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BOEING'S BIG FIX

REVIVING THE
MIGHTY C-17



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A V-SHAPED FUTURE?

KLM'S CONCEPT
TAKES FLIGHT



FAUX FOES
FRENCH NAVY TESTED

WORLD'S LONGEST ROUTES

HAS ULTRA
LONG-HAUL
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ITALIAN POLICE WING REVAMP COMMANDER'S INSIGHT

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Welcome



ello and welcome to an autumnal edition of *AIR International* which offers another exciting glimpse into the future of commercial aviation.

Hot on the heels of our NASA and Lockheed Martin X-59 exclusive on the potential for supersonic travel to return, we ask if future flight could look 'V-shaped'?

A team of engineers based in Holland, working alongside partners from KLM and Airbus are celebrating the latest milestone in the Flying-V programme – a truly pioneering project which literally has the potential to reshape how we all fly. See **page 36** for the start of our special eight-page report.

Moving from shape-changers to sheer scale we go behind the scenes of a true aviation giant – the ubiquitous C-17.

Since entering service in January 1995, Boeing's C-17 Globemaster III has become the most flexible airlifter in the United States Air Force (USAF). This massive, multi-service transport aircraft – 53m long with a 51m wingspan – can deliver troops, equipment, and strategic supplies to almost any airfield in the world. Massive and sturdy, it can tackle harsh terrain and unpredictable conditions while delivering oversized payloads around the clock. No wonder USAF crews call it the "Moose".

But all this heavy lifting requires constant maintenance. Under the Globemaster III Sustainment Programme contract, Boeing is responsible for the C-17's equipment management and depot-level aircraft maintenance.

That's why the company operates one of the largest military aircraft maintenance, repair, and overhaul (MRO) facilities in the world, at Kelly Field in San Antonio, Texas.

We visited Boeing's facility to find out how the C-17 undergoes a complete MRO overhaul inside the largest free-standing aircraft hangar in the world, and learned how the company aims to keep the mighty airlifter flying for decades to come – see **page 30**.

Other highlights within this edition include a detailed look at the latest Chinese-built airliners – see **page 52** – and a fascinating insight into the role of the black box recorder begins on **page 76**. We really push the envelope as we examine the world's longest commercial air routes – from **page 92** – and there's a preview of a new helicopter exhibition, European Rotors, which is on the horizon in Germany as the winter approaches. We'll bring you more *AIR International* insight and analysis at the November show.

Speaking of winter, swiftly changing international responses to coronavirus inevitably continue to impact our industry. The entire magazine team thanks you, our readers, for your ongoing support as we all seek to work through these extraordinary times.

Don't forget to keep in touch and enjoy the magazine.

Carol Randall

Associate Editor, Commercial Aviation

The Airbus A350-900 is part of a new generation of widebody aircraft helping carriers push the boundaries of long-haul flying. This Japan Airlines (JAL) example, JA01XJ (c/n 321), was delivered to the Tokyo-based firm in June last year. See *Plight of the lone rangers*, pages 92-97 Airbus

COVER IMAGE: A render of the sleek Flying-V. Designed to carry around the same number of passengers as the A350 and an equivalent amount of cargo, it could re-shape future flight
Henri Werij/Delft University of Technology





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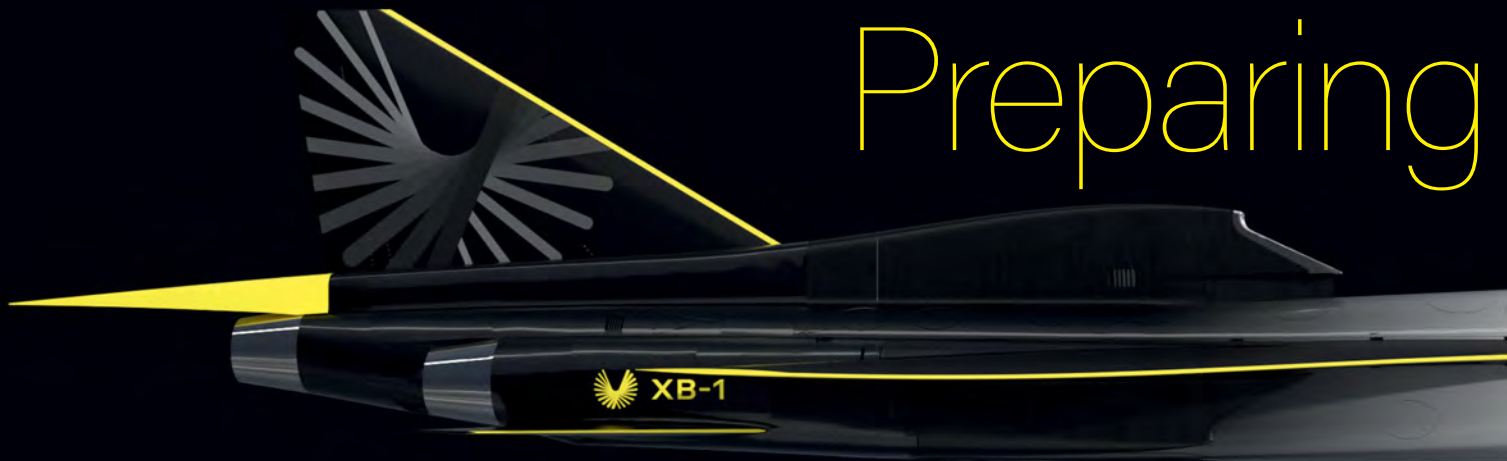
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Before COVID-19, airlines were flying further than ever before with new non-stop city pairings. We investigate the technology and reflect on the issues facing carriers operating ultra-long-haul services. Mark Broadbent reports.

Preparing



BOOM SUPERSONIC is due to unveil its XB-1 supersonic demonstrator in a virtual rollout on October 7.

The jet is a one-third scale demonstrator for a future supersonic airliner proposed by the US start-up company, Overture.

Boom has achieved several production milestones over the last

year, including joining the fuselage to the landing gear, completely closing the wing and fuselage structures and undertaking drop tests on the undercarriage. The firm intends to start test-flying the XB-1 demonstrator from next year.

A company statement read: "Combining advanced aerodynamic

design, carbon composite material and high-efficiency propulsion, [the] XB-1 demonstrates the key technologies for safe, efficient, and sustainable supersonic flight. The completion of XB-1's assembly marks a turning point in commercial viability for supersonic travel."

In July it was stated Rolls-Royce and

Hybrid e-Starling readies for flight

A HALF-SCALE prototype from a UK start-up is being prepared for its maiden test flight.

The Samad Aerospace e-Starling is an unusual hybrid concept, mixing conventional fixed-wing and vertical take-off and landing (VTOL) configurations. To be powered by hybrid-electric engines, the six-seat

all-composite design is intended for regional transport operations between cities.

A Samad Aerospace statement to *AIR International* explained: "The aircraft will be propelled by five electric-powered fans: two on the trailing edge of the wing thrusting vertically, two units embedded in the

aircraft's blended wing body, which are only used during vertical flight [and] one fixed fan coupled with a range extender in the tail providing the necessary thrust to take the aircraft beyond stall speed and transition from hover to cruise for shorter journeys."

Samad Aerospace is a UK-based developer of hybrid-electric vertical take-off and landing aircraft established in 2017. Founder and CEO Dr Seyed Mohseni has an MSc in aerospace propulsion and an MBA and doctorate in gas turbine technology from Cranfield University.

The company is taking a step-by-step approach to the e-Starling development and certification programme to make sure the aircraft operates perfectly as both a fixed-wing aircraft and a rotorcraft platform.

Scale prototype testing will help explore the critical operational challenges, notably turbulence behaviour, wake characteristics and noise levels and validate simulations and mitigate risks before a full-size demonstrator is developed, to fly in 2025.

Samad Aerospace's hybrid e-Starling concept
Samad Aerospace



AMID THE continued fallout from COVID-19, manufacturers are making staffing cuts. In September 2020 Embraer announced around 900 job losses, GKN Aerospace parent company Melrose said it plans a "significant reduction" in its workforce. A further 95 jobs at the Bombardier factory in Northern Ireland, still in the process of being sold to Spirit AeroSystems, are also reportedly at risk.

VIRGIN ATLANTIC has completed a recapitalisation of its airline and holiday business. A refinancing package worth £1.2bn over the next 18 months will be put in place in addition to the £280m annual cost savings and £880m reduction in fleet capital expenditure in the next five years.

for the 'Baby Boom'



Colorado-based Boom had signed an 'engagement agreement' to "explore the pairing of a Rolls-Royce propulsion system with Boom's flagship supersonic passenger aircraft, Overture".

Teams from the two organisations are working together to "identify the propulsion system" that would be suitable for the Overture airframe

and examine certain key aspects of it. "The teams will investigate whether an existing engine architecture can be adapted for supersonic flight, while Boom's internal team continues to develop the airframe configuration".

Japan Airlines (JAL) has a strategic partnership with Boom to support the US company in creating the

Overture, helping the developer refine the aircraft design and define the passenger cabin experience.

The agreement between JAL and Boom includes an option for it to purchase up to 20 Overtures through a pre-order arrangement. Separately, UK-based Virgin Atlantic holds options for ten examples.

An artist's impression of the XB-1 due to be unveiled in October
Boom Supersonic



Big hopes for a 'bullet plane'

OTTO AVIATION has unveiled a distinctive aircraft that it has stated will be "the most fuel-efficient commercially viable passenger aircraft in the world".

The US start-up has already flown its streamlined Celera 500L, N818WM (c/n 001), on more than 30 test flights. The bullet-shaped aircraft "presents a major leap forward in the effort to develop a zero-emission air transportation system", its makers said.

Extensively using laminar flow technology on the fuselage, wings and tail surfaces to reduce drag and maximise

speed and fuel efficiency, the developer claimed its clean-sheet six-seat design "will completely alter the way people and parcels travel". The airframe has a maximum cruise speed of 391kts, more than 3,908nm range, a large stand-up cabin and fuel economy of only 18 to 25 miles per gallon.

Otto Aviation chairman and chief scientist William Otto Sr said: "Our goal was to create a private aircraft that would allow for direct flights between any city pair in the US at speeds and cost comparable to commercial air travel."

He continued: "Individuals and families will be able to charter the Celera 500L at prices comparable to commercial airfares, but with the added convenience of private aviation. We believe when the price of private air travel is competitive with commercial air travel, an enormous market opportunity will result."

The Celera 500L will provide access to more than 5,000 regional airports while providing 40% lower carbon dioxide emissions "compared to the latest commercial transport aircraft", its developer said.

Designed for private air travel, the Celera 500L uses laminar flow technology
Otto Aviation

MATERIAL SUPPORT and services for the Airbus A220 family has been transferred by the manufacturer to its services subsidiary, Satair. The transition means Satair is now in charge of what an Airbus statement called "value-adding activities" supporting the operational A220 fleet including planning and inventory, purchasing, quality inspection, certification, warehousing, customer orders and distribution.

WIZZ AIR is set to expand operations with a second Airbus A320 at Doncaster/Sheffield Airport on October 22. It's launching six new routes: to Fuerteventura, Gran Canaria, Lanzarote, Tenerife (all Canary Islands), Lisbon (Portugal), and Eindhoven (the Netherlands). The Hungarian low-cost carrier is currently extending its network in Europe, Russia and the Middle East.

Europe tests the MAX

The European Union Aviation Safety Agency has test-flown the grounded Boeing 737 MAX Boeing/Paul Weatherman

RECENT EVALUATIONS of the Boeing 737 MAX by the European Union Aviation Safety Agency have moved towards first flights in "steady efforts" to return the type to service.

Following simulator tests at London/Gatwick Airport from September 1, EASA test pilots and engineers flew on a 737 MAX from Vancouver, Canada the following week. The Joint Operations Evaluation Board met at Gatwick in the week beginning September 14 to review those flights' results.

EASA has been working with the FAA and Boeing to schedule its flight tests, a process which an EASA statement said

"has been hindered by COVID-19 travel restrictions between Europe and the United States".

The European regulator said: "While Boeing still has some final actions to close off, EASA judges the overall maturity of the re-design process [and] is now sufficient to proceed to [the] flight tests. These are a prerequisite for the European agency to approve the aircraft's new design."

Efforts to recertify the grounded airliner have stepped up during 2020, with the US Federal Aviation Administration (FAA) flight testing various changes to the jet's flight

control software, including those to the upgraded Manoeuvring Characteristics Augmentation System (MCAS).

Data from the test sorties with the updated software is being evaluated and Boeing's design documentation and pilot training requirements reviewed. The FAA will issue an airworthiness directive outlining required corrective actions before a new certificate of airworthiness is issued. EASA said it is "working steadily, in close co-operation with the FAA and Boeing, to return the Boeing 737 MAX aircraft to service as soon as possible, but only once it is convinced it is safe".



One firm to reintroduce more services is LOT Polish Airlines, whose Embraer 190, SP-LMA (c/n 19000761), is pictured at London/City after landing from Vilnius, Lithuania London City Airport

THE COVID-19 pandemic's devastating impact on air transport continues, with more jobs woes recently announced by major airlines.

United Airlines expects to furlough more than 16,000 staff from October 1. Finnair announced in August that it was to lose 1,000 roles, while Virgin Atlantic said the following month that it will cut 1,150 more

jobs. Then, during the September 2020 CAPA Australia Pacific Aviation Summit, Qantas CEO Alan Joyce said "maybe another 2,500" positions were at risk at the Australian flag carrier.

Amendments to travel restrictions and quarantine rules, typified by the changing status of links between the UK and mainland European countries as

COVID-19 case numbers change, means airlines must continually adjust plans.

Figures from low-cost carrier, Norwegian Air, provide an example of the difficult task of managing capacity for operators as travel restrictions, and therefore demand, change. Despite reintroducing 15 jets to service, Norwegian carried only 313,316 passengers during August, a 96% fall year-on-year, with a 62.1% load factor on the flights.

Despite such challenges, many carriers continue to restore services and introduce new routes. Emirates has restarted links from Dubai to more than 70 points across Europe, Asia-Pacific, and Africa. Delta Air Lines is set to expand its transatlantic and transpacific networks in the winter 2020/21 schedule. Meanwhile, Virgin Atlantic has confirmed it's set to open a trio of new routes to Pakistan: London/Heathrow-Lahore and Islamabad as well as Manchester-Islamabad.

ROLLS-ROYCE IS to close two factories as part of its restructuring. The engine manufacturer is to shut its components plant in Annesley, Nottinghamshire and one of its two fan-blade production sites in Barnoldswick, Lancashire, with some work moving to Singapore by 2023. Around 1,500 jobs are expected to go at Rolls-Royce's Derby headquarters.

ALITALIA HAS received a direct €200m grant from the European Commission to compensate the airline for the impact of the COVID-19 pandemic on the carrier for the period between March 1-June 15, 2020, under the Treaty on the Functioning of the European Union. The Italian Government plans to renationalise the carrier.

THE EMBATTLED UK aerospace sector has urged the country's government to provide further help for the industry to cope with the shattering impact of COVID-19.

Derek Provan, CEO of AGS Airports, owner of Southampton, Aberdeen and Glasgow airports accused ministers of "overseeing the demise of UK aviation", while Heathrow Airport CEO John Holland-Kaye said "leadership" was needed. Provan warned the sector was seeing more job losses than the demise of the coal industry in the 1980s, adding: "That's surely not an accolade any government would like to have."

France and Germany are testing at airports for arriving passengers and the UK is said to be looking at a system under which negative results, several days apart, would mean someone would not have to quarantine for the full 14 days.

Provan said airports' calls for testing "are not getting any response back from the government", which he said was causing "huge frustration".



Holland-Kaye warned: "We have an unemployment crisis looming. The UK government needs to get behind testing as an alternative to quarantine to save millions of jobs in this country."

Meanwhile, ACI Europe, Airlines

Industry plea for more help

for Europe, Airlines International Representation in Europe, IATA, and the European Association of Slot Coordinators, have urged for a waiver for Europe's slot-constrained airports to help stimulate traffic.

Airports have urged UK government action on testing
Heathrow Airports Limited

Updated tech for oil spill 727s

AVIATION SERVICES company 2Excel Aviation has upgraded the TERSUS oil dispersant system on the two Boeing 727s it operates on behalf of Oil Spill Response Limited (OSRL).

Designed and built in-house at 2Excel's Doncaster/Sheffield Airport, South Yorkshire base, TERSUS was first introduced with the 727s in 2016 and has been used in OSRL-led oil spill exercises on three continents.

One significant new enhancement on the updated technology is an ability to fly in known icing conditions. Operations over the North Sea oilfields often see meteorological conditions that might allow ice to form on the

TERSUS external boom structure during transit to potential spill sites.

A modification called FIKI (Flight In Known Icing), which has seen a third supporting strut installed to the dispersant spray boom and the centre section strengthened to cater for possible ice accretion, means the 727s are now able to respond in all-weather flight conditions.

Additionally, 2Excel's design team, working under the guidance of OSRL's dispersant specialists, revised the boom nozzle design to increase laminar flow and reduce the percentage of 'droplet shear' on deceleration during spray runs.

Pat Cafferky, 2Excel Aviation's Head of Counter Pollution, said: "The FIKI modification showcases the commitment of OSRL and its members to continue the through-life development of the TERSUS aerial dispersant capability. We're delighted to confirm that the service provided by 2Excel and our Boeing 727 is scheduled to remain the Tier 3 aerial dispersant platform until 2028."



The 727's TERSUS dispersant system in action
2Excel Aviation

BELOW: All four members of the Dash 8 family can now be converted to Simplified Package Freighter (SPF) configuration until July 2021
De Havilland Aircraft of Canada

Dash 8 conversions to continue

DE HAVILLAND Aircraft of Canada (DHC) will be able to offer its Simplified Package Freighter (SPF) cargo conversion for the Dash 8 series of turboprops until the end of July 2021.

Transport Canada, the Canadian regulator, initially approved the revisions to the Aircraft Flight Manuals for DHC8-100/-200/-300/ and -400 variants earlier in 2020, as a response to the increased demand for cargo capacity due to COVID-19

lockdowns. The conversions enable operators to remove seats and carry up to 8,146kg of freight depending on the variant.

Meanwhile, the -400 has been recertified after complying with the latest ICAO Chapter 14 noise standards, making it the first regional and turboprop example to meet the new requirement, which will be mandatory for all new jets and turboprops from December 31, 2020.



INTELSAT HAS acquired Gogo, whose connectivity services are used on more than 3,000 airliners. An Intelsat statement said: "This transaction will uniquely position Intelsat to deliver more cost-effective and advanced commercial aviation broadband connectivity services. Passengers will benefit from an enhanced connectivity experience that delivers fast and reliable video streaming, browsing and cloud-based applications."

CARGO GROUP Volga-Dnepr recently received its initial Boeing 777 Freighter. The jet, VQ-BAO (c/n 66625), is the airline's first Triple Seven and is operated by subsidiary AirBridgeCargo, joining 22 other Boeing freighters (17 747s and five 737s) in the operator's fleet. Volga-Dnepr signed a letter of intent (LOI) with Boeing for up to 29 777Fs in 2018.



US F-35s arrive at Marham

One of ten US Marine Corps VMFA-211 F-35B Lightning IIs in fading light shortly after arriving at RAF Marham, Norfolk, on September 4 for a lengthy deployment UK MOD Crown Copyright/Senior Aircraftsman Conor Morgan

TEN US MARINE Corps F-35B Lightning IIs from Marine Fighter Attack Squadron 211 (VMFA-211) 'Wake Island Avengers' arrived in the UK at RAF Marham, Norfolk, on the evening of September 4 for a long-term detachment.

The fighters had departed from their base at Marine Corps Air Station Yuma, Arizona, on August 31, routing initially to MCAS Beaufort, South Carolina. Adverse weather conditions meant their planned arrival at RAF Marham on September 3 was delayed by 24 hours.

During their stay, the F-35Bs will initially train with the RAF's 617 Squadron, which also flies the F-35 variant and is based at Marham. They will qualify to operate from the Royal Navy aircraft carrier HMS *Queen Elizabeth* (R 08), on which they will take part in Exercise Joint Warrior. Next year, they will deploy with the carrier as part of Carrier Strike Group 21 (CSG21) to the Far East.

VMFA-211 pilots will conduct synthetic training in the purpose-built simulators at Marham to familiarise themselves with the local airspace and procedures before they conduct training sorties alongside 617 Squadron. They will also participate in Exercise Point Blank with their US Air Force colleagues from RAF Lakenheath, Suffolk, along with other NATO partners.

Once onboard the HMS *Queen Elizabeth* both squadrons will conduct carrier qualification training to ensure all pilots are proficient to operate from the carrier both day and night. Training will also include live and inert weapons training ahead of Carrier Strike Group 21 (CSG21) next year, which will see the carrier deploy operationally for the first time.

With training complete, the aircraft will begin Exercise Joint Warrior from HMS *Queen Elizabeth* which will bring together multiple units to train collaboratively in preparation for CSG21. On completion, both VMFA-211 and 617 Squadron will return to RAF Marham to prepare for a further exercise, Crimson Warrior, which will allow the F-35s to conduct high-end training alongside other platforms in what the RAF calls "a contested and degraded environment, with this year's focus being on Multi Domain Operations."

Below: US Special Operations Command (SOCOM) has taken delivery of its first MH-47G Block II Chinook, Boeing announced on September 1. The company has 23 more to deliver under a contract signed with SOCOM in July

Boeing



First SOCOM Chinook delivered

THE COLOMBIAN Air Force announced on August 14 that it plans to acquire a Leonardo AW139 to serve as the country's new presidential helicopter. The aircraft is expected to enter service in April 2021. It will replace the Bell 412EP which was written off in a crash on October 25, 2019.

Czechs get Vipers and Venoms

BELL TEXTRON has been awarded a foreign military sales contract, worth around \$272m, by US Naval Air Systems Command for the production and delivery of eight UH-1Y Venoms and four AH-1Z Vipers to the Czech Republic government.

According to the announcement made on September 4, work under the deal is expected to be fully completed by November 2023.

A government-to-government contract had been signed at the Pentagon on

December 12 last year between US Defence Secretary Mark Esper and his Czech counterpart, Lubomír Metnar – see In Brief, February, p13.

The deal had been under consideration for some time. On October 23, 2017, the US Defence Security Co-operation Agency (DSCA) announced that US State Department approval had been granted for the Czech Republic to purchase 12 UH-1Ys – see UH-1Y Venoms for Czech Republic, December 2017, p13.

INDIA'S DEFENCE Acquisition Council approved the purchase of 106 Hindustan Aeronautics Ltd (HAL) HTT-40 basic trainers on August 11 to meet the Indian Air Force's requirements. An initial 70 of the type will be procured from HAL. The remaining 36 will be ordered once the HTT-40 is operational.

An Israeli Air Force F-16C Barak and German Air Force Eurofighter break formation during a sortie over Germany as part of the recent German-Israeli exercise Blue Wings. Six Israeli F-16C/Ds arrived at Germany's Nörvenich Air Base on August 17 for the exercise, along with a Gulfstream G550 Nachshon plus support KC-130H Hercules and KC-707s. The Israeli aircraft departed for home on August 28 Luftwaffe

Historic Joint German-Israeli Exercise



New York ANG welcomes UH-60M Black Hawk

A new UH-60M Black Hawk arrives at the New York Army National Guard facility at Ronkonkoma, August 18, on delivery to the 3rd Battalion, 142nd Aviation Regiment. It was the first of two to arrive, beginning replacement of the unit's UH-60Ls
US Army Senior Airman Sean Madden

French Navy retires Lynx

AFTER MORE than 40 years of service, the Westland Lynx was finally retired by the French Navy on September 4. A ceremony on the same date was held at Lanvéoc/Poulmic to mark its withdrawal and the temporary disbandment of Naval Air Squadron 34F which had flown the type since October 1979.

The unit was formed in 1974 with seven Alouette IIIs to provide an anti-submarine warfare (ASW) capability for French Navy frigates. Five years later, the unit converted to the Lynx and latterly operated both Lynx HAS2(FN) and HAS4(FN) variants. The type is being replaced by the NH90 Caiman Marine.

In total, 26 HAS2FNs and 14 upgraded HAS4(FN)s were acquired by the French

Navy. Of these, four HAS2FNs and three HAS4(FN)s were lost through attrition. In addition to 34F, squadrons 35F, also based at Lanvéoc/Poulmic, and 31F, at St Mandrier, had previously flown the Lynx.

With the Lynx retired and the impending withdrawal of the Alouette III, the French Navy will have a capability gap until the new Airbus Helicopters H160M Guépard enter service at the end of the decade. In a bid to overcome the shortage, 12 Dauphins and four H160s will be leased to form an interim fleet. To operate the Dauphins, 34F will be re-activated in 2021. In 2022, squadron 32F will also be reactivated to fly the four interim H160s, three of which will be based at Lanvéoc/Poulmic, with the fourth detached to Cherbourg.



A French Navy Lynx at Lanvéoc/Poulmic during the type's retirement ceremony on September 4 while two other Lynx and two NH90 Caiman Marines perform a flypast French Navy

FOUR ADDITIONAL Embraer A-29B Super Tucanos have been delivered to the Afghan Air Force. They passed through Glasgow Prestwick Airport, Scotland, on August 23 before arriving at Kabul, Afghanistan, on August 28. This brings the total in country to 19, with seven remaining at Moody AFB, Georgia, for training.

THE COLOMBIAN Air Force announced on August 29 that it is to acquire Cessna 172 Skyhawks for primary training at its military aviation school. Deliveries will begin in June 2021 to progressively replace the Cessna T-41 Mescaleros currently used in the role.

Rwandan Air Force to receive two Cessna Grand Caravans

TEXTRON AVIATION announced on August 11 it had won a contract by ATI Engineering Services to build two Cessna 208B Grand Caravan EX multi-mission aircraft for the Rwandan Air Force. The Cessna Grand Caravan EX will be the force's first fixed wing aircraft, which is expected to enter service in the first half of 2021.

ATI had initially been awarded a \$10m foreign military sales contract by the US Air Force to supply the aircraft on June

24. The new deal covers the purchase of airframes, which ATI will modify and fit with a range of equipment, including secure high-frequency and ultra-high-frequency radio systems and a night-vision imaging system, as well as interior/exterior lighting.

The aircraft will also be fitted with reconfigurable multi-mission interiors that have two ambulatory medical stretcher kits, 11 passenger seats, eight collapsible utility seats and a

removable rollerball cargo floor.

Upon entering service, the aircraft will primarily be based at Kigali, Rwanda. They will support the African Partnership Flight initiative, which brings together African nations to strengthen US strategic partnerships. Through the programme, key countries in Africa exchange information on aviation-related topics and enhance regional co-operation and interoperability.

Three more A330 MRTTs for France

FRENCH MINISTER of the Armed Forces, Florence Parly, announced on September 3 that three additional Airbus A330s have been ordered for conversion into Phénix Multi-Role Tanker Transport (MRTT) aircraft.

The General Directorate of Armaments (DGA), France's defence procurement agency, signed a €200m contract with Airbus for the aircraft on August 25. The first two green airframes will be delivered at the end of 2020, followed by the third in 2022. All three will eventually be

converted into A330 MRTT Phénix configuration.

The aircraft will join 12 others already on order, three of which have been delivered, with the final example due in 2023. This will bring the French Air Force's MRTT fleet to 15 and will enable withdrawal of the two A310s and A340s currently in service.

Plans for the order were revealed by Parly on June 9 as part of the French government's Plan Aero initiative to support the French aerospace industry in

the wake of the COVID-19 pandemic. The €15bn stimulus package also included plans to order eight H225M Caracals and bring forward orders for a third King Air 350ER Vador ALSR intelligence, surveillance and reconnaissance aircraft, along with naval VSR700 rotary-wing and SurveyCopter Alianca mini-UAVs.

In addition, ten new Airbus Helicopters H160s will be purchased to replace some of the Gendarmerie's AS350B Ecureuils and two attrition replacement H145s will be ordered for the Sécurité Civile fleet.

The first upgraded Russian Air Force Tupolev Tu-95MSM, RF-94121/'Red 21' Samara takes off for its maiden flight at Beriev's Taganrog facility on August 22 Beriev

Maiden flight for upgraded Tu-95MSM



LOCKHEED MARTIN was awarded a 10-year foreign military sales contract worth up to \$62bn on August 14 to build F-16 Fighting Falcons. It includes an initial delivery order for 90 fighters, which are due to be completed by the end of 2026. Lockheed confirmed that 66 of the initial 90 aircraft are new F-16 Block 70s destined for Taiwan.

LUFTHANSA TECHNIK handed over the first Airbus A350-900 to the German Air Force on August 20 at its facility in Hamburg, the first of the type to enter government service. It had arrived at Lufthansa Technik at the beginning of May and is currently undergoing military certification and crew training. The aircraft is the first of three on order.

F-35As make debut at Red Flag-Alaska



US Air Force F-35A Lightning II 15-5188 'HL' from the 388th Fighter Wing (Hill Air Force Base, Utah) and F-16C 86-0268 'AK' assigned to the 18th Aggressor Squadron (Eielson Air Force Base, Alaska) fly over Denali National Park, Alaska, on August 17, during a Red Flag-Alaska (RF-A) 20-3 mission. This was the first time F-35As had participated in RF-A, which also included examples from the 354th Fighter Wing/356th Fighter Squadron at Eielson after receiving its first two F-35As in April USAF/Tech Sgt Jerilyn Quintanilla

USAF reveals Air Guard locations for F-15EXs and F-35As

THE SECRETARY of the US Air Force (USAF) announced on August 14 that USAF Air National Guard's F-15C Eagles in Florida and Oregon are to be replaced by the service's newest air superiority aircraft, the F-15EX and F-35A.

Kingsley Field, in Oregon, will host the first F-15EX formal training mission from 2022, while the 142nd Fighter Wing's 123rd Fighter Squadron at Portland Air National Guard Base (ANGB) will become the first operational F-15EX unit in 2023.

Jacksonville ANGB, in Florida, will begin receiving F-35As in 2024.

The USAF also plans to replace the remaining Air National Guard operational F-15C/D bases – Barnes Airport, Massachusetts; Fresno Yosemite Airport, California; and Naval Air Station Joint Reserve Base New Orleans, Louisiana – with either F-35As or F-15EXs.

The USAF will complete the required Environmental Impact Analysis Process before making a final decision on which aircraft will go to these bases.

Naval Air Station Lemoore, California, is also being considered for F-35As.

Currently, four active duty operational locations have been identified to host F-35As: Eielson AFB, Alaska; Hill AFB, Utah; Tyndall AFB, Florida; and RAF Lakenheath, UK.

Additionally, three more ANG bases have been identified as F-35A locations – Burlington ANGB, Vermont; Dannelly Field, Alabama; and Truax Field, Wisconsin – along with one Air Force Reserve location, Naval Air Station Joint Reserve Base Fort Worth, Texas.

