

# FLIGHT INTERNATIONAL



## Troubles behind?

Why 737 Max revival is key to Boeing's future **p10**

Store or scrap? Our salvage special **p42**

More action needed on gender inequality **p60**



**Extra smiles**  
BelugaXL to travel further for Airbus **p29**



**Lear regret**  
Bombardier pulls plug on iconic business jet **p21**



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# Expecting the unexpected

Whether Ukraine should have closed upper airspace – saving flight MH17 – depended on its view of separatists' capabilities

If there is a country that understands the unintentional threat to commercial aircraft from a missile launch, it is Ukraine. Its own air defence forces shot down a Russian Tupolev Tu-154 during a military exercise – despite the advantages of discipline, training and peacetime – just 13 years before Malaysia Airlines flight MH17 was destroyed by a surface-to-air missile over conflict-scarred Donetsk.

There's a stark aspect of the Flight Safety Foundation's inquiry into the lead-up to MH17's destruction which deserves more attention than the headline declaration that it "did not find sufficient facts" to indicate Ukrainian officials were properly aware of a threat to civil aircraft.

Its analysis examined whether such a threat could have been theoretically assessed, and drew up a foresight matrix looking at the factors – capability, intent, command and control, and the possibility of unintentional attack – which collectively might have given rise to a risk to aircraft operating at cruise altitudes above the war zone in the east.

For almost all the individual elements within these factors, the Foundation assigned a "high" risk value, based on the reasonable assumptions that the separatists involved in the conflict would be irregular forces, without an organised reporting channel, having no protocol for authorising a missile attack, and a marginal ability to differentiate civil aircraft from military.

With so few safeguards standing in the way of a potential attack, this essentially meant judging the risk to MH17 – or any other civil flight – depended heavily on knowing whether the separatists did or did not have access to powerful high-altitude weapons.

This makes the risk assessment "extremely sensitive" to information about such a capability, says the analysis, and should be considered as a probability range rather than a binary yes-or-no. To put it in terms



Itchy trigger fingers

Anastasia Vlasova/EPA/Shutterstock

of the well-known aviation risk model: guess the size of the hole in the final slice of Swiss cheese.

Its reputation tarnished by the Tu-154 debacle, Ukraine's defence ministry would have appreciated the danger posed by rag-tag rebels engaged in real combat. The country's security and defence council had also openly floated the possibility that a Russian surface-to-air missile system, such as the Pantsir, might have brought down a military Antonov An-26 just three days before the downing of MH17. It had not – but that is not the point.

"From a hundred rabbits you can't make a horse," remarks investigator Porfiry Petrovich in Dostoevsky's *Crime and Punishment*. "A hundred suspicions don't make a proof."

This is important in a legal context, of course, but commercial aviation is an industry in which thresholds are measured against billion-to-one improbabilities. Suspicion is often enough; witness the tidal-wave grounding of the Boeing

737 Max, driven by, at that stage, precaution rather than proof.

The Dutch Safety Board, which carried out the original investigation into the MH17 attack, believed there was "sufficient reason" to close the upper airspace through which the aircraft was fatally permitted to travel.

Apportioning blame is out of the Safety Board's remit. The Foundation inquiry had not set out to convict or exonerate Ukraine, and the Dutch government is unlikely to rethink its view that pursuing a liability case is futile.

But if so much of the potential risk to MH17 hinged on the remote chance that combatants in a lawless war zone – who considered aircraft as legitimate targets – might source the capability to inflict damage beyond their assumed means, the authorities of a country which, in the face of all odds, accidentally shot down a Tu-154 should really have expected the unexpected. ▶

**See p30**

## In focus

Airbus sees fresh challenges **6**  
Autothrottle flaw in 737 crash **8**  
Boeing flags weakness around 777X backlog **9**  
Max: a road to redemption? **10**  
India's future combat system **18**

Bombardier cuts back to rebuild **20**  
USAF eyes cheaper fighters **22**  
LongShot comes into range **24**  
HNA's rise and fall **26**  
Production pause for Dash 8 **28**

Airbus's whale freight **29**  
MH17 evidence 'insufficient' **30**  
Catalogue of failures doomed Swiss Ju 52 **32**  
Part and parcel **36**  
Aviation's man problem **37**



### Better by degrees?

We put Cessna's Longitude flagship to the test



# 10

Regulars **Comment 3** **Straight & Level 74** **Letters 76** **Jobs 81** **Women in aviation 82**

Features

**Aviation's death row** What actually happens to an airliner when it is parted out? **42**

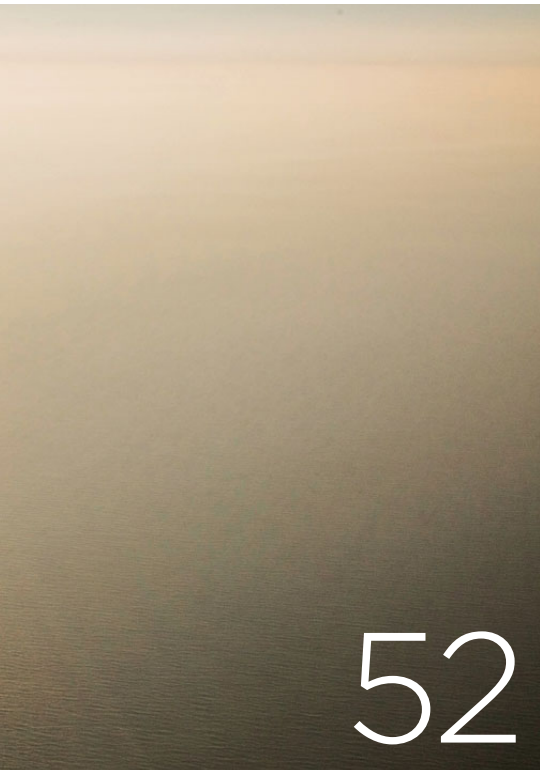
**No trouble in store** Maintenance providers are changing practices to ensure continued airworthiness **48**

**Degrees better** Cessna has made Longitude a pleasure for passengers and pilots alike **52**

**Searching for equality** The industry has yet to find a way to fix its glaring gender imbalance **60**

**Closing the C-suite gap** Change is slow in what continues to be a male-dominated sector **64**

**Spoil for choice** Civil helicopter manufacturers are refining their ranges **68**



# 'Resilient' Airbus sees continued challenges

Airframer looks to brighter future, but warns of more short-term hurdles as it reveals Covid-ravaged 2020 accounts

David Kaminski-Morrow  
and Dominic Perry London

Presenting the airframer's financial results for the pandemic-ravaged 2020, Airbus chief executive Guillaume Faury emphasised the company's "resilience".

Although noting that the group's performance over the previous 12 months was "far from the initial expectations we had set for 2020", Faury stressed that the company had adapted: it had "contained", "recalibrated", "resized", he said.

To some extent, what else could he offer? There was ample evidence in the accounts of how bad a year it had been - including an eye-watering full-year loss at its main commercial aircraft operation of €1.33 billion (\$1.6 billion), after a 37% fall in revenues to €34.2 billion; the unit's profit in 2019 was nearly €1.8 billion.

In a sign of the difficulties in commercial aviation, Faury even singled out the contribution from its defence and helicopter businesses, which "strongly added to the resilience of the group during 2020".

Overall, group revenues decreased to around €50 billion, down 29% from the previous year, primarily as a result of commercial aircraft deliveries that plunged by 34%.

Airbus does not think the crisis is over: Faury points to the current lockdowns and travel bans, noting that it will "be another challenging year": most of its airline customers continue to burn cash and "many uncertainties remain", he notes.

But if 2020 was all about emergency action - hurried retrenchment and right-sizing for the market as jobs were slashed and output cut - then 2021 may at least be less frantic, with fewer fires to fight simultaneously.

"We are committed to demonstrate our resilience once again



## Manufacturer builds for the future with aerostructures at its core

Airbus has removed the 'for sale' signs from its aerostructures units, Premium Aerotec and Stelia Aerospace, as it brings them into closer alignment with the rest of the group.

Presenting the group's full-year results, chief executive Guillaume Faury said that "aerostructures are a core activity".

The two businesses were carved out "more than a decade ago", says Faury, with the "idea that at some point in time these could be divested".

But as part of a drive to increase competitiveness, Airbus will look to "simplify" what Faury describes as a "rather segmented and complex industrial system".

Designating the aerostructures operations "as core" will aid this process, he says, allowing the businesses to remove duplicate functions, for example.

A number of "potential modifications" to the current set-up are under consideration, Faury says, without specifying.

Premium Aerotec is predominantly a German operation, with sites in Augsburg, Bremen, Hamburg, Nordenham and Varel, plus an additional facility in Brasov, Romania; Stelia, by contrast, is largely based in France and includes plants in Meaulte, Merignac, Rochefort, St Nazaire and Toulouse. Other sites are located

in Portugal, North Africa and North America.

Faury says that in addition to the industrial simplification, closer alignment between the digital design and manufacturing processes is necessary to prepare for future aircraft that feature "different architectures and new energy [sources]".

### Staying connected

"The connection between design and the industrial system will remain in Airbus," he says.

However, Faury stresses that there is no plan to move any of the current aerostructures operations to China in order to save costs.



Output of 45 A320s per month is the target for the end of this year

and to protect our competitive positioning," says Faury.

There are still things to finalise, however – notably its restructuring, which will see around 11,000 jobs lost. So far, 3,600 personnel have already left, with about 7,500 still subject to the process.

Faury says the company is "on track with the social plan", but that it has involved a "lot of negotiation".

To some extent, though, 2021 is about preparing for the future. Not for any immediate return to the boom times, but halting, baby steps towards a kind of normality.

### Agreed deliveries

Deliveries this year should match 2020's total of 566, with narrow-body production rising slowly to 45 A320s per month by the fourth quarter, from 40 currently. A220 output should also increase, from four to five aircraft per month by the end of the first quarter. Wide-body final assembly rates, however, will stay at the current low levels.

But Faury stresses that "our focus this year will be on delivering aircraft based on the agreements with our customers" – shorthand for not building white-tails.

Faury says the airframer "continued to reduce" the number of undelivered aircraft in the fourth quarter, bringing this down to "slightly below" 100.

He says these are "vastly" aircraft with customers, with a "small number" of white-tails, adding that the "low number" of cancellations ex-

perienced by the airframer – just 115 last year – means it is "on the safe side when it comes to white-tails".

But even faced with short-term volatility, Airbus is convinced that things will improve. "Despite the overall uncertainty and complexity of the situation, we at Airbus want to be prepared for when the market recovers. Not if, but when," says Faury.

When that will happen remains unclear, he says, with the timing of "the tipping point" still shrouded in mystery. Nonetheless, Airbus continues to prepare for a ramp-up in 2022, which it views as "secure and robust" – at this point at least.

Its preparations include working with suppliers to identify "potential bottlenecks" should output need to rise rapidly; given that the production system was geared to build 60 A320neos per month when the music stopped, a fast ramp-up is possible, he insists, albeit this is likely to be tempered by demand.

In the meantime, of course, there is a longer-term drive to prepare the company for "the next generation of aircraft", both in terms of articulating its future aircraft strategy and transforming its "industrial value chain".

"Over the long term, our ambition is more than ever to lead the development of a sustainable global aerospace sector," says Faury. "We will preserve our ability to invest in decarbonised technologies in order to be well positioned to successfully address future challenges in a sustainable way." ▶



Stelia Aerospace has bulk of its operations in France

"We are making aerostructures competitive on a European basis; it is optimisation in Europe for Europe," he says.

In addition, Faury plays down concerns that Airbus has moved too early to state a preference for hydrogen as a future zero-carbon fuel. While conceding that there are "challenges" with hydrogen, he insists "we really believe that it is a technology that has the potential to come to market".

"You have to be careful with the 'it will never work' attitude. That has proven to be wrong so many times in so many industries."

To make hydrogen power feasible for use in aircraft does not require the "laws of physics" to change, he says, "just a hell of a lot of work".

# Autothrottle flaw in Sriwijaya crash

Indonesia's investigation into 737 loss focuses on unnoticed asymmetric thrust lever condition prompting loss of control

David Kaminski-Morrow London

Preliminary findings from Indonesia's investigation into the crash of a Sriwijaya Air Boeing 737-500 on 9 January support an in-flight upset scenario in which the crew was suddenly caught out by the insidious development of an asymmetric thrust condition.

While no conclusions have been drawn, the highly unusual retardation of a single throttle lever to idle during the aircraft's climb – with no immediate indication that the crew was aware – has intensified suspicion of an autothrottle problem, particularly in the light of a repetitive technical malfunction reported in the week before the accident.

Indonesia's National Transport Safety Committee (KNKT) says that on 3 and 4 January, the 737's autothrottle system was reported to be faulty, but was rectified immediately. Its investigators also found that the first officer's air-speed indicator was replaced on 4 January, after a fault was discovered on 25 December 2020.

Operating flight SJ182 bound for Pontianak, the aircraft had departed Jakarta's runway 25R on the ABA-SA 2D departure pattern, requiring a sharp right turn upon reaching 1,000ft to a heading of 081°.

The investigation authority's initial findings reveal that the left-hand thrust lever started to retard as the jet climbed through 8,150ft, while the right-hand lever remained in position.

The crew then requested a heading of 075°, citing a weather deviation, but while the aircraft subsequently started to turn right, it never managed to complete the planned alignment.

Given the thrust imbalance, the autopilot would probably have been trying to compensate for a tendency to yaw and roll left by commanding right-aileron input.

Although the crew was instructed to level off at 11,000ft in order to avoid a traffic conflict, the aircraft had not reached this altitude before it started to turn to the left, as the left-hand thrust lever continued to retreat.

At 10,900ft and a heading of 016° the autopilot disengaged and the aircraft rolled steeply to the left, with a bank of 45°, and entered a rapid descent. The last data point, indicating 250ft, was received only 23s later.

"The findings show consistency with the engines still being on before the aircraft hit the water," the KNKT says. The crash killed 62 passengers and crew.

Some 27h of information covering 18 flights – including four on the day of the accident – were extract-

ed from the twinjet's flight-data recorder, and maintenance log records showed no damage to the aircraft.

Indonesian officials previously said that the aircraft (PK-CLC) had been certified airworthy last December, after spending nine months in storage.

"Investigation is ongoing and focuses on, but is not limited to, [the aircraft] autothrottle system and related components, including its maintenance, [as well as] human and organisational factors," says the KNKT.

## Experienced pilots

The aircraft's captain had over 9,000h on type from a total of 17,900h, while the first officer had nearly 5,000h on the 737. Over the previous 90 days they had respectively logged 142h and 113h.

As of mid-February, search teams had yet to recover the aircraft's cockpit-voice recorder from a debris field described as 110m (360ft) long and 80m wide, and at a depth of 16-23m.

Sriwijaya has issued an internal safety recommendation reminding its pilots to maintain awareness during critical phases of flight and to write detailed reports of any aircraft maintenance issues. It has also reminded technical personnel to "increase discipline" in regard to following aircraft maintenance processes and procedures.

The initial findings suggest parallels with a fatal China Southern Airlines 737-300 accident near Guilin in November 1992, during which an autothrottle problem affecting its right-hand engine resulted in the crew losing control.

Boeing 737-300s, -400s and -500s were the subject of an airworthiness directive in 2001 which focused on upgrading autothrottle computers following incidents of asymmetric thrust conditions in flight caused by the thrust levers' slowly moving apart. ▀



The aircraft was certified airworthy in December after nine months in storage

Additional reporting by Alfred Chua in Singapore





Service entry for new widebody was recently pushed back to late 2023

Boeing

# Boeing flags weakness around 777X backlog

Airframer says up to a third of its orders for big twin may not be completed

**Dominic Perry** London

**B**oeing has warned that over a third of its firm order backlog for the 777X – a total of 118 aircraft – is at risk due to the financial condition of its customers and delays to the development of the new widebody twinjet.

In its annual report for the year ended 31 December, filed on 1 February, the US airframer stated that firm orders for the 777X total 191 aircraft, down from 309 jets at the end of 2019.

That reduction has been driven by an accounting regulation known as ASC 606. Boeing classifies separately jets for which it holds firm orders, but believes there is a lower likelihood of the contract completing due to the financial position of a customer, or other issues.

## Accounting adjustment

Boeing's orders and deliveries data indicates that a combined 135 aircraft – comprising 118 777Xs and 17 777s – are covered by ASC 606 adjustments.

On their own, the potential 777X cancellations represent over 30% of the 777's current backlog, but that rises to 38% for the new variant.

“The decrease in contractual backlog during 2020 was primarily due to a reduction for orders that in our assessment no longer meet the accounting requirements of [ASC 606] for inclusion in backlog primarily due to [the] 737 Max and 777X, deliveries in excess of new orders, aircraft order cancellations and changes in projected price escalation,” according to the airframer's financial filing.

Boeing has not identified which airlines' orders it now considers to be at risk. Customers for the 777X comprise: All Nippon Airways (20); British Airways (18); Cathay Pacific (21); Emirates (115); Etihad Airways (25); Lufthansa (20); Qatar Airways (60); and Singapore Airlines (20). A further 10 orders are held by unidentified buyers.

However, subsequent to the financial filing, Singapore Airlines announced it was increasing its commitment to the big twin, switching orders for 14 787-10s to 11 777Xs.

Boeing warns that further delays to the 777X may result in “additional reductions to backlog and/or significant order cancellations.”

The airframer recently pushed back first delivery of the GE Aviation GE9X-powered 777X to late 2023, citing weak demand and issues around certification.

ASC 606 adjustments have particularly hammered the 737 Max programme over the last 12 months, with Boeing currently recording 749 orders for the single-aisle that it believes are unlikely to be completed.

But owing to the narrowbody's protracted grounding, customers have also been able to walk away from orders: the airframer received 641 cancellations for the Max during 2020.

Meanwhile, Boeing has pushed back the arrival of the 737 Max 10 by two years, with deliveries of the largest variant of its re-engined narrowbody now scheduled to begin in 2023.

## Approaching milestone

The company also now expects to deliver the first 737 Max 7 – the smallest of the Max family – in 2021; that milestone was previously anticipated in 2020.

“We now anticipate that the first 737 Max 10 and 777X delivery will occur in 2023,” Boeing's year-end report says.

Boeing has not elaborated on reasons for the delay, but they are likely to relate to the modifications that are required for the Max to re-enter service. The 737-10 will be the first of the family to receive updates to its angle-of-attack sensor system.

Previous annual reports placed 737 Max 10 deliveries as beginning in 2020. However, that deadline quietly slipped amid the Max and Covid-19 crises.

The company rolled out the first Max 10 in November 2019. ▶

*Additional reporting by  
Jon Hemmerdinger in Tampa*



# Max seeks road to redemption

Billed as a fuel-efficient step forward for Boeing's best-selling narrowbody, the 737 Max instead became a nightmare of the company's own making

**Jon Hemmerdinger** Tampa

From the start, the 737 Max was meant to be a simple way for Boeing to respond to the popularity of the Airbus A320neo. While a final re-engining for the 50-year-old design posed some challenges, it was seen as quicker and simpler than delivering a clean-sheet model. Fitted with CFM International Leap-1B engines, the Max promised to deliver a fuel-burn saving of around 15% over its 737NG predecessor.

But instead of maintaining a steady source of revenue each year, the Max has cost Boeing immeasurably: its reputation has been shredded; a chief executive has departed under a cloud; orders have evaporated; and billions of dollars in revenue have been lost. The crisis also could not have come

at a worse time, leaving the US giant weakened just as the coronavirus pandemic struck.

And amid the focus on Boeing's lost billions, it is worth remembering the human cost as well: two separate crashes of 737 Max 8s cost 346 people their lives.

The 737 Max's unravelling began on 29 October 2018, when a 737-8 operated by Indonesian carrier Lion Air crashed into the Java Sea shortly after taking off from Jakarta, killing all 189 on board.

## Sensor problems

Investigators quickly revealed that the narrowbody had suffered airspeed indicator problems before it crashed. Boeing released a service bulletin instructing crews to follow existing procedures to deal with erroneous angle-of-attack (AoA) sensor readings, but concerns around the jet's safety were not

# 346

Total fatalities in the Lion Air and Ethiopian Airlines crashes of 737 Max 8s

eased when the next day the US Federal Aviation Administration (FAA) issued an emergency airworthiness directive for the type.

Although it stressed an adherence to existing procedures, it also warned that AoA failures could cause the Max's flight-control system to incorrectly pitch the aircraft's nose down.

It transpired that Boeing had fitted the Max with something it called the Maneuvering Characteristics Augmentation System (MCAS), which is designed to pitch the jet's nose down under certain circumstances.

# 220kt

Airspeed above which pilots could not move the trim wheel manually in simulations of Ethiopian crash

the horizontal stabiliser, moving it upward at 0.27° per second and up to 2.5° in 9.26s each time.

In theory, if pilots followed Boeing's existing procedures for a runaway stabiliser, using the trim cut-out switch and trim wheel to manually correct the pitch, they would be able to override MCAS.

But Boeing's expectations did not take into account real-life considerations such as reaction times, pilot experience or responses to an intensely high-stress situation.

And on 10 March 2019, those calculations proved to be deeply, deeply flawed, when, shortly after take-off from Addis Ababa airport, an Ethiopian Airlines 737-8 came down en route to Nairobi, killing all 157 on board.

Similarities between the Lion Air and Ethiopian crashes prompted safety regulators around the world to unilaterally ground the type, albeit that the FAA was last to act, issuing its prohibition three days after the crash, on 13 March.

Investigations revealed that the jet had pitched down at an angle of 40° after about 5min of flight

following what appeared to be another AoA sensor failure which triggered the activation of MCAS. In all, the automated system attempted to trim the nose down on four separate occasions.

Preliminary details from the investigation showed that the crew had tried to respond in line with Boeing's guidance – using the trim cut-out switch and trim wheel – but the jet still became uncontrollable.

## Aerodynamic forces

Crucially, before the aircraft's final dive it appeared that the crew deactivated the cut-off switch and, flying at high speed, they were unable to overcome the aerodynamic forces being exerted on the stabiliser using the manual trim wheel alone.

Simulations of the flight conducted by Ethiopian investigators, using the thrust and trim settings at the time, aimed to evaluate the control column forces required for the climb and to turn the trim wheel. With both simulator pilots pulling they achieved a nose-up pitch of 5-10°.

But the inquiry stated: "The forces needed from both pilots to achieve this were considered significantly very high and unbearable for the duration held."

The simulations also revealed that, for the trim setting, the pilots could not move the trim wheel manually at speeds above 220kt



Before the storm: 737 Max takes its first flight, in January 2016

Boeing

In Boeing's haste to bring the Max to market, MCAS was added with little fanfare. As a result, many airlines were initially unaware of its existence – or, crucially, of what to do if it malfunctioned. The system was designed to deal with the trim characteristics caused by the jet's new Leap-1B engines. With a larger diameter than the NG's CFM56s, to achieve sufficient ground clearance they needed to be mounted further forward and higher on the wing.

That configuration, however, caused the jet to pitch nose-high during some flight configurations, potentially risking a stall. Hence the addition of MCAS. But if the aircraft's flight-control system thought the aircraft was pitching up when it was not – say, because of a broken AoA sensor – MCAS could kick in and push the nose down.

And because of the way MCAS was designed, it would keep activating



Chief executive Dennis Muilenburg resigned nine months after the twinjet's grounding

Michael Reynolds/EPA-EFE/Shutterstock



Lion Air jet came down shortly after departure from Jakarta

› (407km/h); as the pilots wrestled to control the aircraft, it was flying at 350-375kt.

One month into the grounding, the effect on Boeing was already apparent: it announced that production of the narrowbody was to be cut by almost a fifth, to 42 aircraft per month, down from 52 previously. As it transpired, that would prove to be a high point for output over the coming years – by December, with the grounding well into its eighth month and the land around the company's Renton plant full of undeliverable aircraft, production was suspended entirely.

### Unhealthy relationship

As 2019 went on, more and more troubling details emerged about the Max and its certification process, not least the seemingly unhealthy relationship between Boeing and the FAA.

Matters came to a head in October that year, when Boeing chief executive Dennis Muilenburg testified before two Congressional committees. He defended Boeing's safety culture and said he was unaware until recently of troubling internal messages. In those messages, the company's former chief

## Pressure had been growing on [Dennis] Muilenburg, not least after more damaging revelations about the company were revealed

technical pilot had voiced concern about MCAS and said he had unknowingly lied to regulators, internal documents showed.

That same month, Boeing's head of commercial airplanes, Kevin McAllister, who had held the post since 2016, stepped down. Although he was the first management casualty of the crisis, he would not be the last.

At the time, Muilenburg paid tribute to the departing commercial aircraft chief: "We are grateful to Kevin for his dedicated and tireless service to Boeing, its customers and its communities during a challenging time, and for his commitment to support this transition," he said.

Muilenburg would last two more months – and just a week after the production shut-down was

announced – before his own departure statement was being written; he was ultimately replaced by David Calhoun.

Pressure had been growing on Muilenburg, not least after a Congressional hearing during which more damaging revelations about the company and its internal processes were revealed.

