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ANNIVERSARY

Kelly's heroes

As Skunk Works marks 75 years, how its founder powered rapid development at Lockheed

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iTAWS system made standard for King Air 350i P22

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25 **Special blend** Though accident named it after the illicit whisky operation in a popular 1940s comic strip, Lockheed Martin's Skunk Works unit can on its 75th anniversary toast a well-earned reputation set by Clarence "Kelly" Johnson that would still make any backwoods distiller proud: fast, cheap and potent

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Personnel recovery exercise hosted by Netherlands P19. Airbus introduces higher-weight A350-1000 P9

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The Power of Flight

Image of the week

Anno Gravemaker took this shot of an Italian air force HH-101A Caesar helicopter flanked by a Dutch AH-64D Apache. They were among the contributions made by seven nations during a joint personnel recovery exercise that wrapped up in the Netherlands in early June, after eight days of training

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Anno Gravemaker

The week in numbers

86%

Accenture

Most aerospace companies expect by 2021 to be utilising blockchain technology to improve data security and accuracy

$466m

Flight Dashboard

Oman Air's net loss for 2017 was 40% worse than its 2016 deficit – and more than twice as bad as its losses in 2015

4,700

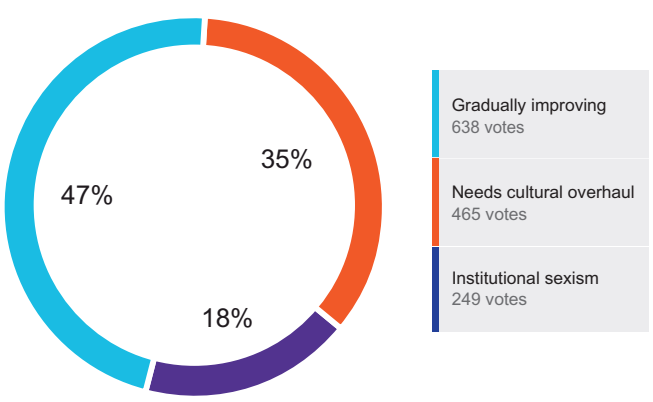
Flight Dashboard

Number of seats Canadian carrier WestJet is buying from Recaro to equip its fleet of 20 on-order 737 Max and 787 jets

Question of the week

Last week, we asked: **Aviation's gender imbalance?**
You said:

Total votes: 1,352



This week, we ask: **Airbus CSeries?**
❑ **Sure-fire success** ❑ **Moderate sales only**
❑ **Chasing scraps**
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CAE

Powerful thinking

As Lockheed Martin's Skunk Works unit speeds past the 75th anniversary of its formation by Clarence "Kelly" Johnson, solving the seemingly impossible remains routine for engineers

In 1986, a team of Lockheed engineers at the Skunk Works gathered around a board to invent what became the F-35 Lightning II.

At the time, of course, these engineers had no idea that the fruit of their brainstorming would lead to a contract award 15 years later for the most expensive weapons system in history.

Back then, their brief from the US Defense Advanced Research Projects Agency looked to be impossible.

For decades, militaries across the globe had ambitions to develop a fighter that could operate without a runway. The only viable contender to emerge was the British Aerospace Harrier, later adapted for the US market in collaboration with McDonnell Douglas.

But DARPA had raised the bar: could the Skunk Works design a vertical/short take-off and landing fighter that was as fast as an F-16 and as stealthy as an F-117?

In keeping with Skunk Works tradition, the team took a lateral approach to solving the problem

Despite several attempts, nobody had developed a supersonic contender, much less one that was also invisible to radar.

But DARPA had come to the right place. In keeping with Skunk Works tradition, the team led by Paul Bevilacqua took a lateral approach to solving the problem.

As recounted in a 2009 paper by Bevilacqua in the *Journal of Aircraft*, the team used a design method known as forced associations.

They made three different lists: all the ways to extract power from hot exhaust gas, transfer that power to other parts of the aircraft, and translate it into thrust. Then, they picked the best option from each list: a gas turbine, a shaft and a lift fan. By combining them together, they discovered the core technology at the heart of the F-35B.

Lockheed Martin

But would he be proud?

Six years later, the head of the US Air Force's Air Combat Command came to the Skunk Works with an unfunded requirement to replace the F-16.

By then, the shaft-driven lift fan concept had evolved into a conceptual fighter design. To their surprise, the Skunk Works staff discovered that when they replaced the lift fan behind the cockpit with a fuel tank, the overall weight only changed slightly.

For the first time, Lockheed could propose a supersonic, stealthy STOVL fighter that could be adapted to a conventional take-off variant with no change in mid-mission manoeuvre performance.

With the Skunk Works unit having just marked its 75th anniversary, the legacy of founder Clarence "Kelly" Johnson appears to be in good hands. ■

See Feature P25

Now, the hard part

On 1 July, Airbus will add two new models to its range when it takes a majority stake in the Bombardier CSeries programme.

After years of uncertainty amid Bombardier's cash constraints, the move will shore up the twinjet family's finances, as well as adding significant firepower to the sales effort and potentially cutting unit costs.

However, these changes can only do so much to stimulate demand.

Back in 2008 when it launched the Pratt & Whitney PW1500G-powered CS100 and CS300, Bombardier forecast 20-year sales of 6,300 units in the 100-150-seat space. But over the following decade, just 805 deliveries were made into the segment by four airframers.

Nonetheless, Bombardier's latest 20-year forecast puts demand at an increased 6,800 units.

Nobody disputes that the CSeries pair are excellent aircraft, featuring a host of technological innovations.

However, the type has only sold in limited numbers: Bombardier had accumulated 402 firm orders at the last count, with the majority being for the larger CS300. For that matter, Airbus has sold just 54 units of the competing A319neo.

Together, the partners should be able to take the order total significantly higher than it is at present. But to meet their lofty sales goals, they must breathe life into a space that has so far shown only modest growth. ■

See This Week P8

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BRIEFING

A340-300 DAMAGED BY FRANKFURT FIRE

INCIDENT A Lufthansa Airbus A340-300 was damaged by a blaze aboard a diesel-powered tow-tractor that was positioning the empty widebody at Frankfurt Main on 11 June. While the full effect of the fire has yet to be determined, pictures on social media show severe damage to the airframe, including a breach of its nose skin. Flight Fleets Analyzer lists the aircraft (D-AIFA) as having been delivered to Lufthansa new in 2000.

$635M DOWNSVIEW SALE COMPLETED

FACILITY Bombardier has completed the sale of its Downsview aircraft assembly site in Toronto to Canada's Public Sector Pension Investment Board for $635 million. After transaction and related costs, the airframer will net around $550 million from the deal. It currently assembles Q400 turboprops and Global-series business jets at the facility, with the latter to be moved to Toronto Pearson airport at a later date.

INDIA TO BOLSTER APACHE ACQUISITION

ROTORCRAFT The US Department of State has approved a possible follow-on sale of six Boeing AH-64E Apache attack helicopters to India, for an estimated $930 million. If finalised, the direct sale will build on a contract signed by New Delhi in September 2015 for 22 AH-64Es to be delivered from next year. The Department of State says the rotorcraft "will increase India's defensive capability to counter ground-armoured threats".

BERLIN SIGNS HERON TP CONTRACT

LEASE Germany's parliament on 13 June approved a €1 billion ($1.17 billion) contract to lease Heron TP unmanned air vehicles manufactured by Israel Aerospace Industries. Airbus Defence & Space – which will receive €720 million from the deal – is to lease seven UAVs from IAI. Five will be capable of carrying weapons, and the other two used for training purposes.

UNITE WINS RYANAIR RECOGNITION

EMPLOYMENT UK trade union Unite has won a recognition agreement from budget carrier Ryanair. The deal secures full consultation and collective bargaining rights for 650 directly employed Ryanair cabin crew. "This is a historic agreement and a significant step by Ryanair," says Unite general secretary Len McCluskey. It is seeking similar agreements with employment agencies who provide Ryanair's remaining UK cabin crew.

RECARO SITTING PRETTY AFTER WESTJET DEAL

INTERIORS Canadian carrier WestJet intends to equip its fleet of on-order Boeing 787 and 737 Max jets with Recaro seats. The German manufacturer says it will supply its CL3710 long-haul economy seat for 10 Dreamliners, while the same number of Max jets are to be fitted with CL4710 business- and BL3520 economy-class seats. Deliveries are scheduled to begin in 2018. The deals spans a total of 4,700 seats.

USAF ORDERS B-1 INSPECTIONS

SAFETY The US Air Force temporarily grounded its fleet of Boeing B-1B bombers for safety inspections on 7 June. The step follows an emergency landing at Midland in Texas on 1 May, made after one of the aircraft's crew escape hatches was jettisoned in flight, without its ejection seat being launched.

STRATEGY **STEPHEN TRIMBLE** WASHINGTON DC

Lockheed doubles new ventures fund

US manufacturer increases capital available for investment in start-ups to $200 million, as it seeks technological edge

Lockheed Martin has doubled a fund designed to invest in start-up companies by using $100 million that was made available by US tax reform savings.

The 18-month-old Lockheed Martin Ventures fund now has $200 million to invest in autonomy and advanced manufacturing. The goal is to make investments that "will grow our business and disrupt our industry", says Chris Moran, vice-president and general manager of Lockheed Martin Ventures.

The outfit is part of a wave of venture capital funds established by aerospace and defence companies in the last three years. Airbus operates the A3 technology accelerator in Silicon Valley and Boeing invests in multiple start-ups via its HorizonX organisation.

Each of the companies had made similar investments in start-ups before creating venture capital funds: Lockheed, for example, has described investing $100 million in 22 start-up companies or spin-offs between 2007 and 2016.

After establishing Lockheed Martin Ventures in 2016, the fund has announced investments in unmanned maritime vehicle developer Ocean Aero and nanosatellite expert Terran Orbital.

Another start-up company on Lockheed's radar was nTopology, the creator of a software tool called ELEMENT, which is dedicated to additive manufacturing machines.

"Our investment in nTopology will bring strategic advantages in Lockheed Martin's computational design processes and help shorten the periods between the design and manufacturing phases," says Moran. ■

Lockheed Martin

MILESTONE

Lightning II soars to 300 deliveries

The US Air Force is the recipient of the 300th Lockheed Martin F-35 Lightning II, with the conventional take-off and landing, A-model fighter to enter service at Hill AFB in Utah. The airframer says it has shipped 197 F-35As, 75 short take-off and vertical landing F-35Bs and 28 carrier-variant F-35Cs, manufactured for the USAF, US Marine Corps, US Navy and international customers. Flight Fleets Analyzer records Australia, Israel, Italy, Japan, the Netherlands, Norway, South Korea and the UK as having so far received the type.

CSeries begins transition onto A-team
This Week P8

SAFETY DAVID KAMINSKI-MORROW LONDON

R-R broadens Trent 1000 inspections

Manufacturer takes "precautionary" measure of checking older Package B powerplants for IPC blade durability problem

Rolls-Royce has extended its inspection regime on Trent 1000 engines to include other models of the powerplant that may be affected by a blade durability issue.

While the analysis and examinations have focused on the Package C version of the Trent 1000, the manufacturer says it has found a "similar" issue with the intermediate pressure compressor (IPC) on Package B engines.

R-R is taking precautionary preventive measures to redesign specific parts in the Package B version, as well as its latest Trent 1000-TEN engine.

R-R's Package B version has been in service on Boeing 787s since 2012 and comprises 166 powerplants. The manufacturer says the durability issue has been identified on a "small number" of high-life engines.

All Nippon Airways has the largest number of 787s with Package B engines (32), as well as the oldest examples, reveals Flight Fleets Analyzer.

"We have agreed with the regulatory authorities, with concurrence from Boeing, to carry out a one-off inspection of our Trent 1000 Package B fleet," R-R says.

The manufacturer had originally said, when it broadened the extent of Package C checks in April, that neither the Package B nor the -TEN would be affected. But it now says it is taking the "precautionary" measure of redesigning specific components in the Package B model as well as the Trent 1000-TEN – which has not shown any durability problems, although the latter fleet is young.

AirteamImages

All Nippon Airways has largest fleet of 787s with affected engines

The European Aviation Safety Agency has issued an airworthiness directive, which became effective on 12 June, covering the extended Package B inspection regime. Cracking occurrences involved blades on the first two rotors of the eight-stage IPC, it says.

"We anticipate there will be a limited impact on customer operations to enable these one-off inspections to take place," says R-R. "Engines will be inspected on-wing using existing techniques."

Civil aerospace president Chris Cholerton insists the company is "committed to eliminating" the IPC durability problem. The company points out it has "successfully" run a redesigned compressor for the Package C engine.

A service bulletin issued by R-R gives instructions to inspect both the front and rear faces of the rotor blades, as well as dovetail posts of the compressor shaft.

EASA's directive requires the inspections on affected engine modules, which have accumulated more than 1,000 cycles, to be conducted within 30 days.

If any discrepancies or crack indications are detected during on-wing inspection, the engine must be removed from service and the manufacturer contacted for repair instructions, says EASA. ■

RESTRUCTURING

Job losses 'will not reduce capabilities'

UK-based Rolls-Royce insists that plans to slash 4,600 positions over the next two years, announced on 14 June, will not cut the capabilities it needs to handle its engine production ramp-up.

R-R is lifting Trent XWB output for the Airbus A350, and builds Trent 7000s for the new A330neo, as well as Trent 1000s for the Boeing 787, Trent 900s for the A380 and Trent 700s for the A330.

R-R says the cuts will reduce management complexity and create a "much simpler, healthier and dynamic" organisation.

The job cuts will fall mainly in the UK and will cost £500 million ($666 million) over 2018-2020 but save around £400 million annually by the end of the period. "The restructuring will not lead to any reduction in the skills and capabilities we require," says R-R. ■

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ACQUISITION **STEPHEN TRIMBLE** WASHINGTON DC

CSeries begins transition onto A-team

Nearly 10 years after Bombardier launched small narrowbody family, on 1 July, Airbus will gain control of the programme

One month before the 10th anniversary of the CSeries programme's launch event at the 2008 Farnborough air show, Bombardier and Airbus executives met in Montreal to finalise an agreement to transfer the majority ownership of the aircraft family to the European manufacturer.

The deal will not become effective until 1 July, but both parties described the early morning signing on 8 June as a historic moment in the bittersweet saga of the CSeries programme and the market for small narrowbody aircraft in general.

"I'm confident that in the near future, we'll look back on this day as a defining moment for the CSeries as well as a game-changing event in the 100-150-seat segment," says John DiBert, Bombardier's chief financial officer.

The deal's finalisation came more than eight months after Airbus and Bombardier startled the industry by coming to terms on a partnership in the first place.

For Bombardier, the agreement appeared to be a lifeline for the first clean-sheet aircraft design developed for the 100-150-seat market in decades.

