀

An increasing number of airlines are joining the international effort to clamp down on illegal wildlife smuggling, as the Covid-19 crisis brings the danger of zoonotic pandemics sharply into focus

Air Trafficking Control



Illicit trade threatens to wipe out some of the world's most iconic species

Kerry Reals London

Global wildlife trafficking has risen to become one of the largest organised crimes in the world, and airlines are unwitting accomplices. As the global air transport network expands, so do opportunities for traffickers to ship illegal wildlife products across borders.

Not only does this illicit trade threaten to wipe out some of the world's most iconic species, but its potential to spread zoonotic diseases means there are also human health implications. But the good news – or bad news for those involved with wildlife smuggling – is that the aviation industry is fighting back.

Five years ago, airlines and airports began signing United for Wildlife's Buckingham Palace Declaration (BPD) – an agreement between the public and private sectors to work together to shut down the routes exploited by illegal wildlife traffickers, by sharing information and raising awareness of the issue. United for Wildlife was created by the Royal Foundation of the Duke and Duchess of Cambridge.

63

Number of airlines that have signed United for Wildlife's Buckingham Palace Declaration against animal trafficking

Since then, more than 120 companies – including 63 airlines, as well as airports and trade associations such as IATA and ACI International – have signed the declaration and joined the United for Wildlife Transport Taskforce. That list is expected to grow as the air transport industry seeks to fly out of the pandemic more sustainably, and protect itself against the threat of future pandemics.

“Five years ago, the fact was that illegal wildlife trade was not a priority,” says Dr Timothy Wittig, head of intelligence at both United for Wildlife and partner group Focused Conservation. “But today, we've worked closely with the aviation industry to put wildlife on the agenda across passenger, cargo and express operations.”

Wittig designed and led the implementation of the intelligence-sharing platform that enables the transport and financial taskforces' public and private stakeholders to share information, and then feed it to specially-vetted local law enforcement units on the ground.

Tackling the illegal wildlife trade is “fundamentally an information problem”, says Wittig. “The airlines



Local taskforces work to combat trade in items such as rhino horns

lack the information – they need to know where to look, where to put extra scrutiny, and how to work with law enforcement.”

Taskforce members receive monthly bulletins updating them on the latest wildlife trafficking threats and trends, as well as detailed alerts on specific areas of concern.

“The more information that's shared, the more awareness that's raised, the more people who are trained, and the more initiative airlines are taking, the easier it becomes,” says Wittig.

IATA joined the Transport Taskforce in 2015 and signed the BPD on behalf of its members when the initiative launched in March 2016. Since then, scores of airlines have signed up individually, “representing 33% of global traffic, as was 2019”, says Jon Godson, IATA's assistant director, environment. “As we've been working over the last five years, the resources available to airlines have massively increased.”

Endangered species

Alongside the drive to protect endangered species as part of their corporate sustainability efforts, it makes sense for air transport companies to take illegal wildlife trafficking seriously because of its potential to spread zoonotic diseases. The Covid-19 pandemic has shone a spotlight on this issue, with the virus strongly suspected to have jumped from animals to humans.

Potentially contaminated bushmeat – or meat from wild animals – is being illegally flown into Europe from Africa and sold in food markets, posing human health risks.

“Hundreds of tonnes of bushmeat are transported into Europe every year, and it's meat that comes from bats, rats and chimpanzees so the risk of another pandemic because of zoonotic transfer is very high,” says United for Wildlife Transport Taskforce manager Ian Cruickshank. “It's coming by air because it's frozen or fresh meat that's time sensitive, and it goes to the markets.”



DHL

DHL seeks to identify illegal wildlife products hidden in legitimate cargo

When samples were taken from bushmeat that was seized in Paris, “they found that there was contamination by microbes and viruses within the meat that was being smuggled”, says Godson.

Unlike high-value items such as ivory and rhino horn, which are trafficked by transnational criminal gangs, bushmeat does not generate huge profits and is more likely to be transported by individuals.

“People aren’t making big profits, so this leads us to believe it’s more related to ignorance – simply being unaware that when you’re flying to Europe you shouldn’t be flying with this meat. This makes it a bit more challenging, but it also lends itself to things like public awareness,” he says.

Common understanding

IATA’s work on combatting wildlife trafficking is supported by the USAID Reducing Opportunities for Unlawful Transport of Endangered Species (ROUTES) partnership. Michelle Owen, ROUTES lead at non-governmental organisation Traffic, says the BPD “has provided a sound basis for common understanding and action that the aviation industry can respond to”.

Part of IATA’s role as a taskforce member is to “make sure airlines actually deliver” on the 11 commitments contained in the declaration. IATA has added an illegal wildlife module to its environmental assessment (IEnvA) programme, and five airlines have now been independently assessed and certified as having met the new standard.

One of those carriers is Air Canada, which signed the BPD in mid-2020.

“We wanted to make sure that when we signed it, we would be able to act on it. We didn’t just want a piece of paper collecting dust,” says Teresa Ehman, senior director of environmental affairs at Air Canada. “We wanted to be able to operationalise the commitments and requirements.”

Following conversations with regulators about the importance of raising awareness in order to fight the illegal wildlife trade, Air Canada started working with the wider Canadian transportation sector to spread the message.

“We said, if we’re going to do awareness let’s go big and make sure we reach all the participants in the supply chain to get people thinking and talking about a call to action,” says Ehman. “It takes a network to fight a network, and the more airlines, airports, freight forwarders and cargo companies who participate, the more chance we have of identifying suspicious activities.”

“We said, if we’re going to do awareness let’s go big and make sure we reach all the participants in the supply chain”

Teresa Ehman Senior director environmental affairs, Air Canada

“They wouldn’t send an entire rhino horn with DHL but they would cut it into discs”

Simon Roberts Former global head of security compliance, DHL Express

One of the founding taskforce members, Kenya Airways, also realised the importance of collaborating with other local stakeholders. The airline has worked closely with the airport authority in Nairobi, the police, customs officials and the Kenya Wildlife Service to crack down on trafficking, says Linda Itindi, the carrier’s former manager of industrial safety and environment.

The first steps the airline took were to introduce a zero tolerance policy towards illegal wildlife trafficking and to train staff to spot suspicious activities. On one occasion, an employee who had recently undergone this training helped intercept three Hong Kong-bound bags containing pangolin scales which had been concealed among wood shavings. The bags were then seized by enforcement agents and the passenger was apprehended.

Training sessions

“That was one of the success stories we had, and it was nice because we were right in the middle of the training sessions,” says Itindi. “For me, it was a proud moment, as well as for the airline as one of the members of the taskforce.”

The fact that wildlife traffickers are masters of concealment is a huge challenge for air transport companies. Illegal wildlife products are routinely hidden among legitimate items or disguised in some way and misdeclared on customs documents, says Simon Roberts, who until his recent retirement served as vice-president, global head of security compliance at Taskforce member DHL Express.

“They wouldn’t send an entire rhino horn with DHL but they would cut it into discs,” he says. “When we saw ivory, they would cut it up into smaller pieces and carve it – sometimes it would be coloured – and it would be shipped as African art made of bone.”

Another challenge is the sheer scale and variety of illegal wildlife products that are shipped.

“There’s a common misconception when people think of wildlife products,” says Roberts. “They think of tiger skins and rhino horns and ivory, but the reality is that there are hundreds of thousands of illegal wildlife products, and they’re not all animal-based.”

This “enormous diversity” makes it “very difficult for people at a screener level to determine the difference” between legal and illegal products.

Screening technology

However, technology could play a key role in improving detection of illegal wildlife products in the future. United for Wildlife is supporting a project at London Heathrow airport which uses advanced screening technology to scan for wildlife items.

The pilot scheme is supported by Microsoft as part of its AI for Good programme, and uses artificial intelligence to detect illegal wildlife products in checked baggage and air cargo.

“It uses images to build up a database so that airlines can use those images to find rhino horns, elephant tusks and any other illegal wildlife items hidden in luggage, which we’ve never been able to do previously,” says Cruickshank.



Kenya Airways works with local police, customs and airport authorities

Pierre-Yves Babelon/Shutterstock

Stronger co-operation across different aviation stakeholders and the establishment of regional taskforce chapters are the next items on United for Wildlife’s agenda as it steps up efforts to combat the illegal wildlife trade. Each region requires a different approach, with the focus in southern Africa being on preventing illegal wildlife products from leaving a country, for instance, while the emphasis in countries such as China is on stopping them from entering.