First RAF centre wing box replacement C-130J redelivered



The first RAF C-130J-30 Hercules C4 (ZH867) to undergo the enhanced service life centre wing box replacement departs from Cambridge on August 7 after completion by Marshall Aerospace and Defence Group. A further 13 RAF aircraft will go through the upgrade which will extend their service lives beyond 2035. Work on the second aircraft is already well under way at Cambridge MADG

TWO FORMER Portuguese Air Force Lockheed Martin F-16AM Fighting Falcons were delivered to the Romanian Air Force at Borcea-Fetești on August 14. They are the first of five additional second-hand aircraft being acquired from Portugal. Two more are due to arrive in October, followed by the fifth aircraft in the first quarter of 2021.

URUGUAY'S MINISTRY of National Defence announced on August 14 that it had taken delivery of the first of two Agusta-Bell 412CP Grifone helicopters for the Uruguayan Navy. Both will be operated by the Helicopter Squadron at Laguna del Sauce. They had previously been operated by the Italian Coast Guard, which withdrew the type from service in March 2017.

Swift soars to



YET ANOTHER ultra-light, ultra-long-endurance system is poised to take NASA science instruments up to 70,000ft altitudes in its next development phase. The Swift high-altitude long

endurance (HALE) system, which is 22m long but weighs less than 81kg, has been produced by Swift Engineering in conjunction with NASA's Ames Research Center. Initially flown from Spaceport

America, New Mexico, back in July 2020, during which it carried NASA's FluidCam high-frame video camera, the Swift is being prepared for a test campaign where it will fly at high altitude "for days to weeks" on end.

Caravan flies unmanned

A US autonomous systems developer conducted the first successful test flight with a remotely piloted passenger aircraft in civil airspace in the United States.

Using a system produced by the San Francisco, California-based start-up company, Reliable Robotics, Cessna 208 Caravan, N927FE (c/n 208B0027), automatically taxied and took off from San Martin Airport and completed a short flight before landing. The developer's proprietary autonomous platform – which includes avionics, software, mechanisms, a communications system, remote command interfaces, and a backup system – was adapted for the Caravan after completing an initial unmanned test sortie with that aircraft in September 2019.

Reliable Robotics'
autonomous Cessna 208
Caravan at San Martin
Reliable Robotics



Intelligent K-MAX gets smarter

AN 'INTELLIGENT' autonomy system is aiming to enable the Kaman K-MAX helicopter to undertake entirely autonomous flights.

Unmanned variants of the distinctive type were used by the US Marine Corps in Afghanistan from 2011 to 2013 delivering cargo to forward operating bases, but the new technology takes the K-MAX's unmanned capabilities to a new level.

The system has been developed by Near Earth Autonomy in partnership with Kaman and US Naval Air Systems Command. A Near Earth Autonomy statement explained: "Using sensors and computing on board, the aircraft can sense its environment to make real-time flight decisions such as deciding to fly around objects in the

flight path and selecting clear places to land or to drop off cargo. Environmental awareness is essential for the vehicle to be able to avoid obstacles and complete autonomous missions safely and efficiently."

Near Earth CEO Sanjiv Singh said: "We are moving from the art of the possible to the art of the practical, to making autonomous flight safe, efficient and robust enough for daily operation. This programme will serve as an important milestone in making autonomous logistics a reality."

The system builds on Near Earth's work in 2014 with the Office of Naval Research to develop a package of sensors and software for testing autonomy in the Autonomous Aerial Cargo/Utility System project.

INSITU PACIFIC is to work with Nova Systems to develop its response to the Australian Army's LAND 129 Phase 3 initiative to find a replacement for the Shadow 200 tactical UAS. Insitu is one of four suppliers shortlisted for the requirement alongside Leidos Australia, Raytheon Australia, and Textron Systems Australia.

SCHIEBEL'S CAMCOPTER S-100 achieved what the manufacturer claimed was a world first for an unmanned system, by flying cargo to an active oil and gas installation offshore. The S-100 flew spare parts the 101km from the Norwegian town of Mongstad to the Troll A gas production platform in the North Sea, before returning to shore.

new heights



A NASA Ames statement said: "If successful, the aircraft could serve as a new operational capability for NASA and other government agencies."

Ames researcher Matt Fladeland said:

"Current NASA science aircraft can meet most, but not all, observing system requirements; HALE aircraft can provide unique data to complement and improve NASA measurements from orbit."

Swift received funding to develop its platform and research into solar panel and battery technologies through NASA's Small Business Innovation Research/Small Business Technology Transfer.

Swift's HALE system on its initial flight
Swift Engineering

BELGIUM'S MINISTRY of Defence acquisition of the General Atomics Aeronautical Systems Inc (GA-ASI) MQ-9B SkyGuardian under the US Foreign Military Sales programme has been finalised.

Initially approved by the US Department of Defense in March last year, the contract involves four air vehicles. It also covers two ground control stations, pre- and post-flight support equipment, electro-optical/infrared video sensors, synthetic aperture radars and ground moving target indicators.

Delivery is due in 2023, with a US Department of Defense statement adding that handovers of the aircraft and support equipment are "expected to be completed [by] March 31, 2024".

The Belgian contract's finalisation follows the MQ-9B's selection by the UK Ministry of Defence for the Royal Air Force Protector programme and the Australia Defence Force's Project Air 7003.



Belgian MQ-9B buy confirmed

Eighteen Belgium-based companies were due to participate in an "industry engagement event" called Blue Magic Belgium to be held in the week commencing September 21. This involves the firms presenting ideas about how they can support and supply the Belgian MQ-9B project to a GA-ASI technical panel, which will evaluate

their pitches before making selections.

Participants will be Airobot, AKKA BENELUX, Altran Belgium, ALX Systems, Any-Shape, Cenaero, Feronyl, Hexagon Geospatial, IDRONET, Lambda-X, ML2Grow, Moss Composites, Optron, Oscars, ScioTeq, Siemens, VITO-Remote Sensing and the von Karman Institute for Fluid Dynamics.

Belgium is the second European nation to select the MQ-9B
General Atomics-Aeronautical Systems Inc

Small UAS go large

ALL US federal government agencies now have access to what the Department of Defense (DoD) called "secure, trusted" commercial UAVs through the Blue sUAS initiative.

The project authorises five domestic small unmanned systems manufacturers, Altavian, Parrot, Skydio, Teal Drones and Vantage Robotics, to provide small unmanned air system (sUAS) options to the US government and military.

Blue sUAS intends to "tailor the best technology from US and allied companies to develop sUAS that can be safely adopted by men and women in uniform" and "quickly pilot and scale cutting-edge technologies across the joint force and the other federal agencies".

Ellen Lord, the undersecretary of defence for acquisition and sustainment, said the reform would lower "the barrier to entry for non-traditional companies" to provide sUAS.

Blue sUAS reforms small drone acquisition
US Defense Innovation Unit



RESPONDING TO consumer demand for buying anything and receiving the goods immediately, Singapore company foodpanda recently tested a delivery service using an ST Engineering UAV. The DroNet solution flew five packets of fried chicken from Marina South Pier to a ship moored 2.4km offshore within 15 minutes of the order being placed.

EHANG IS to demonstrate its autonomous aerial vehicles in the Austrian city of Linz in the first trial of an urban air mobility system in Europe. The developer said: "Various aspects will be carefully studied including the practicality of implementation in urban areas, acceptance by the populace and the expected positive impact on the environment."

Vertical realises electric dream



Vertical Aerospace plans to fly its VA-1X in 2021
Vertical Aerospace

DEVELOPER VERTICAL Aerospace has unveiled the VA-1X, which the UK company says will be the first certified winged electric take-off and landing (eVTOL) air taxi.

The VA-1X will be a five-seat aircraft primarily providing passenger transportation on routes of up to 148km. It will feature a distributed propulsion

system using lithium-ion batteries. At 13m long with a 15m wingspan, the aircraft is designed to operate from existing helipads and airports and be 30 times quieter than a helicopter.

It will have a 450kg payload capability and a 130kts cruise speed.

A company statement said assembly

work will begin "shortly". An initial test flight is expected next year with certification and service entry targeted for 2024.

Since its creation in 2016 by OVO Energy founder Stephen Fitzpatrick, Vertical Aerospace has flown multiple scale model and full-scale eVTOL prototypes, including the Seraph multirotor that took to the skies last year at Llanbedr Airfield in North Wales, UK.

Honeywell is supplying flight control software and has signed a letter of intent (LOI) to provide a vehicle management system for the VA-1X prototype.

Engineers with motor racing industry experience are also involved in the project. Vertical Aerospace has a presence in the Formula 1 cluster in Oxfordshire and Fitzpatrick established the Manor F1 team. The company is looking to combine F1 technology "with aerospace rigour and discipline" to develop its design.



Russian Helicopters' composite blade
Russian Helicopters

A SLEW of Russian Helicopters updates was announced during the International Military-Technical Forum ARMY-2020 in Moscow.

Most notably, the company – part of

Blades, orders and a shipborne helicopter

the state corporation Rostec – signed a contract with the Russian defence ministry on the development of a "modern shipborne helicopter". Russian Helicopters Director General Andrey Boginsky said: "The design has now been completely established and we are moving on schedule, in accordance with the goals set by the customer."

This project intends to produce what the company called a "universal shipborne helicopter" to perform search and rescue (SAR), troop transport and anti-submarine

warfare tasks. Development will be carried out by the National Helicopter Center Mil & Kamov, with initial work planned for completion within three years.

Meanwhile, Russian Helicopters presented new fully composite rotor blades designed to increase the maximum speed of the Mi-28 and Mi-35. Initial factory flight tests on a Mi-28N helicopter saw the new blades pass 216kts.

Other revelations at the forum included the start of Mi-35P production and an order for two more Mi-38Ts by the Russian MoD.

New connections



Sikorsky's HH-60W with the HC-130J
US Air Force/Master Sgt Tristan McIntire

TWO SIGNIFICANT helicopter air-to-air refuelling tests recently took place. The Sikorsky HH-60W Jolly Green II undertook its first such trial with a US Air Force HC-130J above Eglin AFB, Florida to evaluate its ability to connect with the fuel drogue and the resulting handling qualities.

Separately, an Armée de l'Air (AdIA, French Air Force) Airbus Helicopters H225M Caracal from EH 1/67 'Pyrénées' at Cazaux conducted the helicopter's initial 'wet' air-to-air refuelling with an AdIA Airbus A400M Atlas, clearing the air force to refuel Caracals in flight operationally from the transport aircraft from 2021.

THE US Customs and Border Protection agency's Air and Marine Operations has started receiving Airbus Helicopters H125s. Sixteen helicopters have been ordered and they will be delivered to CBP units across the US replacing Airbus AS350s and EC120s. The CBP has also ordered two UH-60 Black Hawks to replace a pair of UH-1 Hueys.

SIX ENGINEERS from the Royal Navy and Army recently returned from Felker Army Airfield, Virginia, following technical training on the Boeing AH-64E Apache. They were instructed about differences in the airframe, hydraulics, engines and transmission systems from the earlier Apache. The training is part of preparations to introduce the AH-64E to UK service in 2022.



Hill's designs on rotary concept

THIS STRIKING design is the HX50, a five-seat, single-engine rotorcraft from UK start-up Hill Helicopters.

According to the company, the HX50 is currently at an "advanced design phase". Flight tests using the first of three prototypes are planned for 2022, with an ambitious development timescale targeting certification the following year.

Built from composite materials, the HX50 will have a shrouded tail rotor and a retractable undercarriage. The helicopter will be 9.8m long and 1.6m wide, with a 1,650kg gross weight and

an 800kg payload capability (including 90kg of cargo) and a 140kts maximum cruise speed and 1,296km range. No details were disclosed of an engine supplier, but the developer said the HX50 will have a 500shp powerplant generating 440shp take-off power.

Innovate UK has provided a £1.4m grant for the project. In its funding application, Hill Helicopters said its design, "is focused on solving well-known deficiencies of existing helicopters to deliver an aircraft with improved flight characteristics,

structural safety and which requires substantially less maintenance".

The company believes the HX50 will appeal to "private owners looking for a practical, luxurious, affordable and well-specified five-seat helicopter with low running costs (£15,000 per year)".

It said: "Research reveals there is high demand for this specification, which is not being met by existing manufacturers. This market segment is ready for rapid commercial exploitation and we will produce helicopters from our UK manufacturing base in Cornwall."

Game changer? The recently revealed HX50 Hill Helicopters

Eaglescliffe landing for Dauphin

THE GREAT North Air Ambulance Service (GNAAS) has introduced Airbus Helicopters AS365 N3+ Dauphin, G-NHAD (c/n 6979, ex-HS-LCF), for air ambulance and helicopter emergency medical services work in Cumbria, North Yorkshire, and northeast England.

Operating from the GNAAS' Eaglescliffe base near Stockton-on-Tees, G-NHAD (named *Guardian of the North II*) replaces AS365N2 G-NHAA (c/n 6431), working alongside AS365N2s G-NHAB (c/n 6407) and G-NHAC (c/n 6497).

According to the Civil Aviation Authority's G-INFO registry, the five-year-old N3+ only had 300 flying hours by June 30. GNAAS director of operations Andy Mawson said: "We were delighted to get her for the price."

The new helicopter has Turbomeca Arriel 2C engines with fuel authority digital engine control, offering 839shp take-off power and 779shp in the cruise. It has a higher 4,300kg maximum take-off weight, a

faster 155kts cruise speed, and two hours of endurance (up from 70 minutes on the N2).

Mawson added: "The additional power and range will give us a greater degree of flexibility when it comes to responding to serious incidents. This aircraft will mean the difference between life and death for some people out there."

The helicopter has digital cockpit

displays and a revised interior layout gives doctors and paramedics improved access to patients. Leeds/Bradford Airport-based Multiflight provides the air operator's certificate, operational support and pilots, as with the GNAAS' other aircraft. G-NHAD's arrival coincided with the charity's relocation to Eaglescliffe from Teesside International Airport.

G-NHAD (c/n 6979), arrives at Eaglescliffe, County Durham Great North Air Ambulance



KOREA AEROSPACE Industries (KAI) is to deliver two KUH-1P Chamsuri helicopters to the South Korean government by February 2023. The new rotorcraft will have electro-optical/infrared imaging systems, searchlights and medical equipment for emergency services work. The KUH-1P is a parapublic variant of KAI's Surion helicopter. KAI said ten KUH-1Ps will equip Korean police.

RUSSIAN HELICOPTERS agreed a contract over the initial Mi-26T2 delivery to the Ministry of Emergency Situations during the International Military-Technical Forum ARMY-2020 in Moscow. The type will be used for rescue operations, medical evacuation, and firefighting. It can evacuate up to 82 people from a disaster area or transport 60 wounded people.

Comlux completes ACJ320neo



The workforce of Comlux Completion in front of the recently delivered Airbus ACJ320neo at Indianapolis Comlux Completion

HANDOVER OF the first Airbus ACJ320neo outfitted by Comlux Completion was announced on September 1. The large corporate jet was delivered to the Berkut State Air Co of Kazakhstan from the company's facility at Indianapolis International Airport in Indiana, where its VVIP cabin interior, with a number of private rooms and accommodation for executive

guests and entourage at the rear, was installed. It originally arrived at the completion centre in March 2019.

The jet, 9H-NEW (c/n 8638), departed Indianapolis on August 26 and arrived at Nur-Sultan's Nazarbayev International Airport in Kazakhstan two days later, with transit stops in Zürich, Switzerland and Malta in the Mediterranean Sea.

Work on two further ACJ320neos

continues at the Indiana site, with deliveries due in the spring and autumn of 2021, while a fourth example ordered in September 2019 is expected to arrive at the facility in April next year.

Airbus Corporate Jets (ACJ) had received orders for five ACJ319s and nine ACJ320neos, of which seven 'green' airframes have been delivered for outfitting.

G180 SPn resurrection under way?



The Grob G180 SPn was designed as a rugged 'utility jet' to appeal to a sector of the market that has proven lucrative for the Pilatus PC-24

David Willis

RESERVATION OF German civil markings for one of the three surviving Grob G180 SPns hint that a revival for the moribund twin jet programme could be under way. On May 15 the markings D-CSST were reserved for the third prototype, currently registered, F-WINT (c/n 90003).

The SPn was conceived by Grob Aerospace as a 'utility jet', first flying on July 20, 2005. Although its external configuration was fairly typical, with a low-mounted wing, rear-mounted Williams FJ44-3A turbofans and cruciform tail unit, carbon fibre reinforced plastic composites were used for major structures, including the wings and fuselage, which was uncommon at the time. The aircraft had a

cabin that could quickly be reconfigured for up to eight passengers or cargo, or a combination of the two, while a robust landing gear permitted operations from austere airfields.

Four development airframes were flown (and assembly of a fifth commenced, but not completed) but a fatal crash that claimed the life of chief test pilot Gérard Guillaumaud and high development costs contributed to Grob entering insolvency in late 2008. While the rump of the company was acquired by H3 Aerospace, the rights for the SPn were transferred to Allied Aviation Technology, which intended to reactivate the programme. Between 2011 and 2012 Daher-SOCATA ('just' Daher from 2015) conducted flight evaluation of the third prototype to judge the type's suitability as a potential jet powered complement to the TBM700/800 family, during which the aircraft was re-registered from D-CSPJ to F-WINT. The French company decided not to take the programme any further, although other plans to continue development were reported from 2015. Re-registration of the aircraft may be a signal that the SPn programme is again moving forward.

Future of D-JET under review

DIAMOND AIRCRAFT intends to release a five-year strategy plan in 2021 that may include resurrecting the stalled D-JET programme. A lack of finance to take the programme to certification resulted in work on the light jet being suspended in February 2013, after four prototypes had been completed. The rights to the aircraft transferred to the Wanfeng Auto Holding Group of Zhejiang, China, following its acquisition of 60% of Diamond Aircraft Industries, the Canadian division of the manufacturer, in December 2016. Wanfeng acquired all of Diamond, including its Austrian facilities, by the end of February 2018. The prototypes remain stored in London, Ontario.



New buyer lined up for ONE Aviation

A NEW proposed owner for ONE Aviation's assets has recently been identified. Until August, plans to take the firm out of Chapter 11 bankruptcy protection involved Citiking International US, based in Wilmington, Delaware, which has served as debtor-in-possession for just under two years. Citiking International US wanted to acquire the company and restart production of the Eclipse 550 light jet, but has failed to secure the necessary finance to take it out of bankruptcy. In late August it was proposed to the US Bankruptcy Court for the District of Delaware that the assets

of ONE Aviation instead be sold to SEF OA LLC, which was formed in the middle of the month in Wilmington. A sale was due to conclude in the second half of October.

ONE Aviation of Albuquerque, New Mexico holds the rights to the Eclipse light jet family (comprising the EA500 and EA550 and the development programme for the larger EA700) as well as the Kestrel K250 single-engine turboprop. It supported the 260 series-production EA500s built by the predecessor company, Eclipse Aviation and also assembled 33 EA550s. Development of the K250 was shelved before the company

filed for bankruptcy protection on October 9, 2018, after accumulating debts of nearly US\$200 million.

The court originally approved Citiking International US's bankruptcy exit plan for ONE Aviation in September 2019, while the Committee of Foreign Investment in the United States (CFIUS) consented to the sale in March this year. The CFIUS approval was required because Citiking is part of a Chinese-owned investment company. No details of SEF OA LLC's plans for ONE Aviation had been released as of early September.

A new buyer is expected to take ONE Aviation out of bankruptcy protection in October

David Willis

First Bossa Nova Phenom 300E goes to PALS co-founder

DURING A ceremony held at Embraer Executive Jets' Global Customer Center in Melbourne, Florida on August 14 the first enhanced Phenom 300E with a Bossa Nova interior was delivered. The light business aircraft was received by Joe Howley, a co-founder of the Patient Airlift Service (PALS). PALS was formed by a group of pilots in the northeast

United States in 2010 to provide free transport for individuals requiring medical diagnosis, treatment or follow-up who are unable to fly on commercial carriers. The handover was part of the organisation's tenth anniversary celebrations.

The Bossa Nova interior initially debuted in the Praetor 500 and 600, winning the Interior Design/

VIP Completion category at the 2019 International Yacht & Aviation Awards in Venice, Italy. Deliveries of the 'enhanced' Phenom 300E, which differs from the earlier standard 300E by having more powerful Pratt & Whitney PW535E1 turbofans, additional functionality for the cockpit avionics and revised cabin systems, began in June.

Global 7500 pilots seeing double



Bombardier announced that it had delivered the first Global 7500 equipped with dual head-up displays (HUD) on August 24. Enhanced and synthetic vision overlays can be displayed on the screens in the line of sight of the pilot and co-pilot, permitting easier switching of responsibilities between the flying and monitoring crew member during low-visibility approaches, as well as system redundancy. The feature is an option in the Vision flight deck of the Global 7500, the largest member of Bombardier's business jet family. The Canadian company delivered five 7500s during the second quarter of this year, representing a quarter of the business aircraft it handed over. This is down from the 35 deliveries recorded during the comparable period last year.

Bombardier Aviation

Arcus Fire launches Firecatcher F-45

An artist's impression of the Firecatcher F-45 Arcus Fire

AN INTERNATIONAL partnership between UK start-up Arcus Fire and two New Zealand firms, Flight Structures and Pacific Aerospace, announced on August 18 it will develop a new clean-sheet, single-engined, high-performance air tanker.

The aircraft, named Firecatcher F-45, will be targeted at the firefighting, cargo and commuter airline markets. Flight Structures has design authority for the new type, while Pacific Aerospace will be responsible for manufacture, as well as final assembly. Both companies are based in Hamilton. Development is being financed and marketed by Arcus Fire, which describes itself as an innovator in aviation wildfire technology, equipment, supply, management, operation and financial operating programmes.

Arcus Fire has developed its own 'Exclusive Use Pay-As-You-Go' (EUPAYG) hire programme that enables a government to have fire-fighting aircraft available to use 365 days a year

but need only pay for them when they are being used, based on a minimum utilisation per year.

Powered by a single turboprop, the F-45 is a fixed-undercarriage, high-wing utility type. The engine is expected to be the Pratt & Whitney PT6A-67F, although the Honeywell TPE331-14 is also under consideration. The cockpit will have Garmin G600 avionics.

To begin with the F-45 will be offered in the 'Restricted' category – specifically for the initial attack aerial firefighting role, and with a 4,500 lit capacity hopper for water or fire-retardant. However, it will later be developed into cargo and passenger commuter versions certified in the 'Standard' category.

The aircraft is based on a design which Flight Structures had been working on for several years. The F-45's first flight is scheduled for 2023, with Restricted category certification the following year.

The cargo variant will have a 2,495kg

maximum payload and feature a large freight door, with the capability to carry three standard LD3 shipping containers.

Maximum cruise speed will be 190kts, with a 1,000nm maximum range and low operating costs. The passenger version would have two-abreast, single-aisle seating for 19 passengers with full stand-up headroom.

The partnership is also developing a dedicated fire-fighting version of Pacific Aerospace's PAC P-750, which is already widely used worldwide, primarily for agricultural spraying and parachuting/skydiving.

Designated the F-25, it is based on the Super-Pac XL version of the P-750 and will have a 2,500 lit water or retardant capacity. It is expected that it can gain a supplemental type certification in time for next year's fire season. A boom scooper is being developed for the F-25 to allow fast refill from water sources close to a fire, although the initial version being made available will not have this feature.



B-52H used for AGM-183A ARRW tests

A US Air Force B-52H Stratofortress operated by the 419th Flight Test Squadron takes off from Edwards Air Force Base, California, on August 8 to conduct a captive-carry flight test of the AGM-183A Air-launched Rapid Response Weapon (ARRW) Instrumented Measurement Vehicle 2. The aircraft transported the ARRW hypersonic prototype to the Point Mugu Sea Range off the southern Californian coast to carry out the test USAF/Matt Williams



GENERAL ATOMICS announced on September 3 that it had successfully integrated and tested the US Air Force Research Laboratory's Agile Condor Pod on the MQ-9 remotely piloted aircraft. The pod provides on-board high-speed computer processing coupled with machine learning algorithms to detect, correlate, identify and track targets of interest.

US AIR Force officials at the 53rd Wing have revealed that its 28th Test and Evaluation Squadron conducted a Force Development Evaluation to operationally test the new BLU-136 Next Generation Area Attack Weapon from July 8-24 at the Nellis Test and Training Range, in Nevada. During the announcement on August 27 it was said that seven missions had been flown, successfully dropping ten BLU-136s from F-16s.



USAF awards contracts for supersonic executive travel

BOOM SUPERSONIC has been awarded a contract to partner with the US Air Force (USAF) to explore a possible supersonic executive flight programme.

The contract, announced by Boom on September 8, will help finance exploration of a configuration for its planned Overture supersonic passenger aircraft designed for USAF executive transport. Both the US Department of Defense (DoD) and the USAF manage all air transport for executive branch leadership, including Air Force One.

Blake Scholl, founder of the Colorado-based firm, said: "Supersonic flight brings people together, whether for work, family or global diplomacy. By cutting travel times we make it possible for US diplomats and executive leaders to connect more frequently in person, meeting challenges and defusing potential crises with a personal touch. We're so proud to help envision a new way for the air force to provide transport for critical government activities."

Boom stated that Overture will offer the USAF a unique combination of passenger capacity, speed and enough space and power to accommodate the requirements of necessary mission systems. The supersonic aircraft can also be configured for multiple cabin zones, affording a layout with as much privacy as necessary. Boom is designing Overture to comply with stringent Federal Aviation Administration worthiness and production regulations. It will be fully adaptable to meet specific requirements for a variety of military end-users.

Brigadier General Ryan Britton,

programme executive officer for the Presidential and Executive Airlift Directorate, said: "The USAF is constantly looking for technological opportunities to disrupt the balance of our adversaries. Boom is an example of the American ingenuity that drives the economy forward through technological advances. We are extremely excited to team with them as we work to shrink the world and transform the future of executive airlift."

In addition to its potential for executive transport, Boom says Overture could be adapted to satisfy other USAF and broader DoD mission requirements. Overture could also become part of the Civil Reserve Air Fleet (CRAF), enabling humanitarian and other critical airlifts in half the time.

Similarly, on August 31, the USAF Life Cycle Management Center announced that the Presidential and Executive Airlift Directorate had also awarded the relatively unknown Los Angeles-based company Exosonic a contract to develop a low-boom supersonic executive transport aircraft based on its Mach 1.8 70-seat

supersonic airliner design. In a statement, Exosonic said: "This represents an important leap for our company's vision to make overland supersonic travel a reality for both government and commercial customers. As a result of the partnership, we are quickly scaling our team to meet these new milestones."

The contract, sponsored by the USAF Research Lab, will support Exosonic's efforts to develop and modify the company's commercial supersonic airliner to serve as an executive transport vehicle.

These modifications will include reconfiguring the aircraft cabin to incorporate the required accommodations, communications equipment and security measures that enable US leaders and their guests to work and rest onboard.

A third USAF development contract for a potential high-speed executive transport was also awarded on August 6 to the Atlanta-based Hermeus Corporation – see USAF asks Hermeus to develop hypersonic jet, page 20 of the September issue of *AIR International*.

An artist's illustration of the Boom Supersonic Overture in USAF VIP colours
Boom Supersonic

Exosonic's proposed low-boom supersonic executive transport aircraft in a USAF Presidential colour scheme
Exosonic



BAE SYSTEMS announced on September 3 that, together with Leonardo, it had been awarded a £317m contract to develop a next-generation radar for RAF Eurofighter Typhoons. The two companies will develop the Active Electronically Scanned Array (AESA) radar, known as the European Common Radar System Mk 2 (ECRS Mk 2), to a standard ready to be integrated onto RAF Typhoons.

THE DEFENSE Advanced Research Projects Agency (DARPA) has successfully completed captive carry tests of two variants of the Hypersonic Air-breathing Weapon Concept (HAWC). The September 1 announcement said the tests involved advanced air vehicle configurations produced by Lockheed Martin and Raytheon Technologies. HAWC is a joint programme between DARPA and the United States Air Force.



Korea's KF-X stealth fighter takes shape

An image released on September 3 of the prototype KF-X fighter in final assembly at KAI's Sacheon facility KAI

KOREA AEROSPACE Industries (KAI) announced on September 3 that it had begun final assembly of its next-generation indigenous KF-X fighter at the company's production facility in Sacheon, North Gyeongsang province.

Mating of the forward, centre and rear fuselage, wing and empennage – took place on September 1. This was achieved just over four years after the £5.7bn system development programme got under way in December 2015.

A preliminary design review was completed in 2018 and machining of the first detail parts began in February 2019. The KF-X passed its critical design review in September 2019.

Completion and roll-out of KAI's prototype is planned for April 2021, followed by a maiden flight in 2022. System development should be concluded by 2026. In total, six prototypes will be used in the flight test programme, all due for completion by 2021.

The KF-X will be powered by a pair of General Electric F414-GE-400K engines. GE Aviation announced on June 4 that the first of these powerplants had been delivered to KAI in May.

GE will produce an initial 15 F414 flight test engines (12 installed and three spares) for the six development aircraft. The Republic of Korea Air Force plans to purchase 120 KF-X fighters to replace its ageing F-4D/E Phantom II and F-5E/F Tiger II fleets.

A French Air Force Mirage 2000D from the CEAM test unit carries out trials with the new GBU-50 bomb mounted under the fuselage during August. Two versions are planned to enter service on the Mirage 2000D: the GBU-50 V1 is based on a 1,000kg Mk 84 bomb, and the GBU-50 V2 on the BLU-109 penetration bomb
French Air Force

French Air Force completes bomb tests



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Two aviation writers who share a rich seam of industry and enthusiast knowledge continue their compilation of *AIR International's* GA Review section this month. Assistant editor **Martin Needham** is a former aviation events organiser and is well acquainted with the UK GA scene. Digital reporter **Thomas Haynes** logged his first hour in a light aircraft at the age of 14, before going on to be selected for the RAF Air Cadet Pilot Scheme, where he soloed and subsequently obtained his private pilot's licence. In the years since, he's flown various types and currently primarily pilots a Pipistrel Alpha



Textron has confirmed SAF as viable across its entire jet and turboprop product line
Textron Aviation

TEXTRON AVIATION, the makers of Beechcraft and Cessna aircraft are now offering their customers the option to choose an initial tank containing sustainable aviation fuel (SAF) with the delivery of a new turboprop or jet aircraft.

Additionally, customers of the company's service centre in Wichita, Kansas have the option of refuelling with the greener fuel as part of their service experience.

Christi Tannahill, senior vice president, customer experience, said: "SAF can reduce CO₂ emissions by up to 80% over [its] lifecycle, compared to those made from fossil sources and provides an active way for the aviation industry to lower its overall carbon footprint."