Airbus

European airframer will use sales muscle to close more deals in underperforming 100-150-seat segment

TRADE HURDLE

Despite brimming with new technology, including fly-by-wire flight controls, composite wing panels, an aluminium-lithium structure and Pratt & Whitney PW1500G geared turbofan engines, the production ramp-up had slowed to a crawl and orders had been curtailed by the threat of a looming trade complaint within the US government that was instigated by Boeing.

The CSeries ultimately prevailed over Boeing at the US International Trade Commission.

Airbus takes control as the programme begins its second decade, and the focus of the joint company is to realise the so-far elusive potential of the CSeries in a long-neglected segment.

"Quebec and Canadian tradition of aerospace innovation can now realise its full potential," DiBert says.

Airbus chief financial officer Harold Wilhelm agrees: "Combining Airbus's global reach and scale with Bombardier's state-of-the-art aircraft will unlock the potential of the CSeries platform."

The quantification of the CSeries' true potential, however, has been a point of some debate over the last decade.

Back at the programme's 2008 launch, Bombardier estimated a market demand for 6,300 aircraft between 100-150 seats over the following 20 years, averaging an annual 315 deliveries over the 2008-2027 period. Halfway through those two decades, the market has fallen short of that estimate: six models have been available in that segment since 2008 – the Boeing 737-700, Airbus A318 and A319, the CS100 and CS300, and Embraer 195 – accumulating a combined 805 deliveries over the last 10.5 years, averaging fewer than 80 aircraft a year, according to Flight Fleets Analyzer.

In fact, demand has weakened in the sector over the last five years: 68% of the 805 deliveries since 2008 were recorded before 2013, Fleets Analyzer shows.

Still, Airbus and Bombardier believe the new partnership can help stimulate demand for new small narrowbodies. Bombardier's most recent market forecast, released last September, estimates demand for 6,800 aircraft in the 100-150-seat category over the next 20 years.

SYNERGY

Airbus executives believe the key to achieving those numbers is to combine the scale of its own industrial and marketing strength with the performance attributes embedded in the CSeries.

Illustrative of the financial muscle the European airframer can bring to bear are the respective revenues of both companies: in 2017, Bombardier Commercial Aircraft generated turnover of $2.4 billion (including regional jets and turboprops), while Airbus brought in $59.9 billion from its commercial aircraft operation.

Starting on 1 July, the focus of the Airbus-dominated management team will be to solve the problems that have slowed the CSeries production ramp-up and constrained sales, which may in some cases be overlapping. As Bombardier approaches the mid-year point, the company has achieved only 25% of its 2018 goal for 40 CSeries deliveries.

"We want to bring the aircraft to market. That's going to be our key challenge," says Philippe Balducci, the Airbus-appointed chief executive of the CSeries partnership. There are no plans to change Bombardier's supply chain, he says.

"The second focus will be to sell the aircraft to the marketplace, leveraging Airbus's firepower today. Those two happening will help reduce the cost and improve the recurring cost."

In addition, the partners will begin construction of a new final assembly line for the CSeries in Mobile, Alabama, next year, with the first delivery to follow in 2020.

Its industrial capacity will allow for building four CSeries aircraft per month at a peak production rate to support customers in the US market, says DiBert. That could be expanded if there is growth in demand for the CSeries from US airlines after 2020, he adds.

Meanwhile, the CSeries assembly site at Mirabel in Quebec – with two parallel lines – will continue to be the main production facility, DiBert says. Mirabel is sized to deliver up to 10 aircraft per month, although it has never delivered more than four.

Under the terms of the deal, for which no cash changes hands, Airbus gains a 50.01% stake in the CSeries Aircraft Limited Partnership, with Bombardier holding 31% and Investissement Québec the remaining 19%. ■

Dr Peters prescribes part out for A380s
News Focus P11

VARIANT **DAVID KAMINSKI-MORROW** LONDON

Weight is over as Airbus adds heavier A350-1000

Airbus has formally introduced a new higher-weight variant of the A350-1000, taking the maximum take-off weight to 316t.

The airframer had hinted a year ago that two more weight variants – a 311t and a 316t version – were under consideration.

Airbus subsequently confirmed the 311t variant, known as WV001, but the European Aviation Safety Agency has newly updated its certification documentation to feature a 316t variant.

Confirming the higher weight offering is available immediately, Airbus says the 316t option provides either an extra 5.5t in cargo or a range increase of about 400nm (740km), to 8,400nm.

The A350-1000, powered by Rolls-Royce Trent XWB-97 engines, was originally approved with a maximum take-off weight of 308t. EASA lists the 316t variant, designated WV002, with the same maximum landing weight and zero-fuel weight as WV001, respectively 236t and 223t.

Airbus has total orders for 168 A350-1000s, which typically seat 369 passengers. ■

Airbus

New version offers 5.5t more cargo capacity or extra 400nm of range

PROGRAMME **STEPHEN TRIMBLE** WASHINGTON DC

CRAIC takes first steps on design path

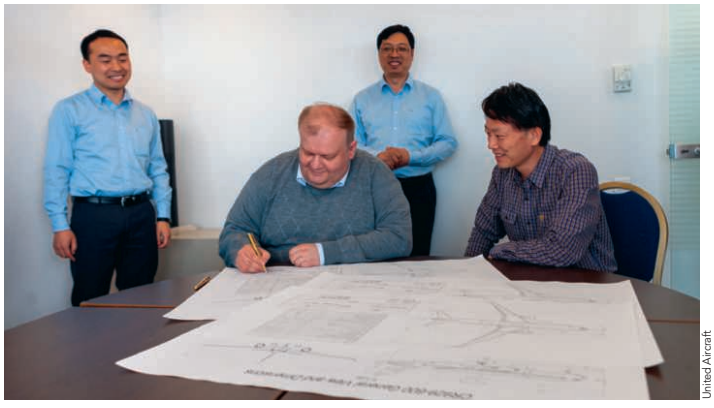
Initial configuration of CR929 Sino-Russian widebody agreed by partners, paving way for major systems selection in 2019

The Sino-Russian engineering team working on the CR929 widebody has finalised its external dimensions and shape, clearing another major design hurdle.

United Aircraft (UAC) chief designer Maxim Litvinov and Chen Inchun, his counterpart at Comac, approved the general configuration during a 6 June meeting, the Russian airframer says.

The 280-seat CR929-600 represents the first of a three-member family of widebody aircraft planned by China-Russia Aircraft International Corporation, a joint company launched last year by the two countries and their commercial aerospace champions.

An image of the general configuration shows the sweep and shape of the wing, revealing a leading-edge similar to the Airbus A350 or Boeing 787 but with a seemingly narrower outboard section.



United Aircraft

Aircraft dimensions have been deliberately blurred out on drawings

The dimensions and performance of the aircraft have been intentionally blurred on the image released by UAC, however.

The configuration agreement also sets the location for the aircraft's two wing-mounted engines.

On 30 May, Comac announced it had received offers from seven domestic and foreign engine suppliers, but did not identify the bidders. They would likely include the two companies that produce engines large enough for commercial widebody aircraft today: GE Aviation and Rolls-Royce. Pratt & Whitney has also proposed to build a new widebody aircraft engine based on its fan-drive gear system. Russia's United Engine and the Aero Engine Corporation of China also have planned domestic alternatives to foreign-built engines. The source of the two other bids for the 75,000lb-thrust (333kN) powerplants is not clear.

By finalising the general configuration on 6 June, CRAIC has closed out the second stage of its internal design process.

CRAIC plans to pass the next milestone by mid-2019, according to UAC. This will involve completing windtunnel tests, choosing structural materials and selecting suppliers for key systems. ■

TRIAL **MAVIS TOH** SINGAPORE

Comac feels no pressure as C919 passes initial static load tests

Comac has started static load limit tests for the C919, initially focused on cabin pressurisation.

The Chinese manufacturer tested the narrowbody fuselage under maximum pressurisation conditions, marking the first ultimate load trial for the C919 static strength evaluation programme.

It adds that the tests met expectations and delivered positive results. They were carried out in collaboration with the Aircraft Strength Research Institute of China and with guidance from the Civil Aviation Administration of China and the European Aviation Safety Agency,

Comac aims to achieve certification and service entry for the C919 in the 2020-2021 period.

The C919 received a boost in early June when China's HNA Group signalled its intention to order 200 of the type under a "strategic co-operation agreement" with Comac. ■

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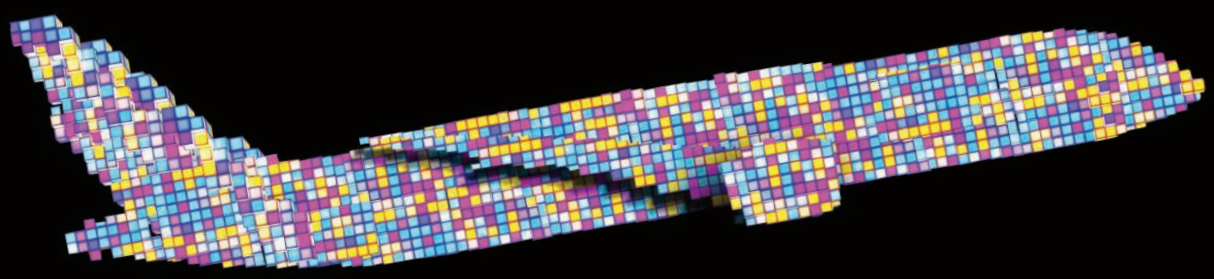

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STRATEGY **SOPHIE SEGAL** NEW YORK

Dr Peters prescribes part out for A380s

German asset manager discloses plans to break up and sell off components of two ex-Singapore Airlines superjumbos

Following many months of exploring options, German asset manager Dr Peters on 5 June disclosed plans to part out two ex-Singapore Airlines Airbus A380s, after talks with several carriers failed to produce any agreement to lease the aircraft.

Speaking to FlightGlobal, Dr Peters chief executive Anselm Gehling estimates that the company can achieve a residual value of about $80 million per aircraft – consisting of $45 million from parting out the airframe, about $4 million from leasing the engines over the next 18 months, and $32-$33 million from selling the engines in 2020.

Flight Ascend Consultancy suggests a half-life base value of $78.4 million (assuming 2% inflation) for a 2008-vintage A380 in 2020.

Dr Peters will put its plan to investors on 28 June and hopes to start selling airframe components in mid-July, via US firm VAS Aero Services. Meanwhile, the aircraft are sitting on the ground at the Tarbes, France base of storage specialist Tarmac Aerosave.

The A380 has been something of a misadventure for financiers who invested in the type when it first started rolling off the production line. During its early days, the aircraft attracted orders from many top-tier airlines in Asia, Europe and the Middle East. It never gained traction with any US carriers, however – and momentum in finding new customers slowed to a halt, while only a handful of repeat orders were incoming.

Airbus had not registered an A380 sale since December 2015 when it was earlier this year thrown a lifeline by Emirates, which signed a follow-on deal covering another 36 of the double-deck aircraft.

The European manufacturer – which has 105 still-to-be-delivered A380s in its orderbook, Flight Fleets Analyzer shows – has scaled back the type's production rate, to one aircraft per month in 2018 and eight across 2019 as a whole, falling to six in 2020.

Tarmac Aerosave

Initial pair of defleeted double-deckers have been stored by Tarmac Aerosave in Tarbes, southwest France

Original forecasts suggested a 220% return to investors, but Dr Peters has revised that to 145-155%, in addition to reducing the period of the fund by five years. It now matures in 2020.

"This is the only solution we have for these first two aircraft," says Gehling. "For the first type of a new series, parting-out carries a very attractive return."

> "The A380 part-out market is likely to be very finite, given the relatively small installed base"
>
> **Michael Lapson**
> Senior valuation analyst, Flight Ascend Consultancy

With no spare parts in the market, Dr Peters views its pole position as a bonus. "For these two aircraft, there is zero competition," says Gehling. "We can more or less dictate the price of these components."

Michael Lapson, a senior valuation analyst at Flight Ascend Consultancy, says Dr Peters "will have first-mover advantage because, prior to this first part-out, the main alternative supply of parts is from the manufacturers, at full price".

He adds: "The A380 part-out market is likely to be very finite, however, given the relatively small installed base and limited engine market because of TotalCare control by Rolls-Royce."

Dr Peters says the two aircraft it is parting out have returned between 3.8-4.2% per year since it established the funds in 2008. Given prevailing interest rates, Gehling sees a 4% return as "a very good result". For instance, German 10-year bonds have yielded less than 1% over the past four years, according to Bloomberg data.

"The commercial results we expect are fantastic," Gehling says of the plan to part out the first two Singapore aircraft. "It's a much better option than a long-term lease at a low rate. That's why we couldn't make it work with [Portugeuse carrier] Hi Fly and British Airways."

Hi Fly confirms it is still preparing to receive its first A380 this summer, and identifies the aircraft as MSN 006, of which Fleets Analyzer lists Doric as owner. Doric did not immediately respond to requests for comment.

Flight Ascend Values Analyzer suggests a monthly lease rental of $929,000 in 2018 for a 2008-vintage A380.

STRATEGY APPROVAL

And, while Dr Peters is hoping to have its part-out strategy approved by investors later this month, the company has not ruled out the secondary market for future A380s. It has an additional two double-deckers on lease to SIA and five with Air France, and will consider its options for these aircraft as they come back.

However, consider the following fact: of the nearly 500 747-400s sold by Boeing, only 50 found homes in the secondary market, and only 25 of those went to new customers.

Thanks to its troubled development history, early-build A380s also suffer from issues relating to weight and performance, which reduce their appeal to new users.

So, while Hi Fly is paving the way as the first secondary operator of the A380, it is questionable whether there is a scalable secondary-user base sufficient to give the superjumbo a second life. ■

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INVESTIGATION DAVID KAMINSKI-MORROW LONDON

Incomplete engine wash caused fumes in cabin

Russian investigators have determined that a Globus Boeing 737-800 was evacuated at Moscow after a high-speed aborted take-off, following a smoke alert traced to improper engine cleaning.

The aircraft – a 14-year-old airframe (VP-BDF) – had been departing Moscow Domodedovo for Novosibirsk on 27 March. Russia's federal air transport authority Rosaviatsia says it had accelerated to 100kt (185km/h) when the crew aborted the take-off roll, stopping the jet on the runway, and ordered the evacuation.

AirTeamImages

The Globus 737-800 was evacuated after its crew aborted take-off

The decision had been triggered by the presence of smoke in the passenger cabin and cockpit.

Rosaviatsia says an "unpleasant odour" was originally perceived by the crew as anti-icing liquid in the air-conditioning system.

All four forward and rear doors, as well as the overwing exits, were used for the evacuation, with slides being deployed.