“We’re busy implementing that model so that we can deliver the right kind of intelligence to the right area,” says Cruickshank. “We’re also starting to go deeper in collaboration with airlines, airports and freight forwarders, so we’re increasing the scope of our operations.”



Skyborne

The investment trainee pilots make means they need to be confident that jobs are available after graduation

Right time to train?

Despite the industry crisis, many flight schools say they are continuing to enrol students on their ab initio courses, as they anticipate a recovery in recruitment. But not all share this upbeat view

Murdo Morrison London

We are in the worst crisis in the history of aviation and recovery seems a long way off. Tens of thousands of pilots have been furloughed or permanently laid off from their dream career, and many fear they may never sit in a commercial cockpit again. So why in 2021 would anyone in their right mind invest a six-figure sum to qualify to fly an airliner?

It is a question that splits optimists and fatalists. CAE, the world's largest ab initio training provider, has suggested that – with demand for air travel likely to overtake 2019 levels in the next few years, and the pandemic accelerating the retirement of older pilots – now is actually the perfect time to start a course. Several smaller schools echo these views.

However, UK pilots' union BALPA is urging aspiring pilots to think again about a cockpit career until the industry recovers. "In this situation it would be irresponsible if we did anything other than warn people to consider delaying their flight training at this time," said the association last November. "This is not a positive picture for anyone whose heart is set on entering this profession."

Cynics might suspect vested interests at play. Schools that have invested in buildings, staff, aircraft, and training devices need to fill their courses to survive. However, would-be pilots will risk those eye-watering fees only if there is a realistic prospect of a steady job and attractive salary at the end. So, for training businesses, talking up the recovery makes a lot of sense.



Some training schools continue to take on ab initio students

Unions representing airline pilots, on the other hand, need to ensure their members get first refusal on jobs when recruitment starts again, and are not priced out of the market by newly qualified aviators desperate to get on to the career ladder. They do not want the supply tap turned on again before demand has fully returned.

For some training organisations, their deeds match their words. The UK's Skyborne Aviation has such faith in the ab initio market that it is trebling in size this year. It is acquiring one of the world's biggest flight schools, in Vero Beach, Florida, and taking on its 135 current trainees and 64 aircraft. Once the deal is concluded, the combined entity will have capacity for more than 400 students.

The mood at Europe's largest airline-run training provider could hardly be more different. Lufthansa Aviation Training (LAT) last year scrapped its ab initio programme, offering 850 students a full refund or the option to transfer elsewhere as part of a new "campus model". It says there was little or no prospect of them getting a posting with a Lufthansa Group airline in the foreseeable future.

New deals

"No-one expected what happened in March [2020], when we suddenly stopped [ab initio] training," says Stefan-Kenan Scheib, head of pilot schools at LAT. "We planned to restart in April, but ended up stopping until the end of 2020. We gave everyone the chance to step out of the contract without any costs, or we said we could send them to different flight schools that we partner with."

Unlike some schools, virtually all the students enrolled on LAT's ab initio courses were on a programme sponsored by a Lufthansa Group carrier. "They didn't have a guarantee, but there was a reasonable expectation they would get a job," says Scheib. In the end, 160 trainees terminated their arrangement, but almost 700 decided to continue their training.

LAT is now looking at relaunching its ab initio programme in 2022, but "the set-up will be smaller, with capacity reduced to the demand of this decade", says Scheib. Of the breezier predictions on the pilot jobs market from some of his rivals, he notes: "I hope they are right, but all the optimistic views we had in the past 12 months disappeared quite quickly."



Skyborne believes that by the time many of today's students graduate, the world will look very different

400

Student places that will be available through Skyborne Aviation, once it has acquired a flight school in Florida



FTA

FTA has been able to keep up its flying schedule, despite strict measures to limit the spread of Covid-19

Who is correct, of course, will depend on your view of when and how fast the industry will recover, and how many out-of-work pilots will seek to return to their old jobs. A student starting an ab initio course this quarter is unlikely to be looking for employment before mid-2023, when aviation could be in a very different shape, maintains Alex Alvarez, chief executive of Spanish flying college FlyBy.

The Burgos-based academy, which offers integrated air transport pilot licence (ATPL) courses, has about 230 students on roll, with the latest cohort of 20 starting this March. “Our courses are filling up nicely,” says Alvarez. Trainees come from 55 countries, from South Korea to Brazil, New Zealand to Uganda, and all are self-funded rather than being on an airline-sponsored cadet scheme.

Long game

“The self-sponsored student tends to have a long-term vision,” he says. “Aviation is a career where you should not be focused on the next 12 months, but on the next 40 years. It takes a minimum two years to train a pilot, more likely three. So those embarking on training now should have a view on what the jobs market will be like two to three years from now.”

Another crucial factor is that many veteran pilots that are currently jobless will choose to retire or switch careers rather than face retraining or reapplying for positions once a recovery begins, believes Alvarez, who took over the then-struggling school in 2015. “Many of them are never coming back, so this will contribute to the demand for new pilots,” he says.

Late last year, FlyBy, which operates a 19-strong fleet comprising Tecnam 2002s and 2006s and Czech Sport Aircraft PS-28 Cruisers, also bucked the gloom in the market by opening a second satellite site, in Soria, taking on 30 students who had been

released by L3Harris’s flight school in Portugal after completing ground training.

Others too are upbeat. Sean Jacob, chief executive of FTA Global, established at Shoreham airport near Brighton 15 years ago, says that, despite wrestling with lockdown rules – which saw its Diamond and Piper training aircraft grounded for two months at the start of the pandemic – FTA has seen demand for places remain strong. “We have not really seen any fall-off,” he insists.

“I truly believe it’s a good time to start training. Students are immune from the worst of the current market if they start now”

Lee Woodward Chief executive, Skyborne

“We pushed hard on marketing and last year was our best ever, with 46 students starting in March, June, September, and December,” he adds. “This year’s pipeline is also strong.” Although the UK has imposed strict measures to limit the spread of Covid-19, FTA has been able to keep up its flying schedule, with students and instructors wearing masks and arriving at the airport only for sorties.

Jacob shares Alvarez’s confidence about a recovery. “Historically, the aviation business has bounced back from every crisis,” he says. He reiterates the point that the length of the ATPL course – two to

three years – cushions trainees from the current downturn. Also, he says, quiet skies – Shoreham is about 50km from the normally busy London Gatwick – mean “now is a good time to train”.

Lee Woodward, chief executive of Gloucestershire airport-based Skyborne, will not reveal from whom it has bought its new Vero Beach academy. However, of the various schools in the Florida resort, FlightSafety Academy, owned by simulator specialist FlightSafety International, fits the description of a campus with more than 200 bedrooms, a swimming pool, sports fields and bookshops.

Thinking big

Woodward – a former British Airways pilot who was part of the management team at UK training school CTC until its 2015 takeover by L3Harris – set up Skyborne with his business partner four years ago. “Our mission was to build a bespoke training school, designed from the ground up,” he says. “We wanted to use big airline methodology, with the aim of training airline pilots, not GA pilots.”

Like his competitors, he thinks this is the perfect moment to embark on a training course. “I truly believe it’s a good time,” he says. “You might expect me to say that, but students are immune from the worst

of the current market if they start now. In round figures, from point of application to graduating is going to take two-and-a-half years. The world then will be very different.”

Training and simulation giant L3Harris is more sanguine. Demand for “whitetail” places on its ab initio courses – where students enrol without a guarantee of a job at the end – is down by about half on previous years, says vice-president sales and marketing, commercial aviation, Robin Glover-Faure. Meanwhile, airline-sponsored programmes have “dried up”.

However, he adds: “The unknown is the rate at which sentiment will return in the second half of this year. People are looking at 2023 or 2024 for the industry to be back at 2019 levels, but the jobs market will be helped by a high level of attrition of current pilots, and less supply from the training sector. So if I wanted to be in the job market in 2023, I would look at starting training now.”

L3Harris’s main competitor, CAE, took a lot of flak from out-of-work pilots after releasing a bullish jobs market report last November, which suggested the industry would need 27,000 new pilots by the end of this year, and 264,000 by 2029. The Canadian company stands by its prediction, insisting that “age-based retirements and attrition” will lead to the shortfall.