Tannahill added: "Offering SAF for customer deliveries demonstrates an important next step in Textron Aviation's commitment to sustainability."

Last year, Textron Aviation flew a wide array of aircraft to major industry events such as EBACE and NBAA-BACE using SAF and it's something they seek to do for future events.

Small Fly!

Continental Aerospace Technologies has received the EASA type certificate validation for its Jet-A1-fuelled CD-170 engine. The powerplant is part of Continental's CD-100 series which have accumulated more than 7.1 million flights hours since its inception in 2000. The piston engines commonly appear on the Cessna 172, Diamond DA-40, DA-42, and Robin DR400 aircraft. The CD-170 operates efficiently on readily available Jet A-1 or Diesel EN590, reducing fuel consumption by up to 50% compared to comparable gasoline engines.

Van's Aircraft has approved the installation of the Lycoming IO-390A powerplant on RV-7/7A and RV-8/8A aircraft following an in-depth review of horsepower limitations for the respective airframes. The approval concerns the 210hp IO-390-A3B6 and 215hp IO-390-EXP119 engines. The latter has also been evaluated and has been accepted as a suitable powerplant for the RV-14/14A, enabling the type to achieve a top speed of 187kts at maximum gross weight and a climb-rate of 2,050ft/min at solo weight.

EASA-approved XCub for Europe

Delivery positions for new EASA-certified XCubs are available for mid-2021 CubCrafters



THE FIRST new European Union Aviation Safety Agency (EASA) certified CC19 XCub has shipped for Europe from the CubCrafters company headquarters in Yakima, Washington. The aircraft, which is to be placed on the UK registry as G-OBTO, is the first EASA type to be approved with the Garmin G3X Touch glass avionics.

The inaugural customer, Gerhard Oberholzer, who intends to base the aircraft at Fowlmere Airfield, Cambridgeshire, commented: "A key purpose of having an aircraft like this is to be able to travel across England, Wales, Scotland and Ireland on business, enabling very efficient access to often remote parts of the islands – using the aircraft as a working tool."

He also noted: "The XCub, with its higher cruising speed and modern avionics, coupled with an advanced autopilot, made a lot of sense. I'm very pleased with where we ended up."

CubCrafters was awarded EASA certification for the XCub in 2018 after having shown full compliance with all European airworthiness, safety, and environmental requirements. The company then followed up the initial EASA certification with an effort to offer Garmin's non-TSO'd (FAA certified) touch screen glass panel avionics to European customers, the only OEM manufacturer to do so in a certified aircraft.

Patrick Horgan, president of CubCrafters added: "The European market is very important to us in the continuing expansion of international XCub sales opportunities. There has been a lot of hard work getting to this point with EASA. We are extremely pleased to see the market has responded and the first new XCubs are now headed for Europe."



Vision jet secures autoland approval

The Cirrus Vision SF50 has been in production since May 2016
Cirrus Aircraft

THE CIRRUS Vision Jet has completed the Federal Aviation Administration (FAA) approval process for the Garmin Autoland system, becoming the first jet aircraft to be certified with the technology.


Cirrus Aircraft has branded the product as the Safe Return system; an innovative feature that allows a passenger to land the aircraft with just the touch of a button in the event of the pilot being incapacitated.

Phil Straub, Garmin executive vice president and managing director of aviation, commented: "Congratulations to our collective teams who contributed to the certification of Autoland on the Vision Jet, a

technology that will undoubtedly have lasting impacts on the safety of our aviation industry and the lives of our customers."

The Safe Return activation button is purposely located on the ceiling of the Vision Jet's cabin for easy access by passengers and can be activated if needed within minutes of the aircraft's take-off.

Once triggered, the jet automatically navigates to the nearest suitable airport for landing, communicates with air traffic control, lands and brings the aircraft safely to a complete stop, allowing passengers to exit the jet.



The Pipistrel Nuuva can accept payloads of up to 460kg
in a 3m³ cargo compartment Pipistrel

Pipistrel opens Nuuva order book

SLOVENIAN ELECTRIC aviation pioneers, Pipistrel, has begun to accept orders for its Nuuva V300 unmanned air vehicle (UAV). The electrical vertical take-off and landing (eVTOL) craft has been designed to carry up to 460kg of cargo and is expected to enter service in the second half of 2023.

The V300's large cargo compartment has been designed specifically to accept up to three EPAL-standard EUR-pallets (measuring 1.2m x 0.8m) and can be loaded using a fork-lift truck rather than requiring specialist equipment. It will also feature options to be flown autonomously using a pre-planned route or by a ground operator.

The Nuuva V300 leverages technology developed by Pipistrel for its Velis Electro two-seat light aircraft – the first electric-powered example to receive a type certificate. It's powered by eight E-811 electric motors. The UAV also benefits from the ability to be charged at Green Motion and SkyCharge by Pipistrel charging stations.

The E-811 electric motors are to be used solely for take-off, landing and hovering while an internal combustion engine in the aft fuselage – likely to be supplied by Rotax – enables forward flight.

The company stated: "This one-of-a-kind aircraft embodies our vision to disrupt aerial cargo transportation by commercialising the use of electrical vertical take-off and landing (eVTOL) vehicles."

It hopes that the type can reduce operating and maintenance costs and is targeting a 10x improvement in economics versus a helicopter being used on a similar mission.

The type is the first dedicated UAV to be developed by the manufacturer, its only previous experience being the Surveyor – an unmanned variant of its popular SW series of light aircraft.

Textron to supply Rwandan Caravans

TEXTRON AVIATION has been awarded a contract by ATI Engineering Services to supply a pair of Cessna Grand Caravan EXs to the Rwanda Defence Force (RDF) in support of the African Partnership Flight initiative. The two Pratt & Whitney Canada PT6A-powered aircraft will enter service in the first half of 2021 and primarily be used in a multi-mission role.

Bob Gibbs, vice president, special mission sales at Textron Aviation, said: "The Grand Caravan EX serves an enduring mission by providing transport, reconnaissance and medical evacuation operations throughout Africa. The aircraft is engineered for challenging missions, high payloads and short, rough

runways while delivering single-engine economy and simplicity."

The African Partnership Flight initiative brings together a series of collaborative engagements between African nations to strengthen US strategic partnerships with key countries in Africa, exchange ideas on aviation-related topics and enhance regional co-operation and interoperability. Seven other nations operate the Grand Caravan EX as part of the initiative.

The turboprops will be the RDF's first fixed-wing aircraft and are to be based in Kigali, Rwanda's capital and largest city. The RDF also operates several variants of the Mil Mi-17 Hip-H as well as examples of the Mi-24 Hind-E and Hind-F.

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Russia seeks to double



Piotr Butowski
outlines the latest
developments
– and setbacks –
in Russian aviation



On August 3, Yuri Slyusar, director general of Russia's United Aircraft Corporation (UAC), was received by President of Russia, Vladimir Putin, to report on the current

situation in the nation's aviation industry.

Slyusar's previous meeting with Putin took place earlier this year, on May 13. Slyusar said the decisions taken at that first meeting had dramatically affected the country's "military enterprises and provided for the advance delivery of aircraft".

According to Slyusar: "The Komsomolsk-on-Amur Aircraft Plant (KnAAZ) has doubled the workload in the current period, and now through to 2028, we have a full workload at this enterprise." The Russian Aerospace Forces (VKS), meanwhile, would "receive a modern

output

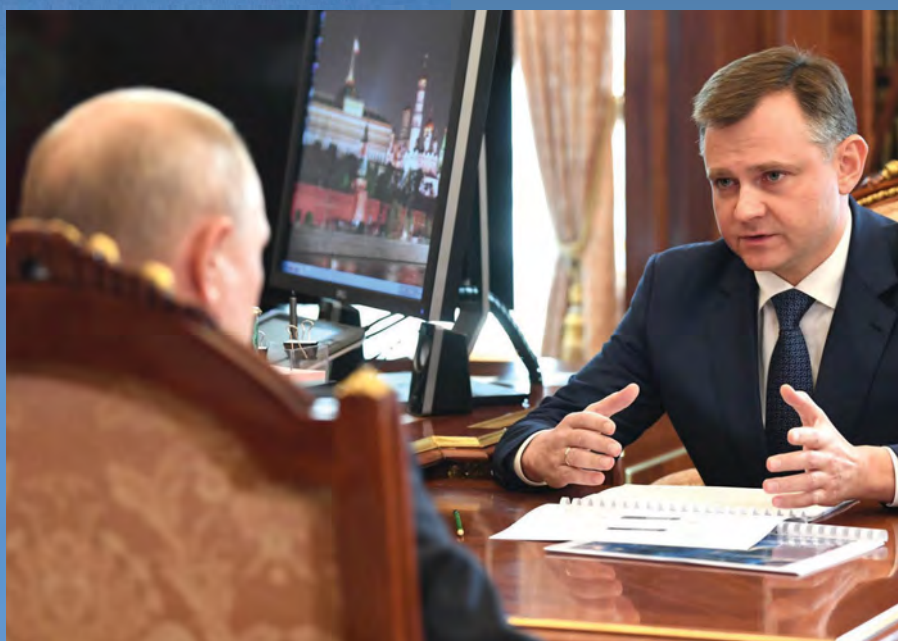
Sukhoi Su-35 in Russia are planned.

As of 2020, the plant has completed its previous contracts for a total of 98 Su-35S fighters for the VKS. Now, only the contract for 31 Su-35 fighters for Egypt remains.

Sukhoi S-70 Okhotnik

Among the achievements of last year, Slyusar singled out the maiden flight of the Okhotnik ('hunter') heavy strike unmanned aircraft. The Sukhoi S-70B '071' Okhotnik demonstrator performed its first flight on August 3, 2019 at Akhtubinsk, in Astrakhan Oblast. Slyusar confirmed that the MoD had set the task of accelerating this programme "in order to start deliveries as early as 2024".

2024 looks set to become a very ambitious year for Russia, especially when taking into account the progress of other large unmanned aircraft programmes, such as the Inokhodets ('Orion') and the Altius,



ABOVE: Yuri Slyusar, director general of Russia's United Aircraft Corporation (UAC), reporting to Vladimir Putin, 3rd August 2020 Kremlin-ru

LEFT: Su-57 fighters flying in formation Piotr Butowski



mass-production system". However, it is not entirely clear what Slyusar meant by these statements.

Had the order for Su-57 fighters – the main product of the KnAAZ factory – been doubled? Or had its execution only been moved to an earlier date? In July 2019, the

Russian Ministry of Defence (MoD) placed an order for 76 Su-57 fighters, with delivery by 2028.

Interestingly, Slyusar mentioned another product of KnAAZ, the Su-35 fighter, emphasising its export purpose. This may mean that no further deliveries of the

which did not meet any of their previously announced deadlines.

However, the Okhotnik has an easier path as it follows the trail cleared by the Su-57. It is a large 'flying wing' weighing about 20 tonnes, powered by one 117BD turbofan engine – a non-afterburner version of the AL-41F1 (117) engine of the Su-57. The Okhotnik carries its weapons in two internal compartments, the same as the weapon bays of the Su-57. The armament itself is also common to the Su-57, and the S-70 radar for Okhotnik is made by the same company, Moscow-based Tikhomirov NIIP, and is a simpler version of the Su-57 radar. Characterising the Okhotnik, Slyusar emphasised its "very long combat operational radius and broad nomenclature of weapons".



The S-70B '071' Okhotnik UCAV demonstrator, taking its maiden flight on August 3, 2019
Russian MoD

Tupolev bombers

Another announcement made by Yuri Slyusar concerned the modernisation of the Tu-95MSM strategic bomber. "I hope that the long-awaited upgraded Tu-95 will take off in Taganrog [in the Rostov region] by the end of August," he said, which means the aircraft should already be flying.

The Tu-95MSM was upgraded at the Beriev facility in Taganrog and is provided with a new NV1.021 radar, S-021 navigation suite and SOI-021 'glass' cockpit. The wing has been strengthened, the NK-12MPM engines have improved life and reliability, while new AV-60T propellers have higher efficiency and less vibration.

"The combat capabilities have doubled after this modernisation," Slyusar explained. Approximately 35 bombers of the Tu-95MS Sprut version are likely to be upgraded to the MSM model.

Slyusar recalled that in 2019 (actually on December 28, 2018) another modernised bomber, the Tu-22M3M Backfire, began trials. "This is fundamentally a new aircraft with enhanced combat capabilities and our latest weapons," he said. New weapons under development for the Tu-22M3M

are hypersonic Kh-MTs (GZUR) missiles, medium-range subsonic Kh-SD cruise missiles and guided bombs. It was earlier announced that deliveries of the upgraded aircraft to military units will begin in 2021.

Ilyushin turboprops

Slyusar said the first flight of the new Il-114-300 regional turboprop passenger airplane will also take place in September in Zhukovsky, Moscow. "The aircraft has already been assembled," he said. "It is undergoing ground testing and is preparing for the first flight."

Serial production of the Il-114-300 will start at the Lkhovitsy plant, near Moscow, which simultaneously produces the MiG-29M and MiG-35 fighters. "We actually plan to produce up to 12 aircraft a year there," he added.

In fact, the aircraft Slyusar was talking about is a demonstrator of the new Il-114-300 version, converted from an Il-114 made in Tashkent, Uzbekistan, back in 1994. The Il-114 prototype was built in 1990, and the Tashkent plant made 15 serial aircraft between 1992-2012. In November 2015, Russia decided to begin its own production

of the improved Il-114-300. The first new Il-114-300 produced entirely on Russian soil will not be completed before 2021.

Compared with the original Il-114-100, the most important change to the Il-114-300 is the use of Russian Klimov TW7-117ST-01 turboprop engines and all-Russian avionics. The previous Il-114-100s had engines by Pratt & Whitney and avionics by Collins Aerospace.

The most revealing detail in Slyusar's account of the Il-114-300 was about the aircraft's military applications. So far, the Russians have presented the Il-114-300 as a passenger aircraft for domestic airlines flying to hard-to-reach regions of the Russian Federation. The military versions of the Il-114 are to replace the "old Ilyushin airplanes with special systems," according to Slyusar. He did not mention any names,



LEFT: A Su-57 in final assembly at KnAAZ, August 12, 2020 UAC

RIGHT: The MC-21-300 '002' passed its tests on a wet runway, July 2020 UAC





but the Ilyushin special aircraft that require a successor are the Il-20 reconnaissance aircraft, the Il-22 airborne command posts and electronic warfare aircraft, and the Il-38 maritime patrol aircraft. All three were built on the platform of an Il-18 turboprop airliner.

Slyusar also mentioned the Ilyushin Il-112V light military transport aircraft, which took flight for the first time on March 30, 2019 at Voronezh, in southwestern Russia. The aircraft will replace the An-26 transporters. The Il-112V is "a highly demanded aircraft", according to Slyusar. "Hundreds of such machines are needed in the coming years." He also announced there are two initial-series aircraft in production which will join the trials together with the first prototype.

Slyusar did not talk about any difficulties, at least not in the reports of the meeting published to the media. But the Il-112V

remains troublesome for the Russians. The first prototype has made only one flight so far, after which it returned to its production hall for almost a year and a half. It turned out the aircraft's structure was much heavier than planned. According to an earlier UAC press release, "the weight of the first aircraft will be reduced by one tonne". It is not known how much of this was realised, but the structural weight of the serial aircraft will now be reduced by 2.5 tonnes compared with its prototype. It is also planned to use lighter materials and equipment.

Superjet seats

Moving on to civil issues, Yuri Slyusar thanked President Putin for launching state subsidies for leasing 59 Superjet passenger aircraft, with a delivery period over the next two years. Some 22 Superjets are to be

delivered to Aeroflot; the rest will go to Red Wings, Azimuth and Yakutia airlines.

Slyusar said: "The Sukhoi Superjet, a 100-seat aircraft, has seen its highest demand during the [coronavirus] pandemic period. Where 200-seat aircraft flew yesterday, now 100-seaters are in demand."

However, as the aircraft was purchased many years ago and the pandemic is much more recent, it could be argued that Slyusar's rationale is unlikely.

Finally, Slyusar informed President Putin that the Irkut MC-21-310 narrow-body airliner with Russian Aviadvigatel PD-14 turbofans will take its maiden flight before the end of 2020. Currently, MC-21-300s fly with Pratt & Whitney PW1400G-JM engines. The seventh example will have Russian engines. In total, it will be the fifth flying example, while two more airframes are used for static tests. **AI**





Boeing's Big Fix

Mike Keaveney speaks with Jay Galloway, San Antonio site leader for MRO, about Boeing's C-17 depot maintenance programme at its Texas base

The Boeing C-17 Globemaster III's first flight occurred on September 15, 1991, with YC-17A 87-0025 at Long Beach, California, home at the time of McDonnell Douglas Aircraft Company's production line for the aircraft. In 1997, Boeing acquired McDonnell Douglas, bringing the C-17 into its portfolio



along with other McDonnell Douglas products like the F/A-18, AV-8, F-15, T-45, AH-64 and MD-500. The last C-17 rolled off the production line in November 2015.

Manufacture of the C-17 ended with one test airframe (87-0025), two static test examples and 276 production aircraft offered over 20 years. Presently, there are nine countries that have purchased the C-17: the United States (223), India (11), Australia (8), the UK (8), Qatar (8), United Arab Emirates (8), Canada (5) and Kuwait (2), plus NATO / SAC (3). Boeing has also been the sole provider of heavy maintenance on all C-17s sold through foreign military sales (FMS) or direct commercial sales (DCS).

To date, Boeing has processed more than 1,100 C-17s through heavy maintenance (depot level maintenance) at its San Antonio base in Texas. AI spoke with Jay Galloway, Boeing's site leader for maintenance, repair and overhaul (MRO) at San Antonio, about the C-17 heavy maintenance programme.

Galloway explained: "The C-17 Globemaster Integrated Sustainment Programme, or GISP as it is called, is the contract that we are currently working



under right now. The heavy maintenance and mod [modification] is just our name for it. We actually split work with Warner Robins Air Logistics Complex at Robins Air Force Base (AFB), Georgia. So, Warner – obviously a military installation – sticks specifically with US Air Force (USAF) ➡

TOP: NATO's Strategic Airlift Capability (SAC) aircraft #2 in for heavy maintenance. SAC has three C-17 aircraft in its squadron. C-17s can spend an average of 160 days going through heavy maintenance

All images by Mike Keaveney

ABOVE: The Boeing C-17 Production Building in Long Beach, California, in 2013

aircraft, and we have all the FMS and DCS aircraft here in San Antonio."

Boeing also performs heavy maintenance on USAF aircraft at the San Antonio site.

"One of the things that sets us apart on C-17 from Warner Robins, generally, is that we do all the unplanned depot level maintenance work. So, we are kind of the centre of excellence for unplanned depot level maintenance as well," said Galloway. "Warner sticks to a very regimented heavy maintenance schedule on their airplanes, and then we split that and kind of take all the others."

For instance, if a C-17 – whether it is a USAF or foreign aircraft – suffered a major engine fire and damage, that aircraft would go to Boeing for repairs rather than the USAF taking the aircraft to its own depot.

The Boeing facility in San Antonio is large enough to support a programme like the C-17: there is hangar space of 1.6 million square feet inside, and several outdoor pads for aircraft. Galloway said that in an average year, the facility could usually carry about 15 to 17 C-17s as work in progress at any given time.

"There are usually between 20 to 30 aircraft deliveries each year, depending on what their [Warner Robins] scheduled production is, and how many they want to get serviced, and how much money they've got budgeted."

For a large aircraft such as the C-17, the scope of work can be quite comprehensive, as Galloway explained: "It takes generally 20,000 to 30,000 hours depending on the condition of the airplane, so it's anywhere from 90 to 120 days approximately, depending on the statement of work. We are not doing any modification work anymore, so if you consider an upgrade or a modification, I think the C-17 programme has been through post-production; they've been through about 23 block integrations, we'll call them, so those were all currently completed.

"But [the USAF] has a long-term plan to continue to fly the C-17 aircraft for decades, so there will eventually be more modification work. We have had what we call 'speed lines' here and, over the course of our history, have done lots of modification work and upgrades to those

C-17A 07-7173 operated by 436th Air Wing at Dover Air Force Base, on the Delmarva Peninsula



aircraft, and I foresee that again in the future. Some of the modification work that has been done on the C-17 in the past has been communication upgrades, addition of the wing centre fuel tank, large aircraft infrared countermeasures (LAIRCM), avionics and mission systems and structural upgrades."

Galloway explained the extensive process that the C-17 goes through on arriving at Boeing's facility.

"The first thing that we do is de-paint it. In all heavy maintenance (HM) there is a five to six-year cycle requiring a complete [paint], or a scuff and paint, but now that the aircraft are getting a little older, it's pretty much a complete tear down of the paint – a strip and paint. We strip them first and then they go back to a representative position in the factory and we do a litany of things."

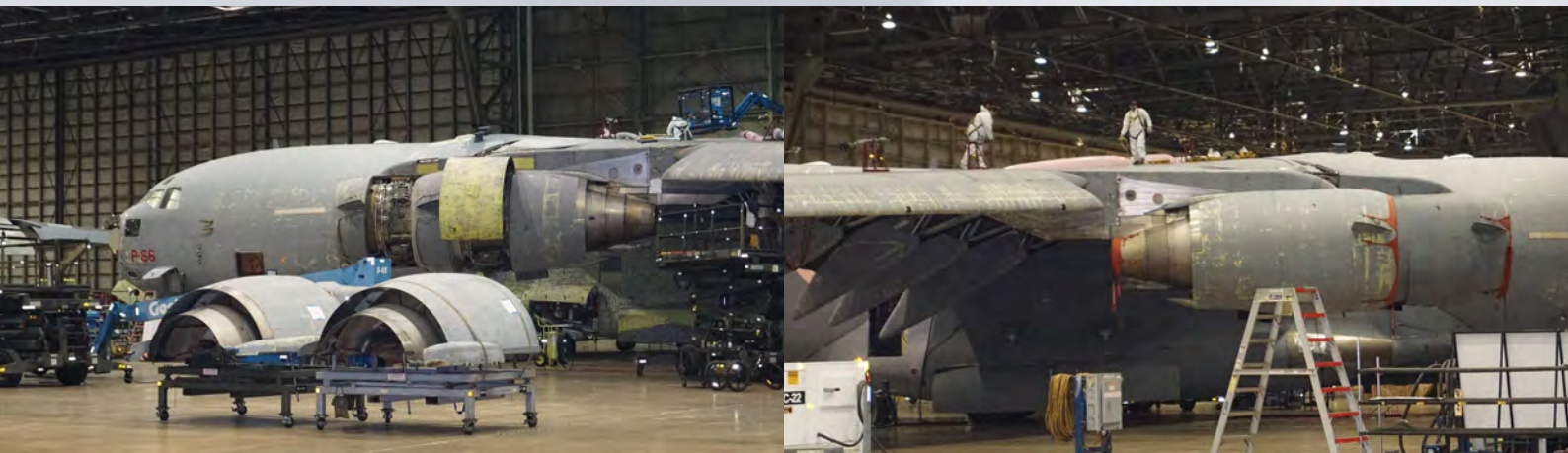
AI asked Galloway what he looked for when the aircraft is back on the line:

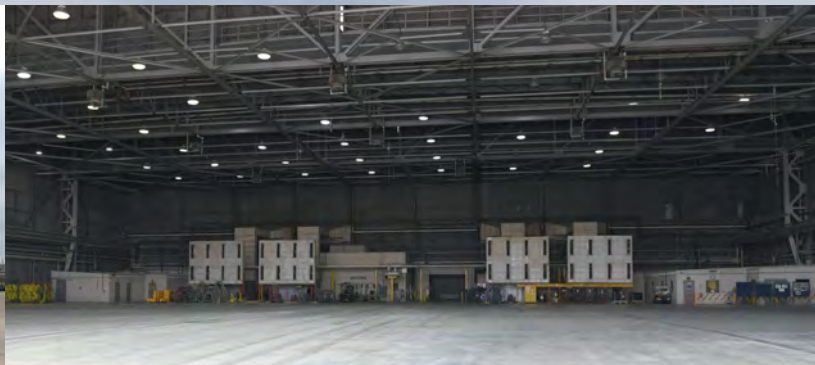
"There's a bunch of what we call corrosion cards or corrosion inspections," he said.

"We are looking for corrosion in various hot spots on the aircraft and correcting those conditions, like the flight control, landing gear and thrust reverser overhauls. Then there are always inspections for various things such as electrical and structural."

In the case of the landing gear, these are shipped out to a supplier to be refurbished. Galloway also explained that the pivot bolt inspection on the horizontal stabiliser – which is located at the top of the tail – is a very critical structure interface.

"Once we complete all that work, it goes back into paint. We have normal paint inspections and then it goes back out onto the ramp for a litany of functional tests," he said. "Eventually, a functional test flight





[is completed] and then a delivery back to the customer."

Has Boeing ever looked at any modifications to the C-17 to increase its load capacity? "Not to my knowledge," said Galloway. "When you compare it to the C-130 and even the C-5 it already has an incredible load capacity, in outsize cargo, what it can do and the capabilities it has. Its flight capabilities and characteristics are landing on very short runways, and unprepared runways, it doesn't need ground support and can back-up on its own.

"One of its most impressive [characteristics] is how [few] crew members they need to operate it; for a full mission, three crew members (a couple of pilots and a load master). You can do just about anything with that engineered floor that has a number of configurations, from pallets to tanks to helicopters and outsized cargo."

On December 2, 2015, the USAF delivered its 500th C-17 through depot maintenance and averaged 160 days and 19,000 hours of work on the aircraft. In 2018, Boeing

ABOVE: Boeing's paint hangar at San Antonio

BELOW, FAR LEFT TO RIGHT: Every C-17 is thoroughly stripped down and, on average, more than 19,000 hours of labour are spent on heavy maintenance

Workers on the C-17A 08-0002 tied off on a safety line

The C-17A 00-0177, from the New York Air National Guard's 105th Airlift Wing, in for its depot maintenance

The interior cargo hold of a C-17 with the wing centre fuel tank visible



C-17 SERIALS

C-17 SERIALS

Country	Model	Serials		# A/C	
US	YC-17A	87-0025		1	Test A/C – Display at USAF
	C-17A	88-0265	88-0266	2	Production A/C
		89-1189	89-1192	4	
		90-0532	90-0535	4	
		92-3291	92-3294	4	
		93-0599	93-0604	6	
		94-0065	94-0070	6	
		95-0102	95-0107	6	
		96-0001	96-0008	8	
		97-0041	97-0048	8	
		98-0049	98-0057	9	
		99-0058	99-0064	7	
		99-0165	99-0170	6	
		00-0171	00-0185	15	00-0173 crashed 7-28-2010
		01-0186	01-0197	12	
		02-1098	02-1112	15	
		03-3113	03-3127	15	
		04-4128	04-4138	11	
		05-5139	05-5153	15	
		06-6154	06-6168	15	
		07-7169	07-7189	21	
		08-8190	08-8204	15	
		09-9205	09-9212	8	
		10-0213	10-0223	11	
			TOTAL	223	PRODUCTION A/C

FOREIGN OPERATORS

Australia	C-17A	A41-206	A41-213	8	
Canada	C-17A	177701	177705	5	
UK	C-17A	ZZ171	ZZ178	8	
India	C-17A	CB-8001	CB-8011	11	
Kuwait	C-17A	KAF-342	KAF-343	2	
NATO / SAC	C-17A	SAC-01	SAC-03	3	
Qatar	C-17A	A7-MAA	A7-MAB		
		A7-MAC	A7-MAE		
		A7-MAM	A7-MAN		
		A7-MAO	A7-MAP	8	
UAE	C-17A	1223	1230	8	
			TOTAL	53	PRODUCTION A/C
		COMBINED TOTAL		276	PRODUCTION A/C
				1	TEST A/C

delivered its 1,000th C-17 through depot maintenance. “We are probably close to another 100 deliveries since then,” said Galloway.

When comparing the hours and days needed to complete an aircraft, AI asked Galloway how this time has tracked with what Boeing has seen: “With the aircraft getting older, the man hours will take longer on average to fix the aircraft,” he said. “An airplane flying in the Midwest is not going to have the same issues as an airplane flying out of Hickam AFB, Hawaii, sitting next to the salt air 24/7. The C-17, being a very old and mature programme, now really has great use of data analytics. The C-17 probably has the most robust data analytics programme because they have been flying so long. They have millions of flying hours on these aircraft. We have seen everything, so you know the supply chain is a lot more robust because of the data analytics. Problems are more predictable and aircraft are easier to maintain.

“The only difference today is if you look at how they [USAF] operated C-17s ten years ago, they didn’t fly them as robustly as they did [back then], so they are actually moving from a five-year HM to a six-year HM. They are stretching that out a little bit, and it is only because they’re not flying it as hard as they once did.”

On the subject of C-17’s heavy





C-17A 05-5141 of the 452nd Air Mobility Wing, March Air Reserve Base, California

maintenance process and whether or not new technologies have been brought on board, Galloway singled out the current process of stripping the paint from the aircraft: "Currently, paint for us is a bottleneck, meaning we have to take it in, strip it, and it takes nine days to do it. It's a very arduous process because they are using a chemical stripper and doing a

lot of work by hand. So, not only is it not entirely a safe process, but it is not a very environmentally sound one. We are going to a full-scale laser ablation on the C-17. We have a three-storey robot that we are working in partnership with Southwestern Research Institute. We are probably about a year away from doing that tear-down process with laser ablation.

"When you talk about technologies and innovations that are going to be really big for C-17, eventually we will get to one we can ablate because there is no dunnage or waste created. You go from 500-600lbs of paint that you pull off an airplane with chemical strippers and literally shovel out of the paint hangar off the floor and out of the paint hangar. To completely strip an airplane down with laser ablation and my [waste] fit in a one-gallon bucket, I can just pour it out, be done, and on to the next airplane. It's going to be a game-changer for us here. We are testing it on other aircraft, not just the C-17." **AI**

Work continues outside on the flight line. This C-17 05-5150 is from the 15th Airlift Wing in Hawaii



Flying-V



Is V the shape of things to come?

Dutch developers are working on a futuristic-looking jet that could revolutionise flight through its shape, sound and sustainability. In exclusive *AIR International* interviews, Tom Batchelor speaks to the people behind the Flying-V concept

It's shaped more like a boomerang than a conventional airliner and has passenger seating and the cargo hold integrated into the wing. Enter the Flying-V concept aircraft with an innovative design which, its developers hope, will revolutionise long-haul air travel with a drastically lower fuel burn and never-before-seen cabin environment.