Eighteen passengers were treated for injuries at the Domodedovo airport medical centre. The aircraft had been transporting 129 passengers and six crew members.

Inquiries determined that the aircraft had undergone an engine wash on its CFM International CFM56 powerplants the previous evening. But the wash procedure, conducted by group sister company S7 Engineering, was not fully completed. Rosaviatsia says the purging of the air-conditioning system was done at low power, whereas the technical manual requires thrust of 60-80% of N1.

As a result, residual liquid in the air intakes evaporated during the departure and entered the aircraft cabin. ■

CERTIFICATION
DAVID KAMINSKI-MORROW
LONDON

PD-14 drives for EASA approval by end of 2020

Russia's United Engine expects to secure European certification for the Aviadvigatel PD-14 powerplant by early 2021.

The company says it has achieved progress with European Aviation Safety Agency approval after clearance of documentation relating to the production organisation at Perm Motors.

Irkut's MC-21-300 is set to have the PD-14 as an alternative powerplant option to the Pratt & Whitney PW1400G.

The production organisation documentation, says Perm Motors managing director Sergei Popov, describes the manufacturing capacity, design information, quality-management process, and several other structural details.

By the end of this year an auditing of procedures will begin. EASA certification will be completed in late 2020 or early 2021.

Popov says that the company will work to ensure that PD-14 production "does not differ" from the detail set out in the EASA documentation. ■

SAFETY STEPHEN TRIMBLE WASHINGTON DC

FAA tells Boeing to justify its GEnx-1B exemption request

Regulator demands evidence supporting waiver for 787-10 powerplant hit by software bug

US regulator the Federal Aviation Administration is pushing back on a request by Boeing for a temporary exemption from a safety rule to allow the GE Aviation-powered variant of the 787-10 to enter service on schedule in August.

The GEnx-1B engine has a software bug that, in one instance, prompted the computer to shut down the powerplant during a step climb to a higher altitude in ice crystal icing conditions.

GE is working to fix the bug, but until that is ready, the GEnx-1B-powered version of the 787-10 cannot obtain an airworthiness certificate without an exemption.

On 4 March, Boeing applied to the FAA to approve a waiver that would keep the delivery of the first GEnx-powered 787-10 on schedule for later this summer.

In a 1 June response to Boeing, the FAA asks the airframer to provide evidence supporting its request. For example, Boeing said in its March correspondence that GE's fix for the shutdown problem is included in a software update called "B200", not scheduled for delivery until December 2019.

Boeing

Airframer wants GE Aviation-powered variant to remain on schedule

However, GE has told FlightGlobal and the FAA that the improved software package will be ready by the first quarter of 2019.

"What justification does Boeing provide for delivering airplanes under an exemption until December 20, 2019?" the FAA asks.

The FAA also notes that Boeing says that there will be no adverse impact on safety during the exemption period, due to the small chance that the automatic engine restart function will not work as designed if the software bug causes an engine to shut down.

"Please provide a description of the assumptions and probabilities incorporated in the system safety assessment that determined the risk to be less than extremely improbable," the FAA says.

Boeing's responses to the FAA are due by 30 June. ■

Texts reveal first officer's captain fears
Air Transport P14

BACKLOG DAVID KAMINSKI-MORROW LONDON

A350 order ends widebody drought

Commitment for 15 aircraft from undisclosed customer drags 2018 net twin-aisle sales at Airbus into positive territory

Long-haul sales at Airbus showed signs of revival in May as the airframer recorded an order for 15 A350-900s.

The deal, assigned to an undisclosed customer, is the first for the A350 for nine months – the last being United Airlines' commitment for 10 in September 2017.

The new A350 sale also takes to 17 the gross number of long-haul twinjets ordered from Airbus so far this year, alongside an SAS A330-300 and a single A330-200 for conversion into a military multi-role tanker/transport.

As a result, Airbus's long-haul programmes – including the A380 – crept into positive order figures, with a net total of three aircraft for the first five months of this year.

Airbus

Royal Brunei was among airlines to receive Leap-powered jets in May

Lufthansa accounted for the only single-aisle orders during May, after agreeing to take six A320neos and three A320s. These took the net total of A320 family orders to 108 this year.

Airbus has also delivered 223 aircraft, 8% down on the 242 reached at the same time last year.

However, the airframer has restored powerplant parity to A320neo-family deliveries, handing over 22 aircraft – 12 A321neos and 10 A320neos – in total during May, equally split between the two engine makers.

Airbus's latest backlog figures show that Pratt & Whitney PW1100G engines and the rival CFM International Leap-1A were each fitted to six A321neos and five A320neos delivered in May.

Total A320neo-family deliveries this year have reached 69 aircraft – comprising 48 A320neos and 21 A321neos – accounting for 40% of all single-aisle output over the first five months.

But this figure remains distorted by the multiple assembled aircraft which remain parked at Airbus facilities awaiting engines.

Interruption of PW1100G deliveries between February and late April meant that, by the end of May, almost 80% of the A320neo-family jets handed to customers this year had Leap-1A engines. ■

MANUFACTURING JON HEMMERDINGER BOSTON

Mobile marks milestone as Hawaiian takes first US-built Neo

Airbus has delivered the first re-engined narrowbody from its manufacturing site in Mobile, Alabama, handing over a Pratt & Whitney PW1100G-powered A321neo to Hawaiian Airlines.

The delivery is a milestone for the Mobile facility, which until now had assembled only A320ceo-family jets.

The Alabama plant has handed over a total of 72 units since its first delivery, an A321 to JetBlue Airways in 2016, says Airbus.

The latest delivery also marks the first time Hawaiian has received a US-produced Airbus aircraft.

Hawaiian now has four 189-seat A321neos in its fleet, with another 14 on order, according to Flight Fleets Analyzer.

The airline received its first two A321neos late last year, but reliability issues with PW1100G engines caused Airbus to halt deliveries in February, with the process only resuming in April; Hawaiian received its third A321neo on 7 May, Fleets Analyzer shows. ■

OWNERSHIP DAVID KAMINSKI-MORROW LONDON

Norwegian seeks further clarity on alternative offers

Scandinavian budget carrier Norwegian is seeking further clarification over recent approaches by parties in the wake of IAG's acquisition of a minority stake in the company.

British Airways parent IAG disclosed in April that it had taken a 4.61% share in Norwegian; the carrier has since rebuffed preliminary offers from IAG for a full takeover.

Norwegian states that it has received inquiries from "several" parties which have shown "indicative and preliminary" interest covering a range of offers.

They have included share acquisition, mergers, structural transactions, group financing, and different forms of operational and financial co-operation, it adds.

"These indications of interest have been preliminary and subject to a number of conditions," it says.

Norwegian says it is seeking "further information and clarifications in a number of areas" to enable it to evaluate the various proposals, and see whether any are worth pursuing.

IAG has not made any legally-binding commitment for its shares, Norwegian adds. ■

AirteamImages

Oslo-based low-cost carrier says it will evaluate viability of proposals

For the full analysis of airline safety and losses in 2017, go to: flightglobal.com/safety2017

INQUIRY JON HEMMERDINGER BOSTON

Texts reveal first officer's captain fears

Co-pilot killed when Shorts 330 crashed at Charleston had previously expressed concerns over superior's behaviour

Newly released video shows the moment an Air Cargo Carriers Shorts 330 turboprop crashed at Charleston's Yeager airport in West Virginia last year, shedding light on an incident in which both pilots were killed.

Documents presented by the US National Transportation Safety Board in early June also prompt questions about the airline's safety culture and reveal that the first officer on the ill-fated flight had previously expressed concerns about the captain's behaviour.

These included sleeping in the cockpit, steep turns and descents at low altitude, and difficulties with instrument flying, the NTSB documents show. However, those concerns involved earlier flights, and the probe has not yet determined the cause of the accident.

The freighter (N334AC) was operating UPS-contracted flight 1260 from Louisville on 5 May 2017 when it crashed at 06:51 local time while attempting to land on runway 5 at Charleston.

The aircraft was manufactured in 1979 and did not carry a flight-data or cockpit-voice recorder.

Newly-posted video shows the aircraft approaching the airport at a steep nose-down angle and then turning left, which the NTSB says was an effort to align with the runway. The video, which the airport confirms was recorded by its surveillance cameras, also shows the moment of impact.

NTSB

NTSB investigators have yet to determine the cause of the accident

> "She described a series of flights where the captain asked her to fly every leg for four days in addition to handling radios while he slept"
> National Transportation Safety Board

"The airplane struck the runway with the left wing, followed by the left side of the fuselage; it slipped off the left side of the runway into the grass and down a hill through trees," says the NTSB.

The aircraft hit the runway in a 42° left bank, with a nose-down pitch of 14° and speed of 88-96kt (163-178km/h), says the NTSB.

Steven Altnau, president of Milwaukee-based Air Cargo Carriers, declines to comment until the NTSB issues its final report. The company currently operates 19 Shorts 360s, according to Flight Fleets Analyzer.

NTSB documents disclose that the first officer, a new pilot and former flight attendant, had expressed concern about the captain, who was at the controls of the twin-turboprop at the time of the accident, according to flight logs and voice communications.

The 47-year-old captain joined the company in July 2015, and earlier worked as a "bush pilot" for several Alaska-based operators.

"Just had the biggest scare of my life. Thought I was going to die," the first officer texted to a friend in December 2016. She was describing a flight during which she and the captain returned to the airport following a landing gear problem after take-off.

"He was making really, really steep turns, like 60° of bank and descending at like 800ft/min," she wrote of the captain. "The whole time I'm like, we're gonna hit the hills.

"We were only a few feet from hitting that bank on the side on the runway when he was able to turn it back," she wrote.

The first officer, who was sending the texts while in flight, noted that the captain was at that moment "sleeping".

"She described a series of flights in February 2017 where the captain asked her to fly every leg for four days in addition to handling radios while he slept," says the NTSB.

Some former Air Cargo Carriers pilots described "a culture where senior pilots with experience as captains felt like they could bend boundaries of [standard operating procedures], and the [first officers] may not be taken seriously."

"Former pilots interviewed stated that they had witnessed instances of [standard operating procedures] being disregarded when they were flying at [Air Cargo Carriers]," documents say. ■

REGULATION DAVID KAMINSKI-MORROW LONDON

EASA calls for checks on Saab 2000 fuel probes

Saab 2000 operators are to be ordered to check fuel-indicator accuracy, after occurrences in which fuel probes have given misleading readings.

Investigation into the incidents suggest that the issue may relate to an "ageing phenomenon" leading to "deteriorated capacity" of the probes, says regulator the European Aviation Safety Agency.

It says that incorrect fuel readings could potentially result in fuel starvation and in-flight engine shutdown on the twin-turboprop type.

EASA is intending to order carriers to perform a one-time functional check of the fuel-quantity system and low-fuel warning system, to determine whether any components are out of tolerance.

It adds that the proposed directive on the issue is an interim measure, and further action could follow.

Operators will need to carry out the check within 1,500h or one year, and replace affected parts if necessary. ■

Boeing-Safran partnership powers up
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IATA

Ourmières-Widener (*front, far right*) with other IATA board members

EQUALITY MURDO MORRISON LONDON

Flybe chief hopes 'bad joke' can be spark for change

Fallout from Akbar Al Baker's sexist comments continues

One of the two women on IATA's 31-member governing board has described as "not a good joke" controversial remarks made by new chair Akbar Al Baker about the suitability of females to run airlines.

However, Flybe chief executive Christine Ourmières-Widener hopes that the comments of Qatar Airways' boss will "cause an awareness that we can build on" about the barriers women face in aviation.

"I have worked with Akbar for many years and I would say it was not really a good joke," she told an Aviation Club luncheon in London on 7 June.

On 5 June, at the airline association's annual general meeting in Sydney, Al Baker responded to a question about gender equality by saying that "of course" his own carrier "has to be led by a man because it is a very challenging position".

Although Al Baker apologised and accused the media of "sensationalising" his remarks, they have highlighted claims of top-down sexism in the industry.

Ourmières-Widener told the Aviation Club that "I still see inequalities at every meeting I attend". She adds that, in addition to the need for "a culture that will allow more women to be promoted", more young females must be encouraged to enter the industry. This could be done by promoting the study of science, technology, engineering and maths among girls, and persuading them to consider careers as pilots and aviation engineers.

A male-dominated industry is making it harder to tackle a shortage of key professionals, she says, adding: "If we get more women [into the industry] we might just solve the recruitment problem."

Ourmières-Widener also calls for an end to the UK's air passenger duty, which she describes as "crazy", claiming it adds an average of 15% – and sometimes as much as 50% – to Flybe's fares.

She suggests abolishing the tax for domestic flights initially.

"It would just take a bit of guts," she says. "But we are killing our business at a time when we are saying the UK is open for business." ■

ACQUISITION DAVID KAMINSKI-MORROW LONDON

LOT Maxes out orders in new 737 lease deal

Polish flag-carrier LOT is ordering another six Boeing 737 Max jets, to be delivered from this year.

The carrier is acquiring the twinjets through a co-operation agreement with Kuwaiti lessor ALAFCO. The airline says it is to take five of the aircraft this year and the last in 2020.

With the latest agreement, the carrier will have 12 Max jets in its fleet by the end of 2020

LOT says that the aircraft – powered by CFM International Leap-1B engines – are "perfect" for its short- and medium-haul network.

The airline took delivery of its initial two 737 Max jets last year, which were part of a batch of six it had agreed to acquire through US lessor Air Lease. Further deliveries are due from June and the final one will arrive in May next year.

ALAFCO chief executive Ahmad Alzabin says that the LOT deal is a "significant milestone" for the lessor.

The carrier says with the latest agreement, it will have 12 Max jets in its fleet by the end of 2020. The lease for the ALAFCO aircraft will run for nine years.

Configured with 186 seats. the jets will be put on a number of rotes across Europe, including services to London, Moscow and Tbilisi. ■

Airbus

PROGRAMME

PAL A350 conducts maiden sortie

Philippine Airlines' first Airbus A350-900 on 8 June conducted its maiden flight at the airframer's Toulouse headquarters. The Rolls-Royce Trent XWB-powered aircraft (MSN221) is one of six ordered by the Asian carrier. Airbus says the airline will use the twinjet on services from Manila to North America and Europe. "The flight marks the start of the final phase of the production process, leading to customer acceptance and delivery in the coming weeks," it adds. PAL is aiming to take delivery of four A350s this year, dating from a six-unit order placed in May 2016. The carrier had stated that it was also taking options on a further six.

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CONSOLIDATION **STEPHEN TRIMBLE** WASHINGTON DC

Boeing-Safran partnership powers up

Airframer and systems specialist join forces to target APU market, as US manufacturer deepens vertical integration drive

Tucked discreetly into the aft fuselages of most aircraft, auxiliary power units are one of their least regarded components, rarely if ever receiving the attention lavished on the engines or avionics (or, from a passenger perspective, seats).