72%

Proportion of commercial pilots who believe commercial aviation will recover to its 2019 peak within three years



Spanish training college FlyBy has bucked the trend by opening a second site in the country



CAE thinks the industry will need 27,000 new pilots by the end of 2021, and 264,000 by 2029

Until the first months of 2020, the industry had been experiencing a pilot shortage. CAE says that the “fundamental factors influencing pilot demand prior to the Covid-19 outbreak remain unchanged”, with retirements of older pilots, the decision of furloughed pilots to turn to other professions, and the return of fleet growth driving demand over the decade.

Boeing last October also forecast a “robust” demand for pilots over the current decade in its latest Pilot and Technician Outlook, even though it admitted that it would take three years for airline traffic to return to 2019 levels. The airframer reckoned that the industry would need 763,000 pilots by 2039, albeit 5% fewer than its 2019 forecast.

Pilots themselves appear to be reasonably optimistic about medium-term job prospects. A poll of 2,600 commercial pilots carried out last October by recruitment agency GOOSE with FlightGlobal found that 72% think the industry will recover to its 2019 peak within three years. And two in three believe that by the middle of the decade there will again be a shortage of pilots.

However, the impact of the crisis has left many jaded about the profession. Fewer than two in three – 64% – would choose a cockpit career if they had their time again, down from 71% in the previous year’s survey. Only 46% say they would recommend becoming a commercial pilot to a young person, compared with 57% a year earlier.

» In many ways, along with the veteran pilots who fear they may never work again – owing to their age and salary expectations – the pilots worst affected by the crisis are not those embarking on training courses now, but those who graduated during the pandemic or will graduate in the next months. Lacking experience, they may struggle for jobs even as traffic returns.

It is a challenge the schools we spoke to are well aware of. FlyBy says it now guarantees its cadets a one-year flight instructor job after its ab initio course, offering 600h of flight experience. The

“Covid is something we will tell our grandchildren about, but not something that will continue affecting the industry for years to come”

Alex Alvarez Chief executive, FlyBy

company says that, as well as providing security for current students, the scheme will provide “a sufficient number of quality instructors to support the next stage of our growth”.

L3Harris has launched what it calls its Current and Airline Ready Programme, promising cadets who complete their training that they can “maintain the validity of their licence/rating and continue the development of their professional competencies” for up to two years or until they get a job. “It will position them to quickly gain employment when the recovery takes hold,” says Glover-Faure.

Woodward says Skyborne recognises “we have to do everything to help these recent graduates until the market returns”. As part of a “skills continuation policy”, it offers former students who have not found a permanent pilot job the option to return for



Retirements and attrition are expected to create vacancies for newly-qualified pilots

a “structured refresher” each quarter and a re-evaluation of their instrument rating at the end of the year.

Additionally, the organisation is increasing its pool of instructors and has a sponsored instructor programme for recent trainees who commit to doing the job for two years. “That’s a huge relief for many of our students,” maintains Woodward. “We have to work with our graduates right now to protect them.”

Busy skies?

It might be difficult to convince a newly-qualified pilot – her heart set on flying a \$100 million machine over continents and oceans, but filling shelves in a super-market to pay back a steep training loan – that the near-collapse of commercial aviation is a blip and that, before long, airlines will again seek out her services and those of countless other unemployed colleagues.

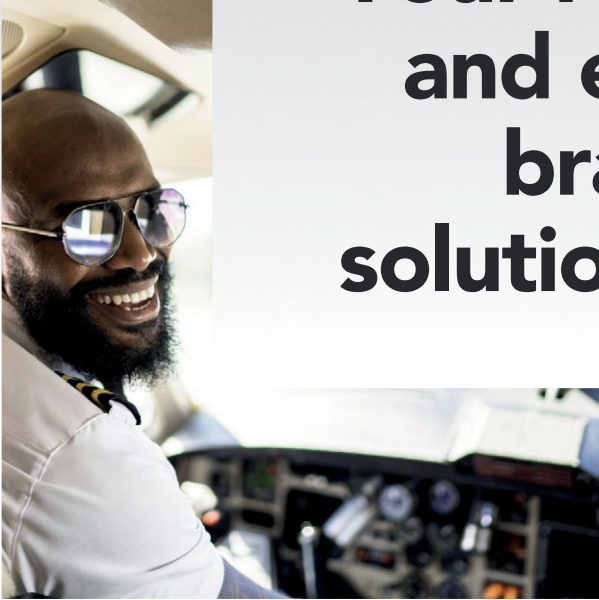
However, just as after the first Gulf War in the 1990s, 9/11, and the financial crash of just over a decade ago, passenger demand will come back, and, with it, demand for pilots. Notes Alvarez at FlyBy: “I have yet to meet anyone who does not agree that Covid is something we will tell our grandchildren about, but not something that will continue affecting the industry for years to come.”

Download our latest pilot survey at: FlightGlobal.com/pilotsurvey2021



Skyborne offers recent graduates refresher courses while they look for permanent jobs

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The year the sims stood still

A spate of acquisitions by CAE – including part of number three player Tru – has tightened the Canadian firm’s grip on the market after a terrible 12 months when many devices were idle

Murdo Morrison London

Full-flight simulators (FFS) are costly pieces of kit, so, in normal times, they tend to be seriously-sweated assets, taking a breather only when being maintained. But these are far from normal times, and, like the rest of the industry, pilot training has had a torrid 12 months. Simulator occupancy and demand for devices plunged as pilots were furloughed, fleets grounded, and deliveries pushed back. Like the aircraft they mimic, hundreds of simulators have sat idle for much of the crisis.

The two big manufacturers of airliner simulators – CAE and L3Harris – reflect this slowdown in their latest financial results. The Canadian company says “civil training utilisation is well below pre-pandemic levels”, with the devices in its own training locations operating at around 50% capacity during the second half of 2020 and into the first three months of 2021. CAE was expecting to deliver 35 FFS in its fiscal year, which ends on 31 March, compared with 56 the previous year.

Reduced demand

For its part, L3Harris took orders for seven FFS in 2020, against 10 in 2019. In its full-year financial results, the diversified defence and aerospace technology company said the slump in the market had “significantly reduced” demand for flight training and simulators for its commercial aviation solutions business. This led to L3Harris temporarily closing some of its facilities and launching a “restructuring” drive to

“align its resources with the outlook for the commercial aviation market”.

The two companies have responded very differently to the downturn. Last November, Bloomberg reported that L3Harris was planning to sell its pilot training unit for \$1 billion. In the event, it was only the military part of the business that was divested, with CAE undertaking to pay its rival just over that amount in a deal announced on 1 March. CAE’s largest acquisition to date reinforces its dominant market share in military training and is due to close in the second half of 2021.

35

Number of full-flight simulators CAE expects to deliver by the end of its fiscal year, compared with 56 devices in 2019

It was CAE’s fourth bolt-on in as many months, with the Montreal-based group taking advantage of its market leadership position and a strong balance sheet to drive consolidation, both horizontally and vertically – something it has been doing for a decade or more. Also last November, CAE announced plans to buy the Canadian-based commercial aviation arm of Textron’s Tru training business – the third player in mainline airliner simulators – for around \$40 million.



Like other operators, L3Harris has seen demand fall due to the coronavirus crisis

L3Harris



Tru Simulation

Tru developed and manufactured the 737 Max simulator for Boeing



CAE

CAE operates several devices at its Gatwick training facility in the UK

Unlike its two competitors, which provide training services as well making the actual devices, Tru is purely a manufacturer of simulators on the commercial side. After winning the contract from Boeing to develop the 737 Max simulator – and installing the first in the airframer’s Miami training centre in 2016 – Tru had supplied around three in 10 of Max simulators delivered. However, the grounding of the re-engined narrowbody in 2019 had put a brake on its growth.

Strengthened relationship

CAE’s new addition comes with 80 employees, an installed base of some 60 simulators, and, as well as a production facility in Montreal, training operations in France and Malaysia, and a minority stake in an Icelandair simulator centre. In a message to employees, CAE said the acquisition would boost its order backlog, broaden its number of airline customers, and strengthen the relationship with Boeing.

Textron, which originally bought the Montreal-headquartered business as Mechtronix in 2013, is not leaving the market – it is retaining its US-based Beechcraft, Bell and Cessna training operation. However, the move leaves just one other mainstream manufacturer in the commercial FFS segment – US training provider FlightSafety International, which provides regional aircraft simulator tuition alongside its core offering in business aviation and defence.