Calhoun's arrival in January 2020 signalled a change in tone at Boeing: less combative and more emollient, with a pledge towards transparency and commitment to safety. At that point, a return to service was forecast by mid-2020.

As 2020 progressed, however, the loss of capacity from the Max grounding became the least of airlines' concerns as the coronavirus pandemic shut down air travel. And in a sign of things to come, ›

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Boeing recorded its first significant cancellations for the type: Brazilian carrier Gol and lesser Avolon were among the customers scrubbing a total of 150 orders.

### Cancelled orders

That figure would snowball as the year wore on, as both cancellations and an accounting standard – ASC 606, which signals that Boeing has less confidence in a deal completing – wiped a combined 1,390 orders from its backlog. Those cancellations were not necessarily a result of concerns about the Max’s safety; but as the grounding had persisted for more than a year, airlines – suddenly faced with huge financial constraints – took advantage of the situation to shed orders.

However, it is worth noting that some commitments still came in during the course of the grounding, the most significant of which were a 75-unit deal from Ryanair in December 2020, and a surprise letter of intent in mid-2019 from British Airways parent IAG for 200 aircraft (of course, whether that order is ever firmed up remains to be seen).

But even as orders fell by the wayside, Boeing began preparing for the jet’s return – and the significant boost in revenue that would bring. By May 2020, production of the Max had resumed, albeit at a “low” rate. In addition, the

### Maximum importance

There was a time not long ago when the Boeing 737 Max held the promise of fuelling several more decades of profitability for Boeing.

After all, before the two crashes and 18-month grounding, the airframer held some 4,700 737 orders and was eyeing production rates exceeding 52 jets monthly.

For those reasons, the Max holds outside importance for Boeing, both financially and competitively. Which is precisely why the grounding left the US aerospace behemoth in such a competitive pickle, and why the narrowbody’s rebound is key to Boeing’s recovery.

“The Max is going to be an enabler of many things,” says Michel Merluzeau, analyst with consultancy AIR. Boeing needs “the Max to succeed to jump further with [a] new airplane”.

The Max had been the jet that would carry Boeing into the 2020s and beyond, helping it retain customers and market share and generate the profits that would fund its next commercial aircraft.

Before the grounding and the pandemic, Max sales generated 30% of Boeing’s revenue, notes Teal Group aerospace analyst Richard Aboulafia.

“When production halted, it became a very big cash drain, due to inventories, supplier payments, customer compensation, idled factories and workers,” he says. “Thus, Boeing’s plans are closely tied to this programme.”

When all is said and done, Boeing will probably spend \$25-30 billion on the Max programme, including penalties paid to customers, estimates Ron Epstein, financial analyst with BofA Securities.

Precisely how much Boeing initially budgeted for Max development is unknown, though FlightGlobal has previously reported a range of \$2-3 billion.

### Failure to launch

Asked if Boeing can ever recoup its Max investment, Epstein responds: “No, they probably won’t... It will be a failure from that point of view.”

But the Max debacle set Boeing back more than financially: fixing the jet consumed the company when it might otherwise have been developing and launching a new commercial aircraft.

“Instead of working on new products, [Boeing] took [its] best and brightest and put them on the Max,” Epstein says. “Had the Max not gotten grounded, they would have been developing something already.”



Ethiopian Max hit the ground at high speed

Xinhua/Shutterstock

following month re-certification test flights of the narrowbody took place, lasting three days.

A draft airworthiness directive followed in August, detailing the modifications the FAA would require. Chief among them: updates to the flight-control software that would prevent erroneous AoA readings from triggering MCAS. The system would also be prevented from operating repeatedly and would limit the degree to which MCAS could move the Max’s horizontal stabiliser.

Come September and FAA chief administrator Steve Dickson had flown the aircraft, declaring that he had no trouble controlling the jet even when it was significantly out of trim. Two months later the agency cleared the Max to resume operations, albeit with a list of conditions attached related to flight control updates and new pilot

# 75

Number of Max aircraft ordered in December 2020 by Ryanair

training. By the end of November, the FAA had issued the first 737 Max airworthiness certificate since the grounding. A week later, Brazil’s National Civil Aviation Agency became the next regulator to greenlight the jet, with Gol the first airline anywhere to resume revenue flights the following month. US carrier United Airlines, meanwhile, became the first to take delivery of a new aircraft following the ungrounding when it received a Max on 8 December.

Two more regulators followed the FAA’s lead in early 2021, when Transport Canada and the



Getting the Max back in the air has diverted resources from Boeing's next projects

“Your competitors, they keep moving forward,” he notes.

In the context of Boeing, “competitors” really means Airbus. While the Max was out of service, the European airframer launched the A321XLR, a wildly popular 4,700nm (8,700km)-range jet with capabilities that no Max variant, current or in development, can match.

Boeing also faces pressure from Airbus at the other end of the narrowbody market from the 110- to 130-seat A220. Designed specifically for that segment, the A220 economically outperforms the smallest 737 – the Max 7.

So how will Boeing respond to such threats? Analysts can only

speculate. They suspect Boeing will eventually launch a 757-sized mid-market jet, or a 737 successor (known informally as the Future Single Aisle), or both.

Whatever aircraft comes next, its success will depend at least partly, if not significantly, on the Max's recovery.

For starters, deliveries of the jet will generate badly needed revenue and enable Boeing to begin repairing its debt-heavy balance sheet.

The Max programme can also give Boeing breathing room to focus on its next project.

“The more the Max re-establishes itself and gets additional orders, the more time

Boeing will have to really think very carefully about the Future Single Aisle,” says Merluzeau. “You really need the Max to succeed to jump further with the new airplane.”

### Ready to deliver

Analysts broadly suspect that Boeing will, in the end, deliver most of the roughly 3,200 737s in its diminished backlog, which has slipped 1,400 units in recent years as a result of cancellations and accounting adjustments.

While many of those cancellations were not as a result of concerns about the safety of the Max – rather, they were connected to the financial state of airlines – the lengthy grounding presented them with the opportunity to walk away because of contractual provisions.

But if, for whatever reason, the Max programme hits additional hiccups – or if the industry downturn continues longer than anticipated – then Boeing's troubles mount significantly.

“This would put additional pressure on Boeing to perhaps do something too early,” possibly before sufficiently maturing its next production system, Merluzeau says. “If the Max doesn't happen the way it should happen, Boeing is faced with a very serious crisis.”

European Union Aviation Safety Agency recertificated the jet (on 20 and 27 January, respectively), although crucially the updates required by both regulators diverged from those stipulated by the FAA.

Recertification of the jet is not the end of Boeing's troubles, however. A huge backlog of parked aircraft must still be dealt with – around 450 at best estimates – some to customers who may no longer want them, or who may even have gone out of business.

A further hurdle to overcome is China: airlines there hold orders for more than 200 examples – and yet, amid a simmering trade war with the USA, the nation's regulator has yet to release a timetable for the jet's re-approval.

### Rebuilding trust

Beyond that, all Boeing has to do is regain the trust of its customers and rebuild a battered reputation – while navigating the steepest downturn the industry has ever seen.

When it unveiled the name of the new 737 in August 2011, Boeing said it was called the Max because it “optimises everything we and our customers have learned about designing, building, maintaining and operating the world's best single-aisle airplane.”

“Maximum efficiency” and “maximum reliability” – along with “maximum comfort” for passengers – were promised. But what the Max delivered was something else entirely. ▶



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## Certification breakdown

While Boeing has felt most keenly the impacts of the 737 Max crisis, the episode has also upended some aspects of aircraft certification, with regulators more closely reviewing new projects and shying away from rubber-stamping decisions made by foreign counterparts.

And more changes are forthcoming thanks to a late-2020 US law that aims to prevent the type of failures that contributed to the two 737 Max crashes.

Investigators determined that Boeing's design of the Max's Maneuvering Characteristics Augmentation System (MCAS), which the Federal Aviation Administration (FAA) approved, was partly to blame for two crashes that killed 346 people.

The crashes and the FAA's initial response – it was the last to ground the Max, after all – prompted widespread criticism of the agency. Now, in lifting the flight ban, several of the world's regulators are no longer taking the US body's lead.

For instance, Transport Canada and the European Union Aviation Safety Agency (EASA) have completed their own 737 Max flight tests, rather than relying on the FAA. They have also lifted the Max's grounding with different requirements from those set by the US regulator.

But it also appears that the FAA is now looking more closely at Boeing's next widebody, the 777X.

On 27 January, Boeing chief executive David Calhoun said the company had delayed the 777-9's service entry one year until late 2023 owing to design changes that align with "expectations of global regulators".

The company is "making prudent design modifications as necessary", including "firmware and hardware changes" involving actuator controls, Calhoun said.

He did not specifically link the changes to increased regulatory oversight because of the 737 Max crashes. And, analysts suspect, the delay at least partly reflects Boeing's disinterest in bringing the 777-9, the first member of the 777X family, to market at a point when customers will neither need nor want new high-capacity long-haul jets.



VDB Photo/Shutterstock

National regulators have diverged from FAA's lead

Still, Boeing's certification and development processes have been under immense public scrutiny since the two crashes, and the FAA, under equal pressure, has pledged a rigorous review of the 777X.

The 777X programme's certification also comes as the FAA implements a broader regulatory overhaul required by a 2020 law that stemmed from the two accidents.

That law seeks to strengthen the FAA's certification oversight, particularly over aircraft that are derivatives of earlier models – types such as the 737 Max and 777X. The FAA cleared the Max under an amended type certificate, and Boeing has been seeking the same certification route for its 777X.

### Realistic response

The 2020 law will require applicants of amended certificates to specifically describe how new variants differ from predecessors, and to demonstrate that designs reflect "realistic" pilot response times.

Companies must also disclose "safety critical information". That includes details about systems that can change an aircraft's flight profile, and handling characteristics that, without software augmentation, fail to meet FAA standards.

The law does not do away with the agency's criticised Organization Designation Authorization (ODA) programme – under which the FAA grants manufacturers authority to perform large swaths of product certification work themselves.

But it does order an "expert" review of the ODA programme

to ensure that manufacturers are capable of safely handling delegated duties. Based on the findings, the FAA may limit or suspend manufacturers' ODAs.

The law also grants the FAA additional funding to hire skilled workers and requires manufacturers to establish formal "safety management systems". It also bars aircraft makers from giving customers any discounts tied to pilot training before the FAA finalises related standards.

In addition to the changes wrought at the FAA and its relationship with overseas counterparts, there is one lingering question around the mutual recognition of standards.

Article 33 of ICAO's Chicago Convention mandates the mutual recognition of certificates of airworthiness. While any national regulator has the right to ground aircraft on its registry, several went far beyond this prior to the FAA acting. Authorities in Australia, China, India and Singapore were among those which imposed a blanket ban on domestic and foreign Max operations, along with EASA.

In theory, in the two months between the FAA lifting its grounding and EASA's re-approval of the Max, a US airline could have tested the application of Article 33 with a transatlantic flight of the type.

The pandemic, of course, might have suppressed any appetite for a legal challenge this time around, and the co-operative efforts to restore confidence in the Max suggest interest in avoiding any widening of the regulatory split.

*Additional reporting by David Kaminski-Morrow in London*



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From  CAE

# India reveals future combat system

New Delhi unveils manned-unmanned teaming concept at first major air show to be held during Covid-19 pandemic

**Atul Chandra** Bengaluru

**S**taged at Yelahanka air base near Bengaluru from 3-5 February, the biennial Aero India event was the first major air show to proceed amid the Covid-19 pandemic, with New Delhi highlighting its ambitious fighter development plans.

State-owned Hindustan Aeronautics (HAL) unveiled a developmental Combat Air Teaming System (CATS) effort, which is understood to have secured the backing of the Indian air force and navy, with funding allocations pending.

Work on the initiative started in the second half of 2018 and began in earnest in late 2019-early 2020, says HAL test pilot Group Captain (Retired) H V Thakur.

Preliminary design work has been completed, with the indigenously developed Tejas two-seat trainer planned as part of a manned-unmanned teaming concept.

"Work is now being done to define the requirements for a future cockpit for the type capable of handling the workload," Thakur says.

Under the concept, the Tejas would act as a so-called mother-ship for air teaming exploitation. A low-observable unmanned wing-

man, the CATS Warrior, was displayed as a full-scale mock-up, equipped with MBDA ASRAAM short-range air-to-air missiles. The design will be powered by a HAL PTAE-7 engine.

Swarming unmanned air vehicles (UAVs), named Air-Launched Flexible Assets and equipped with a CATS Hunter multi-purpose weapons carriage system, could be released by the Tejas, while a high-altitude, long-endurance UAV is also being considered.

Much of the work is being done by HAL, which is also partnering with Indian start-ups to deliver the programme, and scale models are



Atul Chandra

# Mi-17 replacement plan takes off

Heavy-class helicopter in development for Indian armed services also being 'designed with global market in mind'

**Dominic Perry** London

**H**industan Aeronautics (HAL) believes the new heavy-class helicopter it is developing for the Indian military can be "benchmarked" against the best products now on the global market.

The twin-engined Indian Multi-Role Helicopter (IMRH) could be available from 2028, and will have a maximum take-off weight of 13t. The rotorcraft will be able to carry up to 24 troops in a standard transport configuration, or 36 in a high-density layout.

HAL estimates a requirement for up to 314 examples across India's three armed services, pre-

dominantly as replacements for air force-operated Mil Mi-17s.

Detailing its progress on 6 February, HAL said it has already cleared the preliminary design review stage. This will enable it to freeze the configuration within six months of receiving a go-ahead from the Indian defence ministry: a milestone expected late this year or early 2022.

A first flight should take place four years later, with operational clearance for a basic utility variant for the army to occur after 24 months of testing. An armed variant will follow one year later, HAL says.

The company expects to produce three or four flying prototypes, plus ground- and structural-test articles, with the total development activity to take around seven years.

With a five-blade main rotor and four-blade, bearingless tail rotor, composite fuselage and using glass cockpit avionics, the IMRH will have 75% domestic content. HAL says it will produce the type's transmission, including its main and tail rotor gearboxes, along with avionics and digital automatic flight controls.

The aircraft's engines will be sourced from a Western manufacturer; two companies have already been asked for proposals for 2,800shp (2,000kW)-class powerplants, HAL says.

Payload capacity will be 4t at sea level, falling to 1.5t at 13,000ft. Due to the requirements for performance at altitude, the main rotor diameter will be 21.2m (70ft) - roughly the same as the 13t Mi-17.



CATS Warrior UAV was displayed as a full-scale mock-up with MBDA missiles

expected to begin testing in the near future.

Also at the show, the Aeronautical Development Agency (ADA) provided fresh details about India's planned Twin Engine Deck-Based Fighter.

Intended to replace the Indian navy's RAC MiG-29Ks, the type features a conventional delta wing configuration, with canards and a horizontal tail.

With folding wings for deck handling and storage, the 16.2m (53ft in)-long fighter will have a maximum take-off weight of 26t and be powered by two GE Aviation F414-INS6 engines.

Unlike the Indian air force's developmental Advanced Medium Combat Aircraft (AMCA), the naval type will not have internal weapons bays. It is expected to have a maximum speed of Mach 1.6, versus M1.8 for its stealthy counterpart.

India expects to roll out the AMCA in 2023-2024, with first flight slated one year later. Launched in December 2018, the project's preliminary design review phase is almost complete, with Airbus Defence & Space providing assistance.

### Harnessing stealth

"Stealth shaping has been done, with an enormous amount of work on the serpentine [engine] intake for the last seven to eight years," says an ADA official close to the programme. "We have a big stealth programme in the country and the stealth materials for AMCA have already been frozen."

The air force wants a 24,700lb (110kN) thrust-class engine for the twin-engined AMCA, but the first three prototypes will be flown with proven 20,000lb-class engines. The Eurojet consortium, GE and Rolls-Royce have offered potential solutions.

Meanwhile, HAL is approaching the end of a 222-aircraft license production run for the Sukhoi Su-30MKI.

Seshagiri Rao, chief executive of the HAL MiG complex in Nashik, says the penultimate aircraft has been completed, while the last example will be delivered following final acceptance tests.

HAL is, however, expecting to receive a final order for another 12 examples, worth approximately Rs10 billion (\$1.5 billion).

In the meantime, the company will focus on repair and overhaul work on the service's approximately 260-strong Su-30MKI fleet, which also includes Russian-built airframes. Its Aircraft Overhaul Division plans to match its 2020 output of working on 15 fighters this year, but is upgrading its facilities to cater for 20 annually.

Rao says discussions on an upgrade proposal covering a new radar, weapons control system, mission computer, communications suite and weapons are significantly advanced with HAL's Russian counterparts, and that an agreement could be concluded within the next six to nine months. ▀



Russian Helicopters

Mi-17 fleet is set to be retired from 2028

A pair of weapons wings will provide four hardpoints for a maximum of 1,600kg (3,530lb) in armaments. Range is predicted to be 430nm (800km), with a top speed of 161kt (300km/h).

While New Delhi will be the chief customer, HAL says it "designed the helicopter with the global market in mind" and against five current

heavy-class types: the Mi-17, plus Airbus Helicopters' H225M, Leonardo Helicopters' AW101, NH Industries' NH90 and the Sikorsky S-92.

"In every aspect of our design we have benchmarked against the best features available on these helicopters," it says.

HAL has been working on the development since 2017, in anticipa-

tion of a requirement to replace the Indian air force's 239 Mi-17s, which will be withdrawn from service from 2028. It also sees an opportunity to produce a version for civilian use, notably VIP transport duties.

Also at the Aero India show, HAL delivered its first three Dhruv MkIII maritime helicopters to the nation's navy, and two to its coastguard.

S Anbuvelan, chief executive of HAL's Helicopter Complex, says it aims to deliver a combined seven more examples to the operators by 31 March. It expects to complete the transfer of 16 aircraft to each by September, he adds.

The Indian army, meanwhile, announced on 5 February that HAL's 3t Light Utility Helicopter has achieved initial operational clearance. This follows the completion of flight tests in hot and cold conditions, and at various altitudes.

The Safran Helicopter Engines Arden 1U-powered single will replace HAL-built Cheetah and Cheetak rotorcraft. ▀

*Additional reporting by Atul Chandra in Bengaluru*

# Bombardier cuts back to rebuild

Canadian airframer will axe 1,600 jobs and reduce footprint of production sites to recover profitability after pandemic



Bombardier

Manufacturer is banking on the success of large-cabin business jets such as Global 7500

**Jon Hemmerdinger** Tampa

**B**ombardier in 2021 will eliminate 1,600 jobs, concentrate aircraft completions work in Montreal and divest real estate as part of a plan to reduce hundreds of millions in annual costs and recapture profitability.

News of the changes, which include a plan to end Learjet production (see right) in the fourth quarter, came as the company reported losing \$568 million in 2020.

Montreal-based Bombardier's revenue during the pandemic-shadowed year declined 13% from 2019, to \$6.5 billion, it said on 11 February.

The 1,600 job cuts constitute 10% of Bombardier's workforce at the end of 2020 and will leave the company with about 13,000 employees by the end of this year.

Bombardier will axe some production positions, but the job losses will primarily affect office staff, including "management positions and white-collar positions", chief executive Eric Martel says. "This is mainly office work."

Geographically, Bombardier expects to shed 700 jobs in the province of Quebec, 100 in Ontario, 250 in Wichita (tied to the Global

5500 programme and the end of Learjet production) and 100 jobs elsewhere in the USA. The balance of job eliminations will include contract workers and positions vacated by planned retirements.

## Necessary reductions

"These reductions are absolutely necessary for us to rebuild our company while we continue to navigate through the pandemic," says Martel.

In shuttering Learjet production, Bombardier will bring all its aircraft assembly work to Montreal.

The company has not announced any changes to its use of third-party completion partners, which include companies like Peterborough, Ontario-based Flying Colours.

Martel says Bombardier could bring some contracted work back in-house, but he does not elaborate.

Bombardier says it is also "reviewing options for underutilised hangar and industrial space at our Quebec facilities".

As part of that rationalisation effort, the company is "looking to reduce [its] footprint" in the Saint-Laurent district of Montreal, where it produces aerostructures.

"We are sitting right in the middle of the city on a major piece of land which we don't need anymore. We are going to be reducing the footprint of the factory," Martel says, adding that Bombardier is now negotiating to sell parcels of land for undisclosed sums.

Bombardier intends to keep some of the Saint-Laurent facility, but will increase productivity there.

It will use funds from the real estate deals to help finance a new Global jet manufacturing site near

"Clearly, 2020 was one of the most difficult periods for our company, for our industry and for all of us individually"

**Eric Martel** Chief executive, Bombardier

Toronto, Martel says. The company now builds Globals at its Toronto Downsview site but is moving the operation to Toronto Pearson International airport, with work there to start in 2023.

Bombardier estimates the restructuring will save it \$100 million this year and \$400 million annually by 2023.

Bombardier's aviation business turned a \$937 million profit before interest and taxes in 2020, down 22% year on year, with revenue falling 3%, to \$5.6 billion. It delivered 114 business aircraft last year, including 59 of its large-cabin Globals, 44 of the mid-size Challengers and 11 Learjets.

By comparison, Bombardier delivered a total of 142 aircraft in 2019.

"We estimate it will likely take a few years for the industry to return to 2019 delivery levels," Martel says. "Clearly, 2020 was one of the most difficult periods [for] our company, for our industry and for all of us individually."

### Divestment programme

Since the start of 2020, Bombardier has completed three massive divestments: the \$275 million sale of its aerostructures business to Spirit AeroSystems, the \$550 million sale of the CRJ regional jet programme to Mitsubishi Heavy Industries, and the completion this January of the sale of its train business to French industrial giant Alstom for \$3.6 billion. In 2019 it also sold the Dash 8 turboprop programme to Longview Aviation Capital for \$250 million.

"With these transactions behind us we are now entirely focused on designing, building and servicing the world's best business jets," says Martel.

Bombardier ended 2020 with \$10.1 billion in long-term debt, including \$1.9 billion due in 2021 and \$1.7 billion due in 2022. The company starts 2021 with cash and cash equivalents valued at \$5.4 billion.

Martel calls 2021 a "transition year" in which Bombardier expects to mature Global 7500 production, achieve "modest revenue growth" and deliver a similar number of jets as in 2020.

The airframer plans no production rate cuts this year and expects in 2021 to earn an adjusted profit - excluding restructuring costs and other one-off items - of more than \$100 million. ▶

### From Lear to eternity

By the end of 2021 Bombardier will stop producing Learjets, a brand launched in the early 1960s by Bill Lear that quickly became synonymous with luxury travel for movie stars and business moguls.

Learjet had hung on in recent years despite relatively few product updates, the failure of the Learjet 85 programme and heightened competition in the light-jet segment.

Announcing the move on 11 February, Bombardier said it would end production in 2021, "allowing the company to focus on its more-profitable Challenger and Global aircraft families and accelerate the expansion of its customer services business".

Production will cease in the fourth quarter.

Bombardier chief executive Eric Martel says the decision was taken following a review of how the company can best deploy its financial resources going forward.

"I want to make sure the organisation is very focused. We have elected to... be a strong competitor on the Challenger and Global platforms," he says.

"The [Learjet] has a lot of competition," Martel adds. "This is not the market segment that brings profitability right now."

Learjets are assembled at a facility in Wichita, Kansas, which the airframer intends to retain.

"Bombardier's Wichita facility will continue to serve as the company's primary flight-test centre and be a key part of its global services network," Bombardier says.

At Wichita, Bombardier will also support "specialised aircraft" - a category that includes variants customised to perform missions such as reconnaissance, firefighting and medical evacuations.

Wichita will "play a leading role in future special-mission modification contracts", Bombardier says.

The company will continue to service the in-service Learjet fleet.

At the same time, Bombardier unveiled a new Learjet 40/45 "re-manufacturing programme". Through that effort, the airframer will sell a package of upgrades that include new avionics, updated in-flight connectivity, cabin improvements and engine "enhancements and improved aircraft maintenance costs".

More than 3,000 aircraft have been produced since the company was founded in the early 1960s. The first model - the six-passenger Learjet 23 - made its first flight on 7 October 1963.

Bombardier acquired the Learjet Corporation in 1990 and expanded the line to include models like Learjet 40s, 45s and 60s, as well as the modern



First model made its flight debut on 7 October 1963

Learjet 70/75 pairing, which entered service last decade.

But Bombardier stumbled with the Learjet 85, a composite-skinned model that was cancelled in 2015 following a series of delays and production problems.

Meanwhile, Bombardier increasingly focused its attention on its larger business jets, including its Challenger and Global line ups.

Only the Learjet 75 remains in production. Bombardier refreshed that model in 2019 when it launched a discounted variant called the Liberty.

The Liberty, entering service in 2020, was positioned by Bombardier as a competitive response to types such as Cessna's Citation CJ3+ and Embraer's Phenom 300E.