A prototype of the jet, which is being modelled by engineers at Delft University of Technology (TU Delft) in collaboration with KLM Royal Dutch Airlines, completed its maiden flight during the summer. After a period of extensive wind tunnel evaluations

ABOVE: The Flying-V is designed to carry approximately the same number of passengers as the Airbus A350 and an equivalent amount of cargo

All images via Delft University of Technology unless stated

and a series of ground tests, it got airborne for the first time, giving engineers a chance to monitor the flight characteristics. Efforts by the Netherlands-based group to develop the "highly energy-efficient long-distance aeroplane" have been under way since 2017, with the original idea developed by TU Berlin student Justus Benad during his thesis project at Airbus Hamburg.

The team, led by chief engineer Malcom Brown, reported that the improved aerodynamic shape and reduced weight mean the jet will use 20% less fuel than the Airbus A350 – roughly comparable for size and performance. He spoke to *AIR International* about the prospects for a redesigned airliner flying passengers in the near future and how the Flying-V is not the only concept being developed by his engineer and designer colleagues.

The South African aerospace engineer explained: "The aim of the Flying-V project is to introduce a more energy-efficient long-haul passenger aircraft to reduce the



The main cabin is mooted to be equipped in a ten-abreast configuration with a total width of 6.1m, which is wider than the Boeing 777X
Malcom Brown

climate impact of airline travel.

"It is also meant to be a technology demonstrator, showing that new aircraft configurations are technically and economically viable. We hope that this will also open the doors for other novel [types] and reduce the reluctance of the industry towards these radical design changes. This has the potential to be revolutionary and the beginning of the next technological step, just like the introduction of the jet engine or metal aircraft many years ago."

Stretch or shrink?

Asked what the principle hurdles were in getting the initial designs converted into a working prototype, he said: "The main design challenges are how to integrate the pressurised fuselage into the wing, ensuring good stability and controllability without augmented flight control computers. To solve this we have made use of the oval fuselage [which] allows us to efficiently integrate the cabin into the wing without major structural and weight penalties. There is also a challenge innate to flying or blended-wing designs and that is how to efficiently stretch or shrink the aircraft to make a family group with different passenger numbers. This has turned out to be important for airlines as they tailor their purchases to suit their specific routes. We have achieved this on the Flying-V by integrating a section

of the wing that has a constant shape so extra pieces of fuselage can be added or removed without requiring different moulds or tooling that makes it very expensive and [more] complex."

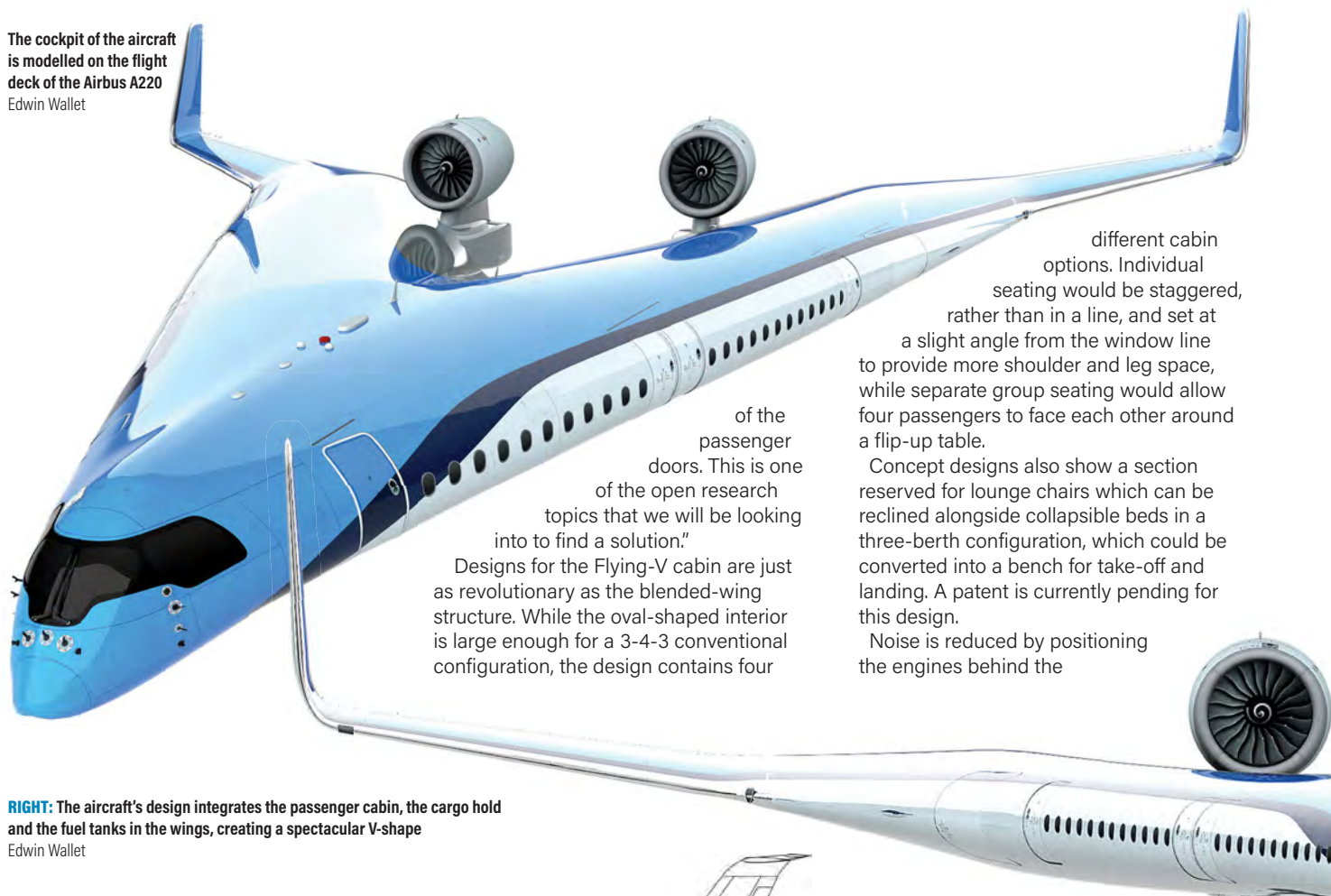
Brown and his team are confident that significant fuel savings can be achieved by improving the aerodynamics of the airframe – and that even greater efficiency would be possible through the development of improved propulsion technology in the future. "The 20% fuel reduction mainly stems from... the fact that there is no fuselage so all the surfaces are lifting, aiding flight, so there is better synergy between the structure and aerodynamic surfaces. Simply put, there is less [aircraft] in contact with the air making less drag. Secondly, due to the increased synergy, the empty mass of the [jet] is slightly less than the reference conventional aircraft, the A350. This reduced mass has a snowball effect on the whole [airliner] and so the fuel required to fly a certain distance. The fuel savings, thus, do not come from improved engine efficiency as we are using fuel consumption figures for the current A350 engines for the calculations. That means if improved propulsion technologies, like hybrid electric or hydrogen powered engines are integrated, the savings could be even more. The Flying-V would also be suited to these technologies, but we

chose not to integrate them yet, in order to establish the baseline savings of the concept and [therefore] reduce the design risk at this stage."

The Flying-V is designed to carry about the same number of passengers as the A350, around 314 in a standard configuration, and the same amount of cargo. It would also have the same wingspan, though would be shorter from nose to tail. This, the developers believe, would eliminate issues faced by the A380, which forced airport operators to redesign terminals to accommodate it. Glasgow International, for example, spent £8m changing the airfield layout and building a triple air bridge for the super jumbo).

"We are working closely with operators in order to ensure that airport integration is taken into account early on in [the] design," Brown said. "Having learnt from the A380, we would like to have a design that does not require any changes to existing airport infrastructure. This has been achieved, so the aircraft can fit in the same gate as the A350 and requires the same runway length. Loading of passengers is also done in the same way as for the conventional A350. Cargo loading could be the only factor that might need a change as traditionally the cargo door is located lower down on the fuselage. This means the loading trucks might not have sufficient height to reach the cargo door, which is at the level

The cockpit of the aircraft is modelled on the flight deck of the Airbus A220
Edwin Wallet



of the passenger doors. This is one of the open research topics that we will be looking into to find a solution."

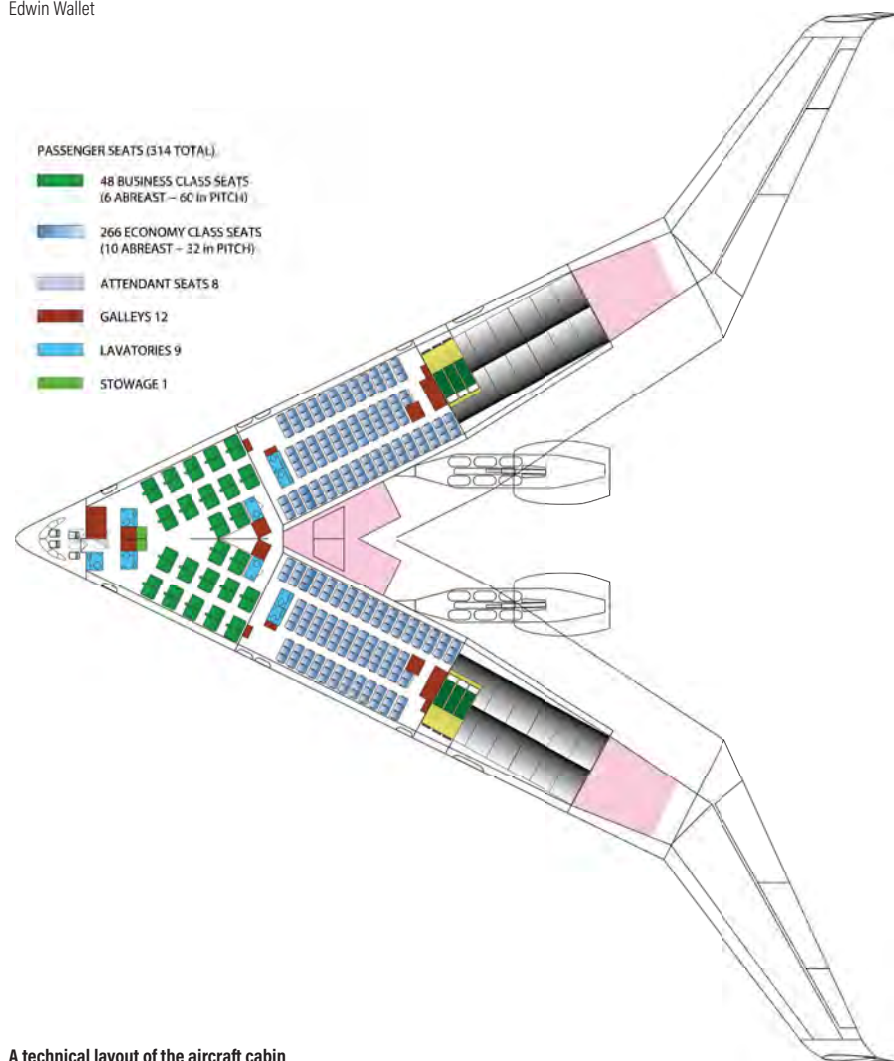
Designs for the Flying-V cabin are just as revolutionary as the blended-wing structure. While the oval-shaped interior is large enough for a 3-4-3 conventional configuration, the design contains four

different cabin options. Individual seating would be staggered, rather than in a line, and set at a slight angle from the window line to provide more shoulder and leg space, while separate group seating would allow four passengers to face each other around a flip-up table.

Concept designs also show a section reserved for lounge chairs which can be reclined alongside collapsible beds in a three-berth configuration, which could be converted into a bench for take-off and landing. A patent is currently pending for this design.

Noise is reduced by positioning the engines behind the

RIGHT: The aircraft's design integrates the passenger cabin, the cargo hold and the fuel tanks in the wings, creating a spectacular V-shape
Edwin Wallet



passenger cabin. This effect is aided by the wing partly shielding the fan and exhaust noise no longer being reflected from the lower surface of the wing. As part of the bid to reduce weight throughout the design, the seating is intended to be 4kg lighter than typical examples currently used on long-haul jets. Furnishing panels and even some of the structural components have been designed using topology optimisation – a computerised process which eliminates unnecessary material by producing a lattice-style design while ensuring the structure can withstand the intended load. While there is no guarantee all of these concepts will feature in any final design, the team behind the project state that the proposals serve as a starting point for further exploration, research and concept development. Studies are already under way to evaluate their feasibility and the effect on travellers.

Cabin comfort

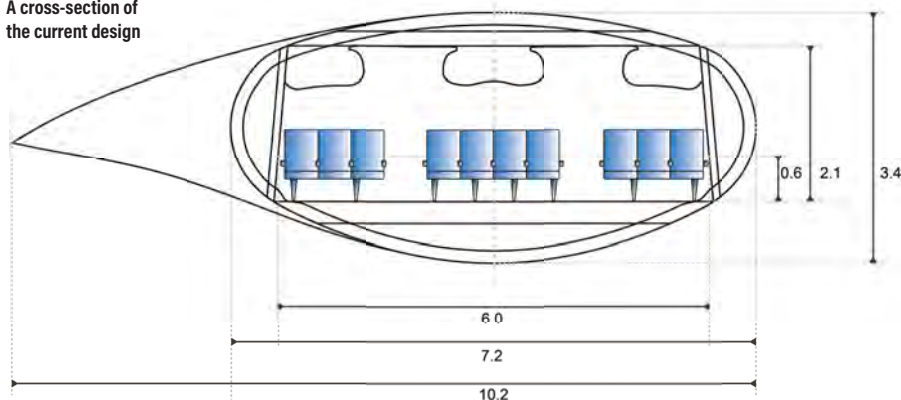
"Improving the passenger experience while flying is one of our main goals and involving the industrial design faculty here at the university has been a big help in that," Brown said. "There are new seating concepts in the cabin, where passengers are able to sit in small groups at picnic bench-type chairs making it easier to socialise and pass the time – chairs that are able to change their posture so that

A technical layout of the aircraft cabin

you don't have to sit in one orientation the whole flight. [There are] even bunk beds in economy that can be used as proper chairs during take-off and landing, allowing passengers to lay flat and sleep. We are also experimenting with the concept that you are able to reserve different seating types for a part of the flight, for example to reserve a normal chair for the first four hours and then a bunk bed for the second four hours of a flight. Of course, this needs careful consideration of operations by airlines but we are working together to make these cool ideas become a possibility. To aid in this, the industrial design faculty has already made a full-scale mock-up of a section of the cabin with these different seating options. It has been displayed for people to try out on a few occasions and give their feedback and rating of the different seating concepts."

But there is one major drawback – for passengers at least – of the V-shaped design, which the TU Delft

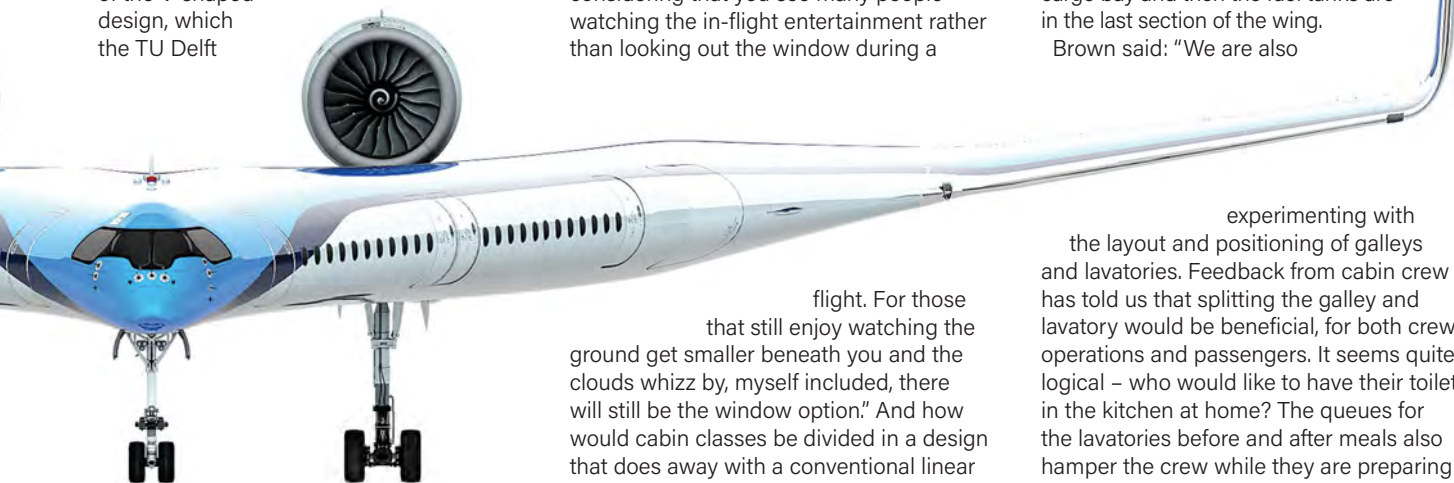
A cross-section of the current design



seats but only on the one side of the cabin, the forward side, because it is not feasible to put windows in the rear side of the cabin in the thin trailing edge of the wing," Brown said. "That gives the Flying-V half the number of windows. We hope that the flying public will be accepting to this, also considering that you see many people watching the in-flight entertainment rather than looking out the window during a

First and business class is located in the front centre section behind the cockpit. The main galley and an open gathering area follow this. Economy is behind this section, extending into the wings until approximately half-way down the wing. Behind that is the cargo bay and then the fuel tanks are in the last section of the wing.

Brown said: "We are also



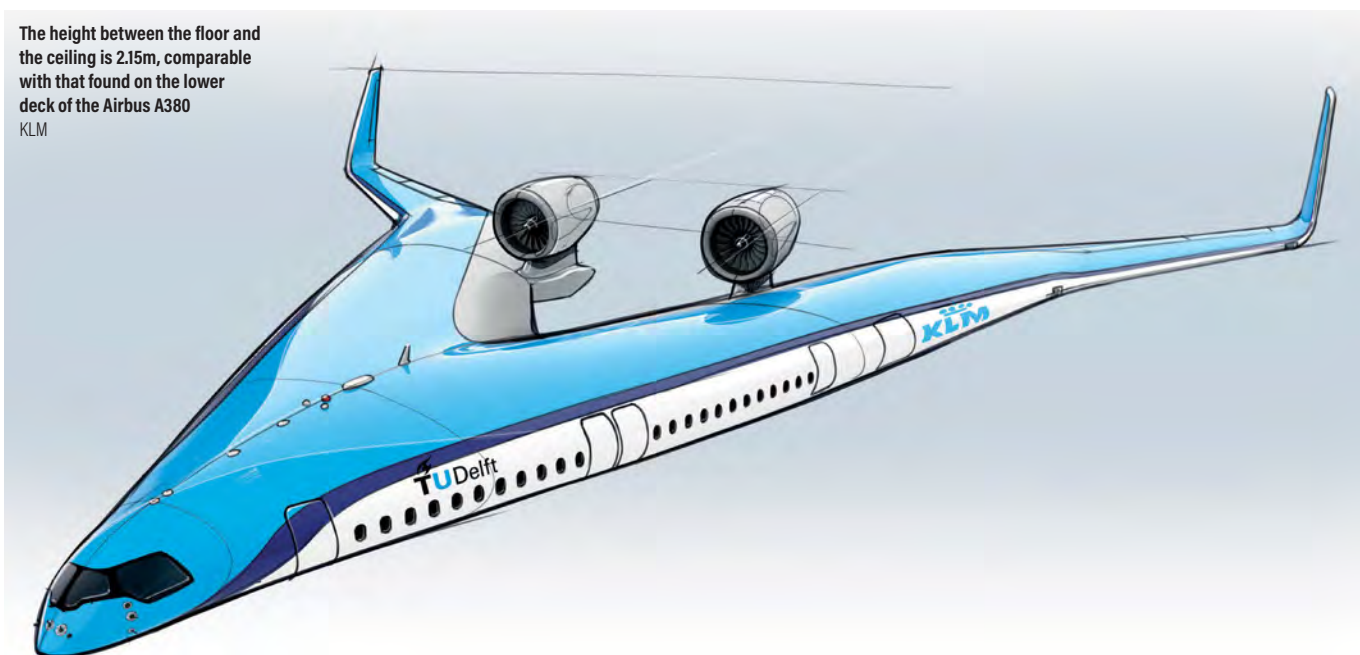
team hope will not be a stumbling block on the road to future commercial flights. "Currently, the aircraft does have window

flight. For those that still enjoy watching the ground get smaller beneath you and the clouds whizz by, myself included, there will still be the window option." And how would cabin classes be divided in a design that does away with a conventional linear pattern incorporating first class passengers near the nose and economy customers towards the back?

At the moment there is a more traditional layout to the different classes in the cabin.

experimenting with the layout and positioning of galleys and lavatories. Feedback from cabin crew has told us that splitting the galley and lavatory would be beneficial, for both crew operations and passengers. It seems quite logical – who would like to have their toilet in the kitchen at home? The queues for the lavatories before and after meals also hamper the crew while they are preparing food or tidying up the galley, so putting galleys and lavatories apart will help that. These are just some of the things that the feedback from industry is helping us with and we welcome even more input." ➔

The height between the floor and the ceiling is 2.15m, comparable with that found on the lower deck of the Airbus A380
KLM





ABOVE: Due to the low radius of curvature of the side arc, relatively large windows can be placed with a limited structural weight penalty Guus Schoonewille

BELOW: Project engineers say the next step is to provide the Flying-V with sustainable propulsion, taking into account that the design seems "highly suitable" for carrying liquid hydrogen instead of kerosene Joep van Oppen



Following these early tests, the team intends to use the data to create an aerodynamic software model of the aircraft Malcom Brown

Tail tale

One of the most striking elements of the aircraft's exterior design is the tail. In fact, the Flying-V does not have a separate horizontal tail plane, instead gaining stability from the location of the wing's aerodynamic centre. Pitch and roll are achieved through elevons – combined elevators and ailerons – at the trailing edge of the outboard wing and yaw control is provided by the rudders integrated in the winglets. The design means the Flying-V lands with its nose at a higher attitude than conventional passenger jets, a feature which the designers say will draw comparisons with Concorde. As a result, the landing gears are stretched compared with comparable aircraft and require an extra hinge point for stowing. The Flying-V has also removed the need for high-lift devices such as flaps. That means fewer moving parts and a reduction in maintenance costs. This is made up for with a wing area which is twice the size of a similar jet, allowing the blended wing to reduce speed sufficiently in the approach.

Dr Roelof Vos, researcher in flight performance and propulsion and the project lead, explained: "Due to the fact the aircraft has no flaps, wing-mounted spoilers cannot be applied to quickly dump lift and transfer all the weight to the landing gear upon touch-down.

"Therefore, during touch-down, the aircraft rotates to an angle of attack of -3° to ensure that the wing no longer provides any net lift. When the nose wheel touches the runway, the aircraft can start braking



without the risk of skidding."

Performance of the Flying-V would, again, be similar to the A350 with an expected range of 14,816km and a cruise speed of around Mach 0.85, though its engineers state it is likely to have a marginally higher cruising level.

Brown said: "Required runway length is also the same since we want to be able to use the same airports, and climb rates and gradients would also be similar as these are also governed by certification, as well as one engine inoperative performance."

Despite the size of the aircraft and its intended use as a long-haul jet, the cockpit is modelled after the flight deck of the single-aisle A220. This is designed for two pilots and the high approach inclination requires large windowpanes to give the crew an adequate view of the runway during the approach and landing.

KLM pilots are involved in the process and have already given their feedback on initial aspects of the design. At a later stage, aircrew will be invited to trial the jet in TU Delft's simulator, with the aim of making handling and performance resemble passenger jets in service today.

Brown explained: "The [Flying-V] should not be drastically different to conventional airliners, having similar take-off and approach speeds and we need to achieve the same handling characteristics [to gain the] certification.

"All of this combined should result in... needing the same amount of training effort, which will also improve the marketability of the aircraft." ➔



ABOVE: Engineers considered inter-engine clearance, the centre-of-gravity and aerodynamic interaction with the wing when deciding where to place the powerplants Henri Werij

BELOW: Dutch flag carrier KLM has been a major partner of the project since last year Joep van Oppen





LEFT: The Dutch team has created a 22kg and 3m-wide scale model of the Flying-V Joep van Oppen

Design and tests

TU Delft's team of students, designers and engineers unveiled a scale model of the project last year and faced an early problem in keeping the prototype model (with a 3.06m wingspan and 2.76m length) under the 25kg needed to meet regulations for the flying of drones. The maiden flight in July passed largely without incident although the team observed a tendency for the aircraft to become unstable – known as Dutch Roll – which made it difficult to keep the wings level and caused a somewhat rough landing. The designers said calculations had predicted that behaviour but since it had been demonstrated in a real flight, the team would be able to adjust

the aircraft accordingly. The challenging week of testing also saw the team have to step in to change the centre of gravity of the aircraft and fix the prototype's antenna.

Brown foresees another two decades of design work and testing on the Flying-V before passengers could take to the skies in one, notwithstanding the massive disruption to the aviation industry caused by the coronavirus pandemic, which has also caused delays for the team at TU Delft. "Considering the large amount of fundamental research that still needs to be carried out and the long design trajectory that new [airframes] require we expect that the aircraft, if viable, could enter service around 2040," he said.

"This is of course only a rough estimation and depends heavily on how the results of the research goes and now also the impact of the crisis on the aviation industry. We have had interest from other airlines [apart from KLM] during the various research workshops and talks that have been held. It is great that others also want to get involved because the more issues we can iron out now, the smoother the whole design trajectory will go. It would be too soon to comment on who a launch customer could be, but it would be neat if KLM, as a first sponsor of the project, could end up [as] the launch customer.

"I also imagine that the aircraft would also be available to purchase for other airlines so the emission reductions can be maximised and for economic viability.

One risk to the Flying-V project is an uncertain marketplace with changing demands both from airlines and passengers, something Brown is acutely aware of. "We are doing our best to predict future markets and position the aircraft in the correct segment, having the same number of passengers and range as the successful A350 segment.

"How the market will evolve over time, also considering the current situation, is



RIGHT: Could the Flying-V be as common a sight as KLM's Embraer fleet at its Amsterdam Schiphol hub? KLM

difficult to know. This is also why we are ensuring that it is possible to make a family of aircraft, by stretching or shrinking the size to accommodate a different number of passengers. Research and development costs for new aircraft are always high and even more so for novel concepts, this is again why we are trying to get the involvement of a wide range of industry partners to iron out issues with all the topic areas while the concept is still in the relatively cheap initial design phase."

So will we see other manufacturers move to a V-shaped, blended wing?

Brown thinks not. "These flying or blended-wing concepts are more suited to larger aircraft since it becomes difficult to efficiently fit the cabin into a smaller wing of say a regional airliner, simply because people have to be able to stand in the cabin, making the wing very thick in a relative sense. What I do hope happens, if we are successful, is that it will open the doors to acceptance of new concepts so that the other configurations also get a chance."

He lists the Prandtl concept of a closed wing – one which forms a loop with no wingtips – as an example. "All of these new configurations improve the aerodynamic efficiency of the aircraft, something that



has stagnated to some degree in the last [few] years because we are reaching the limits of what is achievable with transonic aerodynamics. The industry definitely wants to reduce emissions drastically and this will only be achievable with a combination of aerodynamic and propulsion efficiency gains, so I definitely see this as the way forward."

And the Flying-V is not the only aerospace project being developed by engineers at TU Delft. There is also the DUUC, a tail-less ducted fan concept for new control surface methods; Parsifal, which is a Prandtl plane concept for A320 and A330 size jets; and AHEAD which is a blended wing body (BWB).

"The goal is to investigate a wide range of concepts, trade them off with each other and find out what the challenges are with each of them and which type of missions they are best suited for. We are also investigating new propulsion types, such as hybrid or fully electric aircraft... cryogenic and gaseous hydrogen and natural gas and new more efficient combustion types. New structural concepts and materials are also in the works to reduce aircraft mass as well as morphing or flexible structures to increase aerodynamic and structural efficiency and the link between them. All towards the goal of reducing the overall energy requirements and emissions of the air transport industry as a whole." **AI**



Windows are only located on one side of the cabin
Edwin Wallet

Sentry watch

over the smugglers

In the war on drugs, the United States Air Force's E-3 Sentries have been flying discrete surveillance sorties since the late 1970s, as **Sérgio Santana** explains



arrived at the tiny Caribbean island of Curaçao in the Lesser Antilles.

The C-5M transport aircraft landed at a Cooperative Security Location (CSL) – a US military term for training facilities in counterterrorism and drug trafficking – hosted at Curaçao International Airport.

On June 21, a United States Air Force (USAF) Air Force Reserve Command Lockheed C-5M Galaxy (86-0015, callsign 'RCH104') operated by 68th Airlift Squadron

Its mission was to provide support for an intelligence, surveillance and reconnaissance (ISR) unit that arrived at the same location the following day.

The unit was made up of two types aircraft: a Boeing E-3G Sentry Airborne and Warning Control System (AWACS) aircraft (78-0576, callsign 'THNDR07') from the 964th Airborne Air Control Squadron, part of the 552nd Air Control Wing (ACW) based at Tinker Air Force Base, Oklahoma; and a Northrop Grumman E-8C Joint Surveillance Target Attack Radar System (JSTARS) aircraft (92-3289, callsign



'DRACO002') flown by the 128th Airborne Command and Control Squadron based at Robins AFB, Georgia and subordinated to the Air National Guard's (ANG) 116th Air Control Wing.

The last aircraft of that deployment arrived on June 23, a trio of ANG's refuelling aircraft: one Boeing KC-135T (59-1504, callsign 'SPUR50') from the 147th Air Refueling Squadron based at Pittsburgh IAP Air Reserve Station and part of the Pennsylvania ANG's 171st Air Refueling Wing; and two KC-135Rs – the 58-0109 (callsign 'SPUR51') operated by the 174th

Air Refueling Squadron stationed at Sioux City ANG Base, Iowa and subordinated to the Iowa 185th Air Refueling Wing, and the 59-1466 (callsign 'RCH150'), flown by the 108th Air Refueling Squadron located at Scott Air Force Base, Belleville, Illinois and subordinated to the Illinois ANG's 126th Air Refueling Wing.

According to witnesses, the ISR aircraft of that temporary deployment (which lasted for about a month) would take off for their missions early in the evening and return early morning. The purpose of the operation was a sharp rise in drug

ABOVE: An E-3 AWACS aircraft refuels over the Pacific Ocean off the coast of Ecuador prior to patrolling the skies over South America, July 2005 Efrain Gonzalez, USAF

trafficking detected in the region. Between May and June this year, just over 8,200kg of narcotics with an estimated street value of US\$200m (£150m) were intercepted, compared with around 12,000kg seized for the entire fourth quarter of 2019.

The reason for the spike seems to be directly linked to more clandestine airstrips, roads and ports being used by small and



slow aircraft, vehicles, and even improvised submarines for trafficking illegal cargo.