The Tru divestment follows CAE’s acquisition last November of Amsterdam-based pilot training firm Flight Simulator Company for \$83 million. That business, founded in 2005, operates a suite of mainly

CAE-built FFS, including nine 737s and Airbus A320-family devices, a 747 and a 787, and an Embraer 190, operated in partnership with FlightSafety International. CAE followed that up last December with the purchase for \$25 million of Merlot Aero, a crew management software company.

In its latest results, CAE notes that the outlook for the sector has improved since the start of the pandemic, reflecting “the benefits of a highly regulated aviation industry and the fundamental requirement for aviation training”. This gives many in the sector some hope. Even with a modest recovery later this year, the need for furloughed pilots to regain currency, or re-train on different types as the global fleet mix changes, could drive a hike in simulator hours.

Demand stimulus

“There will be a catch-up of delayed training,” maintains Robin Glover-Faure, vice-president sales and marketing, commercial aviation at L3Harris. “Airlines will also be changing the types of aircraft they operate, with pilots of the 747-400 or other four-engined types having to learn the ropes on an Airbus A350 perhaps. There is also the return of the Max. All these factors will give a stimulus to demand.”

The resumption of Max flights and deliveries after almost two years should give a significant boost to the market as recovery begins. Training organisation BAA is among those planning to introduce a Max FFS at its new Spanish facility this year, with the L3Harris-manufactured device arriving in April, and operational in the second half. It will join a CAE-manufactured A320 FFS installed in January, with other 737 and A320 non-FFS flight training devices to be added this year.

Vilnius, Lithuania-based BBA, one of the largest independent training providers in Europe, says that, although the Covid-19 crisis has “prompted dramatic re-evaluation and readjustment” of its business

\$83m

Price paid by CAE for Amsterdam-based pilot training firm Flight Simulator Company in November 2020



ambitions, it intends to continue with its expansion, which included the opening of a centre in China in June 2020. The company believes that the Max’s return to service will push up demand for training on the type at its Barcelona facility during 2021.

Unsurprisingly, the past year has seen few high-profile simulator delivery announcements. Among the exceptions, in January L3Harris said that Air China would be acquiring three of its FFS – two A320 devices and one A350 – which will go into operation at the flag carrier’s Beijing training centre within 18 months. It is the airline’s second simulator order with the Crawley, UK-based business, which supplied Air China with an A320 FFS in 2017.

The retirement of the last 747-400s from passenger service and the withdrawal of many A380s are

Denmark pays pilots to stay current

A Danish scheme that allows out-of-work pilots to claim the cost of their certificate renewal from the government is thought to be a first of its kind.

For laid-off flight crew who have been out of the cockpit for a long period because of the Covid-19 crisis, the expense of keeping qualifications current can be prohibitive – if there is no employer to pick up the bill.

The Danish government has set aside DKr20 million (\$3.2 million) to fund the programme, launched after a campaign by aviation employees’ union FPU, which will now help to manage it. Any commercial pilots living in Denmark who lost their



Scheme is open to Danish residents and ‘cross-border commuters’ living abroad who have worked for airlines registered in the country

Tru Simulation



A modest recovery will increase the demand for simulator hours

also leading to shifts in the simulator market. British Airways said in March that Air Atlanta Icelandic, which charters passenger and freighter versions of the jumbo, would be taking over one of its three 747-400 FFS, although BA would continue to host and maintain it at its London site. Announcements on the remaining pair of devices are expected soon.

Demand for simulators will return when flights resume in earnest, but ownership models may change as airlines adjust to a new economic reality, believes Glover-Faure. "I suspect there will be moves towards a more variable cost base, with owning capital-heavy training centres becoming less attractive," he says. With L3Harris operating in-house sites in Crawley, Bangkok, and Dallas, that "trend definitely goes in the direction of our business".

jobs after 11 March 2020 will be able to apply for up to Dkr15,000 in order to pay for their certificate renewal, as well as any associated travel and medical costs.

The scheme is also open to "cross-border commuters" who flew for a Danish-registered airline, as well as to newly-qualified pilots who completed their training between 1 January 2020 and 30 June 2021.

Pilots will also be able to apply for the funds retroactively if they have renewed their certificates out of their own pockets during the past year, even if they have found employment outside aviation.

The FPU says almost 1,000 Danish pilots have lost their jobs during the crisis.



Narrowbodies account for more than half of the training devices

CAE takes ever-larger piece of the pie

CAE holds around 59% market share of installed civil full-flight simulators and training devices, FlightGlobal's latest annual Civil Simulator Census shows. That follows its recent acquisition of the Canadian assets of Tru Simulation, which accounted for around 4% of the installed civil simulator market.

The latest Civil Simulator Census covers data for over 1,500 in-service devices, predominantly full-flight simulators. Manufacturer data is unrecorded for around 12% of these devices.

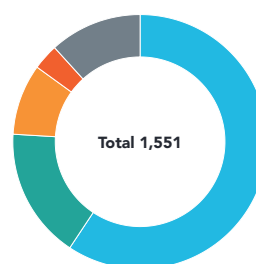
CAE's market share, including Tru Simulation, rises to around two-thirds when these unknown device manufacturers are excluded. L3Harris remains the second-largest provider of civil aircraft simulators, followed by FlightSafety International.

Narrowbodies account for more than half of the simulators and training devices covered by the census, and widebodies around 30%.

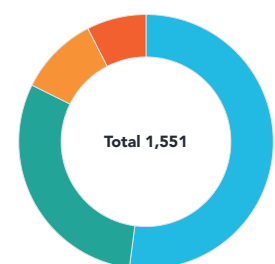
Airbus A320-family aircraft - including Neos - account for around a quarter of installed civil flight simulators and devices. Boeing 737-family aircraft, across classic, next generation and Max models, comprise 22% of the market.

To download your copy of the census, visit FlightGlobal.com/civilsim

Simulator share by manufacturer



Simulator share by aircraft segment



CAE's domination of the market continues, with L3Harris and FlightSafety International in second and third place respectively



Training evolution

Europe's aviation regulator believes pilot instruction and operational safety could be improved by using devices less sophisticated than a full-flight simulator



Peter Bakema/Wikimedia Commons

Concerns were raised after 2013 CitationJet incident over Paris

David Kaminski-Morrow London

For nearly 10 minutes after the left engine of a Cessna CitationJet failed, shortly after take-off from Paris Le Bourget airport, its pilots struggled with flight control and navigation difficulties as the cockpit filled with dense smoke.

Neither pilot had time to put on protective goggles. The captain did not use the quick-reference handbook, leaving the first officer unable to check his actions. Teamwork between the crew of the business jet (F-HCIC) was “almost non-existent”, according to French investigation authority BEA, adding that the aircraft overflew central Paris – a prohibited zone for low-altitude flight – before returning to Le Bourget to land.

BEA found the pilots involved in the incident, in July 2013, were not sufficiently trained on fire, smoke and emergency descent procedures. The first officer had not carried them out since his type rating, while the captain had only simulated the procedure, on a real aircraft, the year before.

Emergency procedures

“Emergency procedures as complex as the ones provided for this incident cannot be considered safe if they are not the subject of training,” the inquiry stated, adding that using a real aircraft was inadequate for such exercises.

“It is illusory to imagine that appropriate training can be given in flight because, in practice, it is impossible to properly simulate smoke or an emergency descent.”

But BEA acknowledged that a full-flight simulator for the CitationJet was restrictive, costing “at least twice the price” of the aircraft, with the result that full-flight simulators for high-performance aircraft were scarce.

Investigators carried out an emergency descent, with fire and smoke, in a fixed training device fitted

with a smoke generator, and found training for the procedure on this type of device was “quite possible”.

BEA pointed out that European regulations on flightcrew licensing mandated the use of full-flight simulators to train for certain situations, including emergency descents, whereas more affordable lower-level simulators were capable of providing the necessary requirements, and recommended that the European Union Aviation Safety Agency (EASA) lift the restrictions.

Similar conclusions were reached after a Piper PA-31 fatally crashed in Toulouse in 2011 after developing an asymmetric thrust issue on approach.

BEA noted that flight simulators were “only rarely available” for high-performance aircraft, and sought alternatives – such as the use of other simulator options – given that asymmetric flight exercises on aircraft are hazardous, and rely on “mimed” gestures with actions “not fully realised”.