But that changed on 4 June, with the announcement that Boeing and Safran will team up to take on Honeywell and Pratt & Whitney Canada in the segment.

The planned entrance of the as-yet unnamed Boeing-Safran joint venture later this year shakes up a market that had only last year seemed to be in long-term stasis.

Honeywell has a stranglehold on the narrowbody sector, as the only company supplying to all five single-aisle aircraft programmes over 130 seats, including the Airbus A320, Boeing 737 Max, Bombardier CSeries, Comac C919 and Irkut MC-21. P&WC also supplies its APS3200 to the A320 programme.

The widebody market remains divided, with a roughly even split of sole-source positions: P&WC APUs are standard on the A380, 747-8 and 787, while Honeywell owns the APU market for the A350 and 777.

BillyPix

Honeywell and P&WC hold a duopoly in segment, with latter firm sole-source supplier on 787 programme

UNCERTAIN OUTLOOK

As the Boeing-Safran team jumps into the fray, many questions remain about how that competitive balance could change. Their joint statement announced plans to develop and build new APUs and service those made by themselves and other manufacturers.

But that is a bold strategy. It is a little-known fact that in the early 1960s Boeing produced several hundred small turboshaft engines for an unmanned US Navy helicopter. But that is Boeing's only experience in the gas turbine business.

And while Safran Power Units already produces the equipment for helicopters and business jets, the French aerospace giant has not been involved in the APU market for large aircraft since its then Labinal division (since rebranded as Safran Electrical & Power) exited the Auxiliary Power International Corporation joint venture with Sundstrand in 1996.

Safran declines to comment on what prompted it to return to the APU market, or how long it might take to field a competitive product.

But the pair are teaming up to take on two established players with decades of experience, a deep installed base and several sole-source positions on all aircraft now in development or production.

"They're going against two extremely competitive, well-honed [suppliers]," says Kevin Michaels, managing director of the AeroDynamic Advisory. "This is a huge business to Honeywell. So it means a lot to them."

Honeywell holds a 65% share of the APU production market for large commercial aircraft, while P&WC claims the remaining 35%, Michaels says.

Phoenix-based Honeywell plans to protect its presence in the market, even if one of its two biggest customers is now to become a competitor.

"Regarding the news from Boeing, we do not anticipate any impact to our position in the market, noting Honeywell has long-term production contracts in place with the original equipment manufacturers, including Boeing, and maintenance and service contracts with a vast number of aftermarket customers around the globe," Honeywell says.

Indeed, Honeywell sounded a similar note a year ago, when Boeing launched a new avionics business, with plans to develop competitive alternatives for a range of potential systems.

APUs are now added to a growing list of Boeing efforts to insert itself into competition with several of its largest suppliers. In addition to avionics, Boeing has launched internal production of actuators, nacelles and aircraft seats.

LEVERAGE

It is a strategy intended to put pressure on the company's biggest suppliers, particularly in areas where there may only be one or two providers.

Although Boeing is committed to developing internal alternatives to traditional suppliers, some analysts remain sceptical about the long-term strategy. The current leadership of Boeing has not experienced a cyclical market downturn since 2004, says Richard Aboulafia, vice-president of analysis for the Teal Group. Decisions that may seem logical during a period of long-term expansion could still backfire if the market reverses.

"I'm a little concerned that Boeing might be a bit informed by an unusually long [growth] cycle. You can invest in anything you want up to and including a high level of vertical integration," Aboulafia explains. "The only thing you're doing is capturing more profit and revenue until things go south, in which case you're stuck with all that fixed cost... and you're taking a 40% revenue haircut."

No further details on the Boeing-Safran joint venture have been released, and both partners are staying tight-lipped on what size aircraft their first product will be aimed at.

However, they indicate that the deal is expected to close in the second half of 2018 and the venture will be based in the USA. ■

Doha on target with Sniper purchase
Defence P18

PROPULSION **STEPHEN TRIMBLE** NEW YORK

P&W powers up for prototypes with Gator Works

On the eve of the 75th anniversary of Lockheed Martin's Skunk Works unit, Pratt & Whitney revealed it is creating a new prototyping arm assigned to develop engines in half the time and for half the cost.

Named Gator Works as a nod to its location, the division opened quietly earlier this year at the company's testing and manufacturing site in the Florida Everglades near West Palm Beach, says Matthew Bromberg, president of P&W Military Engines.

A small group of hand-picked employees are working on four undisclosed prototyping projects with three simple rules to guide them: "Use all of Pratt & Whitney's intellectual property, don't hurt anyone and don't break the law," Bromberg says.

US Navy

Aim is to speed engine development over that for types like the F-35

The goal is to allow the Gator Works to break free from the cumbersome corporate procedures that contribute to 20-year development cycles for large aircraft engines, such as the F135 powering Lockheed Martin's F-35 Lightning II.

The details and scope of the Gator Works' first four projects are being kept secret. P&W says the organisation is charged with developing "state-of-the-art engines", but Bromberg qualifies that the organisation "will walk before we can run".

The Gator Works model is inspired by the Skunk Works, founded in 1943 in Burbank, California by Clarence "Kelly" Johnson. An initial, hand-picked team of 23 engineers and 105 machinists delivered the XP-80 jet fighter within 180 days, and the unit went on to develop breakthrough capabilities including the US Air Force's Mach 3.2 SR-71 Blackbird, powered by P&W's J58 turbo ramjet. ■

See Feature P25

DEVELOPMENT **MURDO MORRISON** LONDON

L-159 partners eye OA-X requirement

Czech-Israeli team pitches "combat-proven" jet in close air support role, arguing turboprops unsuitable for US Air Force

Aero Vodochody and its partner, Israel Aerospace Industries, are making a late bid to be selected for the US Air Force's OA-X close air support requirement, offering an advanced version of the L-159 which they say could be ready for delivery from 2020.

The companies also say that – if chosen for the roughly 350-aircraft requirement – they would consider setting up a production line and supply chain for the Honeywell F124-GA-100-powered jet trainer in the USA.

Although OA-X funding has not yet been agreed, Aero Vodochody chief executive Giuseppe Giordo expects the Pentagon to open a formal competition "soon", and says the "combat-proven" L-159 would be "the most cost-effective and lowest-risk option".

The USAF has already invited Textron Aviation and Sierra Nevada/Embraer to take part in an evaluation exercise this summer involving the Beechcraft AT-6 and A-29 Super Tucano, respectively.

However, Giordo says the USAF "cannot afford the risk of flying with turboprops – we believe that US pilots need to have the best assets in close air support missions".

"This is not a developmental airplane," Giordo notes. "It has been used in a real operational war environment and can perform many roles."

Aero Vodochody and IAI's Lahav division announced in April that they are to collaborate on a version of the L-159 that will be equipped with a "fourth-generation" avionics suite and "other solutions", which are believed to be weapons integration systems. The Czech Republic airframer's current variant already features IAI equipment, including an Elta Systems radar and optional datalink.

The company restarted low-volume production of the L-159 in 2016 after cancelling the programme in the mid-1990s when its sole customer, the Czech Republic, mothballed most of its fleet of 72 aircraft. However, after a successful decade-long effort to sell the surplus assets to the Iraqi air force – which has used them in its campaign against so-called Islamic State insurgents – and US adversary training specialist Draken International, Aero Vodochody has built two additional aircraft.

Katsuhiko Tokunaga/Aero Vodochody

Aero Vodochody and IAI will optimise the type, plus smaller L-39NG

Giordo says two L-159 production lines could be supported – one building the latest version for the transatlantic requirement with IAI and a possible US partner, and the existing facility near Prague.

The partnership could also cover the Williams International FJ44-4M-engined and Genesys Aerosystems glass cockpit-equipped L-39NG. This should fly by November and become operational by the first quarter of 2020. Senegal has ordered four armed examples, and Giordo says the company is "finalising contracts" with two other buyers. ■

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UNMANNED SYSTEMS **STEPHEN TRIMBLE** WASHINGTON DC

USMC outlines scope for MUX contest

Vertical take-off and landing asset should perform combat, surveillance and support tasks, with selection due in 2020

The US Marine Corps expects a new class of unmanned, vertical take-off and landing aircraft that could be selected within two years and fielded by 2025 to be used across a wide range of combat, surveillance and support missions.

A vision for the proposed MUX capability was outlined in planning documents posted on an acquisition website on 4 June. These reveal an intent to test the abilities of industry competitors, which include the Bell V-247 Vigilant tiltrotor and Northrop Grumman Tern tailsitter, to deliver a new fleet of large and versatile aircraft on an aggressive schedule.

An acquisition decision is expected by 2020, the USMC says. The first aircraft should be ready to deploy from a land base with an "early operational capability" by 2025, and additional features rolled out within a further two years. A first ship-based deployment should come in 2029, the documents show.

Northrop Grumman

Northrop Grumman has promoted merits of tail-sitting Tern design

The future aircraft must be capable of achieving 300kt (555km/h) and operating at up to 25,000ft – exceeding the capability of the service's Bell Boeing MV-22B Osprey tiltrotors – plus land vertically and operate from ships. It will be required to carry up to 1,360kg (3,000lb) of payload internally as a threshold requirement, loiter on station up to 350nm (647km) from base for 8-12h, and be able to hover out of ground effect at 6,000ft on a 35°C (95°F) day.

The USMC wants the MUX platform to perform a broad set of missions, including acting as a high-speed armed escort for the MV-22B, carrying eight Lockheed Martin AGM-114 Hellfire air-to-surface missiles. It could also carry other weapons for different tasks, including anti-radiation missiles for an electronic warfare role and air-to-air missiles during airborne early warning. Another requirement could be for it to operate as a cargo aircraft, ferrying supplies to reconnaissance units on the ground.

Other tasks would include providing a variety of surveillance and communications services for Marine units and amphibious ready groups.

Bell has proposed configurations of the V-247 weighing more than 13,600kg, but the USMC documents show it wants the MUX to occupy no more space on a ship's deck than a Bell UH-1Y Venom transport helicopter with its rotor blades folded. ■

PROCUREMENT

Doha on target with Sniper purchase

Qatar's future fleet of Dassault Rafale fighters will be equipped with Lockheed Martin Sniper targeting pods, the US company has announced. "Pod deliveries to the Qatar Emiri Air Force will begin in 2019," says Lockheed. "Integration efforts are ongoing, with flight tests currently in progress." Doha late last year announced its intention to bolster an order for 24 Rafales by adding a further 12 examples. Dassault has previously said deliveries will start before the end of 2018. Lockheed notes that the Rafale will become the 10th aircraft type to operate with its Sniper pod, following the BAE Systems Harrier GR9, Boeing B-1B, B-52, F-15 and F/A-18, Eurofighter Typhoon, Fairchild Republic A-10, Lockheed F-16 and Mitsubishi F-2.

Dassault Aviation

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Turning virtual threats into combat reality
News Focus P20

TECHNOLOGY **STEPHEN TRIMBLE** WASHINGTON DC

Unmanned airlifter will be more than an Ilyushin

Russian unmanned air system developer Kronstadt Group has teamed with Ilyushin to develop a large autonomous aircraft that could deliver cargo to remote areas. The partners plan to start with developing a demonstrator based on the twin-engined Il-112 transport.

"Given the active development of the Arctic, it can be assumed that aircraft capable of transporting up to several tons of cargo from one point to another in an autonomous mode will be highly demanded," says Alexey Rogozin, general director of the Ilyushin Aviation Complex.

Ilyushin is developing the United Engines Klimov TB7-117CT turboprop-powered Il-112V with a 5t payload capacity to replace an aged fleet of Antonov An-26 transports.

St Petersburg-based Kronstadt, meanwhile, is developing a medium-sized UAS called the Orion, a demonstrator testbed for which was unveiled at the MAKS air show in Moscow in July 2017.

"We want to be technologically ready to open this [unmanned cargo] market," Kronstadt says. "Joint work with [Ilyushin] will allow us to optimise the time and resources, and therefore be the first to create answers to market demands."

The companies are now partnering to apply Kronstadt's autonomous technology to Ilyushin's aircraft designs.

Although the project is beginning with an Il-112V-based demonstrator, the companies' ambition is likely to extend to developing a new aircraft to address perceived market needs. ■

Israel Aerospace Industries

Long-range missile can be carried by a range of types, including F-16

WEAPONS **ARIE EGOZI** TEL AVIV

Pair launch supersonic Rampage

IMI Systems and Israel Aerospace Industries have jointly developed a new precision strike weapon suitable for use during stand-off-range attacks.

Named Rampage, the supersonic weapon is 4.7m (15.4ft) long and weighs 570kg (1,250lb). Its rocket and warhead performance and navigation suite enable it to attack high-value, well-protected targets with "utmost precision", the companies say.

Suitable for carriage by a broad range of aircraft types, including the Lockheed Martin F-16, the Rampage missile will boost its host platform's survivability by being released from outside the range of ground-based air-defence systems.

Potential targets could include command and control sites, communication facilities, air bases, maintenance centres and critical infrastructure, the industry partners say. ■

EXERCISE **ANNO GRAVEMAKER** ARNHEM

Allies put personnel recovery skills to test

Event hosted by Netherlands brought together 12 nations over course of two weeks for joint combat rescue training

Helicopters and fixed-wing aircraft from seven NATO and Partnership for Peace countries took part in a multinational personnel recovery exercise that concluded in Europe earlier this month.

Running from 22 May until 6 June, the air-centric personnel recovery operators course (APROC) event was hosted by the Netherlands Defence Helicopter Command, and involved almost 600 participants from 12 nations.

Assets involved included a Boeing CH-47D Chinook and two Boeing AH-64D Apaches from the host country, a Sikorsky UH-60M Black Hawk from the Swedish Armed Forces Helicopter Wing, two Leonardo AW101 Merlin HC3s from the UK Royal Navy and a French navy NH Industries NH90 Cayman, all on debut.

Anno Gravemaker

Types involved included an Italian navy AW101 and Spanish AS332

The Italian air force's combat search and rescue-optimised HH-101A Caesar was flown alongside the Italian navy's baseline AW101 transport, while Poland committed the Mil Mi-24, and Spain the Airbus Helicopters AS332.

Flight operations were co-ordinated by French air force and NATO Boeing E-3 airborne warning and control system aircraft, and by an Italian air force Gulfstream E-550A.

Escort missions were flown by Royal Netherlands Air Force Lockheed Martin F-16AMs and Eurofighter Typhoons of the Italian air force. Italian pilots had previously completed a theoretical course on joint personnel recovery, with Rome's Eurofighters due to assume this role after the future withdrawal of its Alenia/Embraer AMX strike aircraft.

Organised by the European Personnel Recovery Centre, the annual APROC activity is part of a long-term effort intended to improve the preparation, planning, execution and adaptation of such missions, by developing and harmonising policy, doctrine and standards among partner nations.