# USAF eyes cheaper fighter options

Chief of staff says ongoing force mix study could define need for new-build F-16s or clean-sheet '4.5th-generation' type

**Garrett Reim** Los Angeles

**T**he US Air Force (USAF) is studying a future fighter fleet that might include new Lockheed Martin F-16s or possibly a clean-sheet 4.5th-generation type, according to chief of staff General Charles Brown.

For years, the service has advocated recapitalising its fleet with stealth aircraft, in particular Lockheed's F-35. But last year, it partly deviated from that strategy by confirming plans to buy up to 144 new Boeing F-15EX fighters to replace its aged F-15Cs.

Identified benefits include lower operating costs and similar training and support requirements to the legacy model, plus a larger weapons payload.

Now, it seems the service is expanding this interest in less sophisticated combat aircraft.

"One of the areas we are pushing through is a [tactical air] study, to look at the right force mix," Brown says. "There is a high-end fight. There's also a mixture for low-end."

While he acknowledges potential interest in taking more F-16s, Brown has not ruled out a new project.

"I want to be able to build something new and different, that's not the F-16," he says. "I want to entertain a clean-sheet design of something that's not necessarily fourth-gen, but may not be completely fifth-gen either. There's some other low-end-type things in our high-end fight. We need to have the right force [mix]."

Brown identifies the slow pace of software updates on the legacy F-16 as a potential issue.

"I was just at Kessel Run [a USAF software development laboratory], and they said: 'Instead of waiting a year and a half, you can do this within a matter of minutes by updating the code on an airplane, particularly if you saw a new threat.' You don't have that in the F-16 today."

Brown says the idea for a clean-sheet 4.5th-generation aircraft was inspired by the digital engineering that allowed Boeing to rapidly create the USAF's T-7A advanced jet trainer, and the project that designed and flew the service's top-secret Next Generation Air Dominance platform within a matter of years.

## Software defined

"If we're going to do software-defined, and we can do something even more capable cheaper and faster, why not?" he says.

"Tac Air has to do some analysis to show what is the right mix, not only capability but also in numbers, to ensure we are going to be successful in future conflicts," Brown says. "That requires some modelling and simulation, and analysis. That's what I plan to do over the upcoming months. As we get into the budget for fiscal year 2023, that's where we'll make some key decisions."

Separately, the head of the Air Force Special Operations Command says it is aiming to consolidate multiple roles into its Armed Overwatch aircraft programme, in order to save money.

Lieutenant General James Slife sees future Armed Overwatch aircraft as being capable of taking over the tasks now conducted using several specialised platforms.

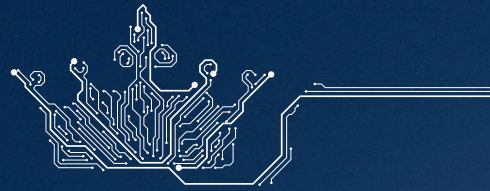
While its requirements have not yet been finalised, the programme envisions using a light-attack and armed reconnaissance aircraft, such as a Sierra Nevada/Embraer A-29 Super Tucano or Textron Beechcraft AT-6 Wolverine, to conduct close air support and strike missions against terrorist groups and insurgents.

The command plans to conduct further demonstrations in FY2021, before delivering a final requirements document in the hope of acquiring aircraft in FY2022, Slife says.

The command's current concept of operations was defined around 2005-2006, as the USA was fighting insurgencies in Afghanistan and Iraq, Slife said during a Mitchell Institute webinar on 16 February.

"Over a target area, we would build a stack of airplanes from 10,000ft to 25,000ft, consisting of gunships, manned ISR [intelligence, surveillance and reconnaissance], unmanned ISR, electronic warfare and [close air support], fixed-wing fighters and sometimes even bombers," he says. "That model is not viable for the future. It's not cost effective."

Slife's vision is for an Armed Overwatch platform "to have some reconfigurable ISR capability. When needed, it will be able to provide [close air support]. It's really a multi-role airplane capable of operating with a light logistics footprint in small disaggregated teams in very austere regions." ▸



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## LongShot comes into range for DARPA

General Atomics, Lockheed and Northrop picked as US agency studies concept of manned platforms deploying armed UAVs

**Garrett Reim** Los Angeles

A trio of companies have been awarded preliminary design contracts for the US Defense Advanced Research Projects Agency's (DARPA's) LongShot programme - a concept that envisions an air-launched unmanned air vehicle (UAV) carrying and firing multiple air-to-air missiles.

General Atomics Aeronautical Systems, Lockheed Martin and Northrop Grumman were selected to perform preliminary Phase I design work, DARPA announced on 8 February. While the value of the individual contracts has not been announced, the agency had requested \$22 million for the activity within its fiscal year 2021 budget proposal.

The LongShot programme aims to develop a UAV that can be car-

ried and released from a fighter or bomber. This would fly ahead of its manned launch platform and be capable of launching air-to-air missiles to shoot down enemy aircraft.

"The objective is to develop a novel UAV that can significantly extend engagement ranges, increase mission effectiveness, and reduce the risk to manned aircraft," it says. "LongShot will disrupt traditional incremental weapon improvements by providing an alternative means of generating combat capability."

DARPA believes that such a system would have advantages over current air combat technologies.

"An air system using multi-modal propulsion could capitalise upon a slower speed, higher fuel-efficient air vehicle for ingress, while retaining highly energetic air-to-air missiles for endgame target engagements," it said of the LongShot effort in its FY2021 budget proposal.

There are two key benefits to this method, DARPA says.

"First, the weapon system will have a much-increased range over their legacy counterparts for transit to an engagement zone," it says. "Second, launching air-to-air missiles closer to the adversary increases energy in terminal flight, reduces reaction time, and increases probability of kill."

An artist's rendering of the LongShot concept released by DARPA shows a platform which appears to be similar in size and shape to Lockheed Martin's stealthy AGM-158 Joint Air-to-Surface Standoff Missile (JASSM).

However, unlike the in-service weapon, the new design has fold-out wings mounted near the top of its body - rather than underneath - and dispenses with the JASSM's pop-up vertical stabiliser.

It is not clear how many missiles LongShot would carry internally, although the graphic indicates that this would be at least two. DARPA programme manager Lieutenant Colonel Paul Calhoun confirms that it wants an "air-launched vehicle capable of employing current and advanced air-to-air weapons".

### Disposable option

DARPA has not said whether it intends to recover LongShot after launch, or whether the platform would be disposable. Some similar "attritable" UAVs in development - along with target drones - can be equipped with parachutes for recovery, instead of accommodating bulky landing gear.

In later phases of the programme, DARPA says it plans to fund the construction and flight-testing of a full-scale LongShot demonstrator. This platform should be air-launched, and "capable of controlled flight, before, during, and after weapon ejection under operational conditions", it says.

Possible end-users for an operational LongShot capability include the US Air Force and US Navy, DARPA says. ▀

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# HNA's rise and fall

Big-spending Chinese conglomerate, which owns multiple airlines, now faces court-ordered bankruptcy restructuring

Alfred Chua Singapore

It may have started life as a collection of aviation businesses, but by the time creditors showed up with bankruptcy filings, China's HNA Group was a massive conglomerate with broad interests; from property to logistics, and aviation to financial services, the company had a finger in every pie.

In the 20-odd years since its inception, the group - built on the foundations of Hainan Airlines - grew rapidly in China and beyond in a debt-fuelled spending spree.

But in the final days of January the juggernaut came to a halt: HNA Group disclosed on 29 January that it had received formal notice that so far unnamed creditors had filed for its bankruptcy and reorganisation at the Hainan High People's Court "on grounds that we cannot pay off due debts".

A day later, Hainan province vice-governor Shen Danyang visited the group's headquarters to discuss - among other matters - the firm's financial situation.

He stressed that the group's predicament will affect "thousands of people", but sought to downplay the notion that it was the end of the road: "Bankruptcy is not... liq-

uidation. It is reorganisation and re-birth," Shen was quoted as saying.

The Hainan provincial government, which in 2020 threw the group a lifeline by way of a joint working group to address HNA's liquidity, also reiterated its support.

Three subsidiaries, including Hainan Airlines, subsequently disclosed to the Shanghai Stock Exchange that CNY61.5 billion (\$9.57 billion) had been embezzled by shareholders and other entities, Reuters reported.

## Creditor applications

Then, on 10 February, the Hainan court approved applications from creditors to place 10 affiliates of Hainan Airlines Holding in bankruptcy reorganisation. These include six airlines: Air Changan, Fuzhou Airlines, Grand China Air, GX Airlines, Lucky Air, and Urumqi Air.

The group's current predicament is a far cry from the bullish years of the mid-2010s, when it went on an aggressive acquisition spree both domestically and abroad.

Precise details of the HNA Group's portfolio are obscured by a notoriously opaque ownership structure. But apart from Hainan Airlines, HNA Group owns - both wholly and partially - at least 11 other Chinese carriers. Many of the group's regional



Group grew from initial operation of single carrier, Hainan Airlines

subsidiaries, such as Guilin Air and Urumqi Air, were set up in partnership with local governments.

But its portfolio grew for over a decade, as it acquired aviation interests across the globe. Initially these tended to be on its doorstep: in 2006 the group completed one of its first major deals, purchasing Hong Kong-based CR Airways. HNA Group took around 60% of the carrier, which was renamed Hong Kong Airlines. It followed up with the purchase of shares in Hong Kong Express, which was repositioned as

## HNA Group's overseas airline investments

Airline name	Country	HNA Group Investment	Current status	Notes
Hong Kong Airlines	Hong Kong	Bought up to 60% shareholding in the carrier in 2006	In operation	Hainan Airlines Holding now owns around 30% of the airline
Hong Kong Express Airways	Hong Kong	Bought 45% stake in 2006	In operation	Sold the carrier to Cathay Pacific; renamed HK Express
Africa World Airlines	Ghana	Incorporated in 2010; HNA's initial shareholding unknown	In operation	HNA Group said to own 70%
Aigle Azur	France	Bought 48% equity stake in 2012	Ceased operations	Filed for bankruptcy in 2019
Azul	Brazil	Bought 23.7% stake for \$450 million in 2015	In operation	Stake sold off in 2018
Comair	South Africa	Bought 6.2% stake in 2015	In operation	Stake sold off in 2018
Virgin Australia	Australia	Took 13% stake in 2016	In operation	Voluntary administration in 2020; now operating under new owners



aapsky/Shutterstock

low-cost carrier HK Express (it was later sold to Cathay Pacific).

As well as airlines, HNA Group moved into adjacent sectors: a 2009 deal (as part of a consortium) for Australia-based Allco Finance gave it a foothold in leasing; and 2010 saw the group move into maintenance, establishing a new company, known as GCA Technik, from the MRO division of Hainan Airlines.

The group then ventured into Africa, in 2010 incorporating Ghanaian carrier Africa World Airlines, which began operations in 2012 using a fleet of Embraer ERJ-145s.

But things only really got going later that decade when HNA Group, by now flush with bank loans, took stakes in multiple companies outside of China. These included airlines – French operator Aigle Azur (48%); Brazilian carrier Azul (23.7%); South Africa's Comair (6.2%); Virgin Australia (13%) – and the acquisition by its Bohai Leasing unit of rival Irish lessor Avolon, in a takeover worth \$7.6 billion; as well as ground-handling firm Swissport International for Swfr2.73 billion (\$2.81 billion); an 80% stake in Swiss maintenance firm SR Technics; and investments in airports in Brazil and Germany.

At the peak of its spending, HNA

Group had amassed a huge portfolio of assets. In hospitality, it took a stake in the Hilton group; in the technology sector, it bought distributor Ingram Micro for \$6 billion; and shipping container and truck trailer leasing businesses were also bought from General Electric.

### Increasing assets

By 2017, it was reported that the HNA Group held CNY1 trillion in assets, employing 400,000 people across its network, with its expansion showing no signs of stopping.

But stop it did – due in part to the Chinese government's new measures, announced that year, to minimise private domestic companies' exposure to foreign investments.

HNA Group, with three other conglomerates, was put under regulatory scrutiny, and several banks halted their loans to the group.

The measures hit HNA hard. Reports of unpaid aircraft leases emerged in late 2017, and a few months later, S&P Global Ratings downgraded the group's creditworthiness. By then, it had already chalked up \$86 million in debt.

The same year, HNA Group sold its stakes in Azul and Comair. It also disposed of assets in other non-aviation companies, including prop-

erty in Hong Kong and Australia, the Ingram Micro and Hilton Group stakes, as well as its shareholding in Deutsche Bank and trailer rental business TIP Europe.

Other investments, such as those in Aigle Azur, Swissport and Virgin Australia have been wiped out by insolvency or restructuring.

HNA Group's issues have had a knock-on effect on its subsidiaries – Hainan Airlines itself struggled through most of 2018, battling heavy losses and numerous changes in its top management. Exposure to investments in and loans to other HNA Group companies is cited as the principle cause for the size of the loss, however.

Those impairment losses are pegged at about CNY46 billion, while the operating loss due to the collapse in travel demand is only around CNY16.5 billion.

Hainan Airlines continues to operate, and is reportedly seeking to protect itself by transferring \$11 billion in debt back to HNA Group.

While it is unclear how the HNA Group will emerge from the bankruptcy restructuring, it is unlikely to ever be the many-tentacled entity it once was.

Perhaps a return to its aviation roots is the medicine required. ■

# Production ‘pause’ for Dash 8

Final assembly of twin-turboprop to be temporarily halted as De Havilland Canada adjusts output to match demand

**Jon Hemmerdinger** Tampa

**D**e Havilland Aircraft of Canada says it will temporarily stop producing Dash 8-400 twin-turboprops and begin vacating its Downsview, Toronto production site in the second half of 2021.

The company disclosed the changes on 17 February, calling the move a production “pause”.

But De Havilland insists it remains committed to the Dash 8 programme, is investing in product upgrades, and intends to restart production as soon as possible.

“Given that prevailing industry circumstances have hindered the ability to confirm new aircraft sales, De Havilland Canada will not produce new Dash 8-400 aircraft at its Downsview site beyond currently confirmed orders,” the company says. “Approximately 500 employ-

ees will be affected by the production pause.”

The airframer describes the decision as “a responsible and prudent measure that reflects current industry conditions, and will limit strain on the market and De Havilland Canada’s supply base as the pandemic recovery occurs”.

De Havilland does not specify how many outstanding firm Dash 8 orders it holds. Work will stop during the first half of 2021, it says.

Cirium fleets data shows that De Havilland holds orders for 17 Dash 8-400s from operators including Biman Bangladesh Airlines, Canadian aerial firefighting company Conair, Nigeria’s Elin Group, Ethiopian Airlines, Philippine Airlines, TAAG Angola Airlines, and the government of Tanzania. De Havilland says it delivered 11 Dash 8s in 2020.

Dash 8s are assembled at a leased facility in the Downsview district of Toronto that dates back to the

twin-turboprop’s previous ownership by Bombardier. The lease expires in 2021, though De Havilland has previously said that could be extended until 2023.

“Accordingly, De Havilland Canada has begun preparing to leave the site. There are a number of excellent production site options in Canada, and the company will be ready to meet new aircraft demand as the industry recovers,” De Havilland says.

The airframer’s parent Longview Aviation Capital acquired the Dash 8 programme from Bombardier in May 2019 for \$250 million. Fellow Longview company Viking Aircraft has its main production site near Victoria on Vancouver Island, British Columbia.

“We fully expect worldwide demand for the Dash 8 to return once the industry has recovered from the pandemic,” says David Curtis, Longview executive chairman. He says the turboprop’s performance and operating economics will make it “an important part of the aviation industry’s post-pandemic recovery”.

De Havilland additionally outlines several “enhancements” it is making to the Dash 8 programme. Those include “investing significant capital” in the Dash 8’s customer support and information technology systems to reduce operating costs.

It is developing modifications to the aircraft, among them “cabin refurbishment features” that include overhead bin extensions.

“While the pandemic has ravaged the global aviation industry, De Havilland Canada is making future-oriented investments to enhance the Dash 8 platform for current and future aircraft operators,” the company says. ▀



Airframer says it remains committed to Dash 8

De Havilland Aircraft of Canada

**Harness the power of analytics with  
CAE Rise™ for more effective pilot training.**





A total of six A330-based transporters will eventually support logistics operations

# Airbus eyes boost for whale freight

Airframer seeks authorisation for extended overwater flights to take advantage of outsize BelugaXL transporter's range

David Kaminski-Morrow London

**A**irbus is to seek extended twin-engined operations (ETOPS) approval for the BelugaXL outsize transporter, in order to support commercial services involving overwater flights.

Three BelugaXLs, based on the A330, have been built, the most recent introduced in October 2020. Another three will be manufactured, the last two of which will have 180min ETOPS approval, according to BelugaXL chief engineer Pascal Vialleton.

Vialleton disclosed the ETOPS plan during a Royal Aeronautical Society event in early February.

He says Airbus wants to have the final two aircraft, due to arrive in 2022 and 2023, to have the flexibility to conduct transatlantic flights, pointing to the possibility of satellite transport to stations in North America.

Vialleton says the current A300-600ST Beluga fleet will be phased out as the XLs arrive. Demand on the -600ST fleet rose from 6,000h in 2014 to 8,600h in 2017, but the XL offers capacity relief because it can accommodate two A350 wings at a time. Each XL will operate about 1,000 flights and 1,700h per year.

This capacity strategy rather than the -600ST's age, says Vialleton, is the main reason for the

fleet renewal: "We still can use the -600ST. But what to do with it?"

He says Airbus has initiated a project to propose new services for the -600ST, for which 180min ETOPS was obtained in 2010.

Airbus previously signalled that it was not seeking ETOPS authorisation because the aircraft's relatively short European logistics hops did not warrant it, and this would generate developmental cost savings.

But the XL has substantially greater range than the -600ST, and having ETOPS capability would enable the larger aircraft to serve as a support for future -600ST services.

"This is why we're developing ETOPS for the XL," says Vialleton.

## Final assembly

Airbus has indicated that it does not intend the XL to replace seaborne transport of aircraft sections between European manufacturing plants and final assembly lines in the USA and China. "Sea transport will continue to be the baseline of Airbus's oversize transport strategy [to these lines]," says the airframer.

Vialleton hints that Airbus has also considered other options for the -600ST fleet, pointing out that it can be used to "carry whatever is big and needs to be transported" – although unlike aircraft such as the Antonov An-124, it cannot unload at ground level, so a mobile platform stored in the aircraft could be necessary for such roles.

Airbus is looking to improve the XL's capabilities following its entry into service in January last year. Its original flight-test aircraft will become part of the operational XL fleet, says Vialleton, but is likely to be the last to be introduced, joining once its on-board test instrumentation has been removed.

The airframer has been conducting a series of flight tests, about 60h so far, to obtain approval for Cat III autoland on the aircraft. This requires an extensive effort to test autoland under various conditions, including crosswind tests performed at Newcastle in the northeast of England in December last year.

Vialleton says Airbus needs to justify design service targets of 33,000 cycles, pointing out that it had achieved only 3,200h at the time of type certification. "So there's quite some activity remaining on the stress side," he says.

The air conditioning system had to be re-examined because pilots reported a cockpit temperature differential in winter. This meant changing the airflow in the cockpit, requiring further flight tests to ensure no effect on smoke detection in areas such as the avionics bay.

Airbus has also addressed a problem of premature wearing on doors, and certified operation of the main forward loading door with up to 30kt (55km/h) crosswind and a 40kt tailwind, which Vialleton describes as "quite impressive". ■

# Evidence of MH17 risk ‘insufficient’

Ukrainian authorities did not have awareness of high-altitude threat to civil aviation before shutdown, report concludes

David Kaminski-Morrow London

Independent analysis has found no evidence that Ukrainian authorities were aware of the threat to high-altitude traffic, and specifically civil aviation, before a Malaysia Airlines Boeing 777-200ER was shot down by a surface-to-air missile.

This is despite Ukrainian national security officials’ openly floating the possibility that high-powered weapons might have entered into the conflict in the east of the country before the 777 was attacked.

USA-based Flight Safety Foundation (FSF) has examined the case of flight MH17, which had been crossing the conflict zone of eastern Ukraine on 17 July 2014, just above a 32,000ft boundary of restricted airspace.

While the adequacy of this upper boundary was questioned during a Dutch Safety Board investigation – given that MH17 was brought down by a powerful Buk anti-aircraft missile – the FSF “did not find sufficient facts” that the Ukrainian authorities could have had proper awareness of a high-altitude threat or a threat against civil aircraft.

“There were numerous reports about the presence of heavy weapons in the region, such as tanks, [man-portable air-defence sys-

tems], artillery and large-calibre machine guns,” says the FSF, in a newly-published factual inquiry into the airspace closure.

“However, there were few reports in the public space about armed non-state forces possessing weapons with a capability to attack above [32,000ft].”

Ukraine’s defence ministry believed military aircraft were vulnerable to man-portable air-defence system attack and, on 6 June 2014, imposed restricted airspace up to 26,000ft to allow military aircraft to operate out of their range – flying at altitudes of 22,000-24,000ft – with an extra buffer above them.

## 32,000ft

Boundary of restricted airspace imposed by Ukraine on 14 July 2014 – three days before MH17 was shot down

But uncertainty surrounds the reasons why this restricted airspace ceiling was increased to 32,000ft, at the request of the civil air navigation service UksATSE, on 14 July 2014 – the same day a Ukrainian air force Antonov An-26 was shot down, and three days before the attack on the 777.

Ukrainian aviation authorities insisted to the Dutch Safety Board that the decision to raise the ceiling arose from the need to put an additional buffer between military and civil aircraft operations, and not from an indication of risk to civil traffic above 26,000ft.

### Unconnected events

The inquiry was also told that the ceiling increase was initiated before the An-26 incident, and was “not connected in any way”.

Dutch investigators could not establish a direct link and concluded the underlying reason remained “unclear”.

But Ukraine’s national security and defence council had openly stated on 14 July, the day the An-26 was shot down, that it believed the aircraft was hit by a “more powerful weapon” than a man-portable system and suggested the possibility that a Russian-built Pantsir surface-to-air missile and artillery system, or an air-to-air missile, might have been involved.

Dutch military intelligence service MIVD, however, shared on 17 July the results of its own investigation into the An-26 loss which found that the aircraft had suffered damage to its right engine inconsistent with the use of a powerful air defence system, and that the use of such a weapon was unlikely.

Further uncertainty had emerged on 16 July, when a Ukrainian Sukhoi Su-25 was shot down, with the Ukrainian defence ministry initially blaming an air-to-air missile, without ruling out a surface-to-air weapon.

While the Ukrainian authorities, in both the An-26 and Su-25 cases, had raised the possibility of weapons being used that were capable of reaching cruise altitudes, neither incident led to the closure of airspace above 32,000ft.

Crucially, the Dutch inquiry concluded that the Ukrainian authorities’ suspicions alone – given their mention of weapons capable of reaching cruise altitude – provided “sufficient reason” for



298 people lost their lives in the disaster

Dutch Safety Board



The Malaysia Airlines Boeing 777-200ER was brought down by a Buk surface-to-air missile

15/Shutterstock

closing the airspace over the east of the country.

It also highlighted that the authorities believed weapons would be used exclusively against military targets and that there was no threat to civil aviation – especially after a tactical suspension of military flights on 16 July – without taking into account the possibility of “error or slips”.

The FSF analysis centres on its integrated standard for assessing airspace security risks, and it studied a range of information including authorities’ statements in public and responses to questionnaires.

“[Our] research did not find any instances before the downing of flight MH17 in which Ukrainian authorities publicly acknowledged the presence in eastern Ukraine of air defence systems capable of reaching an altitude greater than [32,000ft],” it says.

Counterintelligence services’ suspicions of the presence of high-powered air defence equipment could not be verified.

“No facts were found by the Foundation to indicate that the information was disseminated throughout the statewide process to reach the authorities responsible for risk assessment and de-

cision-making regarding airspace closure,” the Foundation adds.

The analysis acknowledges the “conflicting accounts” over the An-26 shootdown on 14 July, “thought by some” to have been brought down by a surface-to-air missile.

#### Missile system

However, it says the “most notable” publicly available information on the capability to attack at high altitudes, prior to the loss of MH17, came from social media reports on movements of Buk missile system batteries, and posts suggesting that Buk vehicles had been observed in east Ukraine.

“The Foundation acknowledges that these were just a few instances of published social media posts out of probably millions of posts made in the region at that time,” it says. “It should also be stressed that the veracity of published social media accounts is difficult to establish.”

It says the identified examples of available information indicating the potential ability to carry out an attack above 32,000ft were “few”, relative to the total volume of information about the conflict zone at the time.

The FSF says – “with hindsight” – that counterintelligence field infor-

mation and intercepted telephone conversations might have indicated a threat to civil aviation.

Without knowing the technological capabilities to process intercepted conversations and social media posts, says the FSF, the analysis cannot conclude that Ukrainian authorities had the means to verify intelligence and co-ordinate dissemination of the information, assess the threat to civil aviation, and close the airspace before the attack on MH17.

It points out that its analysis is bounded by “a number of limitations”, including the fact that its findings about the airspace closure decisions are based on two specific sources: public source information available during 2020, and information obtained from Ukraine and Russia through questionnaires.