With the intention of ensuring that crews develop the correct skills, and resources are used efficiently, EASA has unveiled proposals for a “paradigm shift” in initial and recurrent pilot training. This will, it says, centre on “applying an innovative approach” to the

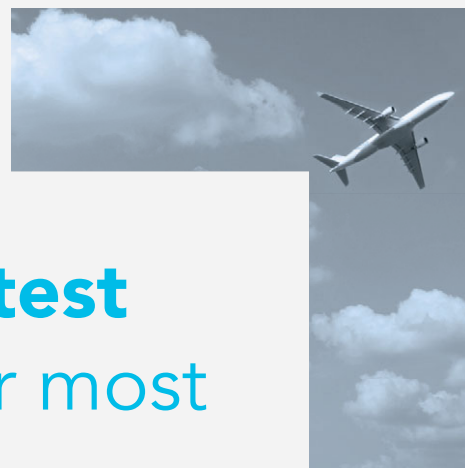
“It is illusory to imagine that appropriate training can be given in flight because, in practice, it is impossible to properly simulate smoke or an emergency descent”

BEA French investigation authority



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Virtual reality system will augment education for KLM Cityhopper

capabilities classification of future flight simulation training devices.

Among the objectives of the proposal is the aim of reinforcing safety levels by addressing the low fidelity of some training devices, or even in some cases the lack of ability of such devices to support training for certain tasks.

“The need to change the rules arises from regulatory discrepancies and barriers that currently limit the possibility to obtain training credits by using other types of training devices,” states the regulator.

“Without this rule change [full-flight simulators] will continue to dominate the training industry [and] flight-training devices will continue to have limited and [non-standardised] capabilities.”

1,400

Number of training devices under EASA authority: about 40% are full-flight simulators, and 40% fixed-base systems

There are some 1,400 training devices under EASA authority, of which about 40% are full-flight simulators and 40% are fixed-base devices – primarily flight and navigation procedure trainers.

EASA wants to introduce standardisation, and establish the necessary simulation fidelity levels necessary to support training, while also providing a path to cater for technological advancements.

The proposal is based on determination of the ‘DNA’ or a ‘fingerprint’ for individual training devices – a ‘capability signature’ – which takes into account features, fidelity levels, and the device’s ability to provide adequate training for specific tasks.

Once a particular signature for training tasks is known, it can be matched with the signature of available devices to see which ones meet or exceed the required capability.

This signature process is founded on a detailed matrix listing procedures to be tested or taught during six different stages of flight – from pre-flight inspection through to take-off, manoeuvring, approach and landing – under various normal and abnormal conditions, including fire, systems failure, and in-flight upset.

These are cross-referenced to system capabilities – such as cockpit layout, handling characteristics, weather, control forces, and motion cues – and one of four fidelity levels is assigned at each juncture: specific, representative, generic, or not required.

Ensuring consistency

Such a matrix, says EASA, provides a means to correlate the signature of a flight-training device with each training task to ensure consistency with approved initial and recurrent training programmes.

“This allows training providers to use the most appropriate and latest innovative training devices,” the agency adds, with the correlation providing “objectivity, transparency and reproducibility” in the choice of equipment.

“We welcome the proposal and believe it is a useful intervention,” says L3Harris Commercial Aviation Solutions vice-president for sales and marketing Robin Glover-Faure. “It provides welcome clarity on what fixed training devices can be used for.”

He says the proposal gives manufacturers certainty that devices they are developing will be relevant to broader training capabilities, while offering flexibility for airlines to use such equipment to supplement full-flight simulators while conducting type-rating and some forms of recurrent training.

“From a training providers’ perspective it offers more versatility to tailor programmes and use a broader mix of devices to suit the airlines’ specific requirements, including current budget limitations,” Glover-Faure adds.



Glover-Faure welcomes EASA’s move to categorise simulator capabilities

» EASA had considered alternatives to the new proposal, including abandoning classification of baseline qualification levels for various devices – from full-flight simulators to basic instrument trainers – and having them qualified only according to specific features.

This idea was rejected because it would require “radical changes” across various training types, says EASA, and potentially have a “negative impact” on US-European bilateral safety agreements – as well as risking variation in standards and increased costs because “every device would be, in effect, unique”.

EASA believes the overall investment required for the proposal will be “very low” compared with the turnover of organisations operating training devices.

Maintenance costs

It expects a reduction in training expenditure, pointing out that the dry cost of using a full-flight simulator is around €250-500 (\$245-590) per hour, compared with €100-200/h for a fixed training device, while recurrent maintenance costs are twice as high for simulators.

EASA estimates the savings in type-rating training, using fixed training devices rather than full-flight simulators, might amount to 20%.

Not only does EASA believe the proposal will result in a direct link between training tasks and device suitability, making training more effective, but also that it will generate fringe benefits.

Simpler non-motion devices can consume 10 times less power than complex full-motion equipment, leading to an environmental advantage, while there also will be reductions in the workload undertaken by regulatory authorities.

“Virtual reality allows pilots to familiarise themselves with the cockpit in advance, so that they make more effective use of their simulator time”

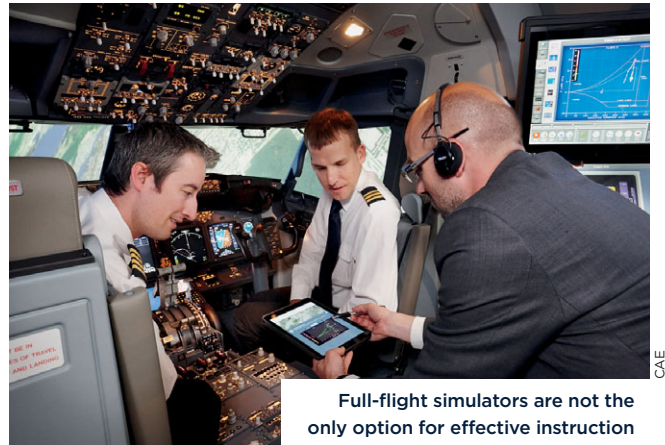
Sebastian Gerkens Senior instructor, KLM Cityhopper

A number of training specialists and manufacturers, including CAE, have yet to disclose opinions on the proposal, whose comment period ran to the end of March. EASA was also seeking input from aircraft manufacturers, pilots and regulators.

Glover-Faure believes the changes will lead to more demand for products, from large carriers seeking to purchase fixed devices to complement simulators and smaller airlines wanting to outsource time on devices to offset simulator time.

“We saw the direction of travel using the ‘middle category’ of devices to support type-rating around two years ago,” he says. “So we invested in our manufacturing and development of them.”

L3Harris has delivered Airbus A320 fixed training



Full-flight simulators are not the only option for effective instruction

devices to companies including Lufthansa and Baltic Aviation Academy – the Baltic agreement including Boeing 737 Max and NG platforms to support single-aisle training demand.

EASA says the regulatory framework for flight-training systems has not changed for 25 years and claims that it “neither stimulates innovation nor paves the way for emerging technologies” – pointing out that the training field is increasingly exploring the use of artificial intelligence and virtual reality.

KLM Cityhopper recently sought EASA’s backing for a new supplemental virtual-reality pilot-training scheme for Embraer E-Jets, which could begin replacing certain classroom instruction.

“Virtual reality allows pilots to familiarise themselves with the cockpit in advance, so that they make more effective use of their simulator time,” says Cityhopper’s senior Embraer instructor Sebastian Gerkens.

Technological advancement, says EASA, means the full-flight simulator – the highest-fidelity training device – is no longer the only option for all training.

“Training needs and their evolution should take a larger role in driving the development of training tools,” it says.

Innovative possibilities

EASA wants to ensure harmonisation with the latest revision of ICAO documents on flight-training criteria, opening the market for devices, with Europe being among the first regions to take advantage of the “innovative possibilities” provided by the revision.

But ahead of any radical shift to cutting-edge training, the new matrix and capability signature scheme will enable the fixed training device to emerge from the shadow of the full-flight simulator, and become a valued asset rather than an understudy.

Glover-Faure says L3Harris is ensuring its latest generation of fixed devices will differ only minimally from their more complex cousins.

“We are using the same DNA and full software load from the aircraft manufacturer as we use in the full-flight simulators. So except for the motion, they offer a comparable full simulation experience,” he says.

“We’ve defined our design approach with the objective of making no compromises on the level of fidelity and standard of training when airlines offset their use of full-flight simulators through the use of our new-generation fixed training devices.”