After two days of academic courses, crews conducted familiarisation flights over the Netherlands, before taking part in eight days of realistic scenarios at Dutch and Belgian locations. ■

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SIMULATION CRAIG HOYLE LONDON

Turning the benefit of virtual threats into a combat reality

Creating synthetic enemies is now essential to training on fifth-generation fighter aircraft

Northrop Grumman is relishing the opportunities arising from complex training requirements associated with advanced combat aircraft such as the Lockheed Martin F-35, and believes that the use of live, virtual and constructive (LVC) technologies will increase markedly as their operation becomes more widespread.

With limited range space constraining the military's ability to fully test the capabilities offered by advanced and widely networked fighters, augmenting live assets through the use of simulators and virtual entities is a growing trend.

"LVC training solutions can provide enhanced realism by adding more virtual and computer-generated aircraft and adversary weapons into an exercise," says Northrop, which made its first venture into the sector more than a decade ago.

"We have provided training to the US Air Force since 2006 in LVC: we have been at the forefront since the outset," says Andy Horler, its air business development manager for the UK and Europe.

During this time, the company has provided more than 150 LVC events in support of the USAF's Air Combat Command and Air Mobility Command, and manages two of the service's distributed mission training networks for simulators. "Those distributed networks plug into the live training ranges," Horler notes.

> "We have provided training to the USAF using live, virtual and constructive systems since 2006"
>
> **Andy Horler**
> Air business development manager for UK and Europe, Northrop Grumman

As a former USAF Lockheed F-16 and F-22 pilot, Northrop's director, airborne C4ISR systems, Phillip Guy, has a first-hand understanding of the challenges posed when conducting air combat training in a fifth-generation fighter. Even during large-scale exercises, such as the Red Flag series staged regularly from Nellis AFB in Nevada, a large package of 80-100 "Blue Air" assets will operate against a much smaller adversary fleet with perhaps only a dozen aircraft – and formed partly of vintage fighters flown by private contractors.

"You need LVC to balance it up," Guy argues. By using a mix of networked simulators and virtual entities, exercise participants can be put through their paces against a comparable-sized "Red Air" component until the event reaches its conclusion. "Then you can strip out the virtual [players] and have 12 live aircraft in one lane" for within-visual-range engagements, he says.

"When we reference LVC, we're talking about the live component – a live aircraft, or a live tank, where there's a warfighter involved," he says. "We're very comfortable in saying we've done the most advanced LVC in the world, because we're the only folks who have connected live aircraft all the way to live simulators where there's a warfighter in each one conducting full-up training, at full-up security levels."

CONSTRUCTIVE INPUTS

Since 2015, Northrop has provided such expanded services to Air Combat Command, and last year put the capability through its paces at the Northern Edge event at Eielson AFB, Alaska. "We've now done more than a dozen exercises where we have had more than 100 live aircraft in a scenario, more than 130 constructive inputs and more than two dozen virtual aircraft," Guy says.

Successes have included enabling the mission crew of a Boeing RC-135 Rivet Joint signals intelligence aircraft to participate when there was no aircraft available to support the manoeuvres. Instead, a simulator for the asset was brought into the exercise network.

"Simulators now are high definition and extremely high quality – to the point that for the majority of simulators in the US, the warfighter counts them as training: just like they were flying a live jet," notes Guy.

Realistic weapons use can also be shown, with the computer-generated employment of surface-to-air missiles (SAM), Lockheed AGM-158 JASSM cruise missiles and Raytheon's miniature air-launched decoy having been simulated during training events.

Guy says that before the advent of LVC, if a crew wanted to simulate a weapon release, they would press the 'pickle' button and make a radio call. "It was totally pretend," he says. "Now, a SAM operator sees those weapons, and has to make a decision whether to try and shoot them down, or keep out of the attack.

"People think live is always the perfect training, but even though we're adding all this LVC and the synthetic component, it actually makes it more realistic for them, because they can 'see' the weapons, and you can simulate SAMs," he adds. "As a pilot, you want to know what SAM, C2 [command and control] and Red Air is active. We don't want them to know whether someone who's fighting with them is live, virtual or constructive. If you can achieve that, then you've achieved your primary goal."

US Air Force

The F-35's advanced capabilities present a major training challenge

New owner polishes Diamond strategy
Business Aviation P22

Large exercises involving types such as the F-22 are enhanced with digital adversaries

US Air Force

Northrop works with more than a dozen threat generation companies to support constructive training, and manages system problem reports for the USAF to feed back to these suppliers. "We provide analysis sometimes on their equipment, to identify what deficiencies may exist, so we can have a more interoperable force," Guy says.

> "People think live is always the perfect training, but adding LVC actually makes it more realistic"
>
> **Phillip Guy**
> Director, airborne C4ISR systems, Northrop Grumman

"If it's a purely synthetic event, you can train at full-up security levels with anyone else that's on the network, regardless of their security classification," Guy says. "We're almost up to 80 sites now in the USA, the UK, Germany, Japan and Korea – and they can all come together and play in same event without experiencing latency or bandwidth challenges."

"We see ourselves as a systems integrator – the fact that we don't make simulators is an advantage to us: we can be agnostic, and help manage the issues between the simulator manufacturers," says Horler.

"Everyone has a vested interest in enabling this training to occur," Guy says. "So whether it's Boeing, Lockheed Martin or CAE, L3 or any of the other vendors out there, their engineers want to make their simulators the best that they can be, so they will share with us any issues."

Outlining the capabilities of its LVC experimentation, integration and operations suite (Lexios) ahead of the ITEC training show in Stuttgart, Germany, last month, Northrop said it anticipates more air forces embracing such technology to support their operational needs.

"As we're looking to bring the F-35 into other countries, where you may not have that range, you really need to leverage LVC and synthetic more, because the capabilities of fifth-generation aircraft really expand the amount of airspace you need to effectively employ," says Horler. "Their sensors and weapons are very capable systems, so you need very large distances. There are only a very few places in the world where you can do that, and if you wanted to do that in the UK or Europe it just wouldn't be possible. With LVC, you can have a nice balance between cost-effective training, but training which is going to be of real benefit, and you can expand beyond the boundaries of a range."

Guy believes that LVC today provides a 10-15% training solution, but adds: "The decisions that are forthcoming for all of our nations are how high do you want to take that?

CORE DEFICIENCIES

"Live aircraft have three core deficiencies: they can't detect synthetic aircraft with their radars; they can't get any radar warning from those aircraft; and they can't see them visually. Those are the challenges that the defence industry is trying to solve today, to advance this."

Options could include providing radar warning receiver information via datalink, or showing virtual infrared signatures via a targeting pod. However, he notes: "The biggest challenge right now for any aircraft provider is having enough memory even to put all the coding in for the synthetic portion for a live aircraft.

"If you hear any of the governments talk, regardless of which country, they all will state that it's going to take a co-operative effort amongst the entire industry to deliver the capability they want."

He notes the funding challenge facing air forces, however: "Do you want more advanced training, or do you want a more advanced weapon, or the next helmet? You're competing for the same resources."

Meanwhile, Northrop is promoting its capabilities to other operators, with the UK a particular area of interest, Horler says. The company is among four bidders pursuing the Defence Operational Training Capability (Air) Core System and Services project, which the Ministry of Defence says "seeks to fill a demonstrated capability gap that prevents air force elements training together as force packages, enable a defence-wide requirement to download live training into the synthetic environment, and allow a rebalancing of live/synthetic training".

The activity is closely aligned to the UK's ASDOT programme, which will provide live aircraft for aggressor training with the Royal Air Force.

The company is also one of the last two candidates pursuing a distributed training requirement for the Australian military, with its teaming also including CAE and Cubic.

"A lot of people think that LVC is a future technology for the next generation of aircrew, but we are delivering capability right now," Horler says. "I believe there will be a growing emphasis on synthetic training and that live/synthetic blend." This will become even more relevant, he says, since using future networked cyber and space capabilities in live training could give away key information or tactics to potential foes. ■

US Air Force

Dedicated aggressor platforms are in short supply for US Air Force

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INVESTMENT **KATE SARSFIELD** WIENER NEUSTADT

New owner polishes Diamond strategy

Sales and support are first areas for Wanfeng Aviation's attention, following acquisition of Austrian firm in December 2017

Diamond Aircraft is stepping up its global sales, marketing and support effort as part of a wider strategy from its new Chinese owner to position the business and general aviation manufacturer as the leading brand and producer of fixed-wing, piston-engined types.

The Diamond Group – including Austria-based Diamond Aircraft Industries and powerplant specialist Austro Engines, as well as its Canadian arm, Diamond Aircraft Inc – was acquired in December 2017 by Wanfeng Aviation.

The Chinese company is now building its strategic vision for the venture. "We didn't buy Diamond simply as an investment opportunity," the airframer's new chief executive Frank Zhang told FlightGlobal in an exclusive interview at Diamond's headquarters in Wiener Neustadt, Austria on 8 June. "We are here for the long term."

Zhang has already shaken up the company's corporate structure, with the Austrian and Canadian operations now functioning as a single entity. "It didn't make sense to have these two operating as separate ventures [as before]," says Zhang. "Now we are under one corporate roof we can pull together as a company and share ideas, expertise and customers."

Diamond is also expanding its presence in Asia, particularly in China, where a handful of models are built under licence through partnership agreements.

Zhang describes China as "a very important market", with huge demand for piston-powered aircraft coming from the country's pilot training industry. "As the country's airspace opens up, we expect to see Diamond aircraft being used by many more owner-flyers and [corporate and commercial] operators," Zhang notes.

In preparation for this surge in activity, Diamond is now "building its [sales and marketing] teams and finalising its strategy for the region", says Zhang. Details will be revealed in the coming months.

Diamond says it is putting "the customer" at the heart of its plans, with focus groups, surveys and dealer feedback now being rolled out across the company, in an attempt to "improve" the overall experience for the end-user.

"There are always things Diamond can do better, and we want to let our customers know that we are listening," says Zhang.

Diamond Aircraft

DA62 represents one of four aircraft families the company produces

Customer feedback will also play a major role in future programme launches and enhancements. Diamond currently manufactures four aircraft families: the DA20 and DA40 piston-singles, and the DA42 and DA62 piston-twins. The latter pair are also sold in special mission or multipurpose guises known as MPP.

It also has a few aircraft at an advanced stage of development, including the Dart 450 and Dart 550 two-seat, aerobatic turboprop trainers, and the DA50 diesel- or Jet A-fuelled piston-single.

A turboprop-powered version of the five-seat DA50 is under evaluation, says Zhang, while development of the Dart 280 piston-engined rotorcraft concept has been put on hold. Unveiled in 2017 by the company's previous chief executive, Christian Dries, the light-single was designed to provide a stepping-stone to a family of rotorcraft.

"We don't want to proceed with any new programmes until we are sure there is a market for them," Zhang says.

He is adopting a similar approach with Diamond's dormant D-Jet personal jet programme. The five-seat single was suspended in 2013 after the airframer failed to secure the necessary funding to complete development.

"It would be great to add a jet to our line-up at some point, and with the D-Jet, the opportunity is there. However, we will have to see whether that's what the market is calling for," says Zhang. ■

ENHANCEMENT **KATE SARSFIELD** LONDON

Textron to make iTAWS standard on King Air pair

Textron Aviation

350i will also receive a multiscan radar and new flightplan system

Textron Aviation has made its integrated terrain awareness and warning system (iTAWS) standard equipment on the Rockwell Collins Pro Line Fusion-equipped Beechcraft King Air 350i/ER, and will add it to the 250 variant of the twin-engined turboprop family "in the near future".

The new iTAWS works side by side with the Fusion synthetic vision system, adding aural and visual warnings that appear on primary flight and multifunction cockpit displays. The integration effort is a less complex solution, Textron says, and eliminates the need for a separate line-replaceable unit and associated wiring.

The flagship 350i also boasts two new options. The first is a multiscan radar with turbulence detection that automatically identifies short-, medium- and long-range weather. The other allows the crew to upload charts and flightplans wirelessly from an iPad via the ArincDirect app.

Rob Scholl, Textron's senior vice-president of sales and marketing, says these latest features are part of the company's investment in the twin-turboprop family, which it says is selling well after four years of decline. For the first quarter of 2018, Textron recorded 17 King Air shipments, compared with 12 a year earlier.

Meanwhile, the company has opened a line maintenance facility at London Biggin Hill airport in the UK, to provide servicing and support for its 1,200-strong fleet of King Airs and Citation and Hawker business jets across Europe. ■

Special blend
Cover Story P25

MODERNISATION KATE SARSFIELD LONDON

Challenger 604XT set for fourth-quarter approval

Nextant Aerospace expects to secure US supplemental type certification in the fourth quarter for its Rockwell Collins Pro Line Fusion upgrade to the Bombardier Challenger 604, and says slots for the modification at its Cleveland, Ohio facility are sold out through the first quarter of 2019.

The Fusion flightdeck replaces the legacy model's Pro Line 4 suite, and marks the first phase of Nextant's modernisation of the large-cabin business jet.

Launched in May 2017, the 604XT is the third aircraft in the company's line-up, joining the 400XTi – a remanufactured Hawker 400A/XP light business jet – and the G90XT, an upgrade of the Beechcraft King Air C90 twin-engined turboprop.

The Fusion-equipped 604XT test aircraft has logged more than 100 flight hours, says Nextant's director of new product development, James Clifford. "Missions have included flying East to West Coast USA, and long over-water segments to Europe. All the equipment is functioning as designed," he says.

Clifford describes customer response to the Fusion upgrade as "fantastic". To satisfy demand, Nextant will bring additional facilities on line from early 2019, including sites in Stamford, Florida and Mesa, Arizona. "There will be plenty of capacity," he says.

Future enhancements planned for the 604XT include a range increase of up to 500nm (925km), which Clifford says will be made via a "significant drag-reduction and wing-extension programme" that is now in its early stages. "We are currently in the R&D phase, and reviewing the different options to enable us to accomplish that performance goal," he says.

Bombardier

Future enhancements on twinjet include wing-extension programme

Nextant is also studying options for a new interior for the 604XT, which will be designed, Clifford says, "to meet the comfort and technology needs of today's high-end business aircraft owner and operators". ■

PROGRAMME KATE SARSFIELD LONDON

PC-24 data dictates new order timetable

Swiss firm Pilatus will evaluate performance from fleet of in-service aircraft before accepting fresh commitments for type

Pilatus Aircraft is likely to reopen the orderbook for the PC-24 business jet in 2019, but only once it has secured the necessary performance data from a broad fleet of in-service aircraft.

Oscar Schwenk, chairman of the Swiss airframer, acknowledges there is "huge" demand for the superlight twin from existing position holders and new customers, but says he will not bow to pressure and is happy to wait until the company is ready.