Among its other findings are that surface-to-air weapons should be a “key indicator” in any airspace risk assessment, given their higher destructive power compared with man-portable systems, and that examination of conflict zones over 1990-2014 did not identify a “uniform practice” of countries’ closing their own airspace during armed conflict when there were signs of a possible attack against civil aircraft. ▀

# Catalogue of failures doomed Swiss Ju 52

Pre-war aircraft that came down in Alps was operated 'below safety margins' by risk-taking crew, investigation concludes

David Kaminski-Morrow London

Swiss investigators have concluded, in a damning inquiry, that a Junkers Ju 52 on a pleasure flight stalled after the crew flew it into a narrow valley at low altitude, at a dangerously low airspeed and with its centre-of-gravity out of limits.

The crew intended to exit the valley via a pass and there was "no possibility" of an alternative flight-path, says the inquiry. Vulnerable to updraughts and downdraughts from turbulence in the area, the aircraft stalled as it entered a turn, from which it had no margin to recover.

None of the 20 occupants survived the accident after the aircraft entered an Alpine valley basin near Piz Segnas. It performed a left turn, which developed into a downward spiral and the three-engined aircraft dived into the ground.

"The flightcrew was accustomed to not complying with recognised rules for safe flight operations and taking high risks," says Swiss investigation authority SUST, in its report on the 4 August 2018 accident.

SUST says the operator, Ju-Air, failed to identify or prevent "frequent violation of rules" by its crews, adding that "numerous" incidents, several of them serious, were "not reported" to authorities.

The inquiry's reconstruction of the accident showed that the centre-of-gravity was 2.07m (6ft 8in) behind the wing's leading edge at the time, in excess of the manufacturer's 2.06m limit.

"This situation facilitated the loss of control," it states.

## Two-day tour

Taking off from Dubendorf on 3 August, on the first part of a two-day flight tour, as the aircraft flew to Locarno it navigated past the Ritzlihorn mountain just 30-50m from the rock face, and continued in close proximity to other parts of the terrain while travelling through the Cristallina region.

The next day, one of the aircraft's two pilots separately travelled back to Dubendorf to conduct three out-and-back sightseeing flights on a sister Ju 52. On all three flights, says SUST, the crews involved piloted the aircraft "sig-

nificantly" below the 1,000ft safety margin in high-terrain areas, on several occasions, and "disregarded essential principles" for safe mountain flying.

Reuniting at Locarno, the two pilots prepared to take the original Ju 52 back to Dubendorf.

No flight recorders were installed in the Ju 52 but SUST used photogrammetry techniques to rebuild and examine its flightpath and altitude in the final moments before the accident.

As part of the flight to Dubendorf the aircraft entered and flew north-northeast along the centre of a valley basin, approaching the Piz Segnas peak, with mountainous ridges rising to 2,800m and above on either side.

As the Ju 52 progressed through the valley it gradually descended to around 2,760m altitude and the crew initiated a right turn before making a left turn. At this point the aircraft was travelling at a ground-speed of about 92kt (170km/h).



Aircraft was used to operate sight-seeing flights in mountains





Laurent Gillieron/EPA-EFE/Shutterstock

Examination of the wreckage turned up multiple defects, including corrosion

The inquiry believes the aircraft had been descending through a downdraught, and that this rapidly changed to an updraught around the time of the turn, fatally affecting the angle-of-attack and the lift over the wing. The Ju 52 did not have enough speed margin to restore the airflow.

SUST found that, during the right turn, the difference between the pitch and the descending flightpath angle increased to about 15°. As the aircraft transitioned into the left turn its pitch reached about 11° while the flightpath angle of its descent was about 10°.

Its roll to the left steadily increased and did not decrease even during a “significant” aileron deflection to the right, says SUST. The Ju 52’s flightpath became increasingly steeper downwards and the left bank continued to increase.

At 108m above ground the Ju 52’s longitudinal axis was 68° below the horizontal, with its elevator deflected upwards and the

rudder pointing to the right, and the aircraft’s roll accelerated into a spiral dive until it collided almost vertically with the ground at 108kt.

The inquiry found that the two pilots had flown a sister aircraft on a similar route through the basin on 6 July 2013, eventually exiting by

# 33%

Proportion of flights operated by Ju-Air that investigators determined violated elementary safety principles

flying over a ridge of the Segnas pass at just 30m above ground.

Comparison of its trajectory with that calculated from the accident indicates that a 180° turn, or an alternative flightpath, in the northern end of the valley basin “would not have been possible” for this earlier flight.

SUST obtained radar data for 216 flights by Ju-Air on its Ju 52 fleet from April 2018 to the date of the crash, to analyse them with respect to the mountain operations, paying particular attention to specific issues such as low-level flying over ridges, flight phases with no possibility of turning back, and approaches to terrain significantly below recommended safety margins.

“It became apparent that, in approximately one-third of the flights analysed, elementary principles of safe flight management in mountainous areas were significantly violated,” says SUST.

Nearly 17% of the flights involved situations with “very high” risk potential, it adds.

SUST also found that the Ju 52 was not fit to fly, having been poorly maintained, although it believes that – despite being “not airworthy in a physical or formal sense” – the aircraft did not crash as a result.

The three-engined Ju 52 involved in accident was a pre- **J**

## Absence of flight recorders forced investigators to perform painstaking reconstruction

With its unusual historic triple engine sound and vintage appearance, a Junkers Ju 52 flying through the high Alps would have presented the perfect photo opportunity.

But the appeal of the pre-war aircraft to onlookers combined with the ubiquity of high-definition mobile phone cameras proved invaluable to those tasked with understanding why it dived into the rocky floor of a remote mountain valley on a clear summer afternoon.

While visually arresting, the unconventional, another-age nature of the Ju 52 was a curse for Swiss investigators. Built in 1939, one of over 4,800 manufactured, the aircraft was equipped with neither a cockpit-voice or flight-data recorder, meaning the inquiry into the August 2018 accident proceeded absent the richest sources of investigative evidence.

But chance favoured the investigators in one respect. The Ju 52 had taken off from Locarno with 1,140 litres (300USgal) of fuel and, although the near-vertical impact destroyed the cockpit and entire forward section of the aircraft, it had been spared an explosion or fire despite a large quantity of fuel spilling from the cells.

This meant investigators could recover 44 electronic devices – including passengers' cameras and mobile phones, potentially yielding vital clues.

While the devices had escaped fire, most were severely damaged or contaminated. Painstaking recovery work eventually enabled

investigators from SUST, the Swiss authority that led the probe, to read images from 10 data-storage units, including carefully-reconstructed video using a blend of high- and low-resolution files with audio tracks from a miniature camera.

Much of the Ju 52's tracks during both the outbound Dubendorf-Locarno flight, and the fatal return leg, was reconstructed from surveillance radar and transponder information.

But this had its limits, partly due to the mountainous terrain, leaving gaps in the radar flight path.

Correlating the images taken on board helped investigators fill gaps in the radar tracks and improve the accuracy.

### Altimeter setting

Video of the cockpit also allowed the inquiry to rule out an incorrect altimeter pressure setting which might have misled the pilots over the aircraft's height as it entered the valley basin moments before the crash.

Images of the aircraft sourced from the general public – via a complex process called photogrammetry – enabled investigators to determine the aircraft's location in the valley with surprising accuracy: some positions could be determined to within "a few decimetres" and some aircraft attitudes to within 0.1°, depending on the quality of the image, among other factors.

Without a flight-data or cockpit-voice recorder, the inquiry faced difficulty in

ascertaining whether the three BMW 132 nine-cylinder radial engines were correctly functioning before the accident.

Audio tracks from video footage enabled investigators to extract acoustic information from propellers and other engine components, and use spectral analysis of the frequencies to determine rotational speeds while examining any changes in the data; ultimately this showed no evidence of technical problems.

Investigators had to assess the complex weather conditions that were present in the mountains, using a range of data sources including satellite imagery, forecasts, webcam pictures,



Photogrammetry helped establish aircraft's trajectory in its final moments

war airframe, manufactured in 1939 and one of three procured that year by the Swiss military for its air defence corps.

They were decommissioned by the corps in 1981, and a Swiss air corps museum enthusiasts' association then began using them for commercial flights from Dubendorf, converting them for civil use.

Swiss investigation authority SUST says that, by this point, there was no longer a type certificate holder to offer support and establish requirements to guarantee the Ju 52s' airworthiness.

Operator Ju-Air emerged from a 1997 merger of the museum associ-

ation and a similar organisation, to form military aircraft preservation group VFL, after which Ju-Air became responsible for maintenance and airworthiness.

SUST conducted an extensive technical examination of the aircraft wreckage following the accident, finding that the Ju 52 had "various technical restrictions".

None of its three BMW 132 A3 engines was still capable of reaching the propeller speed specified by their manufacturer.

The manufacturer had stipulated that the powerplants required a major overhaul every 200-300h, but the aircraft operator managed

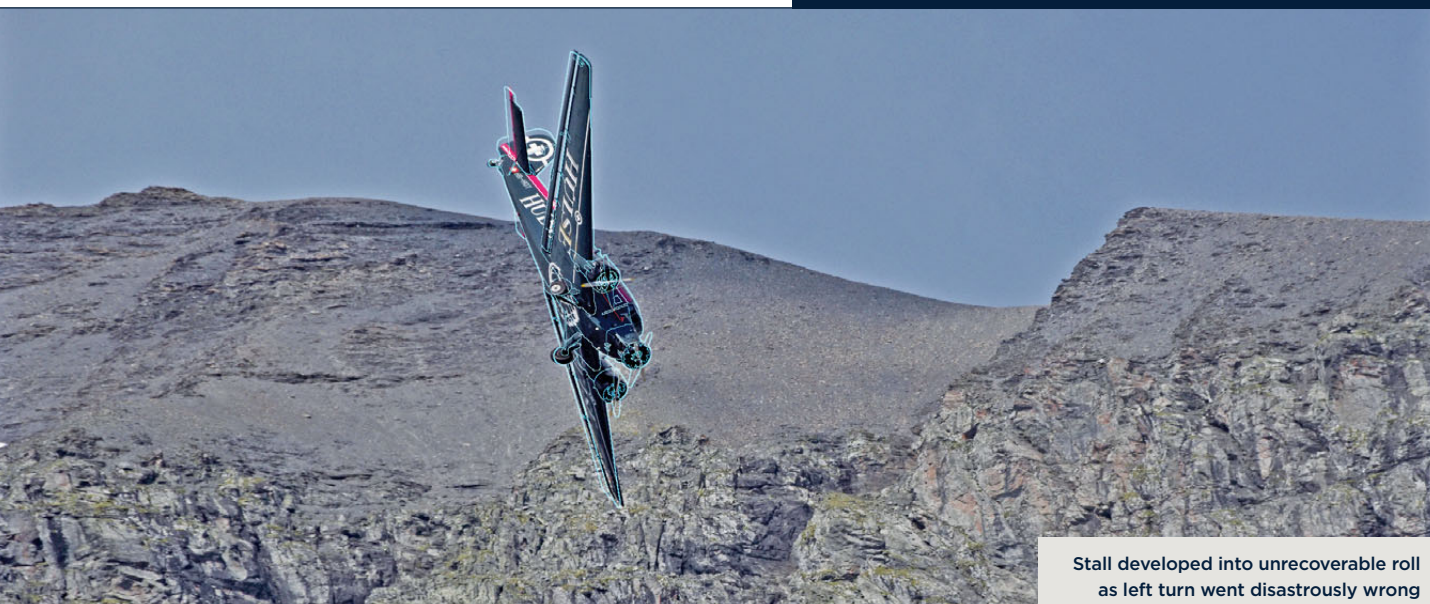
to obtain permission from the Swiss civil aviation regulator gradually to increase this interval to 1,500h.

But the engines had "never achieved" this approved interval, says the inquiry.

### Engine faults

Analysis of operations during the 10 years before the accident shows "numerous" engine faults occurred, including one failure during flight. In 16 instances the operator either had to run the engine at reduced power or shut it down.

Examination of the wreckage turned up multiple defects, including corrosion damage and



Stall developed into unrecoverable roll as left turn went disastrously wrong

and lidar - light-detection and ranging - instruments.

Weather encountered during the flight was in line with forecasts which had not indicated any especially difficult conditions. But the inquiry points out that the valley basin on sunny afternoons usually experiences winds from the north-west and “widely known” is that turbulence should be expected on the leeward side of valley ridges, with the risk of thermal activity generating the “dangerous combination” of rapidly-changing vertical winds.

On the afternoon of the accident the northerly wind had an increasing tendency, says SUST, with the likelihood of more intense turbulence in the basin southwest of the Piz Segnas mountain peak.

Investigators brought together the changing wind direction and speed, the engine acoustic data, the 3D photogrammetry, and a visual examination of the aircraft’s

ailerons from a passenger video to reconstruct the last few seconds of flight in a series of 29 numerical data points.

They showed how the aircraft, heading north-northwest, entered the valley basin to the southwest of Piz Segnas. The crew intended to travel along the centre of the valley and exit the basin via the Segnas pass, which involved a left turn.

#### Wind downdraught

The aircraft passed through an area of wind downdraught, causing it to descend, partly compensated by the crew’s increasing the pitch attitude. Engine data suggests the pilots also synchronised the engines, reducing their power slightly, as they commenced a slight right turn in preparation for the left turn to the exit.

Focused on the engines and with few visual references, the crew’s pitch increase might have been subconscious.

But it left the aircraft close to its angle-of-attack limit and, as the turbulent conditions quickly transformed the downdraught to an updraught, the aircraft - which was longitudinally unstable, flying out of balance - began to stall.

SUST found the aircraft had a true airspeed of 97kt (180km/h) as it encountered the windshear, an insufficient margin of reserve above the stall speed given the conditions. As it entered the planned left turn, the bank exceeded the crew’s intended angle as the stall on the left wing worsened in relation to the right.

Photographs of the Ju 52 from an eyewitness, as it stalled, showed the aircraft 68° nose-down and banked almost 51° to the left at just 108m above ground - far too little for recovery. Video images, from an eyewitness on the Segnas pass, recorded the final 0.4s before impact at 108kt, the aircraft almost vertically nose-down and still rolling left.

evidence of a broken stringer in the starboard wing that - despite being discovered in 2015 - was never repaired.

The investigators also found that various components of the aircraft had been poorly-maintained or replaced by reproduced parts of sub-standard quality.

Ju-Air had addressed the problem of unavailability of original spares for the airframe and engine by reconditioning some components and having others manufactured.

“Some of the companies that performed such work were not certified to produce parts for use in aviation,” says the inquiry. “Install-

tion of such parts on an airworthy aircraft was not permitted.”

This meant the aircraft, at least in a formal sense, could not be declared airworthy.

Ju-Air wrote its own service bulletins for some of the reproduced and reconditioned components and the installation of non-certified parts. But from 2002 onwards service bulletins were no longer written for this work.

“Dozens of components were remanufactured or modified by a large number of subcontractors by order of Ju-Air, mostly using an old and worn part as a template,” says the inquiry.

It says there was little accompanying documentation to support the parts remanufacture and, in most cases, no certification of airworthiness was available for the components. Ju-Air also installed many commercially available, non-certified standard components, it adds.

“Nevertheless, the aircraft functioned in such a way that the identified technical defects did not have an effect on the accident,” states SUST, suggesting that pilots had become “accustomed” to the limited flight characteristics of the Ju-Air fleet and were “unable to detect the remaining inadequacies”. ▀

# Part and parcel

Express shipment specialist UPS is upgrading the avionics on its legacy freighters to allow them to fly on until 2040

**Jon Hemmerdinger** Tampa

Express parcel carrier UPS has received its first Airbus A300 Freighter with updated Honeywell avionics and is now working to have its entire fleet upgraded before the end of 2022.

UPS is replacing the A300F's 1980s-era avionics with the Honeywell Primus Epic system – a technological leap that should enable the Louisville-based carrier to keep the old jets flying until 2040, it says.

The A300F upgrade overlaps with a UPS project to enhance the cockpits of its Boeing 757s and 767s.

On 3 February, UPS received the first updated A300F back from Airbus, which performed the avionics overhaul under a service bulletin. UPS is now identifying MRO facilities that will perform the work on its remaining 51 A300Fs.

The airline operates those jets on domestic US routes.

"We are in final contract negotiations with two MROs," says UPS aircraft maintenance director of engineering Ed Walton.

UPS expects work on the other aircraft will begin in May at one facility, and in June at another. It anticipates each jet will be out of

service for around three weeks for the retrofit activity and that all its A300Fs will have the improvements before the company's peak season at the end of 2022.

UPS acquired its A300Fs between 2000 and 2006 fully knowing their cockpits would need upgrading if they were to be flown to service limits.



Honeywell Primus Epic avionics are replacing 1980s-era systems

The oldest of the company's A300Fs has now accumulated some 14,500 cycles, although life limits are beyond 42,000 cycles.

The ageing flight-management computers fitted to the A300s have too little storage to accommodate massive navigation files. Although UPS strips out unnecessary data, the memory size limits mean the operator must still restrict navigation files to geographically constrained areas, in turn limiting where the in-

dividual freighter can be flown. Uploading new files can take 45min, Walton says.

UPS began studying the A300F cockpit update in 2010, and kicked it off in 2017. The Primus Epic upgrade adds four cursor-controlled screens and, most notably, a new flight-management system.

Other new features include a modern weather radar, integrated enhanced ground proximity warning system, new multi-function control and display units, improved situational awareness tools for pilots, and compatibility with the updated communications technology mandated by the US Federal Aviation Administration (FAA) – the so-called Future Air Navigation System.

Updates to the Primus Epic system take just 2min, says Honeywell senior platform director Allen Fenske.

The FAA has granted UPS an engineering approval to complete the work, though the company is still awaiting the agency's operational approval. It expects the first updated A300F will return to service after late April.

UPS recently completed an effort to modernise its roughly 75 757s with Collins Aerospace avionics and expects to finish equipping around 70 767s with that same system in May. ▶



UPS received its first updated A300 back from Airbus on 3 February

# Aviation's man problem

Competence, not gender, should be the only factor to affect success, says **Pilar Wolfsteller**



Early inspiration

**A**erospace and aviation have a serious man problem. Despite support programmes, mentorships, training, resource groups, workshops, outreach efforts and other corporate initiatives that ostensibly strive to improve gender parity, men continue to drastically outnumber women in the industry.

For women, the imbalance is infuriating. For men, it should be a wake-up call.

At company level, though, the entire gender-balance discussion occupies a space between embarrassment and sheer panic.

The language used is telling – it tiptoes around the issue, cloaked in euphemism, often reluctant to confront matters head-on. When the industry speaks of “unconscious bias”, what it actually means is outright misogyny. When it writes of “gender stereotypes”, think bigotry and bullying.

What’s clear is that toxic masculinity, inequality and subtle harassment continue in today’s cockpits, open-plan office spaces and executive suites across the industry.

Girls are told early on by teachers and parents to work hard, to not rock the boat, because there’s only room for so many women at the top. Women in corporate roles often have their career wings clipped for challenging a majority viewpoint, or expressing a perspective that deviates from the one that has comfortably nestled itself in an industry with a hundred-year history of male-ness.

Female pilots, locked into a tiny space at the front of the aircraft,

more often than not with a male colleague, tell harrowing stories of rampant chauvinism and insidious intimidation as they attempt to concentrate on doing their job. A job, lest we forget, that is about ferrying passengers safely from A to B.

The 2% of aviation mechanics, 5% of commercial pilots and 13% of aerospace engineers who are female are sidelined far too often. They speak of being ignored, spoken over, belittled, outflanked, judged, mansplained and stepped on; of ideas stolen, motivation questioned and intelligence doubted. Too often their voices are still – consciously or unconsciously – discounted.

## Rightful place

Their battle to take their rightful place in the left seat of airliners or on executive boards, though decades old, continues to yield only minor victories.

While there are beacons of enlightenment scattered throughout the sector, they remain almost invisible to the untrained eye. And even where there is progress, information on the topic is often difficult to extract.

Companies are quick to highlight individual success stories – showcasing women who are thriving – and admirable, significant investments and efforts to replicate these. They should, of course, be celebrated. But sector-wide metrics on gender equity across engineering and leadership roles, and the targets these firms set for themselves (if any), are frequently difficult to come by.

None of this will change until the men in power finally learn that in the long run, diversity – of gender, race, sexual orientation, thought, opinion, and perspective – leads to better outcomes for everyone.

Studies show that given the same training, education and qualifications, women are more open-minded, empathetic and take fewer risks. That makes them safer pilots, shrewder strategists and smarter investors.

But despite this empirical data, the number of women in cockpits, leadership pipelines and management ranks in the third decade of the 21st century remains vanishingly small.

At the core of the industry’s man problem is what is often referred to as the “old boys’ club” – the one that continues to block and derail the careers of the part of the populace that still has to work twice as hard to achieve half as much.

Until a critical mass of women establishes an “old girls’ club”, where members are welcomed, respected and taken care of just as well as, if not better than, their male peers, the status quo will not change.

Women know they need to beat men at their own game in order to get ahead. They are now, finally, rocking the boat like never before.

Success will be achieved the day that competence and skill, rather than gender or machismo, always determine who steers the future. ■

**See p60**

*Pilar Wolfsteller is FlightGlobal's Americas Air Transport Editor and is based in Las Vegas*



Embraer

Embraer delivered a total of 44 commercial aircraft last year. Shipments so far in 2021 include this E195-E2 for Nigerian carrier Air Peace

## Best of the rest

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

Windtunnel testing has begun of a composite wing for the high-speed civil tiltrotor funded by the EU's Clean Sky 2 programme



Leonardo Helicopters



US Air Force

Sikorsky has been awarded up to \$981 million to upgrade its yet-to-enter-service HH-60W combat rescue helicopter



Airbus Helicopters

Airbus Helicopters has secured PHI as launch customer for the H160. It will lease four examples on contract to Shell, for oil and gas use



Rostec

Russia's Aviadvigatel PD-14 engine for the Irkut MC-21 narrowbody has met ICAO's latest requirements regarding emissions criteria



Boeing

Boeing on 2 February flew the US Air Force's first F-15EX fighter, from a potential 144 examples



Aero Vodochody

Czech airframer Aero Vodochody has secured a 12-unit order for its L-39NG trainer from Vietnam

# Next month

Our training guide reviews ab initio sector amid Covid crisis

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Hundreds of aircraft are sitting in storage across the world, awaiting their fate. Will the numbers being scrapped increase in 2021, and what actually happens to an airliner when it is parted out?

# Aviation's death row



BillyPix



BillyPix



BillyPix



BillyPix



British Airways 747-400s lined up at Kemble



James Cobbold is ASI's global sales manager and a fan of the 747

» **Murdo Morrison** Kemble

For admirers of the Queen of the Skies, it is a sombre sight. Nine former British Airways Boeing 747-400s – former flagships of the flag carrier and still resplendent in their liveries – line up on the hard standing of a rural airfield in the west of England, all but one destined to be broken into bits.

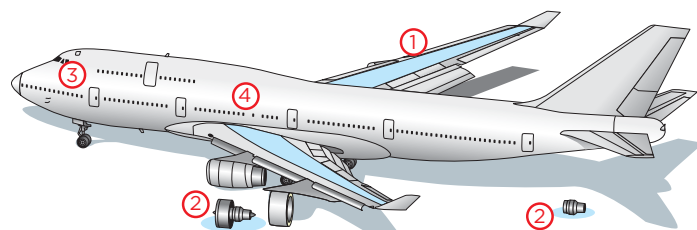
Cotswold Airport, at Kemble in Gloucestershire, is where old airliners come to die, and operator Air Salvage International (ASI) is one of a few aircraft dismantling and recycling specialists in Europe.

James Cobbold, ASI's global sales manager and self-confessed jumbo fan, admits to a pang of nostalgia as he escorts us around the main-deck first-class cabin of one of the 747s, where in seats 1A and 1K – with their prized forward-of-the-cockpit view – BA's most valued customers would have so recently reclined in comfort. This particular example is being saved for posterity (see p46), but the 15 or so other 747s at the former UK Royal Air Force (RAF) station will soon be in thousands of pieces.

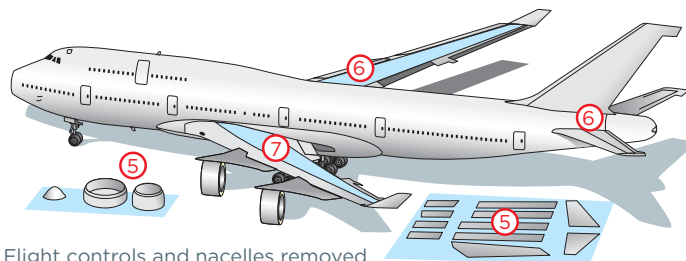
**Subtracting value**

The process of parting out has several stages, and aircraft might sit at a facility such as ASI's for months before an owner decides the sum of its parts on the secondhand market is worth more than the whole. In the case of the BA 747s, the decision was already taken to retire the aircraft before they were flown in, so the tail number is officially removed from the registry. After that, the disassembly process takes four to six weeks for a single-aisle jet; slightly longer for a widebody.