This is why the Sentry and JSTARS entered the scenario, acting in conjunction with the former's Westinghouse AN/APY-2 and the latter's Norden AN/APY-7 radars to detect aircraft, boats, cars and trucks as well as safe houses, installations, terrain and even people. The most recent deployment of anti-drug-trafficking measures was made public on April 1 as part of much larger counter-narcotic operations involving the E-3 Sentry, which dates back to the late 1970s.

'Over the shoulder'

The first of these operations started in 1977, just after the Boeing E-3A Sentry was inducted into the USAF. It came as a suggestion by the then head of Air Operations for Anti-Drug Smuggling that the Sentries could be used as a prized asset for the detection of airborne drug trafficking.

Late the same year, the United States Customs Service (USCS) and the USAF entered into an agreement – also known as 'over the shoulder' because an USCS operator was literally stood over the position of an AWACS radar operator – to co-operate in anti-drug operations as long as these remained incidental to the basic Air Force training mission for the then new system.

The official permission came in 1978 in the form of a joint USCS/USAF programme. However, after three years of operations, the USCS decided to close it after finding the E-3A's radar was not suitable for smaller, slower aircraft used by smugglers. The E-3A was also not allowed to fly special orbits that would meet USCS surveillance needs. What's more, tracking smuggler aircraft to their final destinations through these flexible orbits was prohibited. In fact, these three drawbacks resulted in just one detection and arrest after 1,000 hours of E-3A flight time. As a consequence, the usage of E-3s in counter-drug operations came to an abrupt end.

Customs watch

In a February 1982 memorandum, the then US Vice President, George Bush, tasked the US Department of Defense (DoD) to provide drug-trafficking surveillance coverage with E-3s after the US Navy's E-2C Hawkeyes became unavailable. Accordingly, in 1983 special AWACS orbits were designed by co-ordinating the 552nd Air Control Wing, hosted at Tinker Air Force Base, Oklahoma and the National Narcotic Border Interdiction System, to allow for designated US Customs sorties.

These orbits permitted maximum training

ABOVE: Personnel board an E-3 Sentry airborne warning and control system aircraft, which then flies a counter-narcotic surveillance mission over the eastern Pacific Ocean on August 1, 2007.

USAF/Tech. Sgt Cecilio Ricardo

BELOW: An aerial shot of the Cooperative Security Location Aruba-Curaçao, taken in September 2019 USAF





while also allowing customs to perform a constant watch over drug-smuggling aircraft. All joint operations between AWACS and USCS were co-ordinated by the US Customs National Aviation Centre (CNAC), in Oklahoma City.

In October 1988, a letter of agreement between the CNAC and the 552nd ACW laid out the duties of the E-3s aircrews and

the USCS's detection system specialists (DSS). As a result of this close co-operation, from 1983 through to early 1989, the E-3s flew 335 dedicated missions and 2,301 watch missions – a total of 20,569 flying hours that produced 18 credited arrests.

More success followed.

Between 1988 and 1989, the E-3 Sentry's participation in monitoring and detecting activities increased by more than 700%.

To achieve these results, 13 dedicated E-3s were allocated, one being on a constant one-hour alert.

There were six scheduled designated missions and approximately 40 watch sorties per month.

All missions were directly co-ordinated with the USCS, while the DSS were programmed to fly on 75% of all customs watch sorties from Tinker AFB.

The initial difficulties in detecting low-level, slow-moving, small radar cross-section targets like the single turboprop aircraft – typically flown by drug smugglers – were eliminated when the Radar System Improvement Program (RSIP) was implemented in the USAF E-3 fleet.

It improved the E-3's radar sensitivity, radar reliability and maintainability and doubled the detection range against small aircraft.

The 1990s and 2000s

In 1989, the DoD officially became an active part of the US government's fight against drug cartels in Latin America, along with local and European allies. The 552nd ACW's E-3s became crucial to these operations, the first of which, called 'Support Justice III', took place between October 1991 and May 1992 and was a co-operative effort between USAF and the Peruvian Air Force. In 1991, a broader operation made up of assets from the UK, Colombia, Honduras and Mexico also acted against local drug barons, supported by the Sentries from the 964th Airborne and Control Squadron.

An even broader and more complex operation to detect and neutralise airborne drug trafficking over Latin American skies was launched in March 1995. Called 'Air Bridge Denial' (or 'ABD'), its aim was to deter narcotics trafficking in Peru by E-3 surveillance missions. However, despite the many resources spent on ABD, the results were poor.

Only 19 aircraft were either shot down or forced to land between 1995 and 2000 and the operation was suspended in April 2001 after a civilian aircraft was mistakenly shot down in Peru, killing two US citizens. After a lengthy review of procedures, it resumed in 2003 and continues to this day, but in



a minor role. In April 1996, shortly after the launch of the ABD programme, operation 'Laser Strike' was authorised. It lasted 12 months and was aimed at disrupting the river and coastal smuggling routes used by drug traffickers as an alternative to air transportation in Ecuador, Venezuela and Bolivia, as well as in Peru and Colombia.

Operation 'Laser Strike' was regarded as having tracked a total of 45,000 aircraft, 5,390 of which were considered 'tracks of interest'. Of these, only 150 were suspected of being involved in drug trafficking, with 21 planes eventually forced to land or shot down. In these events, the USAF E-3s were part of a comprehensive radar network that included ground-based radars located in Latin American countries.

Source zones

In 1997, the closure of Howard Air Force Base in Panama – a significant base for counter-narcotic operations – forced the establishment of CSLs within the Andean Ridge 'source zones' and the Caribbean,

Eastern Pacific and Central American 'transit zones'.

These allowed US and allied nation interdiction aircraft to be forward deployed closer to drug-trafficking departure points. These CSLs also allowed for greater counter-drug surveillance 'coverage' at a cheaper cost when compared with operations based out of Howard AFB.

Currently the locations are the Caribbean CSL (one base at Aruba's Reina Beatrix International Airport and one at Curaçao International Airport in the Lesser Antilles) and the Central American CSL at El Salvador International Airport.

Both Caribbean CSL locations required minor construction improvements to include aircraft parking ramps, maintenance and operations buildings. To date, the Aruba CSL has seen limited improvement and use, while the Curaçao CSL has received all required improvements including ramp space for two large, two medium and six small aircraft, plus a fresh water facility, a

maintenance hangar and an operations building. Agreements with the host nations specify which missions may or may not be flown from the CSLs. Authorised host nation personnel fly aboard US aircraft to facilitate in-flight co-ordination with local authorities during operational missions.

The US Southern Command oversees the operations from the CSLs, while the Joint Interagency Task Force South (JIATF-South), based in Key West, Florida, co-ordinates US aircraft usage and operations when they are involved in Counter-transnational Organized Crime (CTOC) missions.

Host nation personnel are responsible for decisions to interdict suspected traffickers within their relevant national borders or airspace, whereas US law enforcement agencies lead interdiction efforts in international waters and airspace. **AI**

BELOW: The USAF's E-3 latest deployment to Curaçao in June 2020 Larry Every



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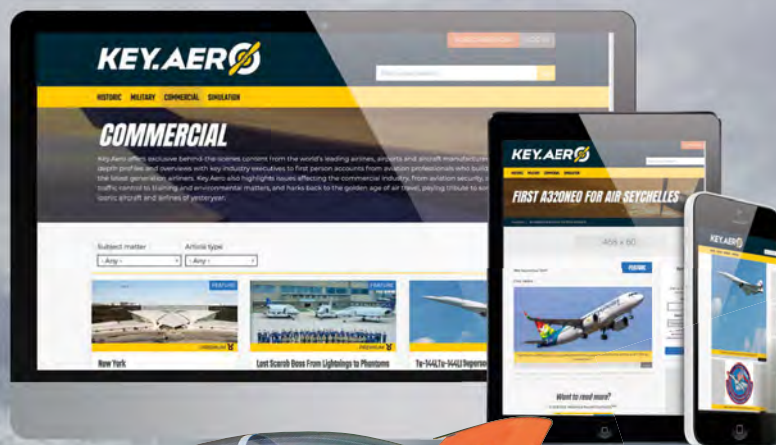
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The TAV is the baseline configuration for a family of multi-role aircraft that are intended to operate as force multipliers. This includes a multi-mission variant – known as the Wasp – and a high-altitude, long-endurance (HALE) version, called Branta.

Marko Ivankovic, senior product development manager and flight test engineer at Icarus Aerospace, said: "We've developed TAV to be in alignment with [the] latest international military armed overwatch and persistent presence requirements and challenges. The aircraft defines a niche of its own and excels in addressing all existing and future daily threats facing our troops, security forces and our world."

Sensor fusion

Much like Lockheed Martin's F-35 Lightning II family, the TAV and its variants will employ sensor fusion and networking capabilities. This enables the platform to better integrate and co-ordinate with allied air, ground and naval forces in the battlespace. Icarus added that the "TAV can utilise its innovative software, avionics and systems to meet a wide variety of mission requirements," whether the aircraft is crewed, being remotely piloted or flying autonomously. The platform employs modern avionics and is integrated with a number of mission and weapons systems. It is also equipped with a 360° active electronically scanned array (AESA) radar, providing enhanced situational awareness and tactical capabilities. Alongside this, both the TAV and Wasp can be fitted with two forward-looking infrared (FLIR) turrets, which are retractable and can be placed on the chin and belly of the aircraft. The firm adds that the platform has been designed to be highly reliable, while remaining relatively simple to maintain.

The Wasp

Described by Icarus as the fully militarised variant of the TAV, the Wasp is specifically designed to conduct armed overwatch, persistent presence and intelligence, surveillance and reconnaissance (ISR) missions. The firm states that, when configured for air-to-ground missions, the Wasp is able to perform armed aerial scout, close air support, counter-insurgency, forward air control and re-arm and resupply tasks. It can also support special forces missions, combat search and rescue, medical evacuation, city protection and border patrol operations. In a maritime setting, the variant can carry out armed coastal and maritime patrol missions, along with anti-piracy and anti-submarine warfare operations. When configured for an ISR mission, the Wasp can be outfitted to carry electronic warfare, signals intelligence, battlefield management and communications/intelligence relay tasks. Icarus adds that the Wasp is fully network-centric and swarm-capable, suggesting that it can either be operated as part of a group of unmanned aerial systems (UAS) or it can be used as a platform that commands and controls a flight of autonomously swarming aircraft.

The Branta

Icarus' Branta – named after the Canada Goose (*Branta canadensis*) – is distinctively different than the TAV and Wasp to cater for its HALE mission. Its wingspan is almost double that of the other two variants, measuring in at 98ft (30m), but it shares the same length as its sister platforms.

Described by Icarus

as being "a logical step in evolution of modern drones and reconnaissance aircraft with further growth in mind", the Branta will be able to counter high-altitude UASs and surveillance aircraft. The platform itself is also able to conduct an ISR mission at such heights.

The Branta features the same armament capabilities, powerplant, avionics and radar/FLIR turret suites as the TAV and Wasp, but it can also accommodate a variety of other mission systems to suit the operator's needs. It can be employed from the same austere environments as its counterparts and shares the same swarming, networking and sensor fusion capabilities. When operating unmanned, there's an option for the Branta's cockpit provisions to be removed to allow more space for mission systems inside the aircraft. Apart from its wingspan, the main differences come in the type's performance. It is slower than its counterparts, having a maximum speed of 611km/h, but has a manned service ceiling of 15,240m. According to Icarus, the platform has an unrefuelled endurance of up to 30 hours, but this becomes dictated by crew limits when air-to-air refuelling is available. When operating unmanned, the company states that the Branta's endurance is limitless.

Concept art depicting a trio of Branta optionally piloted UCAVs in flight. Aircraft operating at high altitude feature longer wingspans, something which is unique to the Branta in comparison with its sister aircraft, the Wasp and the TAV Icarus Aerospace

Icarus stats

The TAV and Wasp have a 15.5m wingspan and are 15.9m long. Both are powered by the same 1,700shp turboprops, which allow for a maximum speed of 668km/h. The platforms will have a service ceiling of 10,972m when manned and when operating unmanned, the altitude limits become more defined by the specifications of the mission/equipment requirements.

Using their internal fuel tanks, both variants have an unrefuelled endurance of six and a half hours, allowing them to operate at ranges of up to 2,408km. When equipped with auxiliary fuel tanks, this rises to nine hours and a maximum of 3,704km. Icarus adds that the endurance of the platform when air-to-air refuelling is an option is dictated by the crew's limitations. Both the TAV and Wasp have a planned payload of 3,628kg, which can be spread across 11 external hardpoints. It is possible to integrate several munitions and armaments with both variants – these are optional and can be customised to suit the customer's needs. The platforms can be equipped with a single forward firing fixed cannon or a belly-mounted 360° turret cannon of up to 30mm in calibre. Both are able to employ laser-guided bombs and rockets, GPS-guided weapons, sonobuoys, anti-ship rockets, conventional unguided munitions, air-to-air infrared missiles and/or two torpedoes.

On August 10, Canadian-based start-up Icarus Aerospace unveiled its Tactical Air Vehicle (TAV) – an optionally piloted, customisable, multi-role force multiplying solution for the world's military and security forces community.
By **Khalem Chapmen**

Icarus

Tactical Air Vehicle



Concept art of two TAV aircraft providing a good view of the platform's 11 hardpoints. Note the aircraft are outfitted for armed maritime operations Icarus Aerospace

Plug and play

Icarus' TAV is the first in a family of technologically advanced multi-mission aircraft and is the baseline configuration from which the Wasp and Branta variants are based. Customers can customise it to suit their specific operational requirements.

All three iterations of the platform are powered by two 1,700shp (shaft horsepower) turboprop engines and each employs a twin-boom tail and high-wing design, with a tandem-seat cockpit configuration. The TAV, Wasp and Branta are designed from the outset to be optionally piloted, meaning it can be flown both manned and unmanned on a variety of missions.

The company describes the TAV as an affordable, all-weather, day or night 'plug and play' solution, adding that it is able to outperform and replace "ageing and near obsolete fleets of more expensive helicopters, aircraft and drones". It can also be refuelled in flight and offers an automated aerial refuelling (AAR) capability, allowing it to receive fuel when flying autonomously.

Designed as a short take-off and landing (STOL) aircraft, the platform is capable of operating in austere environments, from gravel to rough, unprepared runways. Both the TAV and Wasp variants are self-deployable, allowing for greater operational flexibility in the combat zone.

"We are now moving TAV into its next stage of development, to ensure that Icarus Aerospace has the financial resources to bring our exciting new programme to fruition"

Marko Ivankovic, senior product developer, Icarus Aerospace



Chinese takeaway?

In a world dominated by aerospace heavyweights Airbus and Boeing, we assess developments in the Chinese aviation industry. Could republic-built jets extend their reach from the East to take on the duopoly? **Mark Broadbent** reports

China's superpower status is evident from its enormous population expansion, vast urbanisation, a key role in world trade, military technology advances (typified by the Chengdu J-20 fifth-generation fighter) and its rising geopolitical influence.

The People's Republic ambition is also symbolised by commercial aviation growth, with its largest airlines expanding route networks globally and ordering hundreds of new aircraft. Meanwhile, the Commercial



A 2018 mock-up of the Sino-Russian CRJ929 UAC

More deliveries and scathing criticism

In June 2020, the Commercial Aircraft Corporation of China (COMAC) delivered three ARJ21-700 regional jets to the country's largest network carriers: Air China, China Eastern Airlines and China Southern Airlines. Air China and China Southern began using their initial ARJ21-700s the following month. The initial Air China service was from Beijing to Xilinhot, Inner Mongolia, on July 10, 2020, followed five days later by China Southern putting it on its Guangzhou/Baiyun-Jieyang/Chaoshan route. No details were provided on China Eastern routes with the aircraft.

The Civil Aviation Administration of China type-certified the ARJ21-700, the country's first short-medium range turbofan regional aircraft, on December 30, 2014. Several smaller regional airlines

began using early production examples in 2016. Chengdu Airlines now operates 21, Genghis Khan Airlines uses four and Jiangxi Air has two. In the Teal Group's July 2019 report on the C919, the consultancy's vice-president of analysis, Richard Aboulafia, wrote: "Like the C919, the ARJ21 regional jet was touted as proof that China would be the next big jet maker. Instead, it has turned into an overweight and stunningly obsolete product that has no relevance outside of China's tiny regional airline sector. In fact, the ARJ21 looks like too much of a failure to have any use in China at all."

A separate May 2020 Teal Group report on the ARJ21 saw Aboulafia add: "Chinese airlines are looking for the best values and the most appropriate planes,

not something built in-country... the order book isn't exactly reassuring.

"Then there's the design. It offers exactly nothing new. In fact, it's 15% heavier on a per-seat basis than any of its competitors. It looks very much like the DC-9, a classic example of re-inventing the wheel.

"The engines and avionics are pretty much identical to any other regional jet [RJ] designed 20 years ago. The dominant RJ maker, Embraer, is now focused on phasing out the same CF34 engine that COMAC is just phasing in."

Before delivering the jets, COMAC said the ARJ21 would be "suitable for China's actual conditions and building a more accessible and smooth air transport network".

Aircraft Corporation of China (COMAC) – an offshoot of the state-owned Aviation Industry Corporation of China (AVIC) – has developed its own jetliners.

Testing the competition

Although COMAC recently delivered more examples of its ARJ21 Xiangfeng (Golden Phoenix) regional jet (see panel), the focus of indigenous Chinese airliner development is the C919 short- to medium-haul single-aisle example.

Launched in 2008, the C919 is China's attempt to disrupt the Airbus/Boeing duopoly and provide fresh competition to

the respective A320neo and 737 MAX.

Originally, COMAC intended to fly the C919 in 2014, but slow design and development meant the initial flight test aircraft, B-001A (c/n AC101), rolled out of the manufacturer's facility at Shanghai Pudong International Airport on November 2, 2015. The aircraft did not fly until May 2, 2017 and there was a further four-month wait until its second trip in early September.

As US-based Leeham News and Analysis reflected in 2018: "Aircraft ground testing and instrumentation for the [COMAC] C919 were not at the level where continued flight testing was safe or meaningful

after a first cautious hop."

Further tests were eventually conducted at higher altitudes and speeds in the last quarter of 2017 before B-001A relocated from Shanghai to the China Flight Test Establishment at Yanliang, near Xi'an, for its next test phase.

Five other C919s later joined the test fleet, starting with B-001C (c/n AC102) flown on December 17, 2017 and then B-001D (c/n AC103), flown on December 28, 2018. Aircraft four (B-001E, c/n AC104) was airborne on August 1, 2019 followed by B-001F (c/n AC105) on October 26, 2019 and lastly B-001G (c/n AC106) on December 27, 2019. 🇨🇳

In COMAC's programme, the first three aircraft carry out performance, engines and power systems testing. The fourth jet undertakes electrical systems and avionics work, and the fifth and sixth evaluate the passenger cabin. Number six will also be used for the final certification test flights.

In January 2020 Reuters, citing unnamed sources, reported COMAC was struggling "with a range of technical issues that have severely restricted test flights." Glitches reportedly related to engine loads, and cracking in the horizontal stabilisers and the engine gearbox. (The stabiliser problem has been fixed, Reuters said.)

To achieve Civil Aviation Administration of China certification, 4,200 hours of flight tests are required. Since 2018, COMAC has targeted the end of 2020 to achieve certification and deliver the first customer aircraft to the initial operator, China Eastern Airlines in either 2021 or 2022.

Composites and the LEAP-1C

Carbon fibre composites made up 15% of the original C919 design structure by weight, but a July 2019 analysis from the Teal Group consultancy estimates these materials will account for less than 10% of the finished aircraft.

However, Teal also notes the People's Republic of China (PRC) government has mandated that 30% of the aircraft must

Chinese airliners: basic characteristics			
	ARJ-21	C919	CRJ929*
Wingspan	89ft 5in (27.3m)	116ft 7in (35.8m)	209ft 5in (63.8m)
Length	109ft 9in (33.5m)	126ft 6in (38.9m)	209ft 1in (63.7m)
Height	27ft 8in (8.4m)	39ft 2in (11.9m)	58ft 7in (17.9m)
Empty weight	55,016lb (24,955kg)	92,815lb (42,100kg)	TBC
Maximum take-off weight	89,287lb (40,500kg)	160,000lb (72,500kg)	540,000lb (245,000kg)
Capacity	78-90 seats	156 (two-class)	250-320 seats (two-class) depending on variant
Max cruise speed	Mach 0.78	Mach 0.78	Mach 0.85
Range	1,200nm (2,225-3,700km)	3,000nm (5,555km)	6,480-7,560nm (12-14,000km)
* in development			

use advanced materials. Aluminium-lithium is now planned for at least part of the fuselage and carbon fibre composites for the centre wing box.

Various branches of the AVIC conglomerate produce different parts of the C919, from the inner wing and outer wing boxes to the nose, fuselage and tail.

The General Electric/Safran joint venture CFM International, provides the aircraft's engine, the LEAP-1C, with AVIC Commercial Aircraft Engine (ACAE) the local partner integrating it with the aircraft.

As with the other LEAP engine variants used by the A320neo and 737 MAX, the -1C is a twin-spool high bypass turbofan featuring a 13-stage compressor (three low pressure, ten high pressure) and a two-stage turbine. According to CFM, the

LEAP offers 15% reductions in fuel burn and carbon dioxide emissions compared with previous generation engines. At 77in (1.9m) the -1C's fan diameter is larger than the 69.4in (1.7m) equivalent on the -1B model powering the 737 MAX, but slightly smaller than the 78in diameter on the A320neo's -1A.

A future domestic alternative to the LEAP will be the CJ-1000A, a high-bypass turbofan from ACAE, but its certification is not scheduled until 2027 with introduction not expected for three years later.

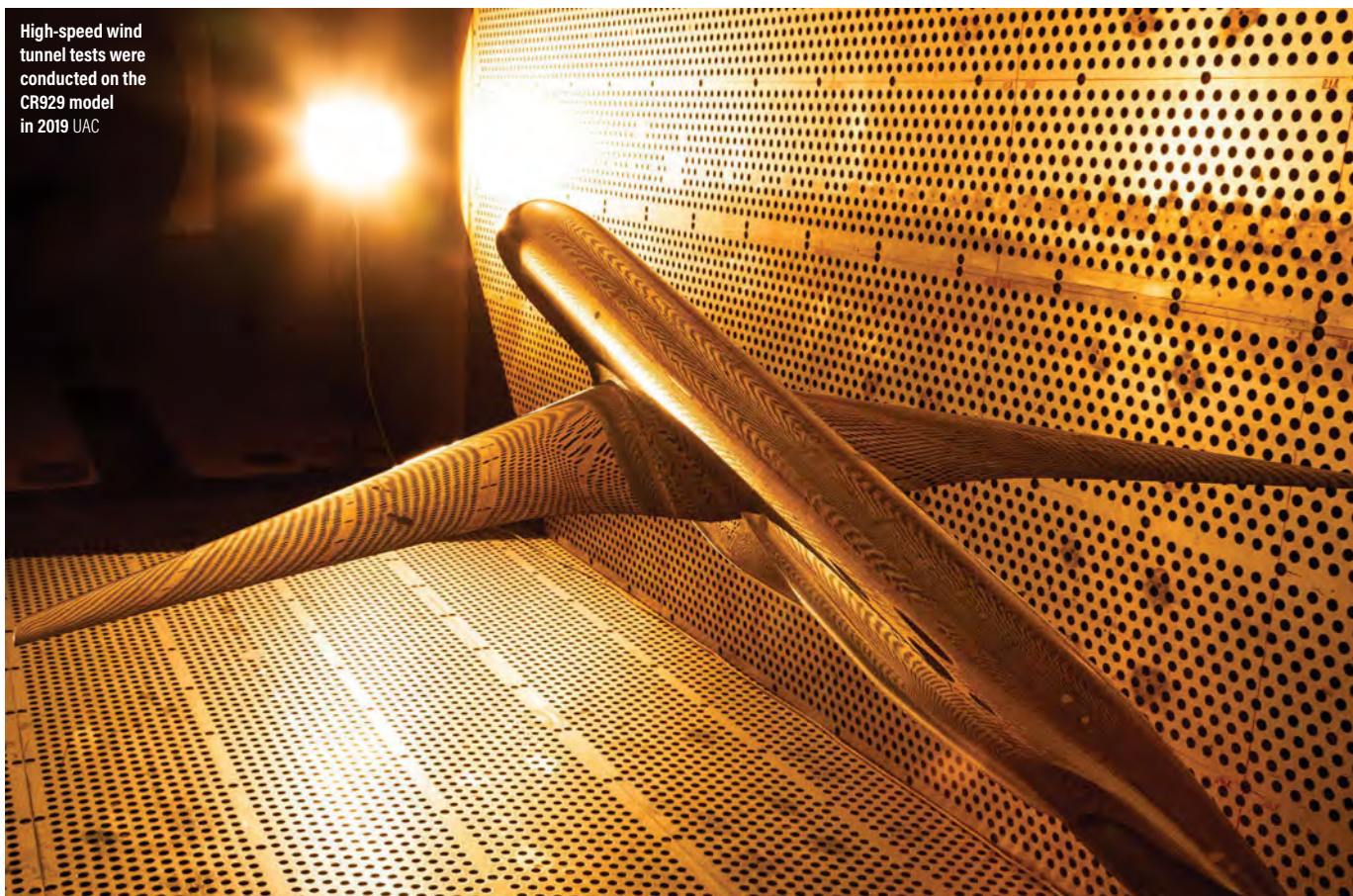
Western involvement

CFM is not the only Western company involved in the C919. Honeywell supplies the fly-by-wire flight control system, wheels, brakes and the auxiliary power unit

The CRJ929 will carry 250-320 passengers depending on the variant UAC



High-speed wind tunnel tests were conducted on the CR929 model in 2019 UAC



(APU), and GE Aviation provides integrated modular avionics, flight deck display screens, an onboard maintenance system and flight recorders.

There are Collins Aerospace integrated weather detection, traffic alert and collision avoidance, surveillance and terrain awareness and warning systems. Liebherr contributes the main/nose landing gear and the cabin air management system, Moog the flap and slat actuation, and Nexcelle an integrated propulsion system.

The C919 also features a Meggitt propulsion system interface control, a B/E Aerospace oxygen system, Eaton cargo door actuation and fuel/hydraulic systems, and Goodrich will supply anti-ice equipment, windshield wipers/heaters and exterior lighting.

Hamilton Sundstrand provides the electrical power generation and distribution systems and Ram Air Turbine while Parker Aerospace supplies the primary flight control actuation, fuel inerting and hydraulic fuel systems.

Towards the CR929

Another Chinese attempt to take on the Airbus/Boeing dominance is the CR929, a medium-to-long range twin-aisle widebody COMAC is developing with Russia's United Aircraft Corporation (UAC) in a 50:50 joint venture, the China-Russia Commercial Aircraft International Corporation (CRAIC).

CRAIC was established in May 2017 after several years of feasibility studies into co-producing a large airliner, with a mock-up of the front fuselage, cockpit and cabin

shown at Airshow China 2018 in Zhuhai.

Three variants are planned: the baseline CR929-600 with 280 seats and 6,480nm range, the stretched CR929-700 offering 320 seats and 5,400nm and the shortened 250-seat CR929-500 with 7,560nm.

Composites and titanium will be used in the structure, and images of the mock-up presented at Zhuhai showed a modern flight deck with a five-screen electronic flight information system and sidestick controls.

December 2019 saw UAC announce the completion of initial high-speed wind tunnel tests on the CR929 using a 1:39 scale model at the TsAGI (Central Aerohydrodynamic Institute) at Zhukovsky near Moscow.

Despite this step forward, the initial ambitions to complete CR929 design work by 2021, fly a prototype in 2023 and introduce it two years later have slipped. A first flight is not expected until the middle of this decade and initial delivery in 2028 or 2029.

In July 2020, a Russian Aviation Insider report quoted Raviil Khakimov, the chairman and president of Irkut (part of UAC), saying CRAIC is still analysing proposals from potential suppliers.

He reportedly said: "We planned to complete this work in 2020 and move to contracting with all the subcontractors and suppliers. Unfortunately, we have some difficulties in co-operation with the Chinese partners, so this stage is likely to move for 2021."

Final assembly of the CR929 is planned 🇷🇺



Order data: correct as of September 1, 2020

Type	Customer	Number
ARJ-21	Air China	35
	China Academy of Sciences	2
	Chengdu Airlines	30
	China Eastern Airlines (operated by OTT Airlines subsidiary)	30
	China Southern Airlines	35
	China Flight General Aviation Company	2
	Congo Government	4
	GECAS	5
	Genghis Khan Airlines	25
	Hebei Airlines	10
	Joy Air	50
	Jiangxi Airlines	5
	Shandong Airlines	10
	Shenzhen Financial Leasing	20
	United Eagle Airlines	30
	Urumqi Airlines	20
C919	ABC Financial Leasing	45
	Air China	20
	AVIC International Leasing	15
	BOC Aviation	20
	BOCOMM Leasing	30
	CDB Leasing	10
	CMB Financial Leasing Company	30
	China Aircraft Leasing Company	20
	China Construction Bank	50
	China Eastern Airlines	20
	CITIC Group	36
	CMB Leasing	30
	China Everbright Group	30
	China Nuclear E&C Group	40
	China Southern Airlines	20
	City Airways	10
	GECAS	20
	Hainan Airlines	15
	Hebei Airlines	20
	HNA Group	200
	Huabo Leasing	30
	Huaxia Financial Leasing Co	20
	ICBC Leasing	55
	Industrial Bank Company	20
	Joy Air	20
	Ping An Insurance Leasing	50
	Shanghai Pudong Development Bank	20
	Sichuan Airlines	20

to take place in COMAC's home city, Shanghai, where CRAIC is based (although the main design centre is in Russia). China will design and build the aircraft's fuselage, horizontal and vertical stabilisers, wing fairings, nosecone, and nose landing gear, while Russia will produce the composite wing and fins, wing flap systems, engine pylons and main undercarriage.

As with the C919, the plan is for the CR929 to use Western engines initially – though a powerplant is yet to be selected – with an indigenous alternative developed by the Aero Engine Corporation of China (AECC) and Russia's United Engine Corporation to be introduced later.

Although primarily intended for Chinese and Russian markets, Sergey Fominykh, the CR929 programme director from the Russian side, said during the 2019 MAKS Air Show in Moscow the plan is to "create an aircraft competitive at the global market," accompanied by customer support and crew training.

What of the future?

While the CR929 remains somewhat distant the C919 is here now – but as the adjoining orders table shows, it has won relatively little business relative to the aircraft it is designed to rival. Between them, the A320neo and 737 MAX have amassed close to 12,000 orders.

Although Chinese leasing companies

and banks have ordered many C919s, the republic's airlines have placed only modest purchases, with relatively small orders from the 'big three' network carriers: Air China, China Eastern Airlines and China Southern Airlines. They have ordered 60 C919s between them, in comparison with 97 A320neos (Air China 26, China Eastern 37, China Southern 34) and 116 MAX 8s (Air China 16, China Eastern 50, China Southern 50).