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Gagarin became a global star after 108min flight in *Vostok* spacecraft

Orbital hero

On the morning of April 12 the Soviet news-agency Tass began to broadcast one of the greatest announcements in the history of mankind. The message began to come through at 0759BST (0959, local Russian time) and opened in the following terms:

“The world’s first spaceship, *Vostok* (East), with a man on board was launched into orbit from the Soviet Union on April 12. The pilot space-navigator of the satellite spaceship *Vostok* is a citizen of the USSR, Flight Major Yuri Alekseyevich Gagarin.

“The launching of the multi-stage space rocket was successful and, after attaining the first escape velocity and the separation of the last stage of the carrier rocket, the spaceship went into free flight on a round-the-Earth orbit. According to preliminary data, the period of the revolution of the satellite spaceship around the Earth is 89.1 min. The minimum distance from the Earth at perigee is 175km (108.7 miles) and the maximum at apogee is 302km (187.6 miles), and the angle of inclination of the orbit plane to the equator is 65° 4’. The spaceship with the navigator weighs 4,725kg (10,416.8lb), excluding the weight of the final stage of the carrier rocket.”

The fact that this announcement was by no means unexpected in no way detracted from its stunning impact on the entire world. Ever since Sputnik 1 went into orbit on October 4, 1957, manned spaceflight has been

the obvious next major milestone, and the Soviet Union, largely as a result of greater available first-stage thrust and apparently excellent reliability, has placed in orbit a far greater tonnage than the US and has successfully recovered spacecraft of much greater size.

As in all Soviet space launchings, no details have been given of the location of the firing, nor of the recovery area, neither have any particulars been divulged concerning the launch vehicle. The space vehicle itself is certain to be the same as that used in all the Soviet firings since May 15, 1960. In addition to the five test shots preceding Gagarin’s flight, the vehicle was undoubtedly subjected to extensive static and systems testing, and the overall reliability of the entire booster and capsule appears to be remarkably high. The vehicle is considerably larger than the American Mercury capsule, which weighs some 2,100lb loaded.

According to the Russian announcements, the capsule had “a double wall of thin metal” – Mercury uses two layers of 0.1in titanium alloy – and the Cosmonaut was strapped to a contoured foam-rubber couch. It may be inferred that it also had a controllable retro-rocket system, and a series of parachutes for final recovery. The launch took place at approximately 0907 local time, and one complete orbit was accomplished. The recovery sequence began at 1025 local time.

During the flight, Major Gagarin is reported to have radioed, “Flight is proceeding normally; I feel well”

Sixty years ago, Yuri Gagarin became the first man to orbit the Earth from space – and one of the 20th century’s most famous figures. This is an edited version of *Flight’s* 20 April 1961 report on the event

(over South America at 0722BST) and “I am with-standing state of weightlessness well” (over Africa at 0815BST). The landing was made “safely at a pre-determined spot in the Soviet Union” at 1055 local time. Gagarin then said “Please report to the Party and Government, and personally to Nikita Khrushchev: the landing was normal, I feel well, I have no injuries or bruises.” Prime Minister Khrushchev at once sent the following telegram: “I warmly congratulate you. I embrace you. Until our meeting soon in Moscow.”

Unique narrative

On April 13, before his triumphant entry into Moscow the following day, Gagarin was interviewed at length by Tass. The result was a unique narrative, in some places of a personal and recollective nature but in others containing straightforward descriptions of sights never before seen by man.

“I had,” he said, “no feelings of loneliness in space. I knew well that my friends, the entire Soviet people, were following my space flight. I was sure that the Party and the Government would always be ready to help me if I found myself in a difficult situation. I felt fine, and could have spent much longer in the spaceship; but the duration of my flight had been fixed in advance.

“The sunlit side of the Earth is visible quite well and one can easily distinguish the shores of continents, islands, great rivers, large areas of water and folds of the land. Over Russia I saw distinctly the big squares of collective-farm fields, and it was possible to distinguish which was ploughed land and which was meadows.

“Before this I had never been above 15,000m (49,213ft). From the spaceship satellite one does not, of course, see as well as from an aeroplane, but very well all the same. During the flight I saw for the first time with my own eyes the Earth’s spherical shape. You can see its curvature when looking to the horizon.

“I must say the view of the horizon is quite unique and very beautiful. It is possible to see the remarkably colourful change from the light surface of the Earth to the completely black sky in which one can see the stars. This dividing line is very thin, just like a belt of film surrounding the Earth’s sphere. It is of a delicate blue colour. And this transition from the blue to the dark is very gradual and lovely.

“When I emerged from the shadow of the Earth the horizon looked different. There was a bright orange strip along it, which again passed into a blue hue and once again into a dense black colour. What struck me most remarkably was how near the Earth seemed, even from the height of 187 miles.

“I did not see the Moon. The Sun in outer space is tens of times brighter than here on Earth. The stars are visible very well: they are bright and distinct. The whole picture of the heavens is much more contrasty than when seen from the Earth.

“When weightlessness appeared I felt excellent. Everything was easier to perform. This is understandable. Legs and arms weigh nothing. Objects are swimming in the cabin, and I did not sit in the chair, as before, but was suspended in mid-air. During the state of weightlessness I ate and drank, and everything was like on Earth.

“I was working in that state, noting my observations. Hand-writing did not change, though the hand was weightless. But it was necessary to hold the writing block, as otherwise it would float away from the hands.

“I was convinced that weightlessness has no effect on the ability to work. The passage from weightlessness to gravitation, to the appearance of the force of gravity, happens smoothly. Arms and legs feel as previously, the same as during weightlessness, but now they have weight. I ceased to be suspended over the chair, but eased myself into it.

“When I returned to the Earth I was overjoyed. I was warmly met by our Soviet people. I was moved to tears by Nikita Sergeyevich Khrushchev’s telegram...” ▶



Aged 27 at the time of his historic – and only – voyage into space, Gagarin had first worked as a foundryman, subsequently attending a military aviation college and serving as a parachute instructor before being selected for Cosmonaut training.

On 14 April 1961, two days after his 108min flight, he was named a Hero of the Soviet Union by Khrushchev.

“He proved an admirable ambassador for the USSR on international visits; and played an important role in training other cosmonauts,” Flight wrote after his death on 27 March 1968. Undergoing instruction to become a fighter pilot, Gagarin was killed with Colonel Vladimir Seregin when their Mikoyan-Gurevich MiG-15 trainer crashed near Moscow.



Gulf Air

Colour revolution

Purple erase

January's AIUa summit in Saudi Arabia that ended a three-year spat between Qatar and three of its neighbours, including Bahrain, appears to have come too late for the aircraft-painters at Gulf Air.

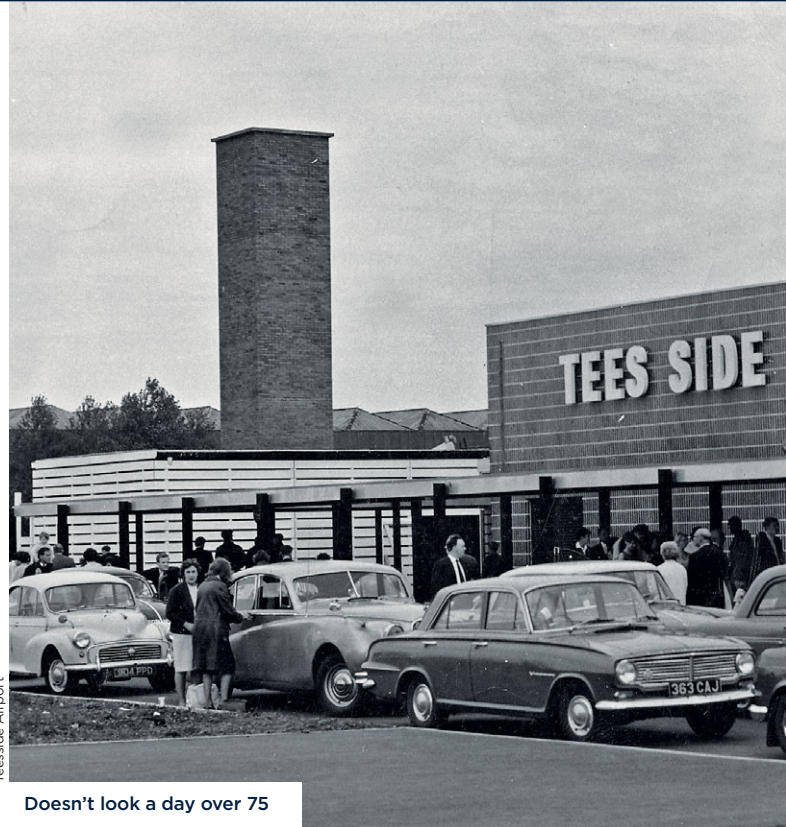
On 5 February, the Bahrain flag carrier welcomed its latest Airbus A321LR to its new airport, sporting a 70th anniversary "Golden Falcon" colour scheme that harks back to its classic 20th century livery.