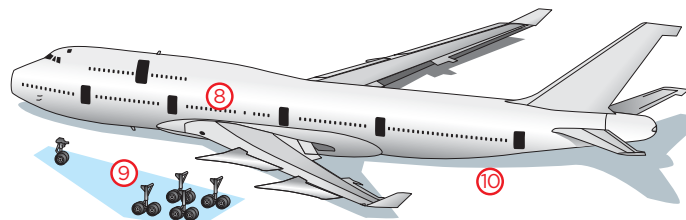
The first items to be extracted are the most valuable – the engines. They are defuelled and deactivated before being disconnected from the nacelle, explains Cobbold. At this stage, the work – carried out in



- 1 Aircraft defuelled and pre-decommission checks to ensure it is safe to work on
- 2 Engines and APU removed
- 3 Avionics and instrumentation removed
- 4 Air conditioning, interior systems and galley equipment removed



- 5 Flight controls and nacelles removed
- 6 Actuation and hydraulic components removed
- 7 Fuel components removed

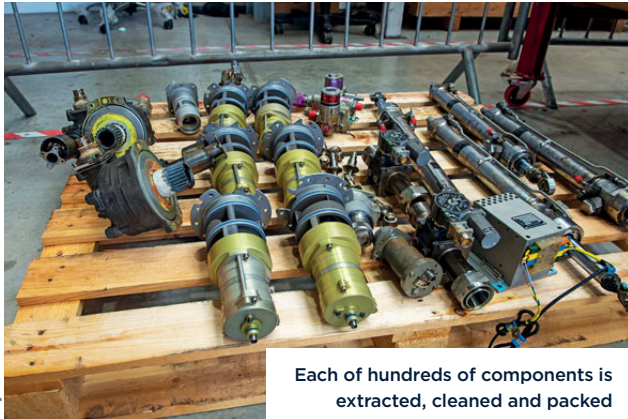


- 8 Interior removed if required
- 9 Landing gear, wheels and brakes removed
- 10 Disposal of fuselage

Tim Bicheno-Brown/Artiscreative



Disassembly and recycling has been much cleaned up in the past decade



Each of hundreds of components is extracted, cleaned and packed

the hangar in the case of narrowbodies and outside for widebodies, but only on fine days – resembles a heavy maintenance overhaul. Technicians then board the aircraft to detach the avionics, air conditioning, pneumatics, flight controls and finally the landing gear.

Each of the 800 to 1,000 parts is cleaned and packed, with owners at any stage able to view progress via an iPad. Next, the interior – seats, galleys, lavatories and luggage bins – is stripped, before what is left of the aircraft is transported to a corner of the site where crews get to work with blowtorches and electric saws, carving the fuselage, tailplane and wings into fragments, which are crushed and sent in truck loads to local authority-accredited recycling firms.

While the smashing up of a perfectly serviceable airliner may seem brutal – and for some “avgeeks” heartbreaking – there is a cycle-of-life aspect to the activity, with at least 92% of the aircraft reused, either

as working parts or for training, in the case of sections of cockpit or cabin. Almost all the metal is repurposed, together with much of any composite material – an area the recycling sector has made great progress with in recent years – with only plastics in the interior usually going to landfill.

The aircraft dismantling profession has been much cleaned up recently, thanks largely to the work of the Aircraft Fleet Recycling Association (AFRA), a body ASI founder Mark Gregory helped set up 15 years ago, and which Cobbold serves as secretary. AFRA, which includes the prominent recyclers as well as the aircraft manufacturers among its members, describes itself as a “global collaboration to elevate industry performance and increase commercial value for end-of-service aircraft”.

### Materials world

As recently as the early part of the century, the market was less professional, says Mike Corne, co-founder of the UK’s other main aircraft salvage specialist, eCube, based at the former RAF base at St Athan near Cardiff. “When we started in 2011, we wanted to introduce processes into a market that was occupied by people who, let’s say, did not necessarily have experience of running complex businesses,” he says. “We positioned ourselves as a materials management business.”

One of the counterintuitive aspects of 2020’s great aviation downturn is that it has not – at least yet – led to a flurry of aircraft retirements, despite thousands of aircraft being withdrawn from service since the start of the pandemic. While there might be a slight lag in the full-year data, by early February Cirium had recorded around 420 permanent retirements of single- and twin-aisle airliners. This compares with some 500 in 2019.

There are several reasons for this. While the total of Airbus A320-family retirements is similar

# 420

Permanent retirements of single- and twin-aisle airliners in 2020, according to Cirium



Almost all metal and a lot of the composite material is repurposed

year-on-year (113 in 2020 against 118 in 2019), the number of Boeing 737NGs permanently withdrawn from service has more than halved, from 56 in 2019 to 24 last year. This is largely a result of the grounding of the 737 Max, which has “delayed the displacement effect in existing 737 fleets”, says Max Kingsley-Jones, a senior consultant with Ascend by Cirium.

However, a bigger contributor might be the limited market for spare engines and material, which has led lessors and other owners to “wait out” the market before committing to permanent retirements and part-outs, Kingsley-Jones suggests. That might change this year, with Ascend by Cirium estimating a surplus of some 1,000 aircraft per year as the industry recovers, pointing to an extra 500 retirements over the 500 or so typically seen annually, he says.

### Safekeeping

Anecdotal evidence from the aircraft scrapperage firms would appear to bear that out. While Cobbold will not reveal exact year-on-year numbers, he says that ASI disassembled 10% fewer aircraft in 2020 than in 2019. However, 25% more aircraft arrived for storage than in the previous year. Meanwhile, Corne at eCube says the “mix has changed”, with parking and storage of aircraft



Aircraft salvage specialists think they will probably be busier in 2021



Market forces will ultimately decide the fate of the parked airliners



Fuselage, tailplane and wings are torn into fragments for recycling

“a much more significant component” of the business during 2020 than in recent years.

Airlines are understandably keen not to have aircraft parked at pricey airports. But unlike the huge US desert “boneyards”, ASI and its rivals do not have the space – or climate – to park dozens of aircraft for months or years at a time. However, both ASI, through sister company GCAM, and eCube, via a partnership in Spain, offer the European Union Aviation Safety Agency Part 145 maintenance approvals necessary for airliners that might one day be returned to service.

During 2020, leasing companies tended to hold on to aircraft rather than parting them out because lack of flight activity and an uncertain near-term outlook had depressed demand for components, says Cobbald: “Parts sellers can’t sell, so lessors are not flooding the market.” However, he accepts that the situation might change during 2021 if asset values for whole aircraft

## Conference centre to keepsake – the fate of two unwanted giants

A pair of examples of superannuated quadjets illustrate the very different destinies of airliners at the end of their working lives.

G-CIVB is a former British Airways Boeing 747-400 that joined the fleet in 1994 and was recently repainted with a retro Negus & Negus scheme first adopted when the airline was created by the merger of BOAC and British European Airways in 1974.

The jumbo will live on at Cotswold Airport as a private-hire cinema venue for conferences and other functions, after being acquired by airport operator Kemble Air Services. It joins another ex-BA 747-400 that will be based at Dunsfold Aerodrome in Surrey as a set for film and television.

A former Singapore Airlines Airbus A380 (MSN003/9V-SKA), on the other hand, is now, among other things, a series of limited-edition identity tags.

They were fashioned from the fuselage of the 12-year-old aircraft after it was broken up at Tarmac Aerosave in Tarbes in 2019.

German company Aviatontag says each of the items sports the aircraft type, registration number, edition number and size of the doomed superjumbo.

MSN003 has its place in history, having operated the first A380 passenger service on 25 October 2007, from Changi to Sydney. It was retired just 10 years later.



More than 90% of a parted-out airliner is put to use

remain low. “We genuinely don’t know, but we do expect to be busy,” he says.

AJW Group is traditionally one of the biggest purchasers of retired aircraft, with the UK aftermarket firm arranging the parting out and selling of components from its warehouse in Sussex. Chief executive Christopher Whiteside says the company has been very careful with what it buys over the past

# 25%

More aircraft arrived for storage at ASI in 2020 than during 2019

12 months, only committing to aircraft “where we think there is a market”. Its main acquisition in 2020 was a trio of 21-year-old former Thomas Cook A330s.

Corne says that with 52 parking stands, eCube still has capacity to accept aircraft for parking, although numbers have risen from “single digits” in 2019 to around 25. A sister facility in Castellon, Spain, has another 20 in storage. Although few of the aircraft have been formally retired, he expects that “except for the occasional A321 or 737-800 which will make it out of here, most will not return to operation”.

### Delayed disassemblies

He adds: “Owners have been bringing them to us because they want to keep their options open, but they know that in all likelihood they will be broken up.” While the “bow wave of disassemblies” has not yet happened, “that can only go on so long”, he believes. “There is a substantial wave of parting out coming, and we are trying to increase capacity so as not to allow lead times to grow in an unacceptable way.”

As ever, market forces will decide. If lessors and other owners are confident of a surge in airline traffic this year, at least some grounded types will once again become more valuable as sources of parts than empty assets, and the recycling firms will be busy. If the aviation sector remains in the doldrums, pressure for parking at facilities such as those in Kemble and St Athan may increase, and their operators may find themselves searching for more storage space.

However, even in a depressed market, owners will at some point have to take a decision as to whether it makes more sense to hang on to a piece of equipment that is costing them money to store and has little or no prospect of returning to service, or cut their losses and summon the teardown crews. Either way – whether through scrappage or storage – business is likely to remain buoyant for the world’s aircraft boneyards. ▀



Aircraft parked at eCube’s site near Cardiff

In extraordinary times, maintenance providers and carriers around the globe are having to adapt their practices to ensure the continued airworthiness of aircraft being kept in long-term storage

# No trouble in store

**Michael Gubisch** Cirium

**T**he continued high proportion of parked aircraft as a result of the Covid-19 pandemic creates a range of issues for airlines and maintenance providers to ensure these assets remain airworthy and ready for a return to service.

“We are doing something we normally don’t want to do,” says Lufthansa Technik (LHT) senior director of aircraft modification Henning Jochmann of the company’s efforts to maintain a huge fleet of aircraft in working order after their deactivation amid the global health crisis.

“We’re keeping aircraft on the ground, while we normally do everything so that they can regularly fly. That is a slightly different way of thinking.”

When airlines parked aircraft en masse in March and April 2020, amid the first Covid-19 wave, LHT quickly received an “immense” number of enquiries from airlines and lessors on how to manage the process of storing aircraft, Jochmann says.

The MRO provider already had short-term parking and long-term storage procedures in place because it was regularly handling around 100 temporary aircraft deactivations per annum, following lease terminations or airline bankruptcies. But the scale of aircraft groundings due to the coronavirus spread was something else, and Jochmann says it was difficult to quickly respond to all the enquiries.

He describes the process of parking aircraft for short periods – perhaps a month – as a simple task, noting: “You don’t need to do a lot.” Provided the weather conditions are not extreme, aircraft can be stored in

most locations. Landing-gear wells and other openings will be sealed to prevent bird-nesting, sensors covered for protection, and routine checks regularly conducted, as would be required for in-service aircraft.

But Jochmann says: “The longer I keep an aircraft on the ground, no matter whether it is a short- or long-haul aircraft, the more I need to do.”

As main airports tend to charge comparatively high parking fees, operators and lessors typically select secondary airports, smaller airfields or dedicated storage locations to place out-of-service aircraft. While it is not a mandatory requirement, dry locations are preferable, to avoid corrosion. “Humidity is never a good idea for aircraft,” Jochmann notes.

## Extended action

For long-term storage, fuel, oil, water and hydraulic fluid systems will be drained and, where necessary, replaced with conservation liquids. Windows, doors and other openings will be sealed to prevent water ingress and sunlight damage. Once the aircraft is prepared for long-term storage, it does not require regular maintenance anymore.

Noting that it takes up to two weeks to reactivate a long-haul aircraft after an extended pause, he says airlines and lessors need to think carefully about which storage programme is appropriate for their individual assets. “You’ve got to have to a plan.”

Air France says that all of its aircraft types have been affected by storage measures except for its newest assets: Airbus A350s and Boeing 787s have primarily been kept in operation. The airline says it has employed a mix of long- and short-term storage “to maintain our flexibility and our ability to adjust our fleet to our flight





Dry locations like Victorville, California, are ideal for extended storage of assets

AirTeamImages

schedule”, and notes that aircraft in short-term storage can be “de-stored easily” if demand increases.

In addition to favouring aircraft and engines with as much available service life as possible before the next heavy maintenance check or engine shop visit, Air France says that cabin-interior standards were also a consideration for selecting aircraft for continued operation, as the carrier sought to “offer best services to our customers”.

Air France has established a dedicated process involving network and maintenance planners, and adapted its organisation to optimise its in-service aircraft and fleet storage activities, it says.

Cirium fleets data shows that out of 297 mainline and regional aircraft in Air France’s fleet, 91 were in storage on 10 February. This total included Bombardier CRJ700/1000, Embraer E170/190 and ERJ-145 regional jets, A320-family narrowbodies, A330/340 and 777 widebodies, and all its A380 superjumbos.

“The longer I keep an aircraft on the ground, no matter whether it is a short- or long-haul aircraft, the more I need to do”

**Henning Jochmann**

Senior director of aircraft modification, Lufthansa Technik

Finnair, meanwhile, is keeping about half of its 84-strong fleet in “operative readiness to fly”, while the rest are parked or in long-term storage. “We keep our fleet in such condition that we will be flexible and fast in increasing our capacity after the travel restrictions are lifted and the demand starts to recover,” the carrier says.

Of the 60 aircraft in the combined fleet of Finnair and partner Nordic Regional Airlines, Cirium data shows that 35 were in storage as of 10 February. All of these were mainline types: 28 of its 36 A320-family jets, and eight of its A330-300s.

### Right-sizing

Reduced travel demand has prompted Finnair to switch flights previously operated by A320-family jets to Embraer E-Jets and ATR turboprops. Meanwhile, one of its A319s was retired in late 2020 to be parted out.

Among the aircraft placed in storage are four A330s that were ferried to Tarbes in southern France to prevent corrosion. Finnair currently deploys its operational A330s for cargo flights only, with passenger seats removed from some to increase capacity, while passenger long-haul services are performed using A350s.

In-service aircraft are being rotated in order to keep as many as possible available for operation, says Finnair, which acknowledges that asset utilisation is lower than before the crisis.

Noting the unprecedented scale of sustained inactivity, it says managing its fleet has been “very much a learning process”.

“There is something new every day that we learn about the parking/storage procedure, and [we]

” develop it further,” says Finnair. “Our experience is that the whole industry has been extremely flexible in supporting the operators during this time.”

Aircraft manufacturers give instructions on how to place and maintain aircraft in storage. Jochmann says these must be followed for primary structures and systems to comply with regulatory requirements and ensure an aircraft’s future serviceability, but that secondary items, such as cabin installations, may be handled more individually to optimise in-storage maintenance, especially as interior equipment varies across operators.

Noting LHT’s design organisation approval, Jochmann says in-storage maintenance activities for many items can be significantly reduced versus OEM instructions, without compromising serviceability.

“Depending on how an airline operated its aircraft before the parking, it may have different requirements to other operators. We try to develop individual concepts so that aircraft can be reactivated – or, if they are disassembled, that components can be extracted – in the best-possible condition.

**Broad approach**

“We are in a position to develop individual, customised solutions, while OEMs have a very broad approach – something they need to have because their documents need to cover all aircraft that have ever been built.”

The central objective in storage management is to ensure that an aircraft does not lose its airworthiness certificate during the inactive period, for example if mandatory checks have not been completed.

Noting the need to present ‘back-to-birth’ equipment documentation to recertify an aircraft, Jochmann says the required paperwork may be impossible to complete for some assets and could therefore result in a write-off.

If maintenance-check intervals have been exceeded during periods of inactivity, operators may have an option to obtain a single-flight permit to ferry an aircraft from a storage location to an MRO facility to complete the required work.

“That’s why it is so important that an aircraft is under good care during a parking period and that you don’t find two or three no-go items that prevent a flight,” says Jochmann. “If you start to, in the worst case, change engines at a remote airfield, it will not only be expensive, but take time and become very complicated.”

If an operator is certain that a stored aircraft will not return to service, the most obvious solution would be to retire it and retrieve its residual value through part-out. But that decision may not be

simple, as it depends on the aircraft’s ownership, financing circumstances, who can decide about a decommissioning, and – perhaps the most difficult overall consideration today – market prospects.

Jochmann notes the large number of in-storage A380s and the stated intention of several operators not to return them to service in a post-Covid world – Air France became the first to prematurely retire all of its remaining superjumbos in 2020 – but says most of the airlines in question have not yet decided the fate of these aircraft. “At the moment, we don’t yet see airlines sending relatively young aircraft to be [parted out].”

**Uncertain future**

Instead, he says, carriers take the comparatively costly option of storing aircraft because they are “insecure what will happen”.

While LHT cannot advise airlines on how air travel will develop over the next few years, the MRO group can provide operators with flexibility by extending services when required or guaranteeing that aircraft can be returned to service within an agreed time when capacity is needed again.

The company foresees bottlenecks if many deactivated aircraft were to be returned to service in a short period of time. “Depending on how many aircraft are in storage, there may be maintenance hold-ups because every aircraft will require some work,” Jochmann says.

Air France, recalling the sharp but short-lived uptick in European airline activity last July-August, agrees this is a challenge “for the aeronautical industry as a whole”.

When travel demand does pick up, the number of active aircraft will likely grow at a slower rate as operators may initially replace smaller types with larger ones and increase utilisation before additional equipment is brought into service.

Jochmann says discussions among airlines and lessors about aircraft reactivation increased late last year, especially after the arrival of initial Covid vaccines. He expects that carriers will study and prepare the reactivation of stored aircraft before demand comes back, to avoid bottlenecks.

He notes that LHT’s parking/storage support does not generate substantial revenue to offset the company’s losses amid the crisis. “It’s more or less a service to the customer, where we try to maintain trust through competence during a very difficult time,” he says. “These are not high-price services. We would rather do any D-check.” ▶

*This analysis was written by Michael Gubisch, part of Cirium’s London-based reporting team*

Jaromir Chalabala/Shutterstock



Finnair currently has more than half of its fleet parked due to travel downturn

# THE FUTURE OF THE AEROSPACE INDUSTRY

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Cessna has drawn on new technology to make its flagship Longitude a pleasure for passengers and pilots alike. We put the super-midsize type to the test

# Degrees better

Though it has the same flightdeck and forward fuselage as smaller sibling, Longitude's overall design is entirely new

**Michael Gerzanics** San Jose

**D**espite the global Covid-19 pandemic, the super-midsize segment of the business jet market is showing signs of life. This is in part being driven by an uptick in demand for fractional jet operators, as businesses and the well-heeled have flocked to their services in order to avoid the perceived risks of travelling via scheduled airline operations.

Bombardier continues to be the market leader in this segment – based on deliveries and orders – with its Challenger 300/350 offerings. Dassault and Gulfstream also maintain a strong presence, with their Falcon 2000S and G280 models, respectively. And from a technological viewpoint, Embraer's Praetor 600 is the

stand-out offering, with a full fly-by-wire (FBW) flight-control system and available head-up display.

Textron Aviation's Cessna brand, which popularised business jet travel with the Citation series, has the newest entry into this market area, having launched its Longitude at the NBAA convention in November 2015. The ambitious goals for the Longitude were to offer transatlantic range while providing the segment's best cabin experience and lowest operating costs. First flight of the aircraft was in 2016, with initial customer deliveries made in the fourth quarter of 2019.

To accomplish these lofty goals, Textron Aviation leaned heavily on its past successes when designing the Longitude. While it is a unique design, the new flagship shares its flightdeck and forward fuselage with the smaller and shorter-range midsize Citation



Latitude. The fuselage also has the same cross-section as its stablemate, but the passenger cabin is 1.1m (3ft 7in) longer, to allow for accommodation of up to 12 passengers.

#### **Big sweep**

The wing is a clean-sheet design with a sweep of 28.6°; an angle exceeded only by the Citation X+ in Cessna's Citation line-up. The wing sports a fixed leading edge as well as gently upturned winglets that add 1.33m of span on each side. The 0.89m-tall winglets are the most prominent of any Citation. The mildly supercritical wing combines with efficient Honeywell HTF7700L engines - each rated at 7,660lb thrust (34.1kN) - to enable a maximum range of 3,500nm (6,480km) while carrying four passengers at Mach 0.80.

While the Longitude has many notable design features, where it really shines is in passenger accommodation. As with all great things, it starts at the foundation, or floor in this case. The Longitude has a flat floor with 1.83m of over-aisle headroom. Typical cabin configurations are a double club arrangement (four seats each), or a club forward layout with a three-place couch and two facing seats in the aft area. The facing seats are berthable, as is the couch.

Forward of the seating area, opposite the aircraft entry door, is a wet galley. All configurations have a spacious lavatory at the aft end of the cabin. In-flight access to the tail cone baggage area is through a door on the lavatory's aft wall.

While the spacious cabin and its appointments are pleasing to the eye, it is what is unheard that truly

enhances the cabin experience. At cruise conditions, Cessna says the Longitude has the quietest cabin in its class. While typical super-midsize cabins have an ambient noise level of 69-72 dBA, the Longitude's is slightly over 67dBA. It must be remembered that decibels are a logarithmic scale, so even a one- or two-unit difference would be appreciated.

The Longitude's interior is further enhanced by its 9.66psi/666hPa differential cabin pressurisation system. It provides a 5,950ft cabin pressure at its maximum operating ceiling of 45,000ft; a level several thousand feet lower than most of its competitors.

### Clean air

Rounding out notable cabin enhancements is the type's partial recirculation system. Cabin air is sourced from the engines' bleed air system, whose high temperatures sterilise the air. This clean air is then cooled (conditioned) before distribution in the cabin. After coursing through the cabin, 78% of the air is vented overboard via outflow valves at the rear.

The remaining air is recirculated/returned to the cabin, a common practice that reduces engine fuel burn. Return air is pushed through a HEPA filtration system – which can capture microscopic particles smaller than the Covid-19 virus, and should prevent the reintroduction of contaminated air to the passenger cabin.

Textron Aviation's close attention to the passenger cabin did not prevent it from also making the Longitude's flightdeck a great place to work. As mentioned, the model shares a common flightdeck with the smaller Latitude. Its Garmin G5000-based avionics suite features three 35.6cm (diagonal)

wide-format LCD screens across the instrument panel: two primary and one main flight display (MFD).

As with the Latitude, four GTC575 touchscreen controllers (TSCs) are handily placed in the cockpit. Navigation within a main display is via cursor control sticks on the bezel of the TSC.

One neat feature resident in the TSC is the ability to use its screen as a track pad. The flight guidance panel (FGP), to control the autopilot (AP) and flight director (FD), is mounted on the centre of the glare shield. A single-gauge electronic standby flight display, with an internal back-up battery, is mounted between the FGP and the MFD.

Garmin's synthetic vision technology comes as standard, as does an auto-throttle (A/T) system. As with the Latitude, the small overhead panel hosts lighting control switches.

The Longitude's flight-control architecture is illustrative of Textron Aviation's incremental approach to new technology. When Embraer developed its Legacy 450/500 (now enhanced as the Praetor 500/600), it did so with a full FBW control system. I think a well-executed FBW flight-control system can be extremely competent, with the potential to

# 5,950ft

Cabin pressure at Longitude's maximum operating ceiling of 45,000ft



Ken Hall

Gently upturned winglets are the most prominent on any Citation

## Cessna Citation Longitude specifications

### Dimensions

Length	22.3m
Height	5.91m
Wingspan	21m
Wing area	49.9sq m

### Passenger cabin

Length	7.67m*
Width	1.96m
Height	1.83m
Baggage stowage (tail cone)	2.78cb m/453kg

### Weights\*\*

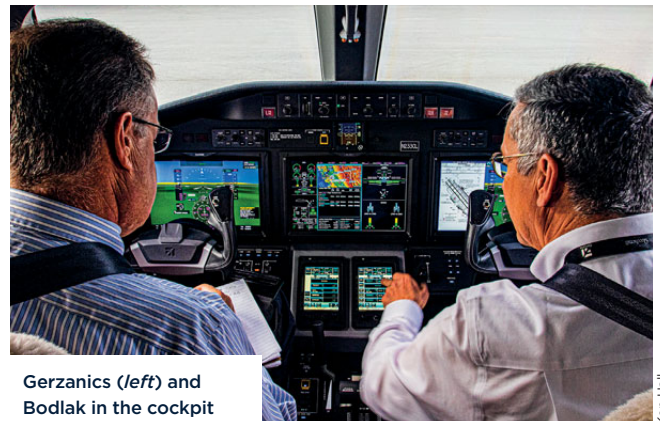
Maximum take-off weight	17,917kg
Maximum landing weight	15,195kg
Basic operating weight	10,705kg

### Performance

Take-off distance***	1,466m
Operating ceiling	45,000ft
Range (M0.80)****	3,500nm
Maximum operating Mach speed	M0.84
Landing distance*****	996m

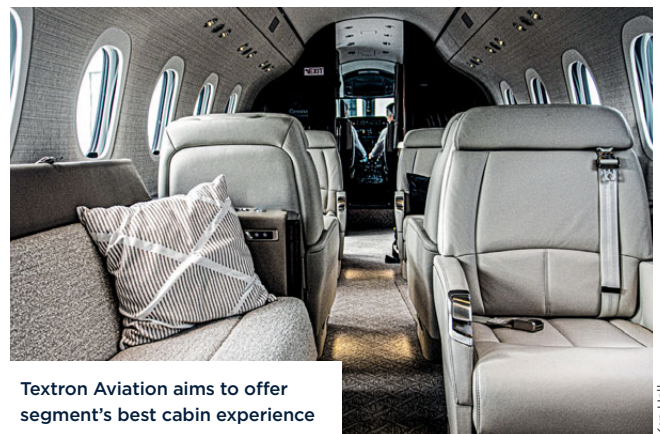
Source: Textron Aviation \*Excluding baggage compartment \*\*2 crew, typical equipment

\*\*\*MTOW, SL, ISA \*\*\*\*2 crew plus 4 passengers, IFR, 200nm alternate \*\*\*\*\*MLW, SL, ISA



Gerzanic (left) and Bodlak in the cockpit

Ken Hall



Textron Aviation aims to offer segment's best cabin experience

Ken Hall



offer envelope protection schemes and enhance performance. Providing these same enhancements in a conventionally-controlled aircraft (with either pure mechanical or hydro-mechanical control surfaces) is a more daunting task.