These figures reflect a stark reality for any new market entrant in commercial aircraft manufacturing – the preference of airlines worldwide for tried and tested equipment.

In trying to crack the Airbus/Boeing duopoly, Chinese jets face well-established products backed by comprehensive spares, training, type ratings, maintenance, and in-service support packages.

During a July 2020 FIA Connect webinar (a virtual substitute for this year's Farnborough Airshow), Air Lease Corporation chairman Steven Udvar-Házy noted the contrast in these respects between Chinese companies and their Western rivals.

Citing the Xi'an MA60/600 turboprop airliner series, he reflected: "They have not been able to support [existing] products out in the field when you have AOGs [aircraft-on-ground situations], engineering issues, system upgrades, airworthiness directives [and] service bulletins."



The Tianjin Final Assembly Line for the A320 Airbus

Udvar-Házy added: "They've just not built the global infrastructure to support their customers outside of China. How do you penetrate the export markets unless you have a massive and credible after-sales support capability?"

Speaking to *AIR International*, Richard Aboulafia, vice-president analysis at the Teal Group consultancy, believes another factor limits the potential for Chinese airliners on the global stage.

He said: "Government-owned companies have a terrible track record meeting market needs in all industries, but particularly this one. The idea of an airline in the real world actually buying a jet built by an arm of the Chinese government is basically inconceivable."

Geopolitical considerations

Trade relations between China and the West are another factor.

Udvar-Házy said in the webinar: "The willingness of the Western world to partner with China has diminished significantly in the last 12 months, so the ability of the Chinese industry to latch onto Western technology is going to be far more limited, and that will be a constraining factor on the timeline the Chinese can become competitive."

Aboulafia wrote a June 2020 post on his website that China will continue to use Western airliners in the short term. One reason is because there will not be enough examples of native types to fill any rebound in air travel demand post-COVID-19.

Teal's July 2019 analysis of the C919 notes that Chinese carriers' A320 Family aircraft are built at Airbus' Final Assembly Line (FAL) in Tianjin and that "Chinese airlines can simply look patriotic by continuing to buy Airbuses." This, it states, "possibly dooms the C919 altogether"

However, in June 2020, Aboulafia wrote in a web post: "China's captive airlines will be forced to take C919s and CR929s instead of Airbuses and Boeings."

A long march: Commercial jetliners in China

1980: Shanghai Y-10 narrowbody airliner flies, but development halted

1985: China signs agreement with McDonnell Douglas to produce MD-80/-90s

2002: ARJ21 regional jet launched, with a 2007 service entry target

2008: Airbus opens A320 Final Assembly Line in Tianjin

2009: ARJ-21's maiden flight

2014: Joint Chinese/Russian widebody airliner project announced, later named CR929

2015: First C919 rolled out

2016: Initial ARJ-21 delivered to Chengdu Airlines

2017: C919 conducts first test flight and China-Russia Commercial Aircraft International Corporation Limited formed to develop CR929

2018/19: Five more C919s join flight testing effort

2020: Initial ARJ-21 deliveries to Air China, China Eastern and China Southern

2021/22: Planned C919 certification and initial delivery

2025: Proposed CR929 first flight

2028/29: Expected timeframe for CR929 introduction

"It has become increasingly clear that China's jetliner industry isn't geared towards competing in the world; rather, it's aimed at a future where China stops importing strategic goods and relies on its own products."

Just like sovereign investments in overseas infrastructure or consumer goods manufacturing, commercial aircraft production is a symbol of its national capability. The republic's bid to play a greater role on the aviation world stage is likely to lead to more home-grown examples getting aloft – but largely plying Chinese skies. **AI**

Air China's maiden ARJ21-700 receives a water cannon salute on arrival at its new Beijing/Capital base at the end of June
AirTeamImages.com/Bastian Ding





The faux foe

French aggressors

With both slow movers and fast jets on its books,
Henri-Pierre Grolleau explains why French company
SDTS is becoming a significant player in naval training exercises

When seen from head on, the Skyhawk cannot hide its naval origins: its long undercarriage legs betray its carrier use
All images by Henri-Pierre Grolleau



FAR LEFT: The MB339's dark camouflage inherited from RNZAF service proves incredibly efficient over the sea. In SDTS service, the 'Macchi' has proved ideal for the Red Air missions against surface combatants and even against Rafales performing basic beyond-visual-range tactics

LEFT: All SDTS aircrews are very experienced aviators. They are carefully selected by the company to ensure that operations can be carried out safely and to provide the best threat simulation tactics to the customer

which were eventually attributed to Secapem. The final one, for electronic warfare and target towing, was won by AVdef (Aviation Defence Service), a French company that operates suitably modified Falcon 20 business jets.

SDTS missions are wide and varied: simulating slow movers with the Cessna 337; mimicking fighter bomber attacks with the MB-339CBs and the A-4Ns; undertaking firing range clearance/range support to ensure the test ranges are clear of any intruding vessels (accidentally or voluntarily), a mission subcontracted by SDTS to a CAE-owned Merlin III twin.

The company started operations in 2015 with four aircraft – two MB-339s and two A-4Ns – loaned from US company Draken International. "This partnership between Secapem and Draken proved decisive in helping us win the contract and launch our activity," said Pierre Arnal, SDTS' Contract Manager.

Today, things have changed, as SDTS has purchased outright a total of nine ex-Royal New Zealand Air Force (RNZAF) MB-339s from Draken. "The two 'MBs' we have operated since the very beginning,

and [they] have been joined by another one, with a fourth expected anytime. The other five will remain available as a reserve should a contract require more flying hours," he said.

Tasked by ALFAN

All SDTS activity is tasked by a dedicated cell within ALFAN (Amiral Force d'Action Navale, or naval action force command). This cell centralises all requests from surface combatants and naval fighter squadrons. "Two months in advance, we receive a plan updated each week for the following week," explained Arnal. "This planning is modelled on the forecast of exercises and of ship training schedules. We work in both the Mediterranean and the Atlantic. We regularly deploy to Brittany, either to Lann-Bihoué, or to Landivisiau.

"The number of flight hours logged by our aircraft varies from one year to another, but we always provide more training slots in the Mediterranean than in the Atlantic. It should be noted that, compared to the previous contract, the French Navy now routinely asks adversary aircraft to show up in divisions of four – two MB-339s and two A-4Ns, or four MB-339s soon – instead of pairs. In 2017, we signed a six-year contract with the DGA, the French defence procurement agency, for maritime test range surveillance missions before missile trials in the Atlantic or in the Med. We operate a Merlin provided by CAE to ensure no ship has entered the danger area before a missile is fired. Occasionally, we also provide the DGA with MB-339s or Skyhawks for various weapon system trials."

Two ex-Israeli Skyhawks

Initially built for the Israeli Air Force, the two A-4N Skyhawks were engaged in combat operations on multiple

Any naval training exercise requires an aggressor to simulate a variety of potential threats. Secapem Defence Training Solutions (SDTS), a division of defence company Secapem, has used a fleet of MB-339CB trainers and A-4N Skyhawk fast jets to mimic tactics used by potential foes, helping train ship crews and aircrews against a wide range of realistic simulated threats.

SDTS also operates a single Cessna 337 Push-Pull slow-mover and a Merlin III twin on loan from CAE. Installed in one of the hangars of recently closed Nîmes-Garons naval air station, the company resembles a small fighter squadron.

In 2015, a contract was allocated by the French Navy to SDTS. The contract was broken down into five separate lots, four of

Over the past few years, SDTS assets have been engaged in various NATO exercises, including the Tiger Meet



occasions before finding their way into the civilian market.

Produced between 1972 and 1976, the A-4N variant is a close derivative of the A-4M developed for the US Marine Corps for light attack and close air support duties. Like the A-4M, it is fitted with a more powerful J52-P408 engine (offering 5080.23kg of thrust, about 20% more than its J52-P8A predecessor), a larger and higher canopy to improve the pilot's rearward visibility, a brake chute to facilitate short field operations, a squared-off fin tip and a more modern avionics suite that includes an AN/APQ-145 ranging radar (not to be confused with the E-2C Hawkeye's AN/APS-145 radar).

The A-4N is equipped with a lengthened tailpipe which allows the jet exhaust to cool down before meeting outside air, thus helping reduce infrared signature and protect vital parts from proximity-fused missiles. The two Colt Mk 12 20mm cannons gave way to two more powerful French-built 30mm DEFA cannons, each with 150 rounds. Unlike the A4M, the A-4N was not fitted with a self-starter, however.

Transatlantic adventure

SDTS' Chief Pilot and Operations Manager, Emmanuel 'Manu' Delin, was one of the initial Secapem pilots to convert to the Skyhawk. "With my colleague, Etienne Rignault, we underwent conversion to type at the Draken facility in Lakeland, Florida, in August 2015," he said. "The syllabus was split into four sorties followed by an in-flight test. Our sixth flight was the first leg of the transatlantic flight towards Nîmes, using the northern route. We flew as a two-ship formation and stopped in Springfield, Massachusetts, Goose Bay [in] Labrador, Kangerlussuaq [in] Greenland, Keflavik, Iceland, and Prestwick, Scotland. It was during the last leg that I truly realised how huge the Skyhawk range really is: early in the flight, I calculated we would arrive in Nîmes with a fair amount of excess fuel.

"As I did not want to have to either dump kerosene before landing or wait in a holding pattern to reach landing weight, I decided to cancel the IFR flight plan and we climbed down to low-level in central France and transited at high speed via the foothills of the Alps to increase our fuel consumption."

A jet suited for missions

Since entering service with SDTS in 2015, the two A-4Ns have proved to be perfectly suited for the missions tasked by the Marine Nationale (French Navy). "The aircraft is exactly what we needed for the role," insisted Delin. "It is agile and fast. Even more importantly, it offers exceptional endurance and range. Its roll rate is just incredible. The flight manual states the roll rate can reach 720°/second. World champion! Here, however, we always operate with drop tanks which considerably reduce the roll rate."

The Skyhawks are frequently engaged in air combat training missions against Navy Rafales, playing the role of hostiles as part of a 'Red Air' scenario. "The A-4 is very good at low level, but its performance rapidly falls as soon as we start climbing," 'Manu' admitted. "At medium and high altitude, its small wing area is a clear disadvantage. When we tighten a turn, the airframe starts buffeting as the angle of attack increases. You have to be careful as the leading-edge slats pop out mechanically and automatically, without any pilot action. Should you allow sideslip to develop, one of the two slats may come

The Skyhawk has proved highly popular with contractors for the Red Air mission. The A-4N's extended tail pipe can clearly be seen on this shot



This SDTS/Draken A-4N Skyhawk breaks away from the camera. SDTS assets perform highly realistic threat simulation missions against Rafale fighters and surface combatants



out first, instantly forcing the aircraft into a snap roll, with a violent wing drop of more than 90°.

"As you can see, in combat, you have to avoid pushing the Skyhawk towards the limits of its flight envelop in order to avoid an embarrassing loss of control that could prove dangerous for yourself and for the aircraft you are tangling with. Our A-4s are particularly difficult to detect visually when operating at very low level because of the dark green colour of their camouflage."

Outdated cockpit

The Skyhawk's cockpit betrays the aircraft's age. Even though it is fitted with an EFIS (Electronic Flight Instrument System) multifunction screen, the A-4's instrument is clearly outdated. Still, it allows SDTS aircrews to fly in all airspaces Draken International specialists have installed all the latest systems: Mode S transponder, 8.33 MHz-spacing radios and ADS-B

[Automatic Dependent Surveillance Broadcast] capability. SDTS Skyhawks broadcast 'Viper' in Mode S, MB-339s 'Shadow' and the Cessna 337 'Joker'.

The Skyhawk is a compact fast jet with a very narrow cockpit. "The cockpit is a very tight fit made worse by the rather cumbersome watertight survival suit we always wear for operations over the sea in all weathers, day and night," said Delin. "The US Navy-style harness is bulky and less user-friendly than traditional Martin-Baker ejection seat harnesses. It only reinforces the fact that space inside the cockpit is extremely limited. This harness is connected to an Escapac zero-zero ejection-seat. What can be taken for granted is that the Skyhawk cockpit is even narrower than that of the Super Étendard, considered to be the tightest of all Dassault fighters."

Low fuel consumption

The low fuel consumption of the Skyhawk's J52-P408 engine has amazed SDTS pilots. "Its fuel burn is incredibly low," 'Manu' added. "I had never seen anything like that before. This is just unbelievable for a jet of that generation. Fuel consumption is much lower than those of the Étendard IVP and of the Super Étendard I flew in the French Navy.

"I'll give you one example: our 'customers,' amphibious warfare ship Dixmude escorted by stealth frigate Guépattre, were sailing off the southeast coast of Corsica, on the far side of the island for us when taking off from Nîmes. Nevertheless, we managed to stay 1h 02 min on station, at 270nm from our departure point, without mid-air refuelling. With any other fast jet type, we would have had to refuel at Hyères [on the French coast] or Solenzara [on Corsica]. Needless to say, the captains of the two ships were extremely pleased. ➔

A CAE Merlin and a Skyhawk share the ramp at Nîmes. SDTS assets can perform a vast array of roles, from slow movers to more aggressive fast jet and missile simulation



The Skyhawk has been incredibly successful for SDTS operations



"For missions in the most commonly used area of the Toulon 'Zonex' [zone d'exercice, or exercise area] our stay is about 90mins on station, a more than respectable endurance."

The Skyhawk offers all the inherent qualities of a carrier-borne aircraft. "It has been conceived to be comfortable in the carrier landing circuits and we take advantage of that," he said. "Even when heavy, at the beginning of a sortie, it is perfectly safe to fly at low speed and we always feel confident. What impresses us the most is its ability to safely fly at 250kts only. That proves crucial for us because we are always trying to save fuel when holding or during the outbound leg, while we can slow down before turning back in again towards the ship for the next simulated attack run. The Skyhawk gives us the ability to slow down without the angle of attack increasing and without any rise in fuel consumption. As a result, we can adopt a true economical speed, allowing us to further lengthen our time on station and to easily work with the slower MB-339s. Thanks to the powerful J52-P408 engine, we still have the capability to rapidly accelerate to initiate an attack run or engage an air-to-air threat."

Skyhawk maintenance

For a contractor providing Red Air services to the military, aircraft availability is a key metric, with maintainers playing a major

role within the company. A team composed of an administrative engineering manager, five technicians and one logistics specialist is in charge of maintaining the Skyhawks, the MB-339s and the Cessna 337.

Chuck Robertson, a former US Air Force (USAF) engineer who spent most of his career in Europe working on F-111 Aardvarks, F-15 Eagles and F-16 Fighting Falcons (mainly at Upper Heyford in the UK and Hahn in Germany), is the Draken representative in Nîmes-Garons. "After retiring from the USAF, I joined BAE Systems in Wittmund, Germany, to perform Skyhawk maintenance," said Robertson. "I actually worked on these very same airframes at Wittmund, although their registration numbers were different back then. These aircraft belonged to the ATSI [Advanced Training Systems International] at one time before being transferred to BAE and then to Draken.

"Here, my role is to do the liaison between Draken and SDTS. I organise the maintenance process, ensure everything is done correctly and fill in all the documentation. Everything is done to ensure the missions tasked by the Navy are flown. When an aircraft encounters a technical problem, everything is done to solve it as soon as possible.

"Overall, Skyhawk availability hovers between 90 and 95%, which is excellent. Operating in an overseas location is the biggest challenge. French pilots are

extraordinarily good, however, and French mechanics as well. They did not have any overwhelming difficulties adapting to the aircraft. For example, most of the documentation is written in English, and some in Hebrew, but they did not have any issues coping with that obstacle."

According to Robertson, the two Skyhawks are in a very good shape. "We just did a big corrosion inspection and found just tiny bits," he explained.

"We could have expected that the aircraft would corrode in its operating environment, at very low level over the sea, but it does not. Our Skyhawks have only reached about half of their lives. Each has logged about 4,500 flying hours and their next big inspection is due at the 7,500-hours mark."

Easy to service

For daily operations, the Skyhawk has proved to be a rugged and reliable aircraft. "Compared to the aircraft I previously worked on, the A-4N is fairly easy to maintain and repair," said Philippe Castaldin, a fitter who joined SDTS in 2019 after a long career with Sabena technics spent on the Canadair CL415, the Tracker and the Dash Q400. "The design of the aircraft is very smart. I must admit that I was rather surprised because I expected 40-year-old aircraft with about 4,500 hours each to be far more labour-intensive. The main problem is sourcing spares. Thankfully, Draken has the capability to build spares from scratch."

The Skyhawk has quickly seduced their French maintainers. "It's a very strong aircraft that accepts a lot of punishment," explained Hubert Demance, a former Mirage F1 and Mirage 2000 engineer.

Daily servicing is very easy. For example, it takes only about 15 minutes to change a wheel. Deep maintenance is far more complicated, however, as it often involves disconnecting the whole rear fuselage to access some components.



LEFT: The Skyhawk cockpit is very tight, as shown on this photo. Here, 'Manu' Delin focuses on his instruments as he signals the engineers to force air from the external jet air starter trolley to start the engine



In France like in many other countries, contracted Red Air assets are becoming more and more popular. SDTS is ready to expand its customer base in France and further afield

"For us, the main problem comes from the fact that the A-4N is not fitted with a battery or with an autonomous starting system. This means we have to rely on a Palouste to provide us with 115 Volts/400Hz current and on an external jet air starter trolley which produces compressed air to feed the engine when starting. Luckily, the French Navy puts at our disposal everything we need at our forward operating locations, including nitrogen and liquid oxygen."

When required, Draken undertakes in-depth Skyhawk maintenance. "Five American engineers recently came to Nîmes to help us for a D Check," said Bastien Cénée, a former Mirage 2000 engineer. "It was a major undertaking which required the rear fuselage and the engine to be removed, the flight controls to be inspected and the internal fuel tanks, drop tanks and external pylons to be all

thoroughly checked. They know the aircraft by heart and the inspection was completed in three weeks only. Very impressive."

MB-339s

The ex-RNZAF MB-339CB trainers have proved equally successful in SDTS service. "The MB-339 is fast and offers a good range," explained Delin. With two tip tanks and two underwing drop tanks, it can reach 430kts thanks to its powerful Rolls-Royce Viper 632 engine, more than enough to replicate a fast jet attack profile. It can remain on station for an hour at 150nm from its base, thus exceeding by 50nm the specifications of the contract with the French Navy."

The MB-339 is fitted with a comprehensive avionics suite that includes a Head-up Display (HUD) and Inertial Navigation System (INS). "It's like flying a Super Étendard without a radar and

Lun'Tech

On top of SDTS, Secapem owns another subsidiary that has become a top international player. Called Lun'Tech, this jewel was purchased by Secapem in 2013. It specialises in the fields of Luneberg lenses (hence its name) and in active radar reflectors. These devices are used to increase the radar cross section of objects so that radars can more easily detect them. Around 12,000 Lun'Tech-built lenses and reflectors are in service worldwide, including countless systems mounted on marine buoys. Their Luneberg lenses are used daily for military exercises and weapons trials in realistic conditions. Like its parent company, Lun'Tech devotes a lot of time and effort to developing new systems. The company has at its disposal an anechoic chamber to test and calibrate its high-end products. It makes about 75% of its yearly turnover on the export market.

without an autopilot," Delin continued. "That is a clear advantage for operations at very low level, at night. Initially, I was concerned that the avionics suite would be difficult to maintain but the MB-339 has proved incredibly reliable. In five years, we did not record any INS or HUD failure."

"Our MB-339s are used for a wide range of Red Air missions from Nîmes and from Brittany, including the training of fighter controllers. They will progressively become our workhorses, taking an increasingly important role within the company."

As part of Red Air, SDTS MB-339s and Skyhawks have flown countless missions against French Navy and foreign surface combatants and against French Navy Rafales and other fighters. The company has established itself as a reliable partner for the French Navy, and its managers are confident they can win the contract again when it comes up for renewal in mid-2021. **AI**

Two Skyhawks and a MB339 are photographed from another 'Macchi' during a transit early in the morning



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Protecting the **no-drone zone**



Safeguarding airports against drone incursions is a complex and vexing challenge, as **Carroll McCormick** reports

In February 2018, footage emerged from a drone of a Frontier jet on approach to McCarran International Airport in Las Vegas. Shot from above and posted widely online, it makes for unsettling viewing, highlighting the danger drones can create in busy airspace. Events like this help explain the unusually frank phrase, "careless and clueless" which followed in the Blue Ribbon Task Force's final report on UAS (Unmanned Aircraft Systems).



One

Commissioned by the Association for Unmanned Vehicle Systems International and Airports Council International - North America, the document is a collaborative effort of several aviation players, including the Federal Aviation Administration (FAA), Los Angeles World Airports, NAV CANADA and Ottawa International Airport.


The private and commercial use of drones, also referred to as UAS or remotely piloted aircraft systems (RPAS) is proliferating, yet airports and those responsible for their security have barely begun to grapple with the challenge of detecting and responding to them.

Case in point: Multiple drone incursions at the UK's Gatwick Airport between December 19 and 21, 2018 led to the facility shutting down, affecting a reported 1,000 flights and 140,000 passengers. Former MP John Woodcock, who until May last year was a member of the British House of Commons' home affairs committee, used the term "keystone cops" to describe the police response, which included the reported arrest and lengthy interrogation of an innocent couple.

The 47-page dossier provides some direction to stakeholders on topics such as UAS detection, the thorny issue of neutralising incursions, and guiding principles for incursion response planning.

Canadian focus

"In Canada, Ottawa International Airport, also known by its IATA code YOW, became one of the first airports to propose a draft intervention plan, incident protocol, and response approach to Transport Canada to assist in the occurrence of a drone incursion within close proximity to their aerodrome," the report notes.

While YOW had already launched some initiatives to deal with drone incursions, "Gatwick brought the significance of that to the fore," said Mike Beaudette, vice-president, security, YOW. The airport reports no drone sightings inside its no-drone zone (flying closer than 3.5 )

ABOVE LEFT: Gatwick Airport was the centre of a high-profile drone alert in December 2018 Gatwick Airport

LEFT: Ottawa Airport CEO Mark Laroche (left) and Federal Minister of Transport Marc Garneau launching a campaign Ottawa Airport

RIGHT: Posted online in 2018, amateur footage taken by a drone in the flightpath of an aircraft shows it preparing to land in Las Vegas





miles to an airport's centre in Canada is forbidden) but the possibility of incursions is a concern.

"It [the possibility of an incursion] is out there and we want to prepare for it," said Mark Laroche, the airport's president, CEO, and one of the report task force members.

To that end, YOW developed an intervention protocol. "We were the first to send an intervention protocol to Transport Canada and signal the absence of one," Laroche said. "We pushed that. I requested that we have a game plan, with a decision

tree, in case something similar to Gatwick [were to happen]."

YOW developed a number of drone incident scenarios and partnered with Transport Canada to conduct the first table-top exercise, which took place in Ottawa on May 22, 2019. Transport Canada noted that a recent table-top exercise – on November 20 last year at Vancouver International Airport – included more than 60 participants from industry and Government of Canada organisations. Their purpose, it explained, is "... to identify gaps

and vulnerabilities related to the response and mitigation to an RPAS incident and to clarify roles and responsibilities... to engage and guide stakeholders through response actions to unauthorised RPAS incursions at airports. The results from each exercise will be used to validate the response protocols and guidance for airports."

This is not to suggest that Transport Canada only began working on the drone incursion problem last year. "We have been involved in this issue for quite some time; for example, several years ago we developed sign [artwork] that airports can use," said Wayne Harvey, vice-president, operational, technical and regulatory affairs, Canadian Airport Council (CAC).

Transport Canada had a five-year, \$33.5m budget approved in 2017, "... to respond to the growth in the RPAS industry with focus on developing visual-line-of-sight regulations, collaborating with industry and municipal/provincial/territorial partners to conduct pilot projects, and establishing industry standards for the safe use of new technologies". More funding came last year.

Regulatory overview

In January of last year, Transport Canada published new rules for flying drones in Canada, covering all those weighing from 250 grams to 25 kilograms and operated within the drone pilot's visual line of sight. Key items include penalties, the requirement for a drone pilot certificate and a registration number on every drone, their registration



A QinetiQ drone detection unit being tested at YOW Ottawa Airport



Government
of Canada

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du Canada

NO DRONE ZONE.

PERMIT REQUIRED



DRONES INTERDITS

PERMIS REQUIS

Canada

with Transport Canada and something called an RPAS Safety Assurance that drone manufacturers must declare to Transport Canada for advanced operations.

"A Special Flight Operator Certificate is what Transport Canada issues to users. To date, 45,000 people have signed up and taken a special course," Wayne Harvey said. Unfortunately, the problem goes

No-drone zone signage makes obligations clear for users
Ottawa Airport

far beyond educating drone pilots, some of whom are rule-abiding, others who are not. Referring to one study's count of incursions at Florida's Daytona Beach and Tampa airports, Bob Poole, director of transportation policy with the Reason Foundation, wrote: "Scaled up to an annual basis, these figures are terrifying – and this

is for drone intrusions presumably without hostile intent," in the *Reason Foundation Aviation Policy News*, #170.

"A lot of this work is for people who choose to work outside these rules," explained Daniel-Robert Gooch, president, CAC.

Myriad challenges face those responsible for airport security. For instance, how to detect an incursion. "People sometimes

Drones and planes do not mix Norton Wolf School of Aviation Technology



think there is a piece of kit that can be deployed rapidly to help us," Mark Laroche said. "Well, guess what: it doesn't exist." And without situational awareness of whether there actually is an incursion or where it is, he added: "... everyone gets prudent."

Prudence that leads to locking down an airport may not be a good 'one size fits all' reaction in Mike Beaudette's opinion: "We are trying to determine how best to detect and track something to judge the potential impact on our operations – for example, to change a runway. Not to overreact, not to under-react."

Who should be responsible for monitoring incursions? "We don't want to get into airspace control updates," Laroche said. "If there is a radar detection system to give situational awareness, this could be a NAV CANADA responsibility. We are not the ones maintaining and operating the radar."

What is an appropriate response to a report of an incursion? "You can say that local police can respond, but you can't just send patrol cars to go around the airport to see if someone is flying a drone," Laroche said.

Interdiction – neutralising an RPAS – is laced with risk. It is easy to suggest solutions such as GPS jamming, lasers, kinetic projectiles such as nets and trained falcons, even shotguns and, of all things, electromagnetic pulses. But which of them are safe to use in an aerodrome?

Transport Canada is working on this problem and states that it "continues to collaborate with domestic and international partners on research, testing and development of detection and interdiction methods near airports. Internationally, this includes working with partners such as the Five Eyes and the US Federal Aviation Administration (FAA) on several RPAS research and design topics. Domestically, Transport Canada is working with its research partners, including Defence Research and Development Canada and the National Research Council of Canada, in their evaluation of a variety of counter-RPAS technologies. Such research is intended to help inform Canada's policy and regulatory framework for RPAS"

New technologies

In the autumn of 2019, YOW partnered with QinetiQ Canada and NAV CANADA to install and begin a 12-month trial of an on-airport Micro Doppler radar system designed to detect drones.

Who is permitted by law to use interdiction tools? The report notes: "Commercial options for UAS interdiction technology are not currently allowed in the United States. The law is even more ambiguous in Canada, where in very limited cases the RCMP [Royal Canadian Mounted Police], provincial police and Canadian military would have limited mitigation authority."

Even this area is open to debate. Beaudette observed: "The RCMP is the only agency with any authority to do any jamming." To which Laroche added: "Radio

jamming? You have to be careful."

While reticent about revealing what possible tools are realistic and being considered, Beaudette noted: "There is some testing going on."

The matter of who may do what is so sensitive that Laroche pointed out that "there was [just] one person on a test site that was allowed to use the test item."

On an agency or stakeholder level, he said: "The airport does not have any intervention authority and I don't think I'd want any. It is not our responsibility. It is a NAV CANADA and Transport Canada's responsibility. I can't shut down the airspace."

Harvey noted: "[They are] still trying to establish who has the authority to lead any mitigation strategy. Lots of different groups are involved."

Meanwhile, defining roles and responsibilities is ongoing, from first reporting an incursion to deciding who makes the call to reopen the airspace.

"Basically, we want to make sure everyone understands their role, and that people who make decisions know what their sandboxes are and what they can do," Laroche explained.

When considering the issue at a national level, he said: "We think there should be a minimum standard, a commonality, a national programme. The common thread is to have a response plan." So should there be a national structure that airports can work from? "Absolutely."

The CAC is helping to keep Canadian airports abreast of developments. "We are ensuring that the information flow is there," said Gooch. "We are the conduit for the information that is produced on this issue and awareness of what is transpiring."

And what is the status of the knowledge acquired from the tabletop exercise? Laroche answered: "What we have learned is that there is much work to be done to identify each person's responsibility." **AI**

The safety and security of passengers and staff is paramount for airport operators
Gatwick Airport



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European Rotors 2020

A new European exhibition for the helicopter industry will be staged in Germany this November. **Mark Broadbent** finds out about an event intended to bring together customers, suppliers and regulators in one place and the measures being taken to host it safely





CLOCKWISE FROM TOP LEFT: Bell will give an update on the 429, among other types

Image Bell

Italian aviation multinational Leonardo is among major players making the trip to Friedrichshafen

Image Leonardo

Aerial firefighting will be a topic in key focus at EUROPEAN ROTORS

Image Airbus

The COVID-19 pandemic has devastated aerospace industry events in 2020 but now the stage is set for an entirely new show. Exhibition centre Messe Friedrichshafen in southern Germany – the venue for the postponed AERO expo – is due to host EUROPEAN ROTORS from November 10-12. The completely fresh event is dedicated to vertical take-off and landing (VTOL) flight, and is organised by the European Helicopter Association (EHA) and the European Union Aviation Safety Agency (EASA).

Meeting industry needs

Speaking to *AIR International*, Dr Frank Liemandt, the show's director and EHA spokesman, explained it was created to respond to association members wanting a "joint European event covering everything".

Dr Liemandt said: "It doesn't make sense to have only operators discussing with industry. We need the regulator [EASA] on board; that hasn't happened in the past. For the first time we have the EHA, the regulator, the leading [original equipment manufacturer] OEMs like Airbus, Bell, Leonardo, Safran [and] the leading operators together. It has everybody on board."

Updates from major companies are fundamental in any industry expo and EUROPEAN ROTORS will see these firms and others share news and important information in dedicated customer briefings. Airbus is scheduled to provide an update on its RACER programme to develop a new-generation high-speed helicopter, while Bell will talk about its key commercial types, the 429, 505 and 525, and provide a safety talk on autorotation.

Conferences

Organisers emphasise there is far more to EUROPEAN ROTORS, thanks to what they call "a unique conference, training and workshop agenda alongside the trade show".