"We must give it time before we start on the next order round," says Schwenk. "We will gather feedback from a range of operators on how their PC-24 is performing, to see what, if any, steps need to be taken to iron out any issues with the aircraft. This will take several months, so it is likely that we will not start taking new orders until next year."

The feedback will also cover operations on unmade runways, as well as steep approaches into challenging airports. These extra performance features are part of the PC-24's post-certification test programme, now under way and scheduled for completion before the end of the year.

PlaneSense

PlaneSense has logged around 400h with superlight twin since 1 April

Pilatus began taking orders for the PC-24 in 2014 – a year after its launch – and the first batch of 84 units sold out within 36h. High demand for the Williams International FJ44-4A-powered aircraft forced it to cap the orders of many buyers, including launch customer PlaneSense.

The Portsmouth, New Hampshire-based fractional ownership company – also the largest commercial operator of the PC-12 single-engined turboprop, with 36 examples – was grudgingly restricted to six units, but is eager to place a "double-digit" order in the next round, it says.

Since entering service on 1 April 2018, PlaneSense's PC-24, bearing the registration N124AF, has logged around 400h.

Pilatus has delivered four PC-24s to date from a planned output of 23 aircraft in 2018; handover of the fifth example is imminent.

"Production is sold out until September 2020," says Schwenk. "We will build 40 PC-24s in 2019 and 50 the following year, which will include aircraft from the second [order] phase."

PC-24 recipients so far have been private owners and commercial operators based in Switzerland and the USA, says Pilatus. It is now preparing serial numbers 105 and 106 for delivery in October and November, respectively, to Australia's Royal Flying Doctor Service (RFDS). The aeromedical operator has ordered five air ambulance examples.

Pilatus is now installing the air ambulance interior for the aircraft, says Schwenk, which it has developed in partnership with Swiss engineering and completions company Aerolite, with input from the RFDS.

The air ambulance variant represents only a handful of PC-24 orders so far, but Schwenk says it is a "growing niche". ■

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The iconic SR-71 Blackbird was a follow-on from the CIA's A-12 – an aircraft that first flew in 1962 but still seems futuristic

Lockheed Martin

Though accident named it after the illicit whisky operation in a popular 1940s comic strip, Lockheed Martin's Skunk Works unit can on its 75th anniversary toast a well-earned reputation set by Clarence "Kelly" Johnson that would still make any backwoods distiller proud: fast, cheap and potent

STEPHEN TRIMBLE LOS ANGELES

It was spring of 1958 and time to balance the books on Lockheed's U-2 contract, so the US Central Intelligence Agency set up a meeting with Clarence "Kelly" Johnson, the founder and head of the company's Skunk Works.

By then, Lockheed's $22.5 million, fixed-price contract to develop and build 20 U-2s was barely three years old, but the high-altitude spying platform had already earned its legendary status. The first aircraft started flying in August 1955 – exactly as Johnson promised when the CIA signed the order.

The first CIA-operated U-2 deployed less than a year later, boldly over-flying Moscow above 70,000ft on its first mission on 5 July 1956. Although the CIA had underestimated the Soviet Union's ability to detect U-2s flying across its borders at high altitude, its Cold War adversary would not possess the weapons needed to shoot down the high-flying "angels" until 1960.

There was no doubt Johnson's clever move to combine the fuselage and jet engine of a Lockheed F-104 with the high-aspect ratio wing of a glider had paid off technically. But was the U-2 a financial success?

The CIA was not in the business of developing new aircraft, so the financial arrangements on the U-2 deal were unique. At one point, the secrecy-obsessed CIA posted a cheque for $1.2 million to Johnson's house, to keep production on schedule.

Johnson assumed great financial risk with the CIA deal. After all, he had quoted a $28 million price in 1954 to the US Air Force for the same aircraft, but the service deemed the bid far too risky. A year later, however, Johnson signed essentially the same deal with the CIA for $22.5 million. He knew the CIA deserved a discount because the agency imposed far less "red tape" on contractors, but the terms of the deal still made him nervous, so the CIA agreed to review the costs three- »

» quarters of the way through the programme.

By that spring of 1958, however, it was clear that the review was a waste of everyone's time. Instead of breaking the CIA's $22.5 million funding limit, Skunk Works' total costs for the contract came in at slightly over $17 million, according to the agency's declassified, official history of the U-2 programme. After including Lockheed's 11.5% profit fee, the CIA's total spending on the original U-2 contract still added up to less than $19 million.

In a remarkable twist in the familiar acquisition story, the government customer received a revolutionary capability on time – and a refund.

CELEBRATING INNOVATION

Lockheed observed the 75th birthday of its heralded Skunk Works organisation on 14 June, with a ceremony in Palmdale, California – where Skunk Works appears as active as ever. The organisation that flew the XP-80 jet fighter in 1944, Mach 3.2 SR-71 Blackbird in 1964 and the stealthy F-117A in 1981 is still pushing boundaries.

As one team works to develop a compact fusion reactor, other Skunk Works groups are leading Lockheed's bid for the US Navy's MQ-25 unmanned tanker contract, pursuing hypersonic vehicles and weapons and designing the replacements for the F-22 fighter and C-130J tactical transport. More projects probably fill hangars and shops around the Palmdale complex that remain closed to outsiders.

In each project, both the company and its customers are seeking to rekindle the magic that fuelled the Skunk Works' 40-year string of breakthroughs from the 1940s to the 1980s. In that period, the only thing perhaps more impressive than the performance of aircraft Skunk Works made was how the organisation made them. To paraphrase Johnson's motto, Skunk Works made its inventions quickly, quietly and on time.

Johnson eschewed the committee-based approach to decision-making in aircraft design. He described his aversion to that standard process in a 1983 interview with CBS News's *60 Minutes* magazine programme: "We're into the era where a committee designs the airplane. You never do anything totally stupid, you never do anything totally bright. You get an average wrong answer. And very expensive."

Another example of Johnson's hard-boiled managerial style can be found in a memo sent to Skunk Works staff in January 1963, as they were struggling to deliver the M3.2 A-12 to the CIA while starting up the SR-71 follow-on project. The subject line of the memo, now stored in the aerospace collections at the Huntington Library in San Marino, California, reads: "Idiot charts and related subjects."

Johnson's original Skunk Works triumph was the USA's first 500mph jet fighter, seen here as the F-80 flown in Korea

Lockheed Martin

"Some of our new members are drawing up 'idiot' charts," he wrote. An idiot chart, he explained, is "one that states by written sentence a subject which is perfectly clear to the audience and which should be to the [sic] presentor. It is generally designed to allow the presentor to spend 4 or 5 minutes on things having nothing to do with the chart."

He concluded: "We will continue to make charts in the old-fashioned manner, which means that they will be few in number and present things in a clear, sharp manner and, if we can't do this, we won't make a chart, for we obviously don't understand the subject ourselves."

DIRECT ACTION

Jack Gordon, who led Skunk Works from 1994 to 1999, joined the organisation to work on the SR-71 programme in 1964, while Johnson still ran the unit with a well-honed management system. Johnson had little patience for engineering committees and bureaucratic process. He favoured quick decisions, even if they led to mistakes that had to be fixed later.

"He had a board review process," Gordon recalled in a public speech on 24 March. "So everybody would stand up at a board, and Kelly would walk through, and he'd say, 'We made a decision last week to make the wing sweep 34°. How'd that work out?' And you were expected to be able to answer how that worked out.

"We kept a decision book. Kelly would say: 'Golly, that [34° sweep] didn't work out too well. Let's try 36°'," Gordon adds. "Then we'd write that in the decision book. And everybody would work on 36°. The genius of that when you think about it is you just took the dither out of the system. He kept the group focused and all working in the same direction, and we did."

Taking the "dither" out of the engineering process is harder that it may seem. In the course of inventing solutions to unexpected problems, it is often tempting for engineers to make decisions slowly and only after careful analysis.

Not for Johnson. In a 2010 interview for an oral history project, Joe Szep, one of the 25 engineers picked by Johnson for the XP-80, described what made Johnson's approach different. "When two engineers come together and

have problems, trying to decide, in a normal operation they say: 'Gee, we better form a committee.' And the committee, says: 'Oh, we have to form a task force and study this.' Pretty soon a task force gives a report. Then they have to study that and come up with an answer. By that time, a month had gone by. Kelly came in and says: 'We'll do it this way.' Every day he made a decision that allowed us to go ahead. And that was the secret of the Skunk Works," said Szep.

> **"We used the most direct approach to the design and testing and constructing of things that is possible"**
>
> Clarence "Kelly" Johnson
> Founder, Skunk Works

Officially, Skunk Works' practices are codified in Johnson's "14 Rules" for managing projects. In broad terms, the rules called for establishing a "small" government programme office, which should delegate nearly complete control over design and suppliers to a Skunk Works manager running a team whose numbers were limited in a "vicious" manner. The small team was expected to use a "simple" system for releasing engineering drawings to the shop, while allowing as much flexibility for making changes as possible.

The rules were a product of Skunk Works' origins in 1943. At the time, Lockheed was overwhelmed with its duty to deliver 35 new fighters and bombers every day. When Johnson won a contract to build an exotic, 500mph jet fighter, Lockheed chief executive Robert Gross informed him that he was on his own.

Gross may have hoped to discourage Johnson from taking on the project, but instead he gave him exactly what he wanted.

Johnson hand-picked 23 engineers and 105 shop mechanics and set them up under a circus tent and walls made of wooden crates on the edge of Lockheed's property in Burbank. Isolated and undisturbed, his team could work on their secret military project without corporate intrusion. It was in this climate of secrecy one day that one of Johnson's hand-picked engineers answered the phone with the unusual greeting: "Skonk Works" – a joking reference to a moonshine still in a popular comic strip. Much to Johnson's chagrin, the name stuck.

That group formed a company within a company – a tiny cell that could act with the agility of a start-up but call upon the infrastructure and financial resources of a larger company. The idea became a model for innovative processes far beyond Lockheed.

Mainly, the idea spread because the XP-80 was successful. The US Army Air Corps gave Johnson 180 days to deliver the aircraft. The first XP-80 was handed over to a ground test team in 143 days. The UK-built Halford H-1 engine was lost on the first day of testing, as the XP-80's inlets buckled under the unfamiliar strain of jet propulsion. A new engine was ordered and the Skunk Works still beat the deadline for first flight by a week.

Johnson's organisation was not always successful. As the U-2 was flying deep behind the Iron Curtain in the late 1950s, Skunk Works was developing a M2.5, liquid hydrogen-powered reconnaissance aircraft for the USAF under Project Suntan. The aircraft, designated the CL-400, might have met the USAF's performance specifications, but Johnson demanded that the military cancel the programme anyway. The challenges posed by the logistics and design constraints of liquid hydrogen fuel persuaded Johnson that the project was not worth it. The USAF objected at first, but cancelled the contract in February 1959.

By then, of course, Johnson was already deeply involved in a competition to build a high-speed successor to the U-2 for the CIA, which became the A-12 Cygnus under Project Oxcart.

The A-12 – which led to the SR-71 Blackbird family of aircraft – got started 17 years after the XP-80, but 58 years on, it still seems futuristic. It remains the fastest manned aircraft to fly an operational mission, requiring new structural materials and the unique Pratt & Whitney J58 turbo ramjet. Skunk Works needed two and a half years to achieve first flight of the A-12 – not less than six months as on the XP-80. But the project proved that the Skunk Works approach could be used to solve the hardest industrial challenges.

"We used the most direct approach to the design and testing and constructing of things that is possible," Johnson told the *60 Minutes* interviewer in 1983. "They didn't think we could do that when we were going into production on the SR-71, the big complicated airplane, but we were able to adapt our methods so that we built the airplane quickly and relatively cheaply, and built every one of them." ■

NASA

Cost savings on the U-2 contract allowed Skunk Works – remarkably – to give the CIA a refund

Lockheed Martin

The F-117A exemplifies an innovative approach to produce a type that was ahead of its time

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Attack surface

Digital technology has brought huge gains in performance, efficiency and customer service to aviation – and left a fragmented, interconnected industry vulnerable to hackers

DAN THISDELL LONDON

Can an aircraft be hacked? The answer would appear to be yes. It emerged last year that, in 2016, US Department of Homeland Security cyber experts had hacked into the avionics of a Boeing 757 obtained by the agency for testing.

The incident, widely reported in the technology press, happened on the ground, not in flight; it is notable that this breach was realised not in a laboratory but out on a runway, using the rather ordinary means of radio frequency communications. Also widely reported was that the weaknesses exploited were known about, or at least suspected, for years.

To talk to cybersecurity experts is to rapidly conclude that other, and newer, aircraft types should also be considered vulnerable. For one truism of cyber security is that no system, if connected to the internet, is truly secure. And, even if a system does not appear to be connected to the internet, or is designed with "airgaps" to insulate it from external connections, it probably is accessible via the internet. Moreover, the aviation industry is, like every other one, becoming increasingly reliant on digital technology – and hence becoming more connected.

Pete Cooper is a former UK Royal Air Force Panavia Tornado pilot and instructor who went on to advise the Ministry of Defence and international organisations on cyber operations and security and, earlier this year, wrote a report for the Atlantic Council think tank. He is clear that the digital era offers great benefits to aviation: efficiency, passenger satisfaction and better information to managers and pilots. But speaking to FlightGlobal, he observes that digitalisation is also creating "exponential" growth in the number of weak points – cyber experts call them "attack surfaces" – and the aviation industry, he says, does not really have an answer to the question of what to do about them. Attack surfaces are prevalent throughout the supply chain, in air traffic control systems and even in jet engines, which often carry geo-enabled SIM cards.

ACTION REQUIRED

In aviation, he says, there is a lot of talk about digital innovation but very little about cybersecurity. Among those who are discussing the subject, there is growing alarm at what »

The US Department of Homeland Security caused a stir in 2017 by revealing it had hacked a 757 during ground tests

Aviation Images/REX/Shutterstock

» they perceive to be an absence of urgency in the broader aviation business. Asked what it will take to push the industry to act, one industry figure close to security on a discussion panel led by Cooper put it thus: "It's going to take the factory over the road burning down before they buy a sprinkler system."

But the fire analogy goes only so far, because no amount of protection of one's own "factory" is sufficient in a connected world. The Atlantic Council report was underwritten by Thales, best known in aviation for its leading presence in air traffic control and in-flight entertainment and connectivity (IFEC) systems. Alan Pellegrini, who heads the French electronics group's North America operations, says research and Thales's work with aerospace majors points to it being "very, very unlikely" that attackers could hack into a flight control system and crash an aircraft: "I firmly believe that."