Textron Aviation has taken measured steps in incorporating FBW technology into the Longitude. The aircraft has mechanical ailerons and elevator, while incorporating a FBW-controlled rudder. This is Cessna's second commercially fielded FBW primary control surface: the first being the Citation X's upper rudder. Interestingly, Bombardier's first FBW primary control surface was the CRJ900's rudder, while for Embraer it was the E170's elevator.

The Longitude's open-loop FBW scheme schedules rudder deflection as a function of airspeed, while performing full-time yaw damper and turn co-ordination functions. Six wing-mounted spoiler panels - three per side - are the Longitude's other FBW control surface. These secondary surfaces augment roll authority, act as speed brakes (SBs) while airborne, and dump lift on the ground to enhance wheel brake performance. These three functions are quite routine, with the FBW implementation reducing mechanical complexity and weight.

Runway performance is also enhanced, as an auto-deployment schedule is programmed.

Envelope protection schemes have long been a strength of FBW control systems, and advances by Garmin are making these same features available to conventionally controlled aircraft. The company's

electronic stability and protection system offers attitude protections in both pitch and roll, along with high- and low-speed protections. For the Longitude's G5000 avionics suite, however, Textron Aviation elected to implement high- and low-speed protection schemes that utilise the AP and/or A/T.

There were 31 Longitudes in service as of late 2020, and in early January FlightGlobal was given the opportunity to see if the type has achieved its goals and can be classed as another Textron Aviation and Cessna "sure thing".

Our preview aircraft was the 33rd example produced, with the US registration N233CL. I accompanied Textron Aviation senior pilot David Bodlak during the pre-flight walkaround inspection on the ramp at San Jose International airport in California.

### Sustainable fuel

While the gleaming heated leading edge of the wing caught my eye, it was an "SAF" logo near the door that grabbed my attention. Textron Aviation gives its turbine-powered aircraft customers the option to have their purchases delivered using sustainable aviation fuel: Jet A/A-1 fuel made from sustainable sources.

Currently there is a cost premium for using SAF, but according to the airframer users can take comfort in knowing that carbon emissions can be reduced by up to 80% compared with fossil fuel. Our preview flight would be conducted with SAF, a facet that would be operationally transparent to me.

The inspection was a snap to complete, with only the fuel panel access door needing to be opened to check engine and auxiliary power unit (APU) oil levels.

As I settled into the Longitude's left seat, Bodlak started the tail-mounted Honeywell APU and put its generator online. With the flightdeck powered, he guided me through its initialisation, loading our route of flight and determining take-off performance. With an electronic checklist still under development, we used a paper one to ensure required pre-start items were accomplished.

APU bleed air was used to start both engines, with the FADEC-controlled starts stabilising each at IDLE in under 30s. The Longitude's nose-wheel steering

tiller fell readily to hand as I negotiated the first 90° turn out of the chocks. During the taxi from the ramp to runway 30R for departure, I was able to track our position on the map display. Flaps had been set to "2" in preparation for take-off.

Once the aircraft was on the runway and cleared for take-off, I released the toe-actuated wheel brakes and advanced both thrust levers (TLs) to the "TO" detent. The FADECs set take-off power of 89.3%, and the Longitude raced down the runway. Bodlak called "Rotate" at 110kt (203km/h) and I found yoke forces needed to attain lift-off pitch attitude were moderate.

With a take-off weight of 14,270kg (31,400lb), including 3,420kg of fuel and three occupants, our aircraft needed only 1,016m of runway. At its 17,917kg maximum take-off weight, the Longitude would require a field length of 1,466m at sea level on a standard day.

Control yoke force changes during clean-up and acceleration to our initial 200kt climb speed were low and easily countered with yoke-actuated pitch trim. I followed the FD's guidance as we proceeded on the TECKY 3 RNAV departure. During the turn



'SAF' logo beside door highlights ability to operate type using sustainable aviation fuel

Cessna Citation Longitude versus competitors					
	Longitude	Bombardier Challenger 350	Dassault Falcon 2000S	Embraer Praetor 600	Gulfstream G280
Cabin (L x W x H)	7.67 x 1.96 x 1.83m	7.68 x 2.19 x 1.83m	7.98 x 2.34 x 1.88m	7.35 x 2.08 x 1.83m	7.87 x 2.11 x 1.85m
Passengers (typical/maximum)	8/12	8/10	6/19	8/12	8/10
Basic operating weight	10,705kg	11,247kg	11,224kg	11,500kg	10,950kg
Range (8 passengers)	3,348nm	3,200nm	3,321nm	3,670nm	3,350nm
Operating ceiling	45,000ft	45,000ft	47,000ft	45,000ft	45,000ft
Engines	2 x Honeywell HTF7700L	2 x Honeywell HTF7350	2 x Pratt & Whitney Canada PW308C	2 x Honeywell HTF7500E	2 x Honeywell HTF7250G
Take-off distance	1,466m	1,474m	1,318m	1,438m	1,448m
Landing distance	966m	720m	705m	660m	829m
Thrust-to-weight ratio	39%	36%	34%	35%	39%
Wing loading, kg/sq m	359	379	378	433	391
Price	\$29.8m	\$26.7m	\$28.9m	\$21m	\$24.5m

Source: Manufacturers





Ken Hall

Evaluation flight from San Jose used 33rd production example

# 31

Number of Longitude business jets in service at end of last year – deliveries began in late 2019

to the southeast, I found lateral control forces, while well harmonised with pitch forces, were higher than I would have liked. I was, however, pleased that, unlike other Citation Jets I have flown, the yoke itself was at a comfortable height when seated at the design position.

As we climbed to our planned cruise altitude of 41,000ft, I engaged the AP and refamiliarised myself with the avionics suite. While I am still finding my way learning all the Garmin system's nuances, I marvel at its capabilities and the flexibility of its interface. Textron Aviation's decision to put the G5000 in the Longitude will certainly please the generation of pilots who have grown up in the Garmin ecosystem.

Once level at 41,000ft, we endeavoured to do a number of cruise points, to spot-check published performance figures. Mountain wave activity near the Sierras prevented us from obtaining accurate data, but we did manage a maximum cruise speed point. At a gross weight of 13,555kg, a total fuel flow of 2,050lb/h held an indicated M0.839; just shy of maximum operating Mach (MMO) speed. Our indicated airspeed of 250kt translated to a true 476kt, under ISA -2°C test day conditions.

Following the flight, Bodlak provided book numbers for a 17,237kg aircraft at M0.84 and M0.79 (long range cruise). True airspeed at the MMO condition would be 477kt, with a total fuel flow of 2,122lb/h. At the long-range condition, true airspeed would be 451kt and fuel flow would drop to 1,820lb/h.

With four passengers, a range of 3,500nm at M0.80 is listed for the Longitude. So what are the type's real world capabilities? Transatlantic flight is no problem, such as Columbus, Ohio, to Paris. Late for the opera

after checking out of the Raffles Hotel in Singapore? No problem, as Sydney is just a nonstop flight away.

Before I left the flightdeck to sample the Longitude's passenger accommodation, I slowed the aircraft to M0.80 and noted the pressurisation system was holding the cabin altitude at just 4,900ft; remarkably low for this flight level, this contributes to less fatiguing and more comfortable journeys.

As I walked back through the cabin I noted that the surface was level, easing transit of the long, flat-floored space. Subjectively, it was one of the quietest business jet cabins I had been in, with Textron Aviation's data backing up that impression. The quietest area was the second row of the forward club seating area, with the ambient level increasing fore and aft of there. I sat in the forward club area and chatted with our safety pilot, Alan Pitcher. He and I had flown together on my Citation X+ preview flight out of Wichita, Kansas, in 2014. We were able to converse at normal voice levels and I enjoyed the opportunity to catch up with him.

## Safety first

After I returned to the flightdeck, Bodlak and I discussed the AP's emergency descent mode (EDM). At 30,000ft or above, loss of cabin pressure with the AP engaged will trigger EDM. The AP will start a descent and accelerate the aircraft to MMO/maximum operating speed. Additionally, the A/Ts will set IDLE thrust to speed the descent to 15,000ft, where the AP will level the aircraft and A/Ts maintain a safe speed. This feature is a great safety enhancer and available in all G5000-equipped Citation aircraft.

Next, we started a hand-flown descent towards a medium altitude block (15,000ft-17,000ft), where we would investigate some of the Longitude's slow speed protection schemes. Taking advantage of our high potential energy, I tested two of the business jet's high-speed protection schemes during the descent. The first used the A/Ts, which had been turned off with the TLs themselves about mid-range. I ignored the several aural and visual warnings as the speed approached MMO. Before reaching M0.84, the A/Ts woke up and retarded the TLs to IDLE in an effort to prevent an overspeed. ▶

Next, I engaged the AP and let the Longitude stabilise below MMO.

While still in a descent I pushed the TLs up to again speed the aircraft towards MMO. This time I held them firm so the A/Ts could not retard them. As the speed increased to MO.84, the AP pitched the Longitude into a 1,000ft/min climb, to prevent it from exceeding MMO.

Level in the medium altitude block at 300kt indicated airspeed, I extended the SBs. As they deployed, the aircraft started to pitch up, requiring about 9kg of forward yoke pressure to maintain level flight. Next I retarded the TLs to IDLE to speed the deceleration rate. Passing 250kt I pushed the TLs up to accelerate back towards 300kt. Giving primacy to the advancement of the TLs as an indication of my intent, the SBs were automatically retracted. Pilots are more likely to drop the SB lever out of their cross-check than the TLs.

Automatic SB retraction is a safety-enhancing feature that should not be overlooked. There is strong speculation that if the Boeing 757 had had such a feature, it might have allowed American Airlines flight 965 to climb over high terrain and prevented the deadly accident in December 1995 near Cali, Colombia.

## The Longitude offers transatlantic range and an outstanding cabin experience

The last medium-altitude events we conducted were two approach to stalls, one in a clean and the other in a landing configuration, with gear down and flaps at FULL. As with the high-speed case, the A/Ts will wake up to prevent a speed excursion, in this instance increasing power to prevent a stall. To disable this feature, the A/T circuit-breaker was pulled, allowing the Longitude to slow at IDLE power in near level flight.

In both configurations the aircraft was responsive to small amplitude control inputs as it slowed towards shaker onset speed, represented by 0.85 units of angle-of-attack. Little if any airframe buffet preceded shaker activation, the indication of an impending stall. Simultaneous relaxation of aft yoke pressure and advancing the TLs recovered the Longitude to normal flight conditions for both configurations.

Pleased with the Longitude's low-speed handling, we headed towards KLIDE, a point on the RNAV (GPS) Y 30L for our recovery back to San Jose. I engaged the AP and A/Ts and monitored their performance as the Longitude expertly flew the coupled approach.

Our ownership position on the MFD map display allowed me to easily keep track of our lateral position. While vertical track position can also be monitored on the map display, it is not always intuitive. Fortunately, the G5000 has a vertical situation display (VSD) that presents a profile view of the desired vertical path. On our initial turn towards KLIDE, reference to the VSD quickly alerted us that we were higher than planned – a situation rectified by deployment of the SBs.

Once fully configured on final, the A/Ts accurately maintained our approach speed of 124kt. At 257ft –



Gerzanic (centre), with Textron crew

localiser performance with vertical guidance minimums – Bodlak called for a go-around and I simultaneously clicked off the AP and ATs. Next, I hit the throttle-mounted take-off/go around (TOGA) switch and called for Flaps to “2” as I advanced the TLs to the TOGA detent. Following FD guidance established an initial climb and I called for gear retraction.

Once safely away from the runway in a 120kt climb, Bodlak simulated an engine failure by pulling the right TL to IDLE. While we had pre-briefed this manoeuvre, it did catch me by surprise, adding to the realism of the scenario. About 25kg of left rudder pedal was needed to keep the Longitude on runway heading as we climbed towards pattern altitude for a visual circuit.

The right TL was kept at IDLE throughout the simulated one-engine approach and landing. Landing configuration was the same as for the previous two-engine RNAV approach. With the rudder trim centred, less than 5kg of pedal pressure was needed to maintain co-ordinated flight at a final approach speed of 124kt.

After a smooth touchdown, I applied moderate wheel braking and deployed both thrust reversers (TRs). Deceleration on the dry runway was quite good, with the Longitude stopping before I had a chance to stow the reversers. A number of aircraft I have flown have a pilot-observed minimum speed by when the TRs must be stowed. This can be driven by a number of factors, including prevention of foreign object ingestion, damage to the aircraft, and controllability concerns.

### Stopping power

The Longitude's FADEC-controlled engines take care of this problem for even the most inattentive pilot. With TRs deployed, as the aircraft slows the FADECs reduce engine thrust to safe levels regardless of the actual TL position. On a contaminated or slippery runway, this feature should prove a big asset, with every bit of stopping power harnessed without worry.

My 2.3h in the Longitude provided a real window into its capabilities, and the flat-floored super-midsize Citation did not disappoint.

The Longitude offers transatlantic range and an outstanding cabin experience: passengers will appreciate the large cabin and class-leading acoustics.

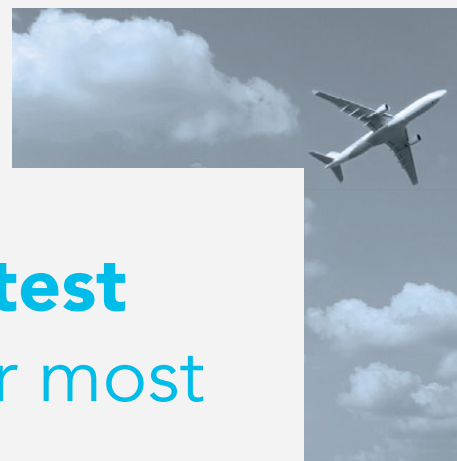
Textron Aviation's measured adoption of technology for aircraft systems and the use Garmin's powerful G5000 avionics suite combine to create an aircraft that pilots will enjoy flying. While not evaluated during my flight, the company reports that the type has the lowest direct operating costs of any super-midsize jet.

As such, the Longitude has attributes sure to please its core stakeholders, and it looks like Cessna has indeed fielded another “sure thing”. ▀



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Despite multiple initiatives conducted over many years, the aerospace industry has yet to find a way to fix its glaring gender imbalance. Could fresh measures finally help, and be of benefit for all?

# Searching for equality

**Pilar Wolfsteller** Las Vegas

One year ago, 13-year-old Makayla Smith's eyes lit up as she stepped into an Orlando hotel ballroom. Before her lay a world of aerospace engineering wonders.

It was "Girls in Aviation Day", an initiative sponsored by Women in Aviation International (WAI), which aims to give eight- to 17-year-olds hands-on experience in science, technology, engineering and maths (STEM).

In a few hours on that Saturday in March 2020, Makayla and hundreds of other girls would learn more about those disciplines than they had in their lives to date.

WAI, a global non-profit entity working for the advancement of women in the aviation industry, holds several such events every year. The organisation strives to make the subjects accessible to this demographic, with the hope that more than a just handful of participants will pursue related careers.

At stations around the hall, attendees could indulge in lessons from across the spectrum of aviation, technology and science. They learned about the aerodynamics of helicopters. They built robots, flew virtual-reality simulators, deciphered aviation sectional charts, tested paper-airplane designs - and even mixed their own lip gloss.

"This exposes kids to stuff they don't see every day," said Tamara Payne, a teacher who took 90 students to the event. "They don't know yet that they can do any of this as a job. And at this age, it's critical to show them."

Allison McKay, WAI's chief executive, agrees. She spends her days trying to figure out how to draw more women into technical fields such as aviation and aerospace, and appealing to the industry to invest in them. The key, she says, is to start empowering girls when they are young.

"Right around middle school is when girls perceive themselves as having less aptitude in the sciences and technology than their male peers," she says. "So it's vitally important to keep them engaged as they make the choices that will lead to their careers."

With 12,000 members, WAI is the world's largest interest group for women pursuing aviation as a hobby or career - in maintenance, air traffic control, military and engineering roles, as well as in the cockpit.

According to the Society of Women Engineers (SWE), a group that focuses on supporting women in engineering and technology, only about 13% of engineers are female. While that is higher than the percentage of women in commercial pilot roles (5%, according to the US Federal Aviation Administration), it is nowhere near the parity to which the industry aspires.

In the past decade, though, female interest in engineering and computer science majors at universities has risen, SWE says. But women still lag far behind their male peers when it comes to actually following such a career. In 2019, about 27% of men expressed interest in an engineering career, compared with 7% of women.

Among the types of engineering degrees awarded to women in 2018, aerospace engineering does not even make the top 10, SWE adds.

Even after the aerospace industry has spent decades



Safran is recognised by a UN scheme promoting gender equality

trying to alleviate the gender imbalance, it still struggles to find a winning formula.

“We haven’t been able to move the needle,” says Boeing’s Sarah Bowen, vice-president of global equity, diversity and inclusion.

### Structural challenges

WAI’s McKay cites serious structural challenges that remain difficult to solve.

Those include a meagre candidate pipeline, resulting partly from ill-equipped school career counsellors who do not effectively guide students towards pursuing engineering and aviation dreams.

After university, many women say they encounter an often-hostile corporate culture full of unconscious bias, gender stereotypes and sub-optimal leave policies. At these companies, commitments from top managers to improve the imbalance can often be lukewarm at best, and appropriate role models remain few and far between, McKay adds.

Major players Bell, Boeing, Gulfstream, Pratt & Whitney, Raytheon, France’s Safran, Singapore’s ST Engineering, and the United Arab Emirates’ Strata have all pledged improvements.

“There are lots of examples of industry actors making a concerted effort to really reach out to the underserved communities, to show that there is a great career path for them if they take interest in those engineering professions,” McKay says.

Savannah-based business jet maker Gulfstream says less than 20% of applications for engineering roles are submitted by women. “The biggest barrier we see is

getting women to apply,” says Vicky Britt, a member of the company’s diversity and inclusion council.

Engine-maker P&W says its outreach programme encourages employees to volunteer to bring STEM awareness and education to schools, partnering with educational groups such as FIRST Robotics and Girls Who Code. P&W has also partnered with Paradigm for Parity, a coalition of business leaders dedicated to addressing the corporate leadership gender gap, and has committed to gender parity in leadership positions by 2030.

Boeing’s female population is about 23%, roughly in line with the overall aerospace industry’s figure of 24%, Bowen says. But that industry-wide figure often skews toward non-technical and non-executive roles such as human resources, marketing and general administration. The actual percentage of female engineers is lower.

Bowen is refreshingly honest about issues the Chicago-based airframer and the industry overall face in addressing gender diversity.

“There are already fewer women in STEM than men. And the women that are in STEM tend to go into medicine, biology, bio-tech – those kinds of things, but not aerospace. When you look at the aerospace pool, it’s significantly lower than STEM generally. So that’s one issue – the pipeline challenge,” Bowen says.

Armed with a degree and once in the workforce, new problems arise for women. Retention of female engineers who want to make their way into top management is an industry-agnostic problem, but in aerospace it seems particularly acute.



Pilar Wolfsteller/FlightGlobal

It is crucial to foster interest at a young age

Of the small number of women who embark on STEM careers, 32% change degree programmes in college, SWE says. And only 30% of women who earn bachelor's degrees in engineering still work in that field 20 years later.

"Inclusivity is the root and diversity is the fruit," says Bell's deputy general counsel for global labour and employment, Danielle Needham. "If we nurture our female employees and our diverse employees, we create [an environment where they are] wanting to stay and wanting to do bigger and better things for Bell."

At Boeing, in the past year, 42% of internships went to women, as did 29% of promotions. Overall, 22% of new hires were women. But only 25% of board members and 14% of members on the company's executive council – a group that reports to the chief executive and has 22 members – are female.

"We know that leadership matters. We know that visibility and representation at those levels matter, and we want to get better," Bowen says. The tipping point, she adds, is about 30%. "That's when you start to see the benefits of gender diversity. Anything lower than that – the women's voices just get overwhelmed. But at 30% or more, you start to see those real benefits."

But she and peers at other aerospace companies say achieving that level industry-wide will take years.

Safran has been among Europe's gender-empowerment leaders, setting robust objectives for the recruitment and promotion of women.

### Recruitment growing

The company – a major player in aerostructures, defence systems, engines and landing gear – aims by 2023 for 41% of all recruits to be women, and for the proportion of senior managers who are female to be 16%, up from a current 13%. The management board of each Safran company is to have at least three women.

The proportion of female engineers Safran recruits annually has been growing steadily, from just under a quarter in 2018 to more than 30% in 2020.

Sceptics of recruiting targets and a fast-track for women to senior positions will point out that these initiatives have limited value unless more young women pursue engineering careers. To address that, Safran sponsors an organisation called "Elles Bougent", or "Women on the Move", which mentors female students and encourages girls to study engineering. Safran is the first aerospace company in Europe to be recognised by a UN scheme for promoting gender equality.

Bombardier has a goal for women to hold at least 30% of its board director seats and at least 25% of management positions. The airframer says that, as of the end of 2019, the board target had been met.

The perception of aviation being an "old boys' club", combined with inflexible policies that do not accommodate professional women's needs as they progress in their careers, can leave some female aviation workers frustrated and demoralised, even leading them to leave the industry, some women say. Outright harassment is not uncommon, they add.

Most firms say they are working to address these issues. Some have revised family leave strategies and guidelines, and established employee resource groups to support minority workers, helping them find allies and mentorship opportunities. Companies have also created internal training curricula that highlight the pitfalls of social stereotyping in decision-making.

Women and other minorities bring diversity of thought and action, they say, which benefits other employees and organisations.

"When it comes to leadership, I think there are a lot of qualities that we might consider typically female that actually work to our advantage," Gulfstream's Britt says. "The whole point is to have [diversity] so you don't take everything with a singular approach."

### Sisterhood

US defence contractor Raytheon says it has prioritised examining bias in everyday situations, such as in meetings and within performance reviews. Such issues have been flagged as needing urgent change.

"We are working to reframe thinking around what it means to be an effective leader," says Lexi Hernandez, senior director for talent development, diversity, equality and inclusion at Raytheon Missiles & Defense.

"Take, for instance, the tightrope bias. Women often find themselves balancing behaviours that historically have been considered too masculine or too feminine, each with their own negative connotations. These perceptions need to change," Hernandez says.

The tension of this "tightrope bias" – where women feel they must be more "masculine" to be taken seriously but also "feminine" to be liked – shows that corporate culture as it has existed for decades can feel hostile to ambitious women intent on moving up in the industry. It is also exhausting.

"I do think that these cultures have to shift so that women are seen as valuable, just like their male counterparts," McKay says. "We don't have to conform



Pratt & Whitney

Pratt & Whitney is one of several aviation companies to pledge improvements on the gender imbalance



Strata

Just over half of the 700 staff at UAE aerostructures firm Strata are female

to the male stereotype, and the programmes have to be put in place so that we can feel supported, while still trying to start a family or raise a family.”

As in any social group, minorities tend to look to each other for encouragement, counsel and guidance. “One of my favourite things at Bell is the sisterhood. It’s very strong. We support one another, we lift one another up and we want each other to succeed,” says Needham.

### Global progress

Progress is also happening in places where at first glance it may be unexpected. By the standards of cosmopolitan Dubai 150km away, Al Ain – a desert oasis city in the UAE – is a conservative place. A decade ago it was unusual to see an Emirati woman outside the home, other than with family, and even more rare for women to have independent careers.