With one subtle change. The original design had gold, green, purple and red stripes to represent its then-four shareholders – Abu Dhabi, Bahrain, Oman and Qatar. The new heritage look has just three.

Bahrain may have kissed and made up with its erstwhile enemy, but not enough it seems to repaint its showpiece airliner with Qatar's purple.

A star is born

Airbus's latest satellite is called the Eurostar Neo. We can imagine how that branding discussion went: "What are we going to call this satellite?"



Teeside Airport

Doesn't look a day over 75

"How about 'Eurostar'?"
"There's already a French train called Eurostar."
"How about 'Neo'?"
"There's already a French aeroplane called Neo."
"Hey, I've got it..."

Acronymble

On the subject of acronyms, Doug Brown is on fine form. "I see China Eastern has unveiled a new subsidiary named OTT Airlines. That's a bit over the top don't you think?" he asks, only to follow it up with: "New Italian start-up EGO Airways has just launched. Must have a high opinion of itself."

From the archive

100

1921 A life of adventure

It is with the utmost regret we have to record the death, through an aeroplane accident, of Lieut J. McIntosh, who with Lieut. R. J. Parer, made that exceedingly plucky and sporting flight from England to Australia last year. It will be recalled that the flight to Australia was remarkable for the succession of mishaps and delays that occurred. On the way to Rome their machine caught fire at a height of 3,000 ft., and it was only by turning off the petrol and sideslipping down that they managed to escape a terrible death. They later had to make a forced landing in the Syrian desert, and spent the night under their machine. In the morning they saw a group of Arabs advancing upon them, but succeeded in holding them off with revolver shots, and managed to get away.

75

1946 Kickstarting Kestrel

"George" Bulman says his test pilot's life was almost devoid of incident – but he has had one or two close shaves. Here is a story told for the first time, filed away in a drawer for years. At a Household Brigade Club meeting at Hatfield "George" put up a remarkable show. To the spectators it appeared as if he climbed vertically to 3,500ft, stopped his airscrew and then, flicking into a vertical dive, regained his engine as he pulled out at no feet. What really happened was that he accidentally gave the Hart a little negative *g* at the top of the climb and this emptied the Kestrel's carburettor. From the wealth of his experience he remembered that an airscrew will start in a pull-out at 3 or 4*g* even when it refuses to do so in a straight dive.



Time for Tees

Teesside Airport near Middlesbrough is celebrating its 80th birthday this year – but it nearly didn't make it, having been brought back into public ownership in 2019 as a last resort after a decade of faltering traffic volumes and losses.

The airport was opened during the Second World War as RAF Middleton St George and became a passenger airport around 20 years later, with the first civilian flight from the renamed Teesside Airport: a Mercury Airlines service to Manchester that took off on 18 April 1964.

Despite the Covid-19 crisis, the airport, in which Stobart Group has a 25% stake, has embarked on a 10-year "rescue plan" and has secured new airlines during 2020, including Ryanair and TUI. A business park also is being developed.

The airport was rebranded as Durham-Tees Valley in 2004, the logic being that visitors to the region would be more likely to have heard of the university city. But a popular vote in 2019 saw the name revert to the no-nonsense Teesside.

Cranfield memories

As Cranfield's College of Aeronautics marks its 75th birthday and prepares to replace its British Aerospace Jetstream flying classroom – the "vomit comet" – with

a Saab 340B, it is asking former students to contribute "memories and photographs" from their time at the Bedfordshire institution. It is part of a project to "record the important contribution to aerospace and aviation" made by the college, which was founded in 1946. Email NFLCmemories@cranfield.ac.uk



Cranfield University

Queasy does it

Raising the baa

From the names that suit the job department, a press release: "Intradco Global has promoted Tom Lamb, who has worked at the firm's London office for nearly seven years, to head up its Toronto office as Regional Manager – North America (Live Animal & Cargo Charter)."

1971 Deaf to supersonic

Means of finding money to continue with development of the Boeing 2707-300 SST have been explored since the Senate decision to finally turn down the necessary finance. But the banks have already given a preliminary reply – a very pessimistic one. But given the first order for Concorde by an American airline, the picture could change and federal money for the SST might again appear a possibility. As the Boeing statement said, "We believe that at some future time the need for an American-built supersonic transport will become apparent to a majority of American people. This will require a greater degree of understanding of the business of air transportation and how its continued advancement is an asset to society."

1996 Russian readiness

Concern over the state of combat readiness and morale of the Russian army's aviation corps has been made public in a letter sent by senior officers to Gennady Seleznev, chairman of the lower chamber of the Russian parliament. The letter says that the bulk of the helicopter fleet is obsolete and that more than 40% of army helicopters are grounded because of lack of spares. In addition, insufficient money is being made available to update the fleet – seven Mil Mi-24 helicopters were acquired in 1995 and two Kamov Ka-50s are to be received this year. The officers say that pilots are logging only 20-30h flying annually because of the shortage of fuel, and that about half of the 4,000 officers and warrant officers have no permanent housing.

Tragic irony

Reading the comments by EASA executive director Patrick Ky in your article 'Out of the ordinary' (*Flight International*, February 2021) regarding the Boeing 737 Max flight tests, I see he said "We pushed the aircraft to its limits... and could confirm that the aircraft is stable and has no tendency to pitch up even without the MCAS".

Given that the purpose of the MCAS was the elimination of "a tendency to pitch up at low airspeeds", one has to wonder whether this system – whose malfunction was responsible for 346 deaths and untold economic disruption for Boeing, along with its suppliers and customers – was necessary to begin with.

Robert P Czachor

Chief consulting engineer (Retired),
GE Aircraft Engines
Champaign, Illinois, USA

Bad for the UK

I wish to highlight the situation with regards to the grossly unfair liberalised US airline cargo agreements now affecting the UK and Europe.

Late last year, Grant Shapps, the UK's secretary for transport, signed off – with virtually no scrutiny – a deeply damaging and outrageous change to the European Open Skies agreement affecting aviation in the UK (*FlightGlobal.com*, 17 November 2020).

This was done in conjunction with his US counterparts, and allows full access to the UK for US cargo airlines to operate unrestricted revenue cargo flights within the UK and to points in Europe as well as the rest of the world.

On top of this injustice, the US crews and staff are not required to pay taxes or any kind of social payments whilst being based long-term in the UK and Europe.

No reciprocal access of any kind has been negotiated for UK companies to be allowed to do anything similar in the USA, which strictly forbids airlines which are not US-owned from operating commercially within the country.

This one-way, sugar-loaded deal has alarming implications for all our future trade deals with the USA post-Brexit.

This sycophantic pandering to US interests is being done without the slightest regard or interest for the plight or welfare of UK airlines and employees such as myself, who are currently being forced out of business by such arrangements – this coming on top of the overwhelming Covid crisis that has been affecting our industry.

I am appalled at the total disregard shown by this government to UK citizens working in the airline industry.

Graeme Pryke

Mulbarton, Norfolk, UK



MCAS malfunction was a factor in two crashes and global grounding of 737 Max

BlueBarron Photo/Shutterstock

VSTOL creation

The Royal Air Force (RAF) has protected the UK from its enemies since its inception. However, its latest fighter – the Lockheed Martin F-35 Lightning – has a number of faults, as you recently reported (*Flight International*, February 2021).

The RAF cannot effectively protect the UK with this aircraft – a different vertical/short take-off and landing (VSTOL) type is needed.

Looking to the past, the VFW VAK 191B could have been equipped with a Rolls-Royce Pegasus 15 engine to provide a supersonic VSTOL capability. The VAK 191B was based on the British P1127, and was tested as part of the European Multi Role Combat Aircraft programme, which went on to produce the Panavia Tornado.

The US Air Force also needs to replace its Fairchild-Republic A-10 fleet – perhaps a VAK 191B/Pegasus combination could have done the job as a ground-attack aircraft also suitable for RAF and NATO use?

A Roberts
Bristol, UK

Editor's reply: Germany pulled the plug on the VAK 191B project in 1975; Italy had already walked away from their partnership before a first free flight in September 1971, and three prototypes completed only 91 flights. Had it entered service, its service life would almost certainly have ended by now, as with the UK's Harrier and Sea Harrier fleets. The UK's F-35Bs form part of its Carrier Strike capability, with the nation being protected by the Eurofighter Typhoon.