The event has also integrated this year's Police Aviation Conference Europe, due to have been held in Berlin in June, but cancelled due to COVID-19, and the EASA Rotorcraft and VTOL Symposium.

Established in 2007, the latter is described by EUROPEAN ROTORS' organisers as "the premier platform for European helicopter operators and the industry to jointly discuss current and future challenges with the European regulator".

Bringing the symposium into EUROPEAN ROTORS enables the regulator, the organisers say, "to expand its audience and reach out to new entities within the rotorcraft industry".

Issues to be addressed will include airworthiness and certification standards, research and development, safety initiatives, safety enhancement actions and future developments post-COVID-19.

A broad objective for EUROPEAN ROTORS is enabling attendees to learn about subjects in depth from others, for example, in the area of aerial firefighting.

Dr Liemandt explained to *AIR International*: "Countries like Spain and France are used to having a firefighting season from April to October. We can learn from that. We need European standardisation on handbooks, machines, pilots to be able to communicate with ground forces that may not speak English."

The firefighting focus fits into the wider theme of linking industry and government. Dr Liemandt noted: "We have someone from the European Commission [attending] and we can address directly to him the concept [for European standardisation]. This is a good example of the show sharing best practice from different regions and how we can improve from our neighbours."

There is another important element of EUROPEAN ROTORS. The organisers said: "For the first time in Europe, visitors can take the opportunity of joining an aviation trade show and booking training courses with certificates given on completion."

Highly renowned organisations will offer a great bandwidth of subjects for pilots, engineers, and technicians."

Workshops

Workshop topics will include operational safety working with unmanned air vehicles (provided by Airbus World Training), performance-based navigation (PBN) in instrument flight rules conditions (Pegasus Aviation Group) and UAV and VTOL design in urban air mobility (Institute of Helicopter Technology and the Technical University of Munich).

EASA will run workshops on rotorcraft icing, air operations regulations and PBN. AeroEx GmbH will focus on regulations compliance – relevant for special applications such as pipeline and powerline patrolling, aerial survey and sling load operations.

IDP European Consultants looks at EU funding, and Leocopter will examine the vortex ring state (a condition that causes a loss of lift on rotors) and how to avoid human error in helicopter operations.

There will also be two innovation days. Dr Liemandt said: "One [is] organised by the German Aerospace Center, the DLR, with a lot of interesting topics such as maritime simulation for rotorcraft and pilot-induced oscillations [and] generic topics [such as] innovations and propulsion systems." The second, focused on VTOL development in Switzerland, will be opened by Swiss Helicopter Association president, Martin Candinas. Dr Liemandt noted Candinas is also a Swiss politician and said his attendance "shows the bridging we want to achieve" at EUROPEAN ROTORS between industry stakeholders and putting its views "in front of the decision makers".

Training

Certified training will be provided on various topics. Pegasus Aero Group will run courses on airspace/operational

management, crew resource management (CRM) and safety in firefighting operations, as well as a separate course simply titled 'Forest Fire Fighting for Helicopter Pilots'.

Bettina Schleidt, Professor for Applied and Business Psychology and Human Factors at SRH University Heidelberg's Applied Sciences department, will run a CRM course and Aerossurance will host on safety culture and leadership and AeroEx GmbH and Renz & Partners on accountability.

Aerossurance will also provide training on contracting aviation services, while Pegasus Aero Group has separate courses on aerial reconnaissance/intelligence gathering and EU funding for rotorcraft. Lorenzo Costantino, a partner at IPD European Consultants, will host a programme called 'Horizon Europe' focused on EU research and innovation.

Details of further courses and workshops were due to be revealed after this article was published.

Electric VTOL and Rotorthon

With numerous developments in urban air mobility, inevitably the emerging class of electric vertical take-off (eVTOL) aircraft will have a presence.

Tobias Bretzel, Project Manager and Sales at Messe Friedrichshafen, told *AIR International*: "The show is reflecting it in multiple ways. The first will be in products and concepts from OEMs; for example, you will see something from Airbus."

Bretzel added eVTOL suppliers will have exhibition stands and part of the conference programme will be dedicated to eVTOL subjects such as propulsion systems and traffic management.

A further part of EUROPEAN ROTORS is Rotorthon, held in collaboration with the student association EUROAVIA.

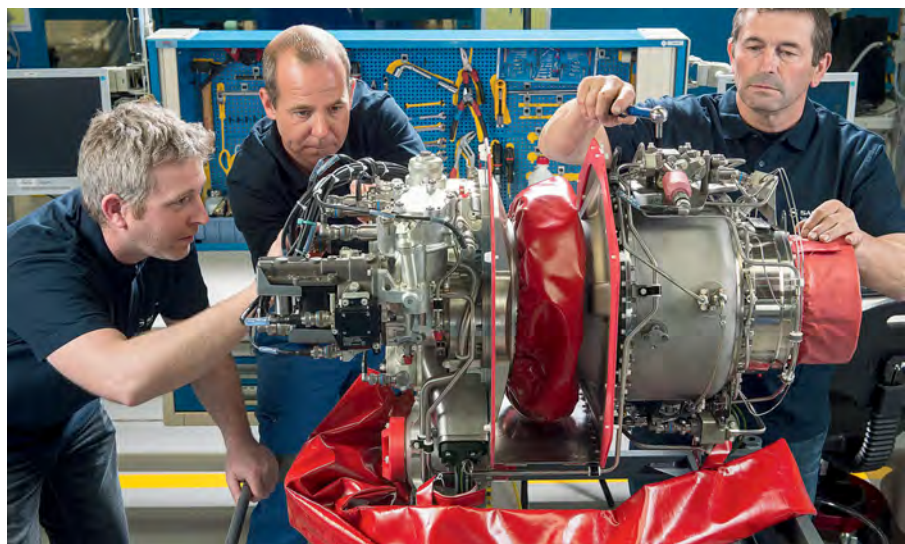
Mirroring the concept of a 'hackathon' – where IT engineers brainstorm solutions to problems over a couple of days – six teams of students will be tasked to find answers to specific design, infrastructure and airspace organisation challenges, before their responses are presented to a jury on the last day of the trade show.

David Solar, head of the VTOL department at EASA, said: "We are facing many challenges in the VTOL and rotorcraft sector, from integrating a complete new user group into the airspace [eVTOL] to questions on next generation designs. It will be interesting to see how young talents will find answers."

Coping with COVID-19

In 2020, travel restrictions due to the COVID-19 pandemic have forced cancellations of numerous industry events. While EUROPEAN ROTORS' organisers are pressing ahead, they have introduced extensive measures to maximise safety.

Everybody will have to wear face masks, there will be a 'no handshakes' policy, and



ABOVE: Companies in the supply chain such as engine supplier Safran will be there

Image Safran

TOP: Airbus is due to give an update on the RACER

Image Airbus

LEFT: Show director Dr Frank Liemandt
EUROPEAN ROTORS

social distancing of 1.5m. Exhibitors are required to regularly clean their stands, including after each individual meeting. Events at stands are not permitted and places for meetings and attendance at workshops and conferences must be pre-booked.

Bretzel told *AIR International*: "We had to look at aisles and floorspace and adopt a plan for the conference rooms so, just like a cinema, for example, each attendee has a dedicated seat in a dedicated row where they have to sit; you can't just show up and sit wherever you want."

An air ventilation system in the venue separates used from fresh air. All the venue's toilet facilities will be cleaned and disinfected regularly. No standing will be permitted in the conference areas and separate entrances and exits, with all doors (except fire doors) remaining permanently

open to reduce surface contact. All visitor tickets must be bought online to control and monitor visitor numbers and help maintain social distancing. Attendees must also register in advance to ensure organisers can quickly identify people in case of a COVID-19 infection.

Reconnecting

Bretzel told *AIR International*: "People can't expect a trade show that looks and feels the same, but the most important thing is that they're a safe space for people to connect. From the organiser's perspective, we expect that for at least the first half of next year masks [will be worn] at the shows." He added: "A new objective for the show is [for] the industry [to] come together and see each other in secure conditions, reconnect personally, [say] 'how are you doing?' and [discover] what options we still have. The reasons for having a show are never more important than now." **AI**



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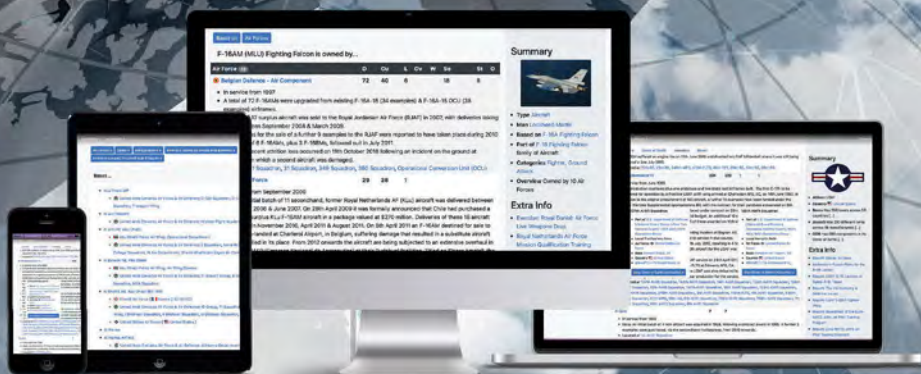
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Black boxes



Designed to withstand the temperature of lava and the weight of a white rhinoceros, black box flight recorders have assisted air crash investigators for the last 50 years. **Thomas Haynes** examines their history and speaks to a manufacturer and an accident investigator to explore the future of these robust systems

The black box recorders' ability to survive a crash is one of their most important characteristics. These devices are designed to outlast the most extreme environmental conditions and forces, all so that the precious data contained inside them can be used by accident investigators.

When an aircraft incident occurs, finding out how it happened and what caused it is a critical process that enables regulators and manufacturers to prevent the recurrence of a similar event. Flight recorders or 'black boxes' as they are widely called, are one of the most valuable tools investigators have at their disposal to identify the complex chain of events that always precedes a crash.

The testing requirements for the devices are very stringent. The systems are covered by a fireproof box that is certified to withstand 1,100°C for 30 minutes – that's almost exactly the temperature of lava. Following this, the black boxes must then survive a sustained 260°C heat for ten hours. Imagine that – you could put your oven on its maximum setting and it still probably wouldn't be hot enough.



The crash of Malaysian Airlines Flight 370 in March 2014 led to a mandated increase in the battery life of flight recorders' locator beacons from 30 to 90 days

AirTeamImages.com/PhilippeNoret

built to survive

LEFT: The form-factor of most black boxes is the same, which means that they can be upgraded easily
Honeywell Aerospace

a range of parameters every and every second. The concept of recording flight data and cockpit voices has been around for more than 60 years, but in that time, the developments have been relatively small.

All in all, they are incredibly rugged pieces of kit that are tested and designed to stand the best possibility of protecting their contents during a crash scenario.

Black box origins

In the beginning, there were two competing designs – one from Australia and the other from the United States – both of which followed the same principles. They each wanted to record the flight data to assist investigators.

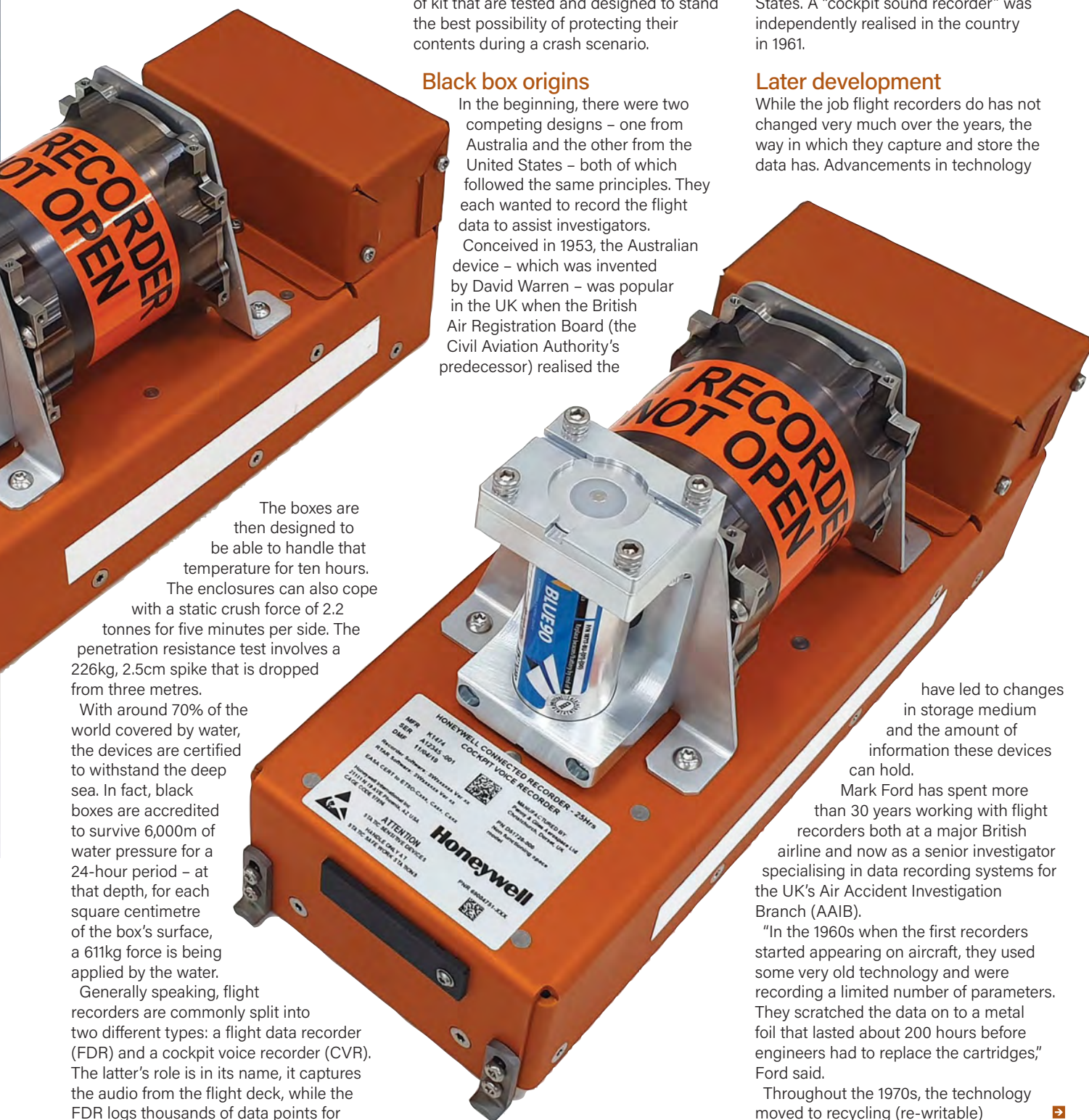
Conceived in 1953, the Australian device – which was invented by David Warren – was popular in the UK when the British Air Registration Board (the Civil Aviation Authority's predecessor) realised the

significance of the invention in aiding its investigations.

During the same year, James Ryan – the person who also invented retractable seat belts for cars – applied for a “Flight Recorder” patent in the United States. A “cockpit sound recorder” was independently realised in the country in 1961.

Later development

While the job flight recorders do has not changed very much over the years, the way in which they capture and store the data has. Advancements in technology



The boxes are then designed to be able to handle that temperature for ten hours.

The enclosures can also cope with a static crush force of 2.2 tonnes for five minutes per side. The penetration resistance test involves a 226kg, 2.5cm spike that is dropped from three metres.

With around 70% of the world covered by water, the devices are certified to withstand the deep sea. In fact, black boxes are accredited to survive 6,000m of water pressure for a 24-hour period – at that depth, for each square centimetre of the box's surface, a 611kg force is being applied by the water.

Generally speaking, flight recorders are commonly split into two different types: a flight data recorder (FDR) and a cockpit voice recorder (CVR). The latter's role is in its name, it captures the audio from the flight deck, while the FDR logs thousands of data points for

have led to changes in storage medium and the amount of information these devices can hold.

Mark Ford has spent more than 30 years working with flight recorders both at a major British airline and now as a senior investigator specialising in data recording systems for the UK's Air Accident Investigation Branch (AAIB).

"In the 1960s when the first recorders started appearing on aircraft, they used some very old technology and were recording a limited number of parameters. They scratched the data on to a metal foil that lasted about 200 hours before engineers had to replace the cartridges," Ford said.

Throughout the 1970s, the technology moved to recycling (re-writable)

RIGHT: Flight recorders are certified to withstand 1,100°C – almost exactly the same temperature as Lava USGS

BELOW: Following the crash of Air France Flight 447 on June 1, 2009 it took nearly two years for the black boxes to be recovered from the crash site
[AirTeamImages.com/Philippe Noret](http://AirTeamImages.com/PhilippeNoret)

BOTTOM: The first flight recorder was conceived by Australian scientist, David Warren in 1953
[Getty Images/Fairfax Media](http://GettyImages/FairfaxMedia)



recorders and then in the next decade, the progression to magnetic tape was eventually realised. The Boeing 747-100, Lockheed L-1011 TriStar and the BAC One-Eleven all featured recycled metal foil recorders, effectively removing the need to

replace the various cartridges.

"Through the 1990s we started to see the introduction of solid-state recorders with memory akin to what you would have in a USB flash stick. But because of the sheer cost [of storage], the earliest recorders only

had about 2MB of capacity, but they could still fit 25 hours of recorded flight data," Ford recalled.

The development of the CVR followed much the same path as the FDR. The transition between storage mediums was

The Lockheed L-1011 TriStar and Boeing 747-100 were among the first aircraft to feature re-writable flight recorders AirTeamImages.com/Wolfgang-Mendorf



similar but slower than the data recorder moving to solid state, because of the memory limits.

Currently, the requirement for the CVR is that it records the last two hours of each flight. Soon, this is set to expand to come in line with the FDR at 25 hours.

Leap to live streaming

The aviation industry is one of those sectors within which change usually occurs in response to regulatory mandates or guidelines. An example of this is the CVR recording time extension, which came because of a European Union Aviation Safety Agency (EASA) mandate.

A separate regulatory directive covers the future requirement for all flight recorders to be able to allow for the "timely recovery of data." The mandate doesn't specify how this is to be done, it simply states that the retrieval of information needs to be completed in a timely manner.

One company at the forefront of combatting this challenge is Honeywell Aerospace. The Arizona-based firm is no stranger to developing and manufacturing flight recorders as they have been doing it for more than 60 years

and are now on their sixth generation of the devices.

Borka Vlacic, director of marketing and product management for satellite communications at Honeywell Aerospace, noted: "We are very well recognised by the industry as a leader for black boxes for all commercial aviation. We have also been involved in developing industry standards for a long period

connected variants. Honeywell is currently in the process of creating devices which are linked to the cloud through satellite communications. These systems are being designed to satisfy the EASA "timely recovery" mandate which is due to come into effect in 2023.

"When you think about timely recovery of data, how do you get that with something that's flying at 30,000ft? There are a few interesting options, but the most logical one to us was to leverage the satellite communication capabilities

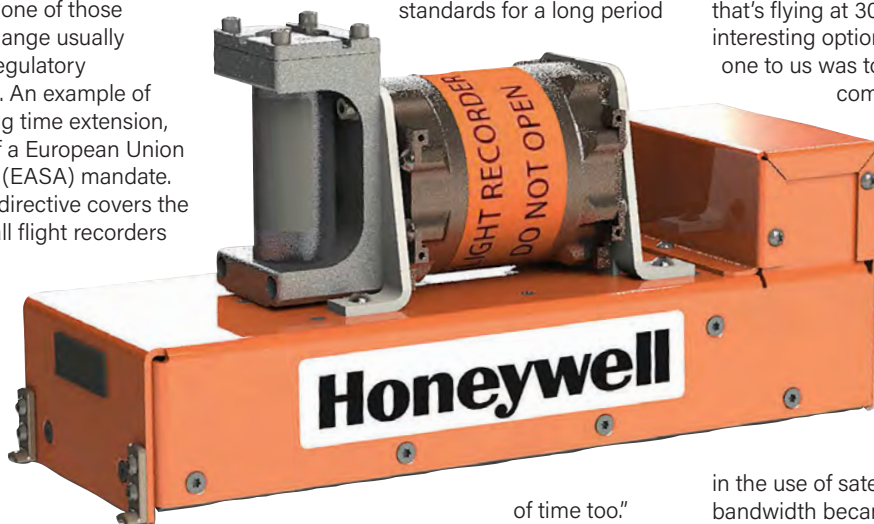
that we have and integrate that into our recorders," King explained.

The technology to allow connected black boxes to function has been around for quite some time, however, Vlacic said the cost was uneconomic until recently:

"With the increase

in the use of satellite communication, bandwidth became wider, transmission and installation costs also dropped. All that boom and development allowed something to happen and made it possible and accessible."

Honeywell is working with satellite operator and long-time partner, Inmarsat →



of time too."

Amanda King, vice president/general manager of aerospace connected secure solutions, added: "Honeywell is on all the narrowbody aircraft and most of the widebodies; the designs we made previously and the ones we're developing for the future are easy to upgrade. We make the form and fit the same... and this is how we secure our position on so many aircraft, as we are today."

The next big step in the development of flight recorders comes in the form of

ABOVE: Honeywell's HCR25 flight recorders benefit from real-time data streaming and cloud-upload capabilities
Honeywell Aerospace

LEFT: Borka Vlacic is director of marketing and product management for satellite communications at Honeywell Aerospace
Honeywell Aerospace

RIGHT: Amanda King, vice president/general manager of aerospace connected secure solutions
Honeywell Aerospace





to bring this next generation set of devices to the market. Called the Honeywell Connected Recorder (HCR-25), the system will enable flight data and cockpit voices to be streamed live via a satellite to a secure facility on the ground, reducing the urgency to find the boxes when an incident occurs.

There are several options to do with data and how much of it is transferred live from the aircraft. The first and simplest, is the live transmission of everything in real time, the downside to this of course, is that this will use a lot of bandwidth.

The second option is a condition-based setup which would transmit certain parameters if a predetermined event were detected. This choice would limit the total bandwidth requirements for the device.

"Flight has core parameters – airspeed,

attitude, altitude and another subset of things that are also important – and if anything were to go outside the limits the system could trigger something that would then start auto streaming so we don't have to use the bandwidth 100% of the time but we want it when we need it," King confirmed.

Traditional recovery

The connected variants will allow the pressure to find the black boxes to be taken off investigators as it's thought the information will be safe in a data centre. But right now, the units have to be located. So how do investigators do it, and what tools do they have available?

Currently, the vast majority of recorders in service are fitted with underwater locator beacons. Prior to the MH370 and Air France 447 crashes, the requirement was

LEFT: Flight recorders are typically secured in place at the rear of an aircraft

Wikimedia Commons/YSSYguy

ABOVE: Recovery of flight recorders offshore is very difficult; that's why a connected unit is favourable because it would negate the need for retrieval

US DoD/Spike Call

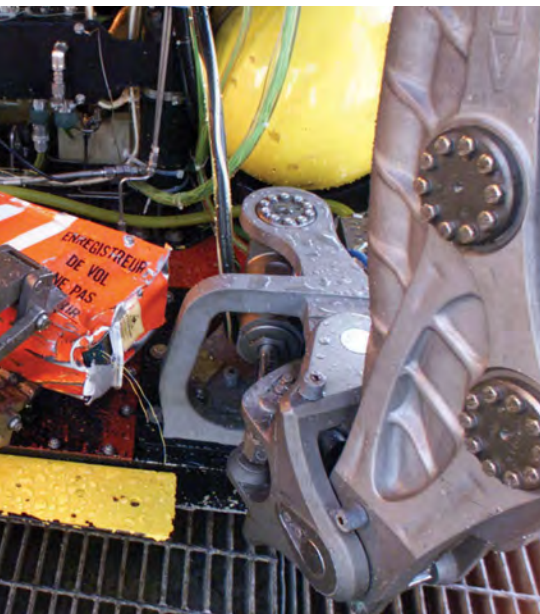
RIGHT: Both the CVR and FDR were removed from the Asiana 214 crash aircraft relatively undamaged NTSB

for a high frequency beacon at 37.5khz that would last 30 days. Following these crashes, it was extended to 90 days.

Ford commented: "The rationale behind that is that if you have an aircraft crash inshore, you should be able to find it reasonably quickly but, as we know, if something is a long way offshore, it takes a lot of time to get the ships which are

The cockpit voice recorder was crucial in discovering the cause of the Asiana Airlines Flight 214 crash at San Francisco International in July 2013 Wikimedia Commons/Aero Icarus





required to search deep waters in place.”

These beacons have relatively short ranges – depending on the sea-state, they may only extend to 3.7km. If the aircraft is deep, Ford says they use underwater hydrophones to locate the devices.

The AAIB tows the equipment behind a boat at roughly 4kts (5mph) along a racetrack-type pattern up and down at 1,500m spacing. Investigators are then listening for a tone which indicates the presence of the recorders.

On some aircraft that fly over water, there is also now a set of recorders that have a low frequency beacon that transmits at 8.8khz. The benefit of this option over its high frequency counterpart is that it provides much better range, topping out at around 18km.

“The idea is that you would use this to

home in on the approximate location and then use the high frequency beacon which will give you better direction. One we’ve identified the area of the wreckage we have equipment that divers can go down with to use to home in on the recorders,” Ford said.

If the crash has occurred in a location where the water is deeper than is allowed for divers, the agency uses remotely operated vehicles to carry the hydrophone equipment humans would otherwise be using.

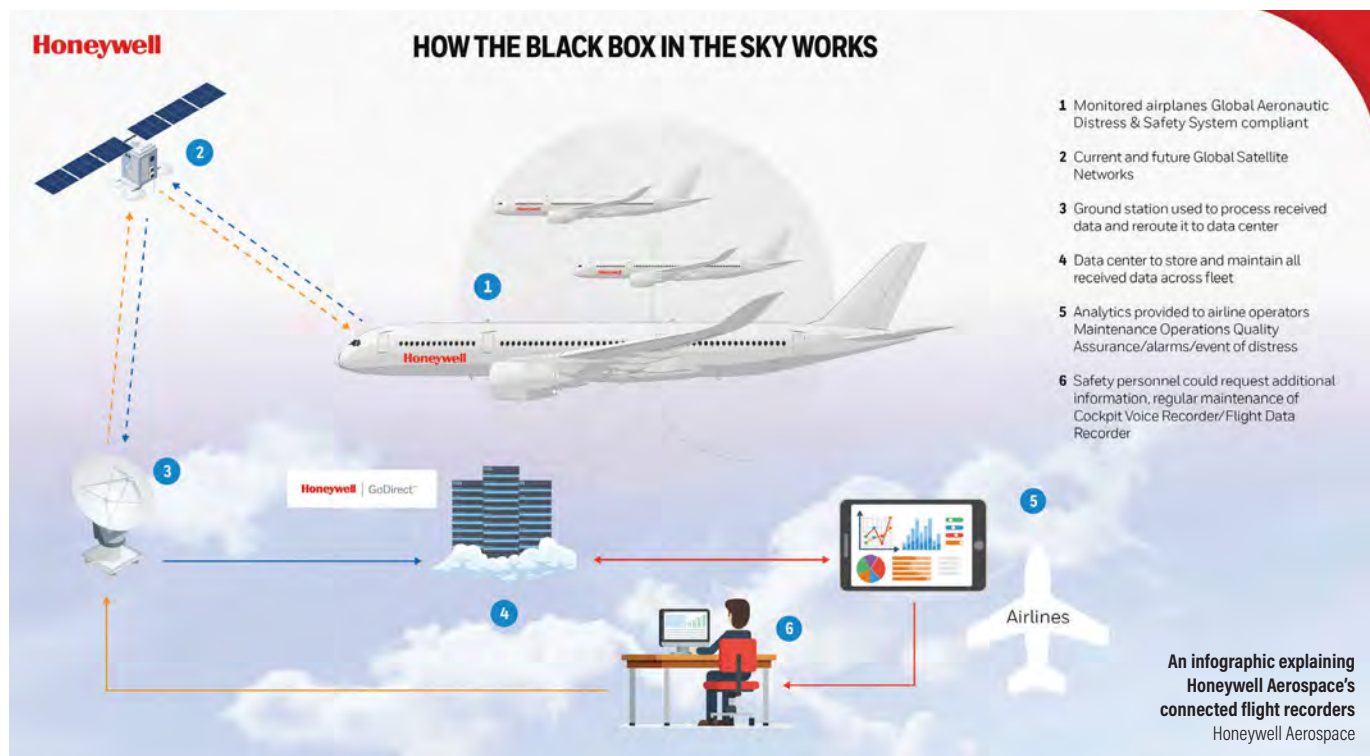
Future focus

For accident investigators like Mark Ford, the next generation connected units will allow for a much faster information-gathering process: “Clearly the big benefit for us is that rather than having to go out to sea or visit the accident site, in theory we will circumnavigate that part,” Ford said.

There are a number of issues that sometimes makes locating the crucial devices very difficult: “They can be notoriously hard to find, for example if the recorders are embedded deep into the sand or under aircraft wreckage; all of those factors can affect the range of the beacons so it can take some time.

“Hence, this is why we’re looking to livestream the data. It’s also expensive to recover them especially if you’re working deep sea,” he said.

With the connected capability right around the corner, we’ll soon see these devices rolled out on new and existing aircraft around the world. The advancement will undoubtedly change the way investigators work and marks a significant step forward in the development of flight recorders. **AI**



New wi for the **Gua di Fin**



The AW169 is fitted with mission systems which are technologically advanced All images by Riccardo Niccoli

ings rdia anza

In 2019, the air component of Italy's Guardia di Finanza policing service saw the delivery of two new aircraft: the P-72B patrol aircraft and the AW169M helicopter. **Riccardo Niccoli** interviews Brig Gen Joselito Minuto, commander of the Centro di Aviazione della Guardia di Finanza, about the unit's modernisation programme



Q Following the delivery of the AW169M helicopter, completed on November 12, 2019, how has its introduction into service been managed?

Commander Minuto: In order to facilitate the introduction into service of the first example of the AW169M, the first crews to be trained were selected from the instructor pilots of the Servizio Aereo (Air Service) with the widest flying experience. [They] were serving with the I Gruppo Aereo Addestramento (1st Air Training Squadron) of the Centro di Aviazione (Aviation Centre), and completed a complex formative training path which enabled them, in line with EASA regulations, to qualify as certificated Instructors at the Leonardo Training Academy at Sesto Calende, Varese.

This academy also prepared the maintenance personnel from the base at Pratica di Mare [in Pomezia] in order to guarantee the correct technical and logistical management of the new fleet. Through this, both the theory and practical phases were conducted with the aim of permitting the personnel undergoing training to perform valuable service as instructors at the newly created ATO (approved training organisation) in the Centro di Aviazione, at which also under development is the Centro di Simulazione Aeronavale (air-sea simulation centre), which will initially involve the acquisition of both FTD (flight training device) and FFS (full flight simulator) simulators.