That is why the significance of Strata, an Al Ain-based aerostructures firm set up in 2009 by Abu Dhabi wealth fund Mubadala, cannot be overstated. Just over half of Strata’s 700 staff are female – almost all of them UAE citizens. They include the majority of the production workers, but also engineers and managers. A majority of team leaders and supervisors are Emirati women.

Strata, which builds composite components for Airbus, Boeing and Pilatus aircraft in a modern factory beside Al Ain airport, has pursued an aggressive strategy of both “Emiratisation” – recruiting and training locals for jobs traditionally held by expats – and creating career paths for local women in the traditionally male-dominated society.

“A key measure of Strata’s success has been our ability to attract a skilled Emirati workforce,” Strata chief executive Ismail Ali Abdulla says. “Gender is irrelevant when it comes to ensuring Strata has the right people to support our growth.”

Lee Hui Fung, head of innovation and continuous improvement for commercial aerospace at ST Engineering, takes the sector to task on the gender equity question. But she says society as a whole must also shift to make female leaders more commonplace, rather than exceptions.

“While it is heartening to see the positive changes that have been taking place at the workplace and within the aviation industry generally, the road ahead in our journey to achieve greater gender diversity is still long,” she says. “Gender diversity not only has to be promoted at the workplace – it has to start with the family, school and society as a whole. The current family support system has yet to reach a stage that allows women to work without disruption and progress smoothly in their career.”

Government programmes in Singapore, she adds, have provided additional support. But meaningful systemic change is always hard, especially in large organisations with long histories and deep traditions.

“Boeing [has] been around for more than 100 years. That’s more than 100 years of a culture being shaped by the majority, and the majority has been largely male and largely white,” Bowen says. “Anytime you get a group that so dominates a culture, it can start to become narrower than what is possible.”

She looks forward to a time when women truly see themselves as central to the company’s culture, products, vision, mission and leadership. “I don’t think we are there yet as an industry, and I don’t think we are there yet as a company,” Bowen says. ▶

*Additional reporting by Alfred Chua, Jon Hemmerdinger, Murdo Morrison and Garrett Reim.*

Visit [FlightGlobal.com](https://www.flightglobal.com) for more from our interview with Women in Aviation International chief executive Allison McKay.



Airbus

Air France's Anne Rigail is one of only three female chief executives among the world's top 100 airlines

**Lewis Harper** London

The world's largest passenger airlines are employing more women in top executive roles – albeit on a trend that means it would still be the mid-2050s before half of such positions had female incumbents, FlightGlobal's latest survey shows.

Some 14% of the roles surveyed across the top 100 airlines had female incumbents in October 2020 – continuing the one-percentage-point increases seen in each of the past three surveys.

The year-on-year increase in 2020, however, marks the largest rise in women employed across the six roles in absolute and percentage terms since FlightGlobal began tracking trends in 2017. There were 85 female incumbents working in the 600 surveyed positions in 2020, compared with 76 in 2019 – an increase of 12%, versus rises of 5.5% (four women) in 2019 and 11% (seven women) in 2018.

Overall, the survey – of carriers and groups that feature in FlightGlobal's top 100 World Airline Rankings by 2019 revenue passenger kilometres – continues to show the sector lagging trends in the wider economy.

It also shows that women are still rarely appointed to the chief executive role at carriers, with just three of the top 100 having a female incumbent in that role – a drop from four in 2019.

Across the six surveyed positions, only four of the top 100 carriers had a 50:50 female-male split, with no operators having women in a majority of the roles.

That reflects mixed progress from an industry that went into the coronavirus crisis having identified a better gender mix in C-suites as a priority. Indeed, European commissioner for transport Adina Valean said in October that the coronavirus crisis is an opportunity for the sector to address the “poor” gender imbalance among workers.

**Right objective**

Speaking at the International Aviation Women's Association annual conference, Valean noted that “gender balance is not an objective in itself”.

Rather, she points to recent research showing that “a lack of diversity in the workplace leads to other problems such as harassment, bullying or depression”, while more gender balanced workplaces provide “major benefits to society, the economy, the environment, and the companies themselves, enabling them to perform better”.

That is crucial, because “we need, more than ever, as many brilliant minds around the table as possible”,

12%

Year-on-year increase, from 2019 to 2020, in women employed by airlines in executive roles



More women are working in the top jobs at airlines, but the pace of change is slow in what continues to be a male-dominated industry. Our exclusive survey looks at the recent trends

# Closing the C-suite gap



Jayne Hrdlicka recently took the top job at Virgin Australia

Valean states, in reference to the air transport sector's current predicament.

In encouraging signs, the survey marks the first time that a region - North America - exceeded 25% of senior executive roles taken by women.

This indicates genuine progress towards meeting the goals of IATA's 25by2025 initiative - one of the industry's most high-profile efforts to increase female representation at the top of airlines.

Launched in 2019, the IATA initiative aims to encourage its airline members to sign up to a commitment to increase the number of women in senior leadership positions and under-represented areas by 25% - or to a minimum of 25% - by 2025.

Speaking during a panel discussion at an FIA Connect event in July last year, Adefunke Adeyemi, IATA's regional director of advocacy and strategic relations for Africa, pointed towards the 25by2025 scheme as a sign of "moving the needle" in gender representation at the executive level within airlines.

## Unconscious bias

"[This] is not a sort of 'playing the gender card' kind of metric for us. Not at all. It's actually designed to address... two problems: unconscious bias, as well as the tendency of women themselves not to lean in," Adeyemi said.

Of the 600 senior executive roles surveyed in October 2020 - covering chief executive, chief financial officer, chief operating officer, chief commercial officer, chief information officer and HR director, or their equivalents - some 85 were taken by women. This compares with 76 in 2019, 72 in 2018, and 65 in 2017.

The HR director position continues to be occupied by the most female incumbents, at 37. That is followed by the chief financial officer position with 15, chief commercial officer and chief information officer with 13 each, chief operating officer with four, and chief executive with three.

】 The year-on-year increases in 2020 comprise one more female chief financial officer, a single extra female chief operating officer, three more women in the chief information officer role, and five more in the HR director role. The number of female chief commercial officers was flat, while women in the chief executive role fell by one.

Removing the HR director position from the survey continues to paint a bleaker picture in terms of gender diversity, but also one that has been on a trend of marginal improvement since 2017. Of the 500 roles remaining when the HR director position is removed from the survey, some 48, or 10%, were held by women, compared with 44, or 9%, in 2019; 36, or 7%, in 2018; and 32, or 6%, in 2017.

Splitting the results by business models shows network carriers lagging others in terms of women in the C-suite, with the gap widening by a single percentage point year on year.

Across the 64 network carriers in the top 100, 13% of C-suite roles were taken by women.

Across the remaining 36 operators – the vast majority low-cost carriers, alongside a few leisure airlines – women took 16% of executive roles.

Split by business model and job role, the only outlier from a broadly harmonious trend was the chief operating officer role, with three of the four female incumbents across the top 100 airlines working in the low-cost/leisure sector.

# 48

Number of executive roles held by women out of 500 when the HR director position is factored out

Only three chief executives at the top 100 airlines are women: Air France’s Anne Rigail, Air Europa’s Maria Jose Hidalgo, and VietJet Air’s Nguyen Thi Phuong Thao. In 2019, the total was one higher, thanks to Zuks Ramasia’s time as acting chief executive at South African Airways (SAA).

Since then, Ramasia has left SAA, and the ailing airline has in any case dropped out of the top 100 carriers by traffic.

Following the deadline for consideration in the survey, Virgin Australia announced Jayne Hrdlicka, the former head of Jetstar Group, as the airline’s new chief executive.

Outside the top 100 carriers there are other female leaders, including RwandAir’s Yvonne Makolo, Wingo’s Carolina Cortizo, Blue Air’s Oana Petrescu, Transavia France’s Nathalie Stubler and Indonesia AirAsia’s Veranita Yosephine Sinaga.

Speaking to FlightGlobal in September last year, Makolo acknowledged that although the sector has taken steps to address the imbalance, “a lot more work needs to be done to really bring more women into the industry”.

“There is a gap, definitely, and I don’t think I should stand out as a woman in aviation. It should be the norm – more than ‘there’s the one woman CEO’.

“The good thing is, everybody recognises that there is an issue there, and IATA is addressing it and different organisations are addressing it, so I look forward to seeing more women in the aviation industry at leadership positions.”

Across the rest of the C-suite there were a number of notable appointments in the 12 months between our reviews. Among them, Vanessa Hudson became Qantas Group chief financial officer in October 2019.

Shilpa Bhatia became chief commercial officer at SpiceJet in February 2020, and Charlotte Svensson took up the chief information officer role at European carrier SAS in the same month.

### Network remit

At Iberia, Maria Jesus Lopez Solas became commercial, network development and alliances director in September, and Leanne Geraghty was appointed as Air New Zealand’s chief customer and sales officer in October.

North America is again significantly ahead of other regions in terms of women in the C-suite, with some 29% of surveyed roles taken by women across the 14 carriers in the top 100 – although more than half of them were in the HR director position, with a female incumbent in that role at 10 of the 14 carriers surveyed.

In Air Canada, North America also contains one of the few airlines that had female incumbents in 50% of the roles surveyed.

AirAsia Group, Air New Zealand and TUI Group were the only other carriers in the top 100 to achieve that 50:50 split, with no operators having more women than



Mark Farwell

VietJet Air’s Nguyen Thi Phuong took her budget airline public in February 2017



Adefunke Adeyemi is IATA's regional director of advocacy and strategic relations for Africa

# 29%

Women in the C-suite for North American carriers – currently the best gender balance in any region

men in the six roles. This marks a minor uptick from the 2019 survey, when three carriers had a 50:50 split.

On a regional level, Asia-Pacific – across 36 carriers in the top 100 – and Europe – 32 carriers – both saw upticks in female representation year on year, at 15% and 18% female incumbents respectively.

Across the Middle East, four women were in C-suite roles across the seven surveyed airlines. In Latin America, a trend of slight year-on-year improvement in gender balance was reversed across the nine airlines in the top 100.

The relatively small number of African carriers – two in the top 100 – means year-on-year comparisons are difficult, but it is worth noting that the region has seen a relatively high proportion of women in senior roles among its smaller carriers.

Meanwhile, FlightGlobal's survey shows that the airline industry continues to lag the wider economy in terms of women in C-suite roles. Data released in September by non-profit organisation Catalyst – which works to build workplaces “that work for women”

– shows some 32 chief executives among S&P 500 companies were women, based on the December 2019 S&P 500 list. That translates to 6.4%, versus just 3% across the top 100 airlines.

Airlines also trail FTSE100 firms. Data from financial services company IG shows in a report released in 2020 that 5% of FTSE 100 chief executives were women.

### Finance short

Across other roles in the C-suite, the airline industry is also behind wider trends. Grant Thornton's Women in Business 2020 report – which surveys thousands of mid-sized firms across different industries – shows, for example, that some 30% of chief financial officers were women, versus 15% at the top airlines.

Airlines also trail the wider economy in the chief operating officer role – 4% versus 18% – the chief information officer role – 13% versus 16% – and the chief people officer position – 37% versus 40%. ▶

*FlightGlobal's survey of gender diversity in the top 100 airlines is based on publicly available data. The primary sources are company websites, financial reports and FlightGlobal data. Research was undertaken through to early October 2020. Given the fluid nature of employment, the survey can only give an indicative snapshot of the industry. The 100 airlines and groups surveyed are drawn from FlightGlobal's 2020 ranking of carriers by full-year 2019 revenue passenger kilometres. Similar roles of equivalent seniority are considered where the specified job titles are not used.*

Despite the current business slowdown, civil helicopter manufacturers continue to refine their ranges, adding new products and capabilities, from the lightest to the heaviest rotorcraft



# Spoilt for choice

**Dominic Perry** London

**W**hile it is arguably the most competitive part of the helicopter market, the light-single segment is not necessarily blessed with the most modern designs.

The biggest seller is Airbus Helicopters' H125, which dates back to 1975 and the Aerospatiale era – reflected by its original AS350 designation. The design has been through numerous iterations since that time, however, with the latest tweaks unveiled by the manufacturer aimed specifically at the utility work segment.

At the heart of the upgrade is a power increase for the H125's Safran Helicopter Engines Arriel 2D turboshaft, with maximum output rising to 952shp (710kW), from 847shp. This in turn boosts maximum external load to 1,140kg (2,150lb): a 140kg increase from the current limit, while the type's hover ceiling rises by 1,490ft, to 12,640ft. However, if BLR Aerospace's FastFin modification is also fitted, these increases grow

to 190kg and 2,300ft, respectively. Approval for the changes is still awaited.

Airbus Helicopters additionally competes in this segment with the H130, although sales are more usually to corporate or VIP customers.

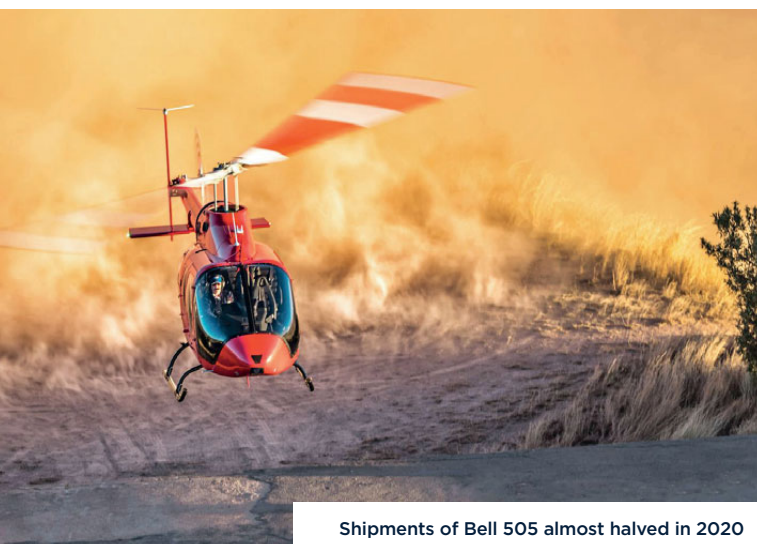
Although sales of both models were weak in 2020, falling respectively by 21% and 42% year on year, the manufacturer is laying the foundation for future upgrades – and low-carbon operations. Using an H130 as a flying testbed, which it calls the Flightlab, the company is already evaluating a number of new technologies, including a battery-based system that provides emergency back-up power in case of engine failure.

In the nearer term, though, the H125 is likely to face competition from a new arrival, the Kopter SH09 – the only new helicopter to land in this part of the market for decades. Previously a standalone company, the Swiss manufacturer was last year acquired by Leonardo Helicopters, which has added the 2.65t maximum take-off weight (MTOW) SH09 to its product portfolio.



Over 1,100 AW139s have been delivered since 2003 service entry

Leonardo Helicopters



Shipments of Bell 505 almost halved in 2020

Bell

# 140kg

Increase in useful load on H125 from raised power limit on Arriel 2D engine

While the gestation period of the Honeywell HTS900-powered rotorcraft has been slowed – service entry now looks to be 2022 or 2023 – the considerable financial and industrial heft of its new owner should make the SH09 a more certain prospect.

The acquisition has also obviated Leonardo from the need to develop an in-house successor to its AW119Kx. While this model continues to sell, and has benefited from obtaining instrument flight rules (IFR) certification in the USA, the company would be the first to admit that its strength sits further up the weight range.

A portfolio bias towards heavier machines is also the case with Russian Helicopters. However, the company is looking to change this with the development of the VR Technologies VRT500 light-single, which features a 1.6t MTOW and is powered by a Pratt & Whitney Canada (P&WC) PW207V engine.

The most recent schedule sets certification for late 2022, but there has been no news so far on a first flight, potentially putting that timeline in doubt. Similarly, a 2019 agreement for Tawazun Economic Council of the United Arab Emirates to take a 50% stake in VR Technologies does not yet appear to have concluded.

At the lighter end of the segment is the Bell 505 Jet Ranger X. A consistent success for the US manufacturer since its service entry in 2017, the 1.6t 505 is powered by a single Safran Arriel 2R engine and boasts an impressive cruise speed of 125kt (231km/h) and 306nm (566km) range. Although 2020 deliveries were hit by the coronavirus pandemic as owner-fliers reined in discretionary spending – falling to 49 from 101 the year before – Bell has continued to evolve the helicopter, last year adding the Garmin G1000 NXi avionics suite.

Bell also produces the 407 light-single, with the 2.26t type currently produced as the GXi variant.

With a 1.25t MTOW, Robinson's R66 is the lightest helicopter in the category. The California-based company also passed a significant milestone in 2020, handing over its 1,000th example a little under 10 years after shipments of the Rolls-Royce M300-powered model began in late 2010. The in-service fleet has accumulated over 1.2 million flight hours.

Elsewhere in the USA, MD Helicopters has announced certification for an MTOW increase on its MD530F, rising to 1,500kg from 1,400kg previously. Upgrade kits for the R-R M250-C30-powered type are available for existing operators.

Lastly, there is a potential new entrant to the segment: UK-based start-up Hill Helicopters, which is intending to develop a 1.6t MTOW rotorcraft with an 800kg useful load. Powered by an in-house GT50 500shp engine, first flight of the five-person helicopter is due in 2022, with deliveries to begin the following year. Production facilities will be sized to support output of up to 500 aircraft per year.

### Twin peaks

Airbus Helicopters' German civil production is devoted to two models in the light-twin segment, both of which continue to sell strongly. The smaller of these is the H135, which in November 2020 passed the 1,400th delivery mark with a handover to French operator Mont Blanc.

Since its introduction in 1996, the H135 has been through numerous iterations, with the latest standard including the manufacturer's Helionix avionics suite and a four-axis autopilot. It holds an impressive 25% share of the emergency medical services (EMS) market, in which almost 650 examples are operated.

This year, the H135 became available as either 2,980kg MTOW or 3,100kg alternate gross weight

# 1,400

Deliveries of Airbus Helicopters' H135 as of November 2020, after handover to Mont Blanc

variants. Endurance has also increased by 40min, and range by 75nm. Power on the light-twin comes from either the Arrius 2B2plus or P&WC PW206B3. Although the majority of H135s are built in Germany, assembly is also taking place in Qingdao, China.

But the manufacturer's success story at the moment is arguably the H145, which has had consistently strong orders; sales of the 3.8t platform fell by just seven units in 2020, to 84. Last year it gained a further edge with the service entry of the D3 variant, which features a five-bladed main rotor. European approval of the modification was obtained in June, followed in September by the first delivery and in late November by US certification. The additional rotor blade, and changes elsewhere, lift useful load by 150kg.

Leonardo's presence in the segment is confined to the AW109, which is available with wheeled landing gear as the GrandNew, or equipped with skids in its Trekker guise. The latter variant scored its first win in the USA in 2020 with a contract from Life Link III, an EMS operator in the upper-Midwest, covering Minnesota and Wisconsin. In addition, the type also had its first success in France, securing a contract to serve Rouen hospital in Normandy. To date, around 70 examples have been sold.

Powered by the same PW207C engines, and equipped with a Genesys Aerosystems glass cockpit, the GrandNew and Trekker are largely identical, with the performance difference confined to a 25kg lower MTOW for the latter.

Bell competes in the light-twin market with the 429, which is powered by PW207D1 engines, each rated

at 600shp at take-off power. While there have been few recent developments to the basic helicopter, Bell has been testing a new tail rotor architecture on a 429 prototype.

The Electrically Distributed Anti-Torque (EDAT) system – which comprises four electrically powered fans in the tail – has been trialled at the company's Mirabel plant in Quebec, Canada. The EDAT stops moving once the aircraft is on the ground, reducing danger to bystanders, says Bell. It also costs less to operate, has fewer mechanical components and is significantly quieter. The manufacturer is currently working on optimising the system, but cautions on any service-entry timeline.

Russian Helicopters is beginning to see success with the Kazan Ansat light-twin. At the tail-end of December 2020, the manufacturer flew the first example of the upgraded Ansat-M, which boasts enhanced range and flight performance.

Under an initiative funded by Russia's trade ministry, which has provided Rb230 million (\$3.1 million) for the



Russian Helicopters

Kazan Ansat-M made its first flight in December 2020

work, the longer-range helicopters will be delivered to regional airlines. An extra fuel tank lifts range to 431nm, from 272nm. Changes have also been made to the size and positioning of the tail's stabiliser end plates, which has improved stability, says the manufacturer.

New, more aerodynamic main and tail rotor blades are also being developed, in order to enhance manoeuvrability and reduce noise in the cabin. Avionics have also been upgraded, allowing flights in IFR conditions. Later this year, the helicopter will also gain a three-axis autopilot and new anti-icing system. Powered by PW207K engines, the Ansat boasts a MTOW of 3.6t. However, Russia's United Engine is developing a domestic replacement – the 650shp VK-650V – with certification due in 2023.

Also in the same segment is the Kamov Ka-226T. Powered by Arrius 2G1s and using a coaxial rotor system, the utility rotorcraft has a 3.6t MTOW. The VK-650V also will in the future be an option.



Airbus Helicopters

European approval for H160 was gained in July 2020

## Medium-twin rivals

Leonardo offers two medium-twin products: the AW169 and AW139, which have respective MTOW figures of 4.8t and 7t. Having made its debut in 2015 there has been little change to the AW169 since, save for a 300kg increase over its original MTOW.

However, in January 2020 the manufacturer announced the addition of two performance packages for the AW169 that will increase engine power, transmission rating and available payload. Called 'Enhanced' and 'Superior', the packages rely on software updates and minor aerodynamic changes. European approval is expected early this year, and the modifications will be available as line- and retrofit options, says the manufacturer.

Available payload increases by 200-350kg, depending on the phase of flight and external conditions. Output increases by around 144shp on each 1,000shp P&WC PW210A engine.

Meanwhile, the AW139 continues to roll relentlessly on. Having passed the 1,000th delivery milestone in 2019, Leonardo has little need to change what remains a highly popular and mature platform.

However, in July 2020, the European Union Aviation Safety Agency announced the certification of a Phase 8 software update for the AW139's Honeywell Primus Epic avionics suite, and for the enhanced ground proximity warning system optional kit available on offshore modes. Updates contained in Phase 8 include an advanced synthetic vision system specifically tailored for helicopter applications, improved 2D maps and wireless data loading. Leonardo has logged more than 1,200 orders for the P&WC PT6-powered helicopter.

Over at Airbus Helicopters, the H160, its big challenger to the AW139, has taken a significant step forward. European approval for the 6.1t twin was obtained in July 2020 after a development lasting five years – around two years longer than originally planned. However, first delivery of the Safran Arrano-1A-powered H160 to its USA-based launch customer will have to wait until US certification is achieved in early 2021.

Although 2020 orders were flat year on year, the manufacturer expects more sales to emerge this year – notably from the French government, which should sign for 10 examples to equip the Gendarmerie Nationale, plus a contract for an eventual 169 units for the country's armed forces.

Bell's long-running 412 is its contribution to the medium weight category. Although the programme has been around since the late 1970s, the helicopter is now being produced in the newest EPI and EPX standards. The former is a Bell-only effort, while the latter also sees the involvement of Japanese manufacturer Subaru as part of an offset deal with Tokyo for 150 military transports.

Both offer broadly similar performance levels – capacity for 14 passengers, speed of around 125kt, and 365nm range – but the EPX additionally boasts a number of modifications. These include an enhanced main gearbox which features a longer run-dry capability, internal maximum gross weight that rises to 5,530kg and external gross weight to 5,900kg, from a uniform figure of 5,400kg on the EPI.

Engines are a pair of FADEC-equipped PT6T-9s, which deliver a 15% increase in hot-and-high take-off power. Launch customer for the Subaru-built examples is Japan's national police force.

Russian Helicopters, meanwhile, continues to make glacially slow progress with its Ka-62. In development since the early 2010s, the 6.5t twin is still inching its way toward certification. Prior to the Covid-19 pandemic, Russian Helicopters had hoped to complete certification flights in 2020 using a three-strong fleet. However, little has been heard on its evaluation efforts.

The manufacturer had intended to conduct 480 flights between design bureau Kamov and airframer Progress Arsenyev Aviation Company. Progress is also being made towards serial production of the Ka-62.

Kamov additionally builds the 5t-class Ka-32, which features its traditional co-axial rotor system. It is also the only model in Russian Helicopters' line-up to have gained European certification – largely due to its popularity for aerial fire-fighting missions.



Baseline version of AW189 is powered by twin GE Aviation CT7 engines

## » Super-medium wait

A few years ago there were many forecasts that new super-medium-class helicopters would sell strongly. This has not quite come to pass, with continued weakness in the oil and gas market dampening demand; for example, in 2020 Airbus Helicopters sold no H175s, having only sold four the year before.

The airframer says it remains “optimistic” on the 8t type’s future, and is working on upgrades including a new de-icing system. The PT6-67E-powered type has found particular favour with Belgian operator NHV, which operates 13 examples, largely in the North Sea region. In 2020, NHV’s fleet passed 40,000 flight hours – more than 60% of the overall H175 fleet’s total.