However, Pellegrini sees the aviation industry as being in a difficult position over cyber protection. Airlines, manufacturers and organisations like IATA or ICAO are aware that cyberattacks happen, but at the same time are increasingly vulnerable, owing to digitalisation. Concrete action, he observes, is difficult because aviation and aerospace are fragmented industries, with many connected actors and computer systems. It is not, he says, like a single company that might decide to take action to protect its own IT system.

The gold-standard attack may be to hack the flight control system, but there are easier ways to cause severe mayhem

That interconnectedness, he says, has each organisation relying on others – including Thales – to make their systems secure. But without a systematic, industry-wide concept of security each link in this chain is vulnerable. Thales, he says, would like to see a "collective approach", driven by one of the big industry organisations.

ICAO has not been ignoring the cyber threat. A working paper published in 2016 calls for "states and industry stakeholders" to identify threats, define responsibilities of national agencies, "encourage the development of a common understanding... of cyber threats and risks", share information and, among other things, "collaborate in the development of ICAO's cybersecurity framework". That paper references 2013 resolutions which, subject to resources, should be undertaken in 2017-2019. Cooper reckons that is too slow.

Meanwhile, a Thales document echoes Cooper in underscoring that, for all its benefits to operational performance, digitalisation is also giving aircraft "more appeal to attackers". The "rising interconnection between aircraft, service and data providers", it says, is causing "an expansion in threat vectors and has opened up the aircraft itself as a potential future attack surface".

Asked to identify attack surfaces, Pellegrini responds immediately with aircraft cabins. In-flight entertainment systems, he says, were not historically networked or connected – but today they are (hence the more recent term, IFEC). Those in-cabin systems increasingly handle financial transactions and passengers' personal data, and so represent an attractive target for hackers.

NEXT TIME YOU FLY

But while IFEC might be a highly improbable route for a hacker to reach the flight control system, improbable is not the same as impossible. The cabin as an attack surface is the focus of much work by two UK companies. To grossly oversimplify, an aircraft cabin IFEC system works much like home wi-fi, with a router distributing data to and from mobile devices. Owing to their shape and the number of connected devices, aircraft have several routers along their length, often supplied by VT Miltope. And those routers can run software by RazorSecure, which uses machine learning algorithms to identify unusual activity; is the passenger in, say, seat 28C streaming a movie or attempting to interrogate the operating system?

RazorSecure chief technology officer Lewis Oaten and VT Miltope business development director Markus Gilges describe this monitoring approach as a critical "active" step beyond "passive" security measures, such as firewalls and passwords. They cite work by Lockheed Martin, which has developed a concept called the "cyber kill chain", which recognises that most of the activity associated with a cyberattack happens inside the password-firewall barrier, and notes that the average time between a security breech and its discovery is 180 days – that is, six months.

The crux of the problem, says Oaten, is that there is no such thing as total security. "Security is a delaying mechanism," he points out. Most locks, he observes, are pickable – but they are useful devices and widely used, because delay allows time for response. Cybersecurity should be seen in a similar light.

Oaten cites as an example another widely covered hack, of a Jeep Cherokee automobile in 2015. This was a controlled demonstration that severely rattled a *Wired* magazine reporter riding in the vehicle while remote hackers took control of the throttle and brakes. Significantly, the hackers started with the passenger-facing systems and "picked locks" until they had access to the controls.

There is, says Oaten, no complete separation of IFEC from flight control. A successful attack on an aircraft's control system via the IFEC would, he is certain, involve attackers taking many flights to reconnoitre the system and probe weaknesses. Meanwhile, a system like RazorSecure would in principle be alerted to abnormal activity.

The important point is that by setting the bar high enough, a security system will thwart an attack by diverting attackers' attention to an easier target – not unlike domestic security; burglars are typically deterred by a locked door because they know some neighbour is likely to have left a window open.

Another weak point is in the cockpit, which Pellegrini notes is more and more networked. Tablet computers used as electronic flightbags, he says, are "an area of increasing concern". These are connected in real time, for example for weather updates, and so are points of vulnerability. Electronic flightbags are also used to calculate flight plans, says

Communications is a security weak spot, as data links replace radio voice contact between pilots and controllers

Aviation Images/REX/Shutterstock

Cooper, and an attack that fed in false data could be disastrous.

Communications generally is a danger zone. Thales understands air traffic control intimately, and Pelligrini sees hazards in the shift – again driven by increasing digitalisation – from air traffic controllers talking over the radio to pilots to cockpits receiving data directly from air traffic control computers.

A related concern is navigation; ground-based radar is increasingly being supplemented – or, over oceans, supplanted – by Automatic Dependent Surveillance-Broadcast. ADS-B relies on navigation satellite signals to tell each aircraft where it is and where other aircraft are, and informs air traffic control. That is, aircraft are effectively nodes in an automated network. US GPS and European Galileo signals are reasonably secure but receivers can be spoofed; indeed, RazorSecure offers a GPS anti-spoofing function as an add-on.

Even the aircraft component supply chain offers attack surfaces. Cooper's report includes the conclusion that the benefits of 3D printing – reduced component weight, less material waste in manufacturing and, eventually, cost-efficient just-in-time on-site production of spare parts – comes with a cybersecurity caveat. If hacked, the software that directs a 3D printer to make a particular part could be perverted to produce a part "designed" to fail under load. And, he says, it is entirely possible that nobody would suspect the attack until there was a crash.

PATH OF LEAST RESISTANCE

But while crashing an aircraft by hacking into the flight control system or taking over air traffic control might be the "gold standard" cyberattack, there are easier ways to cause disruption that go far beyond that caused by the theft of passwords or credit card numbers.

Looking back inside the cabin, Gilges and Oaten flag up the disturbing prospect of an IFEC system hack that plays games with the passenger-facing moving map. Those maps, notes Gilges, may not offer access – at least, easily – to the flight control system, but they get their information from that system. If a hacker were to change the images or substitute a message – political or threatening – what would be the impact on passengers' confidence in their safety?

And, if passenger confidence were undermined, what would be the effect on the airline industry? Oaten warns that these attacks do happen. RazorSecure has rail clients, which run IFEC systems similar to airlines'. One client, he says, experienced periodic gaps in passenger wi-fi, and when RazorSecure installed software to monitor the system it discovered those dropouts to be not technical glitches but, instead, denial-of-service attacks.

A high-profile example of an incident that should have the airline industry worried was the May 2017 WannaCry ransomware attack that disrupted computer systems globally. One victim was the German railway network, Deutsche Bahn; passengers were faced with station message boards that gave details not of train times and platforms but demands for payment to restore service.

Cooper is in no doubt that aviation needs to take very seriously its vulnerability to such attacks. Air transport, he says, "is a massive trust industry". Like other industries, aviation has gone digital without considering cybersecurity – and now faces the prospect of having to add in security features that should have been built in from day one.

Two critical changes are needed if aviation is to maintain that trust in the face of a cyber attack. One is a change of mindset. In his research, Cooper says he is repeatedly confronted by industry leaders who say, in effect, that their operations are secure so passengers can travel in confidence.

But any assumption of security "is a very, very big statement" which leaves no room to respond to the disaster of trust that would follow an attack. Consider, he says, the response to 9/11. Increased security at airports and secure doors on cockpits were a visible signal that passengers' safety concerns were being addressed. No similar measures are available to respond to a cyber attack.

A second shift is for the industry to recognise that while it cannot be truly, totally secure, it can be resilient. Resilience includes measures to protect timely and confident decision-making by appropriate human actors. This, again, is a question of trust. Pilots, for example, must be able to trust the flight-critical information they receive in the cockpit.

The mistake is to follow the typical approach to security concerns, which is to focus on technology; this method may tighten security but ignores resilience, which is about being ready to respond to a problem. Instead, says Cooper: "Focus on trust." ■

Time to get a digital grip

From techniques that accelerate online price comparisons to offering the most attractive payment methods, airlines are in a running battle to stay ahead of tech-savvy passengers

GREG WALDRON BANGKOK

The Technology and Innovation in Airline Distribution conference in Bangkok, Thailand – jointly organised by FlightGlobal and T2RL and staged from 22-24 May – explored the technological issues and challenges facing airlines as they court increasingly tech-savvy consumers.

Representatives from airlines and suppliers discussed topics from how to deal with online travel agents and search engines, to keeping travellers engaged through personalisation and the correct timing of communications.

Quanwu Xiao, director of big data and analytics at Ctrip, says the company uses exclusive customer feedback, along with search and buyer data, to inform its marketing efforts, along with weather, third party and passenger name record information.

"Around 80% of our bookings come through our mobile app," he says.

One system the company uses to expedite user searches for air ticket prices is what Xiao calls pre-search, which cuts the number of milliseconds a customer waits for ticket price information. This technique involves anticipating their pressing the search button, and conducting the activity before the user requests the information. The results are cached on the passenger's mobile device, and pop up immediately when the search button is pressed, giving the impression of a very fast response time.

Pre-search covers about 60% of Ctrip's activity, which Xiao says helps it to retain impatient customers. The company's scale gives it the data to predict prices and demand, spot anomalies, and help with route analysis, he adds.

WEB SCRAPERS

Bert Craven, chief strategy and research officer at T2RL, says the number of pricing searches hitting airline servers is growing, placing more demands on carriers. He notes that a large proportion of searches will not lead to a direct sale, as they are conducted by web scrapers and aggregators. This type of traffic is also not conducive to the airline controlling the ultimate offer to passengers, he notes.

The advent of smart speakers – such as Amazon's Alexa and Google Home – presents another challenge. As people who ask for flight information will not be willing to listen, in voicemail style, to a long menu of options and ancillary information, the delivered offer must be exactly right immediately.

"This type of intermediary will push technology even further," says John Stewart, senior vice-president of sales at Farelogix. "People won't listen unless it's the right offer, and this is something we've already seen with mobile platforms."

Meanwhile, a panel discussion focused on inventory and revenue management observed a trend whereby full-service carriers manage their domestic revenue networks like a low-cost carrier, with lower fares, while their international networks use a more traditional revenue management approach.

Revenue management will continue evolving into a full dynamic pricing model, but will go through three phases. The first – where most airlines are currently positioned – places seats in pricing buckets, creating fare bands for specific seats. The next state will be dynamic ticket pricing within each class, based on passengers' willingness to pay. The final phase will be a so-called "classless fare," where the price is determined in real-time.

Steven Buchers, senior director sales and support, Asia-Pacific at Revenue Management Systems, says artificial intelligence (AI) will have an impact, but today is mainly a phrase the industry is excited about. "AI will provide some benefit, but it is more buzz[word] than anything substantial," he says.

Machine learning is currently entirely reliant on accurate data to generate the correct decision via AI, with inaccuracies and anomalies hurting this process and accurate pricing data also required from other airlines.

One airline representative expressed dissatisfaction with the providers of revenue management software. "Sometimes suppliers don't understand airlines' commercial needs," the official says. "In many cases they provide closed products, which we can't customise. If a process is not used by other airlines or is in the development roadmap, you're in trouble."

In the early 2000s, Nok Air distributed tickets via convenience stores

AirTeamImages

This means that revenue management analysts often need to make manual overrides. "This is cumbersome and leads to more paperwork. Adding complexity, analysts tend to conduct overrides in their own individual fashion," the source adds.

Also during the event, the topic of payments and distribution in China was addressed. While the nation is viewed as a crucial market that will have a profound influence on the airline business even beyond its borders, it presents significant challenges.

"If you don't go to China, China will eventually come to you," says Michael Moore, managing partner at T2RL.

Annemarie Perry, partner director airlines and travel at Worldpay, points to China's penchant for QR codes. "These are the preferred way to pay for things in China, but how do you translate this into the airline ticketing environment? If you are a Chinese carrier looking abroad, how do you process those payments?"

Amine Boulaghmen, head of IATA settlement services, says it is essential for airlines to accept payments in the form the customer prefers. "The moment you don't accept a payment, you lose a passenger forever," he says.

GREAT FIREWALL

A substantial challenge is coping with China's so-called "Great Firewall," which blocks access to most internet sites beyond the nation's borders. One airline representative notes that while their company's website works in China, it faces problems with payments due to the protective firewall.

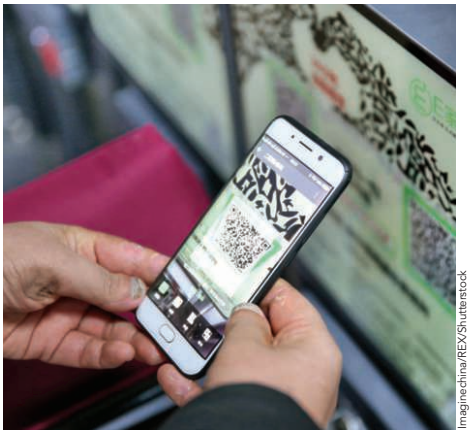
Xiao notes that in Ctrip's experience, Chinese passengers dislike emails, and says that if airlines want to communicate with them, it is best to use text messages or a chat function.

Meanwhile, a panel session on the future of distribution tackled how to appeal to the always-connected "digital traveller".

Patee Sarasin, former chief executive of Thai low-cost carrier Nok Air, notes how passenger expectations have changed over the years. To illustrate this point, he recalls how Nok scored an early coup in the early 2000s by arranging for 7-Eleven convenience stores to provide a distribution channel for tickets.

On the critical issue of how to provide travellers with meaningful and useful communications on small smartphone screens, Sarasin says timing is everything. "When the passenger is at the baggage carousel, for example, the app can ask if they have received their bags. If they haven't, then it can help the airline take the right action."

Boulaghmen says that getting payments right is a key element to the passenger's digital experience, and refers to Uber – where riders leave the car and their credit card is debited automatically – as a good example of how seamless this process can be. However, an IT executive from one airline stresses that when developing an app, carriers should not to be too ambitious from day one, but rather aim to add capability incrementally.


Imaginechina/REX/Shutterstock

Chinese travellers like to pay with QR codes

"You shouldn't put all your dreams in one bucket, because you won't get there," the official says. "You'll just end up with a mishmash of functions."

Potential pitfalls airlines can encounter include trying to develop their app too quickly, suppliers' failure to meet deadlines, and the involvement of other departments internally, the executive notes. A critical element which must be present from day one is IT security, they add, since this requirement can have a major influence on the functionality of the finished product.

Yanik Hoyles, director of the New Distribution Channel (NDC) at IATA, outlined the objectives for the technology standard, which will allow an airline to provide the same range of offerings through online travel agents and global distribution systems as through its own website.

Calling on carriers to embrace NDC, Hoyles contends that it offers them a competitive advantage. "Technology is moving. If you want to take part you should do so now, because then you can influence it," he says.

Hoyles notes that the investment banking community also feels that the NDC standard is a positive step. A Deutsche Bank report published in February stated that "distributive freedom" could boost the European airline sector's earnings before interest and tax by as much as 20%, while a Citibank study drew similar conclusions.