Out there

Okay, own up. Who's the *Space: 1999* fan in the FlightGlobal office (Straight & Level, March 2021)?

RobAvia
via Twitter

Editor's reply: That one wasn't on our radar back in the day – our tastes range more from *Starfleet* to *Herge's Explorers on the Moon...*



Is it realistic to expect half of commercial pilots to be women?

An impossible dream

Regarding Pilar Wolfsteller's opinion piece 'Aviation's man problem' (*Flight International*, March 2021), the assumptions made and conclusions reached are just plain incorrect.

The science clearly, consistently and repeatedly shows that men and women, whilst being equal, are different. The biggest difference is that as a population men show more interest in things and women show more interest in people.

To test this, we can look to the Scandinavian nations and their very advanced egalitarian societies. There the gender role disparity has become more pronounced, not less. In Scandinavia, more women are choosing people-based work and more men are choosing things-based work than in the past.

This is the science, these are the facts and it's been repeatedly shown. Just Google the science literature – not opinion pieces – to see it.

What is the justification for expecting a pilot population of 50% women and 50% men? There is none. Many of the girls whom your author so stridently advocates for are just not that interested in jobs as pilots and mechanics. This is why business finds it so hard to recruit women into certain roles.

Most men are not misogynistic bigots looking to bully and intimidate any female colleagues and sideline them out of the industry. It is not such men who are "stopping" girls from entering the industry, but simple disinterest. You can hold a door wide open, but if no-one wants to enter, no-one will.

Some of the best pilots I know are female, and they are welcome in the cockpit any day. As a man, I apologise on behalf of my fellow men for those harrowing times when girls have been bullied or sidelined. That is not right, and there are no excuses.

What we must do is focus on equality of opportunity through an egalitarian culture. The desire for equality of outcome is simply a politically correct fashion, an unachievable nonsense, just another opinion piece justified by oft-repeated tales of yore.

via email

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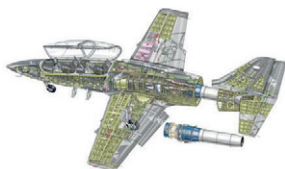
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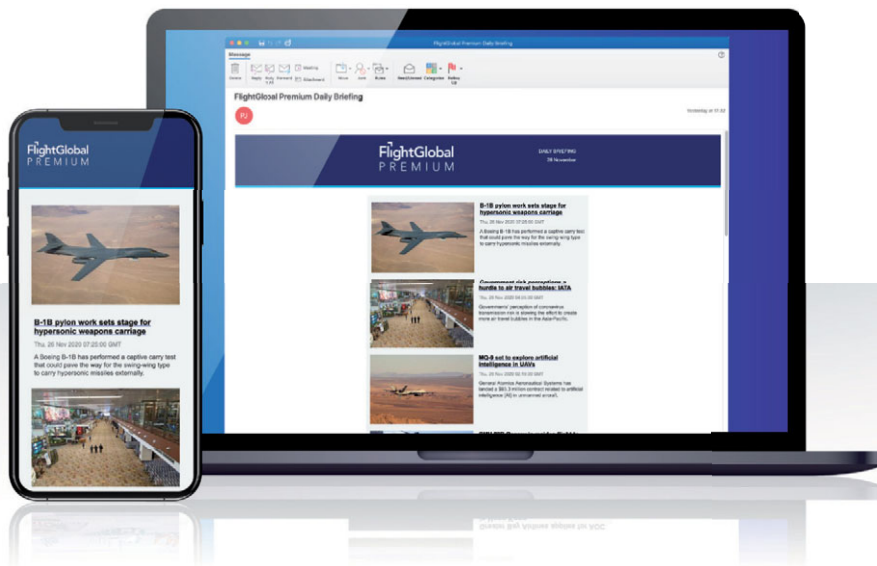


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As senior executive in charge of medical services and corporate social responsibility, **Nadia Bastaki** has led the UAE flag-carrier's response to the pandemic, ensuring the safety of passengers

Covid-proofing Etihad

Pilar Wolfsteller Las Vegas

When the coronavirus suddenly disrupted aviation worldwide a year ago, airlines went into their own kind of lockdown. They rapidly grounded aircraft, laid off staff and shrunk networks to a minimum, conserving cash as travel screeched to a halt.

But as air travel was slowing down, Nadia Bastaki, Etihad Airways' vice-president of medical services and corporate social responsibility, was getting to work.

"Covid-19 put me into a platform where I was the forefront advisor to the CEO and senior management. We developed an entire programme for Covid-19. Well-being was not only important for passengers, pilots and crew, but for the entire company," she says.

Protecting passengers

Under her leadership, the airline quickly developed a comprehensive, organisation-wide health and safety concept. The effort involved rethinking every aspect of the airline's business through the lens of how to best protect passengers, workers and the company from the highly contagious, rapidly-spreading pathogen.

The airline redesigned uniforms, implemented Covid-19 testing procedures, developed smartphone apps intended to help customers navigate travel requirements, created quarantine zones inside their aircraft and introduced new ways to package and serve in-flight food.

"We created a whole multi-disciplinary working group around the Covid-19 pandemic," Bastaki says. "I worked with multiple external committees [including] an emergency crisis management committee and a civil aviation committee. I was on these committees to ensure that I get the information and then do the right thing for the company."

Bastaki also was responsible for developing new internal policies and processes as well as a health and hygiene training programme.

"The aviation business is a 24-hour business, and although it slowed down, we were still operating.

"So we needed to make sure that the core group operates really well."

Bastaki, 41, became the face of Etihad's coronavirus pandemic response. And her journey through the male-dominated aviation industry in a society that often marginalises working women has been nothing short of extraordinary.

She was educated as a doctor in Scotland and completed a postgraduate specialty aerospace medicine programme at London's Kings College.

"My family always encouraged me to do something I loved," Bastaki says. "I didn't just want to be a number. I wanted to be something different. So I searched a lot and I looked at specialties that are different and unique. And I came across something called aviation medicine. And it just lit a spark in me."

Following that training, Bastaki returned home to the United Arab Emirates, where she was recruited by Etihad. One of her duties as the airline's medical officer was to examine pilots in order to grant or revoke medical certifications. Having trained as a private pilot herself, Bastaki felt she was in a position to better understand the holistic effect of flying on crew.

"I wanted to be the doctor that could relate to them," she says. "I had a good perspective about the mental and physical well-being of a human, and the connection pilots have with their aircraft." So if something goes wrong in flight, she says she has a

"I wanted to be something different. So I searched and I came across something called aviation medicine. And it just lit a spark in me"

solid understanding of how that affects their overall health and well-being.

As a young woman in her field, she found she often had to deal with stereotypes, and her expertise and skills were questioned.

“The first pilot who saw me said, ‘Where’s the doctor?’ I said, ‘I’m the doctor’. I am a Middle Eastern woman who wears a scarf. When I asked him to remove his shirt he says, ‘You are going to examine me? Are you sure you want me to remove my clothes?’ It took the pilots some time to get to the point where they could trust me.

“When I had to advise them on their licensing or revoke their license, they would say, ‘You’re not experienced enough to do that.’ And I had to build all that into my personality, into my voice, the way I converse, the way I develop that relationship with the patient. So they understand that yes, I am very up with my culture, but at the same time I am your doctor.”

Respected leader

In the almost 14 years she has been with the airline, Bastaki has moved up through the organisation’s ranks to become a well-respected leader in her field, both in the UAE and abroad.

She helped establish Etihad’s medical well-being centre for staff, and as she joined management, she developed specialties in employee engagement and corporate social responsibility. Bastaki was the first woman to be elevated to an executive level at the airline, and is currently one of five female VPs. She now also leads Etihad’s initiatives on diversity and female empowerment.

Age and experience has also brought her a degree of wisdom, she says. “In the beginning I thought I had to be harsh, and very loud, for people to hear me. Then I realised, no, I don’t have to change my personality or my demeanor. I needed to have good negotiation skills for them to understand me.

“Also, I needed to put my foot down if someone crosses the line, so they understand that I’m here for a reason. I make decisions based on my merits and my knowledge and my skill. You have to be confident of what you know and say, ‘This is what I am. And this is what I’m going to deliver.’”



Etihad Airways

Bastaki has won the trust of flightcrew

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