Other notable offshore operators including Babcock and CHC also count the H175 in their fleets. The type has also found some success in VIP and search and rescue (SAR) roles, in the latter case having been selected by the Rescue and Salvage Bureau of China’s transport ministry for an initial two-unit requirement. That adds to the seven H175s already operated by Hong Kong’s Government Flying Service for SAR missions.

Leonardo’s super-medium offering is the AW189. The 8t-class type comes in two variants: a baseline version powered by twin GE Aviation CT7 engines, and the Safran Aneto-equipped K-model. The 2,500shp-rated Aneto-1K offers around 25% more power than the CT7 and boosts performance in hot and high conditions.

Leonardo in January 2020 secured its first contract for the variant, with Qatar-based Gulf Helicopters revealed as the launch customer; deliveries are due to start in mid-2021.

European approval for the Aneto-engined model was gained last June. Type certification documentation shows the AW189K can operate at up to 15,000ft, some 5,000ft higher than the baseline GE-engined version. However, GE-powered helicopters with a new Phase 5 avionics release can also operate to the higher altitude. MTOW for both variants sits at 8.6t.

The third contender in the trinity of super-mediums is the Bell 525, which remains in development. Heavier than its rivals, the 525 offers a 9.3t MTOW and can carry 16 passengers and two crew for 580nm at a speed of 160kt.

Bell describes the type as the “world’s most advanced commercial helicopter” – largely driven by its application of fly-by-wire (FBW) controls. Assuming it beats Leonardo’s AW609 civil tiltrotor to certification, the 525 will in fact be the very first civil rotorcraft to incorporate a FBW system.

However, uncertainty remains as to when the 525 will gain regulatory approval. Bell has been reluctant to disclose a revised date after missing previous deadlines, but in September 2020 did indicate that it was in the final stages of certification testing; the first four production helicopters are also in final assembly. Power for the 525 comes from CT7 engines.

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### Bigger beasts

Formerly a leading light of the heavy-twin segment, Airbus Helicopters' Super Puma family is slowly forging a future beyond its former core oil and gas market, as the H225 is likely to remain locked out of that segment for the foreseeable future.

The manufacturer is confident it has solved the safety problem related to the H225's gearbox – the cause of a fatal crash in 2017 – but the helicopter would have a significant reputational hurdle to overcome were it to be re-introduced for offshore transportation.

Equally, the ongoing weakness in the oil and gas market has meant that operators in that sector have not required the additional capacity the Super Puma would provide. With this market effectively closed off, Airbus Helicopters has instead been forced to cultivate alternative sales prospects for the type. While there have been a number of successes for the military variant, it has also gained traction with the H225 for SAR and disaster recovery operations.

Additionally, the airframer's repurposing of ex-oil and gas-roled assets to utility helicopters continues as it works through a large amount of stored inventory: at



Cougar is launch customer for enhanced S-92A+

the last count, 75% of those helicopters had found new homes. The Super Puma family currently comprises two models: the 11t H225 and the 8.6t H215; both are powered by variants of the Safran Makila turboshaft.

The great beneficiary of the H225's absence from the oil and gas market has been the Sikorsky S-92. Although this dominance has not translated into a sales increase – the sector is sufficiently depressed that no additional capacity has been required – what it has meant is an increased focus on the performance that the CT7-powered twin can offer.

With a MTOW of 12,000kg, the S-92 can carry a full load of 19 passengers in its offshore guise. However, that 12t figure can be increased to 12,250kg with the US manufacturer's S-92A+ upgrade kit, which also includes a new main gearbox with increased run-dry capability.

Sikorsky has secured a launch order for the A+ modification kit, with Canada's VIH Aviation Group signing a four-unit agreement for the fleet of its operating business Cougar Helicopters.

In addition to the upgrade kit, Sikorsky is also incorporating the modifications into new-build S-92 helicopters as the B-model variant. In addition to the MTOW increase and new gearbox, the more powerful CT7-8A6 engine is also available, alongside avionics improvements. Sikorsky anticipates the S-92A+ kit will be delivered by 2023 and the S-92B helicopter in 2025.

Russian Helicopters, meanwhile, has quietly launched a new variant of its long-running Mil Mi-171 heavy-twin aimed squarely at the offshore oil and gas market. However, key details remain vague: aside from a handful of characteristics such as MTOW and range, the manufacturer has so far stayed silent on much of the Mi-171A3's specification and any differences over the current A2 model.

Indeed, the airframer says that digital renderings released by parent company Rostec do not entirely reflect the final configuration of the helicopter. But there are some clear changes over the A2: although MTOW remains at 13t, range increases by 108nm, to 540nm, and passenger capacity rises from 20 to 24. In addition, the helicopter will be fully compliant with international oil and gas transport standards.

Automation has also been added, including for take-offs and landings. However, the identity of the type's engine and avionics suppliers have not been released; twin Klimov VK-2500PS-03s power the current variant.

Production of an initial prototype is already under way, says the manufacturer, with work on the A3 design having commenced in 2018. First flight is set for 2021 – likely ahead of an appearance at the MAKS air show in Moscow in July, to be followed by service entry in 2022.

### Grist to the Mil

Topping the Russian Helicopters range (excluding the giant Mi-26), the Mi-38 has a 15.6t MTOW. A first serial example was handed over in March 2020, with the heavy-twin to be used for VIP transport missions by Moscow-based operator Russian Helicopter Systems.

Russian Helicopters forecasts a civil market for 100 examples of the Mi-38 in the period to 2030. Although the company displayed a VIP-roled example at MAKS and the Dubai air show in 2019, it is also promoting the type for offshore and utility transport missions.

Russian certification of the Mi-38, which is powered by Klimov TV7-117V engines, was obtained in December 2015. Prior to the March delivery previous examples had gone to the Russian air force.

Development of Leonardo's AW609 continues, although the Covid-19 pandemic has not helped the manufacturer hasten certification. Service entry is now anticipated in 2022, with the merged Bristow/Era Group still in line to take the lead example of the PT6A-powered aircraft for EMS operations.

Production of the first two serial AW609s is under way at the manufacturer's Philadelphia site in the USA, with the Federal Aviation Administration the lead regulator for the programme. Leonardo is hoping that the vertical take-off and landing performance of the tiltrotor, combined with its speed, range and ability to fly at up to 25,000ft, will tempt buyers from a variety of segments.

Indeed, the Tokyo Metropolitan Government in 2020 began evaluating the performance of the 8t-class aircraft to improve connections with Ogasawara island, more than 540nm away from the Japanese capital. ■

## Moon monikers

NASA famously named its Space Shuttle test orbiter 'Enterprise' in honour of the television show *Star Trek*, so surely there's an opportunity for a similar homage via the Artemis programme to return to the Moon?

Fans of the science-fiction series *Space: 1999* will recall the exploits of castaways on a lunar outpost after the Moon is blasted out of orbit by a far-side nuclear explosion – although best you don't think too hard about the Newtonian physics of that – which featured rocket craft called 'Eagles', echoing the Eagle lander that took Apollo 11 astronauts to the Moon's surface.

NASA wants to set up the first lunar colony (unstable nuclear waste dump probably not included), which is just begging for the name 'Moonbase Alpha'. And if that's not enough of a hint, the colonisation mission in *Space: 1999* was funded by an organisation called ILFC – the International Lunar Finance Commission.

We are not trying to dictate NASA policy here, but since the sale of the aircraft leasing firm ILFC to AerCap, the Internet domain name 'ilfc.com' has been for sale for a sum which will hardly break the Artemis budget. "Eagle One to Moonbase Alpha" – how cool would that sound? What on Earth are you waiting for?



Crown Copyright

Crowds will hopefully enjoy sights such as the Lockheed Martin F-35B at RAF Fairford next summer



Embraer

## Salute to Silva

The life of Ozires Silva (*left*) – regarded as the father of Embraer and a legend of Brazil's aerospace industry – has been celebrated in a short animated film marking his 90th birthday.

*O Voo do Impossível* – or *Flight of the Impossible* – is a 14min video that tracks Silva's life from schooldays through his career as a military pilot and aeronautic engineer with the country's air force, where his dream of designing a home-grown aircraft culminated with the launch of the Bandeirante and the formation of Embraer in 1969.

It is available on Embraer's social media channels.

From the archive

# 100

### 1921 Jacuzzi monoplane

An interesting American commercial 'plane has been constructed by Jacuzzi Bros, of Berkeley, California, in which are incorporated several novel features. It is a monoplane having externally braced wings of a comparatively thin section, giving a high maximum L/D at low angles of incidence and high speed. The chord of the wings tapers considerably from root to tip, which enables a uniform wing section to be employed throughout, and at the same time giving a deeper section at the root. The wings are of wood construction, fabric covered, and are attached, high up on the fuselage, to a "centre section" which forms the roof of the cabin. They are braced by a streamline sectioned strut under each wing, there being no top bracing.

# 75

### 1946 The Atlantic Gap

The news that the B.O.A.C. transatlantic flying boat service from Poole to Bermuda via West Africa and South America makes its last run today will be by no means unexpected. The discontinuance of this service was bound to come soon, for, although the three Boeings, which have been in constant use since 1941, have given excellent service, they could not be expected to go on for ever. The service has always been something of a stop-gap, but, in spite of this, one weekly transatlantic flight has been made in each direction during the winter months, and four flights in each direction throughout the summer each year. The wear and tear on these machines must have been considerable, and praise is due to B.O.A.C. for having maintained such a schedule with these resources.



## Permanent Tattoo

This year marks a full half-century since a band of enthusiasts organised the inaugural Air Tattoo gathering, at North Weald airfield in Essex. Supported by the UK Royal Air Force, the 1971 event also attracted flying contributions from Austria, Denmark, France, the Netherlands and Norway.

To mark its Golden Jubilee, the Royal Air Force Charitable Trust Enterprises has published *Air Tattoo 50 - The Story of the World's Greatest Airshow*, which looks back at its evolution into one of the main highlights of the aviation calendar.

Authored by Ben Dunnell, the book takes a year-by-year look at the aircraft and participants that gave the show so many unforgettable moments.

Sadly, the coronavirus pandemic has led to the planned 16-18 July show's cancellation for the second year running. We have everything crossed that a safe and successful celebration can take place in 2022.

To order your copy - priced £30, plus postage - visit [airtattoo50book.com](http://airtattoo50book.com)



## Hugh Field

Hugh Field, who has died at the age of 91, was assistant, then associate, editor of *Flight International* from 1969 to 1979, during which time he substantially improved the magazine's general aviation coverage.

Having begun his career at aero-engine maker D Napier and Sons in 1945, he joined the UK Royal Air Force in 1950 and was fast-tracked into instructing on the Gloster Meteor. He graduated from the Empire Test Pilots' School in 1956, and later while at the RAF Flight Safety Directorate began writing on air safety for its training magazine *Air Clues* - perfect grounding for his time on *Flight*.

Field left the RAF in 1967 to work for CSE Aviation, where he was involved in Handley Page Jetstream sales and assisted in the certification of the original Learjet. After his term on *Flight*, he joined the ill-fated Cranfield Airline College, but quickly ended up in the public affairs department at British Aerospace Hatfield, promoting the BAe 146.

After retiring from BAe in 1991 he carried on writing and in consulting work - his last article, on flying the 1950s prone-pilot Meteor, was recently published in *Aeroplane*. He was Master of the Guild of Air Pilots and Air Navigators in 1980-1981, and flew more than 200 different aircraft types, from the vintage machines of the Shuttleworth Collection to fast jets such as the BAe Harrier, Sepecat Jaguar and Saab Viggen.

## 1971 Israel's air authority

Whatever the peace settlement which may be negotiated in the Middle East, it looks as though Israel is prepared to maintain an armed airborne surveillance over the area from which her forces may be withdrawn - the Sinai desert to the east of the Suez Canal. Reconnaissance over this area, to interpret any possible Egyptian moves, will form a main role for the F-4 Phantoms which Israel is getting from the United States. So far, Israel has received 63 F-4s and 12 more are due to be delivered by May, making a total of 75 - the original 50 provided under President Johnson's administration plus the 25 supplied since. Israel's air strength is also likely to be improved by locally modified Mirages, fitted with General Electric J79 engines.

## 1996 Battle of the giants

Boeing's growing family of large widebodies will be in competition with the Airbus A3XX in a market which could be worth as much as \$254 billion over the next 20 years, according to the US manufacturer's latest long-term forecasts. Boeing's 1996 Current Market Outlook divides aircraft with more than 400 seats as a separate category for the first time. To date, that includes only the 747-400 and 777-300, but they are due to be joined by the stretched 747-600X and longer-range 747-500X before the end of the century, as well as by the A3XX, if Airbus opts to launch the programme. Looking through to the year 2015, Boeing estimates that this market could total 1,588 aircraft, with the emphasis clearly on sales in the fast-growing Asia-Pacific market.

## Stick to the facts

In the 'Accidents and incidents' section of your annual airline safety report (*Flight International*, February 2021), there seemed to me to be a thread of sensationalism creeping in to your reporting – rather than being simply factual, as your learned readership has come to expect in the past.

The UK Air Accidents Investigation Branch (AAIB), as I'm sure you know, has been very succinct with its reporting, and long ago set the bar for the tone of these kinds of reports. Its sterile and succinct wording, pertinent to the cause, is non-judgemental nor sensationalist by design.

For me, some examples from your report (see below) conjured up a vision of rather puerile *Air Crash Investigation* type programmes on television.

"The pilot was able to escape from the aircraft and climb on to a part of the fuselage that remained above the water."

"The pilot steered to avoid the hangar, but the aircraft only came to a halt when the left outboard engine hit a tug."

"Ethiopian soldiers mistakenly believed the plane was on a

potential suicide mission as they had not been informed of the flight and the aircraft was flying low."

"The man who was killed was subsequently reported to be 'a homeless person known to police'."

"They selected the gear down but nothing happened."

"The fire and rescue crew could not attend the damaged aircraft because their crash rescue vehicle had flat tyres."

Come on, *Flight* – we are experts here – just give us the salient facts and spare us the needless hype.

**Tim Procter**  
via email

**Editor's reply:** We appreciate the feedback, but are not attempting to replicate how the AAIB covers such events; we are a magazine, not an investigative or safety body. We strongly believe that all the examples you cite were statements of fact, and free from sensationalism. We have to be selective in our listings, due to space constraints, but always strive to impart a clear picture of what happened. Meanwhile, we hope that our new monthly layout and larger typeset made the listings easier to read than in our old weekly format.

## Para memories

With reference to Ian Goold's recollections of the Blackburn Beverley (*Flight International*, February 2021), I was a serving member of the Parachute Regiment when the type replaced the Handley Page Hastings.

The Beverley was the first British-built aircraft specifically designed to drop parachute troops and their support equipment. The cargo bay was cavernous, and could easily absorb more than 90 fully equipped troops who jumped from two doors at the rear of the plane.

It could carry a further 40 troops in the tail boom upstairs, who left through a hole in the floor. It was possible for all three exits to be used simultaneously.

Interestingly, on the flight to the drop zone, you and the load you were carrying were restrained not by the usual seat belt, but by an individual cargo net.

The Beverley was noisy, cold and uncomfortable. The Armstrong Argosy which replaced it was luxurious, but it was soon replaced by the Lockheed C-130 Hercules.

**Albert Rowley**  
Thundersley, Essex, UK



Reporting on events such as fatal Pegasus 737-800 overrun last year should be free of sensationalism

Worth splashing out?



Airbus

## Bang on

As a close support aircraft for ground troops, the Lockheed Martin F-35B would have to be fitted with wing hardpoints – a la Harrier – in order to carry the weaponry needed for that role.

**Albert Gorton**  
Harpole, Northamptonshire, UK

**Editor's reply:** The F-35 already can be equipped with external stores, although carrying such equipment decreases its stealth credentials.

## Floating an idea

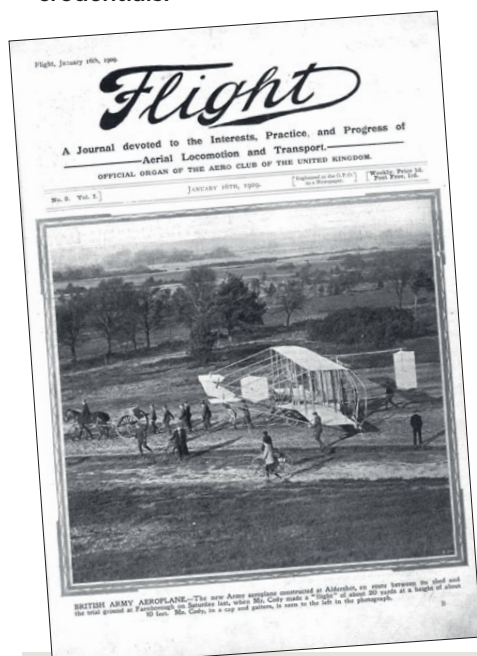
I have watched with amazement the ability of America's Cup-contender sailing yachts to rise up on their sea legs and "fly" at astonishing speeds, often under good control. Then I think of the blended-wing airliner projects under active study by Airbus, Boeing and others.

I see a capacious, buoyant shape, with high-mounted, spray-protected engines at the back. Put a conventional V-shaped hull along the centreline and you get a flying boat, but still with maritime drag.

However, by getting rid of that traditional hull and using fully retractable foils, you would have a water plane that could match the economics of a normal aircraft.

In parts of the world which are hard to access otherwise, there might just be a use for such a specialised creation.

**David Stevens**  
Woking, Surrey, UK



## Calling for Cody

Congratulations on making the move to producing a monthly magazine. This change means that there is more time for you to go into more depth in the articles, and more time for the reader to consider such subjects from a broader perspective.

I am also enjoying the magnificent cutaway posters occasionally provided in the magazine, giving insight into the complexity and mechanical beauty of these amazing machines.

As your magazine now has the space, and the historical content to provide such articles, I wondered whether you would like to produce an in-depth article on Samuel Franklin Cody;

the first man to build and fly an aeroplane in England, and who should be much more well-known than he is at present?

I am astonished that this man is so little known, even in America, where they usually like to advertise one of their own as having been the first to do something anywhere in the world.

**W D Barbut**  
London, UK

**Editor's reply:** Mr S F Cody featured extensively in *Flight's* early editions, from 1909 (the year after his historic first) until his death in a 1913 crash. Perhaps the next Farnborough air show, in 2022, might offer a suitable platform for us to again remember his achievements.

We welcome your letters about our coverage, or any other aerospace-related topic. Please email [flight.international@flightglobal.com](mailto:flight.international@flightglobal.com), or write to: The Editor, Flight International, 1st Floor, Chancery House, St Nicholas Way, Sutton, Surrey, SM1 1JB. Letters should be no longer than 350 words in length, and supplied with the correspondent's name and location. Letters may also be published on FlightGlobal.com, and do not necessarily represent the views of the editor.

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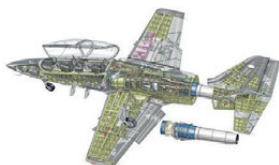
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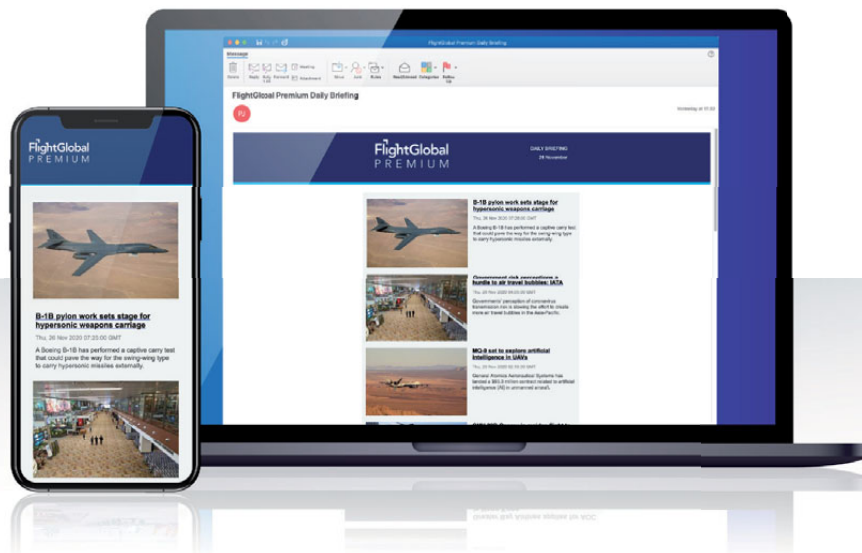


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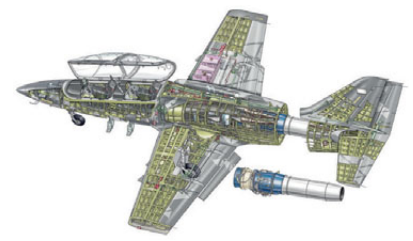
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Gulfstream aerodynamics engineer **Cathy Downen** leads the airframer's certification team – meaning she has the final say on what flies and what does not. She is a firm defender of the ODA scheme

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# Signing off Savannah's finest

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**W**hen Gulfstream's Cathy Downen was a teenager, she often watched her father tinker in his workshop. "He was an electrical engineer and he would design things on paper, little sketches," says Downen. "And then he would build things – he would build a computer, all kinds of stuff."

Once a year the family went to a local air show.

"I was just enthralled with the grace, the power, everything that is an airplane," Downen recalls. "At one of the shows, I asked my father: 'Is there such a thing as an engineer who designs airplanes?' And when he said, 'Yes', I thought: 'That's it. That's what I want to do.'"

Two aerospace engineering degrees and three decades of aircraft design experience later, Downen leads some of the most crucial certification and airworthiness decisions for any new aircraft rolling off the Savannah-based airframer's final assembly line.

She has been with the business jet manufacturer for 10 years, and currently directs Gulfstream's type certification programmes, a job in which she has complete oversight of certification activities.

"Whenever we have a new airplane design, or even a change to an existing design, we have to demonstrate to the regulatory authorities that it's safe, and that it meets all the regulations," she says. "Our team is the interface between Gulfstream and those regulatory people to make sure that we are doing everything necessary to show compliance for the aircraft."

Downen is also Gulfstream's Organization Designation Authorization (ODA) programme administrator, overseeing aspects of certification work delegated to Gulfstream by the US Federal Aviation Administration (FAA). Airframers have largely credited self-certification programmes with enabling them to bring safe technologies to market faster.

But ODA – known by its detractors as "marking your own homework" – has been under scrutiny following two Boeing 737 Max crashes in 2018 and 2019. The

accidents led investigators and lawmakers to criticise both the FAA's delegation process and Boeing's 737 Max design, with allegations that it muscled the Max through certification despite internal concerns.

Though controversial, Downen says the authorisation is difficult to attain, and extremely valuable for both the company and the regulator.

"The FAA is very selective and careful about who they give that authority to," she says, describing a year-long process she went through to get the qualification.

"Women leaders are very different from men, and sometimes the men are uncomfortable with that"

She adds that without delegating some of these responsibilities to experienced engineers like herself, the FAA would not have the resources to track and manage every aspect of every certification process in a timely fashion. That would delay programmes and increase cost.

Previously, Downen was Gulfstream's programme manager for the G600, the airframer's super-large-cabin, long-range business jet that entered service in 2019. In that role, she oversaw the jet's design, development, flight testing, certification, and entry into service.

"I am so very proud of that aircraft in particular," Downen says.

The 19-passenger G600 has a range of 6,500nm (12,000km) and can reach Mach 0.925.

Working with the FAA on groundbreaking and innovative technologies can be challenging, Downen says. But the end goal is to build a safe and reliable aircraft. To achieve that, collaboration is essential.



Gulfstream

Downen oversees Gulfstream's type certification programmes and is the manufacturer's ODA co-ordinator

“Often, our new technology has no regulations to govern it. So, since we have a good relationship with the FAA, we can work with them early to talk about... what we are thinking about doing five to 10 years out, and start to work with them on what we need to do to show compliance for this type of new technology,” she says.

While her aerodynamicist credentials are impressive, actually piloting an aircraft is not for her. “I took lessons while I was in college. And it turns out I’m a really bad pilot. I never got to solo because my instructor and I both agreed it was best that I just walk away,” she says.

But her experience in the cockpit was invaluable as part of her engineering education, “to understand [an aircraft’s] handling characteristics, and what flaps do, and what it means to put your gear down and how it feels on the airplane”.

Throughout her aerospace engineering career, Downen was often the only woman in the room. When she spoke, heads turned.

“Being in an industry dominated by men can be intimidating, just even to say something in a meeting,” she says. “That took bravery in the beginning.”

As her responsibilities grew and she moved into leadership roles, she was coached to “be more like a man” – advice she promptly discarded. “I was told that would make me more successful and more useful. And each time I have pushed back and said: ‘That doesn’t work for me’.

“Women leaders are very different from men leaders, and sometimes the men are uncomfortable with that leadership style,” she says.

So, as she mentors young women in her field, she gives them two critical pieces of guidance: speak up, and be different. “At Gulfstream we value innovation, and innovation does not come from everyone thinking the same,” she says.

“Have confidence in what you know, and don’t be afraid to share it. Find your voice and don’t be afraid to use it.” ▶



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