But Ian Tunnacliffe, editor-in-chief of T2RL, says that airlines need a clear idea of their ultimate objectives before implementing NDC.

"First, airlines need to get their commercial and product strategies to where they want them," he says. "What are you trying to achieve and what do customers expect? NDC is the icing on the cake that will let you deliver it to the channel." ■

Apps could help at baggage carousels, by asking if passengers have got their luggage

Alex Segre/REX/Shutterstock

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If it's not Boeing, Kim's not going

DPRK media coverage of Kim Jong Un's summit-bound arrival in Singapore must have baffled ordinary North Koreans, not used to being given the full facts when it comes to world affairs.

The Supreme Leader was pictured on front pages stepping off not the ageing Ilyushin Il-62 that is the country's official "Air Force One" but an Air China 747, built in what was, until weeks ago, the Evil Empire, and with a big Star Alliance logo – whatever that is – by the door.

Perhaps Kim needed the miles to retain his tier status.

Xinhua News Agency/REX/Shutterstock

"With greatest respect, Sir, we are not sure you arriving in Singapore this way quite sends the right message."

Bird of pray

US televangelist Jesse Duplantis is asking his followers to help him fund a Dassault Falcon 7X – because if Jesus was around today he "wouldn't be riding a donkey".

Now, we are in all in favour of the argument that private jets are a smart way of doing business, whether that business is spreading your investments or spreading the word.

But surely Duplantis's implication that a 21st century Messiah would be preaching his sermon on the mount from 40,000ft is theologically flawed, if nothing else. Shanks's pony was Jesus's first century preferred mode of transport. He is recorded riding a donkey (or ass) only once, for his entry into Jerusalem – a humble parody of a Roman general's triumphal parade on horseback.

His ministry focused on a small area within modern Israel and he never opted for the Roman Empire's equivalent of a business jet – a Mediterranean trading ship – leaving the later proselytising around the known world to his apostle Paul.

and local upheaval – delivering vital new capacity far more cheaply and sooner. A bigger Gatwick would mean London had two world-class airports rather than one. And Crossrail will any

An Emirates Boeing 787 Dreamliner flies over the Instrument landing system at Heathrow

Top Geer

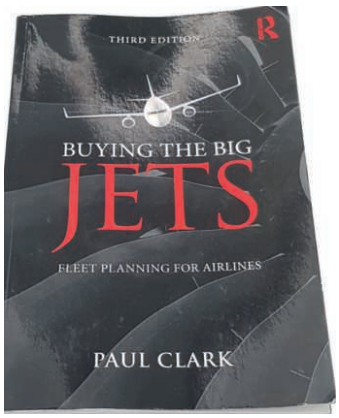
From the names-that-suit-your-job dept: Rolls-Royce's chief engineer on its UltraFan engine – which has a geared design to deliver power at high-bypass ratios – is one Andy Geer.

Four-sight

Great scoop from the *Sunday Telegraph* (*left*), which has revealed a previously undisclosed image of a four-engined version of the 787 being flown into Heathrow – and by Emirates, until now not known to operate Dreamliners.

How to buy big

Just out in its third edition, Paul Clark's *Buying the Big Jets: Fleet Planning for Airlines* is a great primer and refresher for anyone looking to understand "the vastly complex" business of airlines opting for the right aircraft.



Clark, who spent over 20 years at Airbus and now runs his own aerospace consultancy, writes with authority, and crucially clarity, about the wealth of factors that influence buying decisions. Topics include cabin design and aircraft performance, as well as fiscal considerations.

A number of case studies throughout clarify and distil the book's major themes. The book is highly readable and provides a through overview of its topic. Recommended.

100 YEARS AGO

Ostrich industry

There is a relation between flying men and the future of the South African ostrich feather industry. There was recently exhibited at Grahamstown an airman's waistcoat, made of quilted satin and lined with short stock feathers. Here one may have the genesis of a new industry.

75 YEARS AGO

Serious altitude

According to an Axis report, experiments are being made in Germany of the construction of a glider equipped with a special high-altitude cabin. Prof. Georgii, who is in charge of the research, expects an altitude of about 30,000ft. will be possible with the new glider.

50 YEARS AGO

Everybody eject!

There are still people who believe that all aircraft seats should have an ejection device fitted to them; but this would be impracticable because of the extra weight involved, and untrained passengers would hardly be likely to be able to use an ejector seat and parachute effectively.

25 YEARS AGO

French financials

Airbus is asking Paris to ensure that French tax revenues are not used indirectly to finance airlines' Boeing 777 purchases. The issue arises over 777s powered by GE90 turbofans – in which state-owned engine-maker Snecma has a 25% share.

100-YEAR ARCHIVE
Every issue of *Flight* from 1909 onwards can be viewed online at flightglobal.com/archive

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airtattoo.com

16-22 July
Farnborough International Airshow
Farnborough, UK
farnboroughinternational.co.uk

23-29 July
EAA AirVenture
Oshkosh, Wisconsin, USA
eaa.org/en/airventure

15-18 September
World Routes
Guangzhou, China
routesonline.com/events

19-23 September
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Waterkloof, South Africa
aadexpo.co.za

16-18 October
Helitech
Amsterdam, the Netherlands
helitechinternational.com

16-18 October
NBAA
Orlando, Florida, USA
nbaa.org/events/bace/2018

6-11 November
Airshow China
Zhuhai, China
airshow.com.cn/en

14-16 November
Bahrain International Airshow
Sakhir air base, Bahrain
bahraininternationalairshow.com

28-29 November
Aerospace Big Data Summit
London, UK
flightglobal.com/bigdataemea

10-12 December
MEBAA
Dubai, United Arab Emirates
mebaa.aero

7-11 January 2019
AIAA Science and Technology Forum and Exposition
San Diego, California, USA
scitech.aiaa.org

26 February-3 March
Australian International Airshow
Avalon, Australia
airshow.com.au

5-7 March
HAI Heli-Expo
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heliexpo.rotor.org

10-12 March
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Cebu, Philippines
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16-18 April
Aeromart Montreal
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FlightGlobal

OGMA

Global fleet business intelligence is helping OGMA's commercial team validate and explore new commercial opportunities to drive further success.

OGMA is a world-leading manufacturing, repair & overhaul (MRO) organization based in Portugal, with around 1700 people working in the main facility near Lisbon. The company is 65% owned by manufacturer Embraer and 35% by the Portuguese Government. The business turns over approximately €200 million a year and conducts airframe, engine and component maintenance across military, commercial and executive aircraft. It also has another business unit dedicated to manufacturing metallic and composite structures.

The military sector accounts for 66% of OGMA's total business while the civil sector is responsible for 34%. More than 90% of the commercial and business jets work is base, engine and component maintenance requests for Embraer aircraft.

This specialization means it is fundamental for OGMA's commercial and senior management teams to have a detailed view of the location and ownership of all Embraer commercial aircraft and other military aircraft.

The challenge

To produce insight that supports business decisions OGMA's analysts must carry out in-depth research. An essential element of this research is data that includes the location of aircraft, engines or landing gears. OGMA's analysts must access validated data that is comprehensive, accurate and timely to confirm or dismiss assumptions successfully. If OGMA did not have access to a verified fleet database, it would be impossible to deliver high-quality analysis.

OGMA realizes that data quality, accuracy and timeliness would be critically impaired if its analysts had to source data directly because multi-source data management is a complex process. Certain investments, which can be time consuming and expensive, must be made to meet the required levels of reliability and trust in fleet data, such as:

- Maintaining the right relationships with airlines to collect data
- Developing processes for updating data
- Implementing methodologies to process and validate data

Proper data collection and management can take years to perfect. If the analysts at OGMA had to perform searches for their research using multiple sources, it would put them at risk for using scattered, unreliable data. As a result, commercial and senior management teams could make decisions that would negatively influence the growth of the organization.

OGMA needed to ensure it had a premium fleets solution that would save time with researching and validating data, and provide it with the most up-to- date fleet information to power their business intelligence.

The challenge

OGMA needed accurate and timely fleet data to conduct high-quality research and make business decisions with confidence.

The solution

Flight Fleets Analyzer contains over 100,000 commercial aircraft records and has provided a platform for OGMA to conduct in-depth analysis of the global fleet.

FlightGlobal's fleets database, Flight Fleets Analyzer, is the number one solution available in the market place."

Goncalo Correia – Business Intelligence Manager

The solution

FlightGlobal's Flight Fleets Analyzer is a great fit for OGMA. It provides more than 100,000 commercial aircraft records and has a comprehensive view of all in-service, stored, retired, and on-order Embraer aircraft. The business intelligence (BI) team manages the process of exporting and analyzing the fleet data directly from Flight Fleets Analyzer. These requests for fleet analysis typically come from the commercial teams looking to validate assumptions on core details affecting a potential deal or providing them with a map of potential opportunities by segmenting a specific aircraft type and sub-series by operating base/location.

OGMA has improved its ability to conduct market sizing by using Flight Fleets Analyzer to export searches on the number of aircraft operating in a specific region. This data is broken down into further detail to analyze the trends of current operators, managers and owners.

The commercial team takes a large market analysis and can request further granular research from the BI team surrounding an individual aircraft record, with the objective of sourcing the maintenance history and supplier. Flight Fleets Analyzer makes these granular requests simple by allowing the user to search by serial or registration number. The aircraft profile page displays a detailed aircraft history, hours and cycles utilization data, owner, manager and previous maintenance events, giving the sales staff detailed and credible information to support their discussions with the prospect or customer.

If the sales manager wants a deeper analysis of maintenance records, Flight Fleets Analyzer allows the BI team to dive down into core details about existing maintenance contracts. The team has access to details of more than 25,000 maintenance contracts broken down by airframe maintenance, including A, B, C and D checks, landing gear, components, composites, wheel/tyre/brake providers, and more than 7,500 additional engine/APU overhaul contracts.

One of the key aspects of Flight Fleets Analyzer is the ability not just to conduct fleet overviews but to dive down into engine analysis. OGMA is currently using this solution successfully to conduct an in-depth market-sizing exercise of the number of Rolls-Royce engines operating on Embraer aircraft.

The data supplied by Flight Fleets Analyzer has helped OGMA's sales function to save time in researching the location of new opportunities, allowing more time to focus on pursuing commercial opportunities with confidence and authority.

> **"Flight Fleets Analyzer makes it possible to achieve the level of in-depth granular fleet analysis needed to power our business intelligence."**

Goncalo Correia – Business Intelligence Manager

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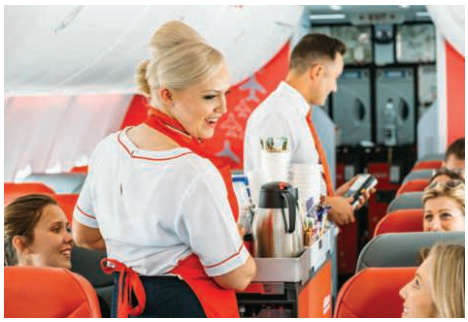

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WORK EXPERIENCE JON RAMBEAU

Turning information into a weapon

As leader of Lockheed Martin's C6ISR business, Jon Rambeau is spearheading the drive to ensure that customers are able to strike first in battle by analysing and acting on the huge volume of data available

How did you first become interested in aviation?
My father served in the Vietnam War as an infantry soldier. When I was young, we talked about his experiences. One vivid memory is his description of the McDonnell Douglas F-4 Phantom IIs that would fly low overhead as he was out on patrol. I felt the pride in his words as he reflected on that. Later, when I joined Lockheed Martin, I was drawn to our aircraft business and had the privilege to be part of the F-35 Lightning II programme team, which will no doubt be one of the greatest highlights of my career.

How has your career developed?
I began with Lockheed Martin in 1996, straight out of university, and have worked in many different segments of our business, including naval combat systems, training and logistics, and cybersecurity. My first true aviation assignment was working on the F-35 as the vice-president for international programmes. During my tenure, we made our first international aircraft delivery – to the UK, commenced production in our Italian final assembly factory, and were selected by Japan to provide their air force with the F-35.

What does your current job involve?
As vice-president of C6ISR (command, control, communications, computers, combat systems, cyber, intelligence, surveillance and reconnaissance), I lead a diverse portfolio and a team of nearly 6,000 employees around the globe. We deliver multi-domain and undersea mission superiority. We're experiencing an exponential increase in the volume and the velocity of information available in the battlespace. The future of battle management depends on our ability to synchronise the systems in each domain – land, air, sea, space and cyberspace – so we have the best picture of the battlespace. That's what we do extremely well: turn data into knowledge, and knowledge into decisions and action.

Lockheed Martin

People are a vital factor in success and an inspiration, says Rambeau

What is a major recent project?
Lockheed Martin continues to grow our workforce in Australia. In my last role, we won the Department of Defence's Project Air 5428 pilot training system contract and the first Pilatus PC-21 acquired under the effort made an appearance at the Avalon air show last year. We've also recently secured the contract to develop and deliver the combat system for Australia's future submarine. We are additionally making strategic investments with the intent to support Air 6500 – the Royal Australian Air Force's major programme to develop a joint battle management system for Plan Jericho. That initiative aims to leverage all the platforms in Australia's inventory and make them operate together, allowing its military to become a more effective 21st century combat force. Thanks to Lockheed Martin's experience as prime developer and systems integrator for the two most transformative fifth-generation assets – the F-22 Raptor and the F-35, we have shown a proven ability to integrate disparate systems and platforms to enable operational capabilities going beyond the power and resilience of any individual asset.

What is the most enjoyable part of your job?
The most enjoyable part, by far, is the people. People come to work at Lockheed Martin because they want to make a difference. I'm inspired every day by our workforce; by the dedication and commitment they demonstrate to serving our customers and being the world's greatest provider to the US military and allies around the globe. I love my job because I am passionate about our people, and the work they do.

And the most challenging?
My greatest challenge is time. I lead an exciting business, and it is truly a global enterprise. While having a strong leadership team makes my job easy, there are never enough hours in a day to do everything I would like to do. It's important that I strike a balance across several areas – namely managing our operations, engaging with employees and customers, and shaping our strategy. It's a challenge to achieve the right balance every day, but one that I enjoy wholeheartedly. ■

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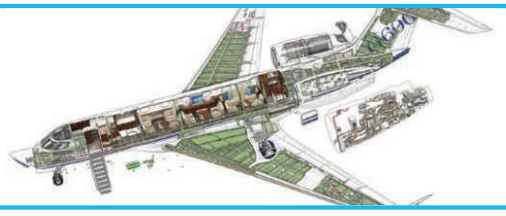

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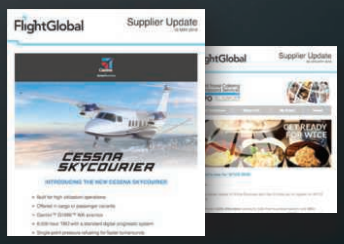

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