[Following] completion, it will offer the possibility to simulate operational scenarios which involve the



simultaneous simulated engagement of aircraft, naval elements and system operators. The practical activity in particular that resulted in VFR/IFR qualification and the certification as TRI (type rating instructor) was sub-divided into four specific phases, which have also involved the use of the simulator at the base of the Leonardo Training Academy: conversion on the FFS simulator for a total of 18 hours; flights in the helicopter and a subsequent examination to EASA standards (four hours); an advanced phase known as 'Experience' to permit the acquisition of experience on the helicopter, in terms of both flying hours and the enabling of pilots to pass on to the subsequent phase for instructors (a total of seven hours in the FFS and eight hours in the helicopter); and finally the instructor course and the achievement of TRI qualification on the AW169, requiring a total of around 16 hours.

Q How has the training of the first crews proceeded and how will this training continue?

The pilots consequently selected to frequent our course were initially those serving with units operating in the mountains, specifically Bolzano and Varese. Following the theoretical element, again held at the Leonardo facility, they gained their qualification by following training paths specific to their acquired experience and the qualifications they previously held; in general, these being related to the OH-500, MCH-109N and HH-412C fleets and therefore not a homogenous training baseline, for which it was necessary to appropriately re-module the training programmes, resulting in a complete training programme of around 35 hours for newly qualified pilots, and



Helicopter missions are managed by the ATOS-RW/MMS system



The AW169 is one of three different helicopter lines with a common cabin layout



The introduction of the AW169M will deliver a higher quality of performance and operational results



2021 will see the entry of the first AW169M mission systems for maritime patrol

a reduced syllabus of 15 hours for those pilots who already hold qualifications on twin-engine helicopters.

Q How many missions/flying hours are required to achieve operational capacity?

The part of the training relating to operational capacity was performed on the helicopters of the [Guardia di Finanza] Corps and was divided into two distinct phases. A first, basic phase, held at the Centro di Aviazione, and the successive, more advanced phase, held at the units where the trainees were based, with the aim of exploiting the predictable scenarios for their subsequent operations in the high mountains and to enable them to directly appreciate the characteristics, peculiarities and potential of the new helicopters in specific activities. For example, rescue operations using the hoist.

Q Which helicopters will the AW169M replace, and which fleet will be the first to be withdrawn?

The AW169M, a machine which represents the maximum evolution of the sector, is fitted with mission systems which are technologically advanced and of the latest generation. It is the first helicopter of this type assigned to an Italian government agency and, as has already happened with

the AW139, it is the Guardia di Finanza that represents, among others, the first military institution, also on a global level, to have acquired this model of helicopter. [It] will go on to progressively constitute the equipment of the flying units now operating the HH-412C and MCH-109N, and the more obsolete, albeit still useful training asset, OH-500.

The completion of the acquisition programme for this new medium-light twin engine helicopter should see the delivery of the first seven examples during 2021, and a further 15 helicopters by 2023. The first four helicopters, all delivered in 2020, are in mountain rescue configuration and are designated UH-169A.

Q How does AW169M integrate itself with the other helicopter fleet, like the AW139 in its military version PH-139D?

The AW169 and AW139 will be the only two helicopter lines that will cover the operational needs of the Corps on the whole national territory. The AW169 has been conceived for a dual use: mountain operations, where it is used, beside the normal missions, in search and rescue operations (SAR). Its configuration includes a hoist and a new equipment, the IMSI/IMEI Catcher, used to localise cellular phones, and therefore useful also for SAR operations. Also, there will be the

traditional use with the coastal air units that operate against international illegal trafficking at sea.

As a consequence, in order to optimise our resources and standardise the fleets, the AW169 has been developed with an integrated mission system like that which has been installed in the AW139 line, which is formed by electro-optical sensors and modular subsystems, flexible and usable according to the missions to be accomplished. Of course, the PH-139D, being the most [performance-based] aircraft in terms of endurance, is operated for the control of European boundaries in the sea police duties.

Q Besides the Centro Aviazione, the first unit to receive the AW169M was the Sezione Aerea di Bolzano (the Bolzano air section of the Guardia di Finanza). Which other units will be involved in the conversion to the new helicopter?

Besides the Sezione Aerea di Bolzano, the new helicopter was delivered in June to the Sezione Aerea di Varese (Varese air section), where they are just finishing the training phase for the pilots and maintenance staff. By the end of 2023, the flying units involved in conversion onto the new type will be the Sezione Aerea di Genova and also Pisa, Napoli, Palermo, Lamezia Terme, Rimini and Venezia. ➔



Guardia di Finanza's pilots say the helicopter is very reactive to the flight controls

The second half of 2021 will see the entry into service of the first AW169M FOC (full operational capability) fitted with mission systems for maritime patrol, and the procedure to deliver these to the units involved will be immediately launched, as at the same time the training activity for all the associated specialist personnel will have been completed.

Q A specific requirement of the Guardia di Finanza calls for the presence of skid landing gear on the AW169 in place of its current wheeled system. The first helicopters have been delivered in this configuration, with fixed landing gear with wheels. How is the programme developing?

The need for skids comes from the specific employment of the Corps helicopters that usually are called to operate in different scenarios that may include landings outside airports, in rough territory and in adverse weather conditions. The programme foresees that the next helicopters in the operational configuration will have skids in place of wheels. This feature also allows a slight improvement in terms of weight and endurance.

Q Could you illustrate what equipment will form the mission system in your version of the AW169M?

The mission system installed on board the AW169M helicopter will be managed by a system known as ATOS-RW/MMS (airborne tactical observation and surveillance – rotary wings/mission management system), a design already in use and consolidated in the PH-139D fleet.

It is principally composed of a workstation computer (WSC), which is the heart of the system, and allows the operator, through two full HD screens with touchscreen technology, plus a keyboard, to manage all the systems. Then there is an interface unit (IFU) that creates a link between the ATOS system and the navigation management systems; a Gabbiano TS-20 radar system (with capability to search on the ground and at sea) which operates in ISAR (inverse synthetic aperture radar) mode to build the target shape up even at long range; a LEOSS MK2 geo-referenced and geo-stabilised electro-optical system, formed by three cameras that allow you to identify a target by day or night; three lasers (marker, illuminator and rangefinder) [that] can be operated by the pilot and the

systems operator, and has a storage unit of 1 TB; an IMSI/IMEI Catcher apparatus to identify mobile phones in UMTS, GPRS and 4G bands; a Video-downlink; an AIS transponder to identify all ships at sea; and a TRAKKABEAM searchlight complete with a NVG [night-vision goggles] filter.

At the end of each mission, the system is able to produce a mission report in Word or PDF format, which recalls all the data of the mission.

Q From a piloting point of view, how is the AW169M compared with the AW139?

The AW169 is one of three different helicopter lines of the so-called 'AW Family' with innovative systems that allow excellent flight performances and high safety standards, besides the common cabin layout and the common design philosophy. This approach offers the operators real savings on costs such as training, maintenance and support.

About piloting – we must say that the pilot manages a helicopter that is very reactive to the flight controls. The flying philosophy is quite similar to that of the AW139, but for the piloting position it takes advantage of wide windows and elevated seats that



The AW169M allows you to start up the engines without engaging the rotor, a feature useful in SAR operations



The LEOS MK2 electro-optical system is formed by three cameras that allow target identification day or night

The FMS (flight management system) is very easy to use, very intuitive, and with a graphic that in many ways is similar to smartphones

Brig Gen Joselito Minuto

Commander of the Centro di Aviazione della Guardia di Finanza

offer an excellent view, [especially] when operating with NVG or with the hoist.

The features of the main rotor that are new to this category can be appreciated especially when flying at high altitude (2,438/3,352m), where its efficiency makes the helicopter easy to be managed by the pilot. It's interesting to note that the AW169M allows you to start up the engines without engaging the rotor, a feature useful when, for example, it's necessary to embark personnel or injured people in SAR operations.

On the avionics and mission systems part, the FMS [flight management system] is very easy to use, very intuitive, and with a graphic that in many ways is similar to smartphones and tablets. Compared to the FMS installed in the AW139, the information is not immediately usable and some improvements are needed.

One of the innovative features is the synthetic vision system (SVS) that shows on the pilot display a series of information in 3D of the territory, improving the situational awareness. Of particular interest is the autopilot system which, even under continuous changes in attitude, is able to provide a stable flight. But it would be better to

reach the same standard as the system installed in the AW139, which can be considered state-of-the-art.

Finally, it would be better to have a greater endurance, to [provide] wider control [of] the territory. [In some ways], the AW169 is more advanced than the AW139. For example, it has an APU mode and FADEC engines [auxiliary power unit and full authority digital engine control] that allow you to remove the traditional engine throttle, replaced by simpler controls.

Q What more can the new helicopter offer when compared with the AW109N Nexus that it will replace?

The gradual replacement of the A109N fleet through the introduction of the new AW169M will deliver increased potential in terms of quantity. But above all [it offers] quality of performance and the delivery of operational results. This is thanks, obviously, to the major evolution in electronics and the implementation of very technologically advanced systems, such as the 'full glass cockpit', a system for the visualisation of information by the pilot which is completely digitalised.

Moreover, the three different databases containing navigation, information and geo-topographical mapping will enable the display on the monitors of a representation of the area. The same data is also sent to [the] terrain awareness warning system (TAWS), which generates messages of information, an alert for the pilots when there is risk of proximity with obstacles.

Compared to the MCH-109N, the new machine will deliver enhanced autonomy in respect of the number of personnel that can possibly be embarked, thanks to its weight and the maximum take-off weight (five tons), with the concrete possibility to perform around three hours of flight. With its hoist, it will be possible to perform rescue and recovery tasks that would be difficult to execute with the Nexus.

In terms of the mission systems, there has been a metamorphosis in both the sensors installed on board and the quality of the results obtained. I should also underline the provision of a FLIR [forward-looking infrared] system which is totally advanced and with characteristics that are highly superior to those presently used in the MCH-109.

Q What is included in the current contract with Leonardo in terms of maintenance and support?

At present, the contract signed with Leonardo includes an integrated logistic support for the whole fleet – with major inspections at the Leonardo facilities – while normal maintenance is carried out by our personnel on the various air unit sites. This allows us to provide a high efficiency rate of our helicopters and a reduction of the maintenance costs. **AI**

Orion the hunter

Some 25 years after the MQ-1 Predator attack drone, the Russian military has finally got its own Predatorski. **Piotr Butowski** reports



In April 20, Nikolai Dolzhenkov, the Designer General of Kronshtadt Technologies, told Russia's TASS news agency that his company had handed over to the Russian

Ministry of Defence the first Orion unmanned aircraft system with three aircraft. Dolzhenkov added, however, that "the military made additional requirements that were initially not specified. Therefore, we will take the system back and refine it according to the additional customer request"

After a hiatus of almost 20 years, and following the collapse of the USSR, the Russian armed forces expressed a serious interest in unmanned aircraft after the war with Georgia in 2008.

In the short term, Russia launched the assembly of Israeli Searcher II (as the Forpost drone). Simultaneously, the Russian Ministry of Defence (MoD) defined the requirements for a new generation of indigenous unmanned aircraft systems (UAS) in several categories and presented them to potential contractors.

The tender for the development of a one-tonne medium-altitude long-endurance (MALE) class unmanned aircraft was agreed in 2011 with the Transas Company (later reorganised into Kronshtadt), in Saint Petersburg.

In October that year, the company was awarded a contract worth RUB2,279m

(£23.3m) from the MoD for a research and development project codenamed Inokhodets ('Ambler'), with the first aircraft due to start flight tests by the end of 2014.

Later, when the aircraft was shown to the public, it was given the name Orion. While both names are used interchangeably, only the Russian military calls it Inokhodets. Inside the company, however, the aircraft was given a rather unusual designation: 'izdeliye (item) 2NL311-10'.

In April 2016, after a considerable delay, the first prototype '01' was transported to the flight test centre in Zhukovsky in Moscow Oblast, where on July 26 it made the first of a series of 'hops' – lifting off the runway momentarily.

Kronshtadt had been refused permission to fly a large unmanned aircraft near Moscow, so it transferred further trials to Protasovo airfield, near Ryazan, about 161km from the capital. Here the company built four 20m x 20m hangars, and on October 15, 2016, the Inokhodets completed its maiden flight.

The results of this test remain vague to outside observers.

What is known is that in May 2017, the aircraft reached an altitude of 18,700ft. On November 16, 2019, the aircraft '05' – which probably means the fifth test specimen – fell

about 1,968ft from the Protasovo runway, close to residential buildings. The aircraft was destroyed on impact, but no one was hurt and damage on the ground was minor.

Innovative airframe

Orion weighs 1,000kg at take-off and is able to loiter for 24 hours, which makes it the Russian equivalent of the American General Atomics MQ-1 Predator. It has a long, unswept wing and V tail and is powered by a single piston engine with a pushing propeller. The aircraft has a retractable undercarriage with a nose wheel, as well as a retractable rear support to protect the aircrew.

Nikolai Dolzhenkov, designer of the Orion, said that when the work was starting "there was no single ready device or system we could use", neither in the aircraft, nor in ground equipment. Thus, he said: "The level of novelty was 100%". Nevertheless, despite high risk: "We managed to develop several key technologies which we could not buy abroad"

Most important, Dolzhenkov said, was the design and production techniques of lightly loaded composite constructions for flying vehicles. "We have mastered the technology of a series production of the airframe made entirely of carbon fibre



TOP RIGHT: Nikolay Dolzhenkov, Designer General of Kronshtadt All images by Piotr Butowski unless stated

LEFT: The Orion 01 Kronshtadt

BELOW RIGHT: Inokhodets operators post

BOTTOM RIGHT: MOES EO payload for Orion

composites by the method of vacuum infusion," he said. Indeed, not only the skin, but the entire load-bearing structure of the airframe is made of composites.

The previously existing technologies in Russia for making composite elements for aviation were suitable only for high-speed jet aircraft and did not allow the creation of thin-walled ultra-light structures necessary for low-speed and long-endurance UAVs.

Another novelty was the electro-impulse de-icing system for thin carbon fibre structures.

"We have made such a system now and can use our aircraft in a much broader geographical range, as well as in cold regions," Dolzhenkov said. "One more achievement is that we, as the first in the country, have made a fully electric aircraft of this size. Orion has no hydraulics or pneumatics; all drives are electric."

A troublesome engine

The engine remains a problem for the Orion. When work on the aircraft began, there was no suitable engine in Russia. Several Russian companies, and even the Ukrainian Motor Sich, were trying to make an engine for the aircraft, without success. Finally, in 2013, the task was given to the small Itlan company, from Rybinsk.



Kronshtadt Orion-E specification

Wingspan	16m (52ft 6in)
Length	8m (26ft 3in)
Height	3m (9ft 10in)
Take-off weight	1,000kg (2,205lb)
Payload, standard	60kg (132lb)
Payload, maximum	200kg (441lb)
Operational speed	65kts (120km/h)
Ceiling	7,500m (24,606ft)
Endurance, with standard payload	24 hours
Communication range, direct	135nm (250km)
Communication range, with relay UAV	162nm (300km)
Required runway length	900m (2,953ft)



Its APD-115T (Aviatsionnyi Porshnevov Dvigatel, aircraft piston engine) with a power of 115hp (86kW) is actually a heavily reworked Austrian Rotax 914. The engine drives a two-bladed composite AV-115 (Aviatsionnyi Vint, aircraft propeller) variable-pitch pushing propeller, made by Aerosila.

However, adaptation of the Rotax to the needs of the Orion turned out to be much more difficult than the designers expected. At first, it seemed enough to add a turbocharger to increase the flight altitude. However, in order for the engine to work with the turbocharger, a completely new engine control unit was required. Each change followed another.

The aircraft began flight trials with a temporary engine in the so-called KO-1 (Konstruktivnyi Oblik, construction shape) version without a turbocharger and with only minor changes to the control system. The propeller was non-adjustable, with the pitch fixed in one position. The current production aircraft – including the first three delivered to the military this year – are powered by APD-115T KO-2 engines, with a turbocharger and a Russian control system. It is also not yet the final version: further changes to sensors, actuators and wiring are needed.

At the same time another company, Agat, from Gavrillov-Yam, in co-operation with the Moscow Central Institute of Aviation Motors (CIAM), is making an APD-110/120 (110hp is the nominal power; 120hp is the take-off power) four-cylinder piston engine with a turbocharger for the Orion. It is not completely known what engine will be installed on this aircraft in the future.

The system

Depending on its tasks, the unmanned Orion system has three to six aircraft, as well as a ground control and data processing station, a separate ground control station for take-off and landing, a data link module and a support equipment for diagnostics and →



maintenance. The aircraft is equipped with a communication system developed by the Rybinsk Luch design bureau, with a range of up to 250km – or more, if a radio relay UAV is used.

The Orion has two mission equipment bays, a small one in the lower forward fuselage and larger one in the lower centre section of the fuselage. In the forward bay, the MOES electro-optical turret made by Moscow-based NPK SPP company with use of Argos platform supplied by South African Airbus DS Optronics, is installed as standard.

The MOES sensor has the diameter of 410mm and a weight of 55.8kg. It houses a thermal imaging camera with zoom lens, two TV cameras (wide-angle and zoom), laser rangefinder and laser target designator. The sensor can detect, automatically track and indicate targets for guided weapons.

The other reconnaissance equipment placed in the central bay is optional. A suite of digital photo cameras made by TsNIIAG institute, or a 360° passive electronic scanning aerial (PESA) surveillance radar made by Tikhomirov NIIP can be placed there. In another variant, radio and signal

intelligence systems are installed in both bays. Finally, in the tasks of enemy air defence suppression, the Orion takes a large ventral pod with jamming equipment.

Small weapons

According to Dolzhenkov, the Orion is primarily designed for reconnaissance, while combat operations are the domain of larger unmanned aircraft. However, the one-tonne Orion also has two weapon pylons under the central part of the fuselage, as well as the SUO-90P stores management system that controls the weapons release. The Orion began its

weapon tests in summer 2017 at the Dubrovichi training ground near Ryazan.

In 2018, two Orion aircraft were deployed to the Russian Hmeimim base in Syria, from where they made around 60 sorties with a total flying time of more than 200 hours. Most of them were reconnaissance missions. However, the aircraft also dropped small bombs. Most likely these were 55lb guided bombs made especially for unmanned aerial vehicles (UAV) by the Aviaavtomatika company, from Kursk (the Orion was seen with them previously).

The armament dedicated to unmanned systems is still an initiative of individual companies in Russia; the MoD does not have a co-ordinated development programme for the UAV weapons.

In 2017, Aviaavtomatika presented three guided bombs for UAVs, one at 25kg, and two at 50kg. The bombs have a body with the same rectangular cross-section with rounded angles, but different lengths; different variants of the wings and tails, as well as nose sections, are attached to the body. In 2018, Kronshtadt showed its own concept of a 50kg guided bomb for the Orion.

Last year, the Institute of Applied Physics, in Novosibirsk, introduced a new 57mm S-5U unguided rocket. Such 57mm rockets had long since fallen into disuse in Russia; the revival of this small calibre is precisely the result of the emergence of new light platforms – tactical UAVs. The S-5U rocket has a weight of 6kg, including 800g of explosive charge, and can fire up to 4,000m.

The armament dedicated to UAVs is also being developed by Russia's largest manufacturer of aviation armaments, the Tactical Missile Corporation (KTRV). According to a statement by the head of the corporation Boris Obnosov in February 2020, these are missiles weighing 50kg and 100kg; they have never been shown to the public.



The Orion is primarily designed for reconnaissance

The Orion-E with photocameras



Kronshtadt Orion-E and General Atomics MQ-1B Predator Comparison

	Orion-E	MQ-1B Predator
First flight	2016	1994
Engine	APD-115T, 115hp (86kW)	Rotax 914F, 115hp (86kW)
Wingspan	16m (52ft 6in)	14.8m (48ft 7in)
Length	8m (26ft 3in)	8.23m (27ft)
Height	3m (9ft 10in)	2.1m (6ft 11in)
Take-off weight	1,000kg (2,205lb)	1,020kg (2,249lb)
Operational speed	65 to 108kts (120 to 200km/h)	70 to 90kts (130 to 170km/h)
Ceiling	7,500m (24,606ft)	7,620m (25,000ft)
Endurance, with standard payload	24 hours	24 hours

Military service

After entering service, the Orion will be the largest operational unmanned aircraft in Russia. Currently, the largest is the 454kg Forpost. Unmanned aircraft in Russia, first the Forpost and now the Orion, are being deployed primarily to naval aviation units; there are few Forposts in the Aerospace Forces.

There are fewer restrictions over the sea, however. The unmanned aircraft are replacing the Su-24MR Fencer-E manned reconnaissance aircraft. Their main task is to conduct reconnaissance and indicate targets to ship- and shore-launched anti-ship missiles.

The first operational military unit to which the Orion will be deployed is the 216th Independent UAV Regiment located at Severomorsk-1 air base, belonging to the Northern Fleet.

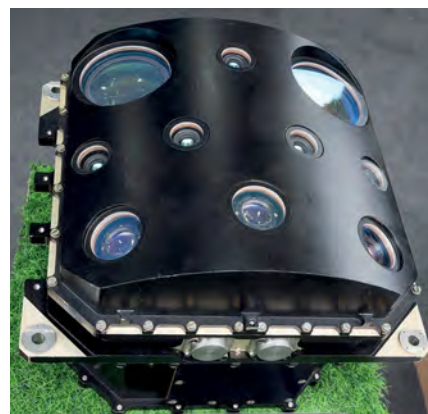
It is the first unit of its type in Russia, established as a sub-unit with 20 troops in 2013, expanded to squadron size in 2014, and then regiment size in 2017. Currently, the regiment is equipped with Forpost UAVs. The second Orion regiment will be formed at the Yelizovo base in Kamchatka, as part of the Pacific Fleet.

In August 2017, Kronshtadt signed an agreement with Rosoboronexport arms trade company about the marketing of the Orion-E (export) abroad. The Russians count on their traditional clients in Southeast Asia, the Middle East and North Africa. However, Orion-E will face strong competition from China in Africa. The Russians assure that the Orion is

better than both the Chinese CASC CH-4 and Chengdu Wing Loong I, but Chinese aircraft are in large-scale production and have already been bought by the 'traditional buyers' of Russian hardware – Algeria, Egypt, Iraq, and among the former Soviet states, Kazakhstan and Uzbekistan. Kronshtadt offers the Orion for civilian users to monitor large areas, too. For example, for early detection of forest fires in Siberia or patrolling the Northern Sea Route in the Russian Arctic. As the requirements for basing places in civilian applications are less restrictive, the civilian Orion can use longer runways and have the take-off weight increased to 1,100-1,200kg, with more equipment accordingly. **AI**



The Orion-E at MAKS air show, Russia, in 2019



ABOVE: The Orion photo suite by TsNIIAG

BELOW: A Kronshtadt missile



Plight of the long

Before COVID-19, airlines were flying further than ever, with new non-stop city pairings. We investigate the technology and reflect on the issues facing carriers operating ultra long-haul services. **Mark Broadbent** reports

Ninety years ago, the unofficial 'Blue Riband' contest for the fastest transatlantic crossing saw shipping lines compete to see who could sail between Europe and North America in the quickest time. Network carriers' ultra long-haul flights are perhaps the nearest equivalent to such boundary pushing and time-shrinking endeavour in travel today.

Marathon flights

Technological leaps have enabled aircraft to fly progressively further over time (see panel on page 95). Many of the longest trips


to capture mainstream media attention have been one-off non-stop flights, for example Qantas receiving its initial Boeing 747-400 in 1989 flying 9,188nm from London to Sydney. Manufacturers have also used long-distance flights for promotional reasons, such as an Airbus A340-200 flying Paris-Auckland in 1993 and a 777-200LR (Long Range) travelling from Hong Kong to London/Heathrow in 2005. For these longest of legs, the aircraft carried minimal numbers of passengers and payload to reduce weight and maximise range.

The new breed of highly efficient twin jets, the A350 and 787, have now made ultra long-haul a realistic commercial

proposition over recent years – so much so that eight of the current ten longest distance flights have only been introduced since 2016.

One such service is the current furthest non-stop route – the Singapore Airlines (SIA) connection from Singapore to New York/Newark (Flight SQ21), which is a distance of 8,285nm.

The airline uses seven examples of the A350-900ULR (Ultra Long Range), a specialised model of the type with increased fuel capacity, to operate this route and its SQ22 return leg. The carrier has also used its -900ULRs on other ultra long-haul rotations to North America, the



Airbus A350-900ULRs operate the world's longest flight between Singapore and New York/Newark
Image Airbus

rangers

7,621nm-long SQ35 to Los Angeles and SQ31 to San Francisco at 7,340nm.

Although SIA is the sole operator of the -900ULR, the baseline A350-900's range capability (8,100nm) means even the basic model has the 'legs' to fly a long way. Meanwhile, Philippine Airlines employs the standard jet for its 7,404nm link between New York/JFK to Manila.

Boeing's 787-9 has been used on several ultra long-haul rotations, including United Airlines' San Francisco-Singapore and Houston-Sydney flights, and the route that is perhaps the

highest-profile is Qantas' Perth-London/Heathrow round trip. Introduced in 2018, flights QF9 (outbound) and QF10 (inbound) were the first regular non-stop commercial services on the 'Kangaroo Route' between Australia and Europe. Qantas' *Project Sunrise* initiative wants to further push boundaries by launching non-stop routes from London and New York to Sydney and Melbourne.

Three of the carrier's 787-9s operated 19-hour research flights to Sydney from Heathrow and New York/JFK in 2019 to gather data on aircraft performance and passenger/crew comfort (see panel and *'Longreach' for the Skies, AIR International*,

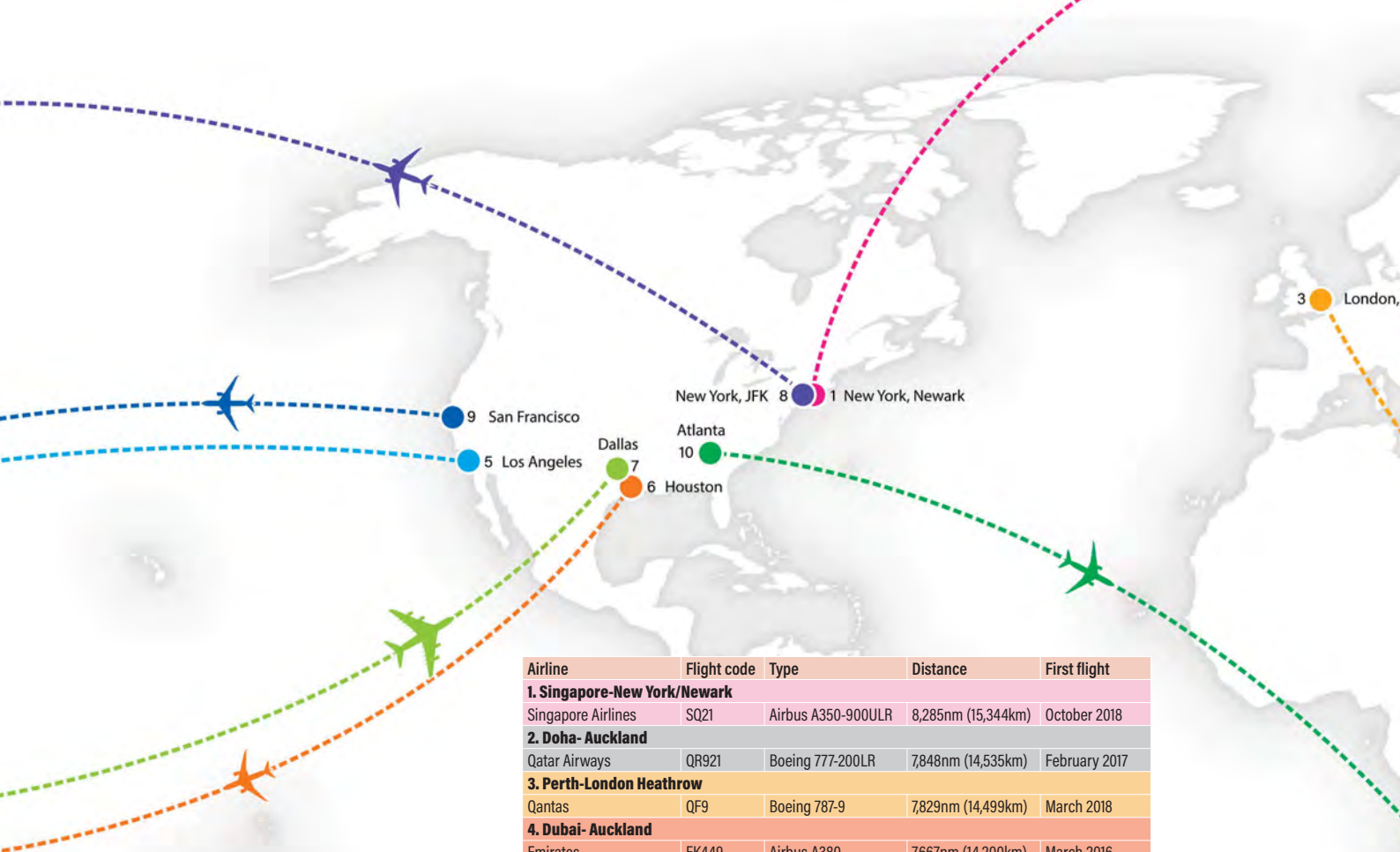
January 2020). The Australian flag carrier later signed a provisional deal with Airbus for 12 examples of an optimised A350-1000 sub-variant for these services pending the go-ahead to launch Sunrise flights.

Pause and effect

Then COVID-19 happened. The resulting travel restrictions, massively reduced demand and schedule cutbacks suspended the ultra long-haul 'non-stops' from late March 2020.

Amid its wider three-year restructuring programme, Qantas doesn't plan resuming long-haul legs until well into 2021, delaying the return of the Perth-London





ABOVE: A graphic illustration of the world's longest scheduled routes prior to the COVID-19 crisis
Key Publishing

BELOW RIGHT: Philippines Airlines use its six-strong fleet of A350-900s fly to New York from Manila Airbus

BELOW LEFT: Qantas used its contingent of 12 A380-800s to serve Dallas/Fort Worth from Sydney/Kingsford Smith Airbus

Airline	Flight code	Type	Distance	First flight
1. Singapore-New York/Newark				
Singapore Airlines	SQ21	Airbus A350-900ULR	8,285nm (15,344km)	October 2018
2. Doha- Auckland				
Qatar Airways	QR921	Boeing 777-200LR	7,848nm (14,535km)	February 2017
3. Perth-London Heathrow				
Qantas	QF9	Boeing 787-9	7,829nm (14,499km)	March 2018
4. Dubai- Auckland				
Emirates	EK449	Airbus A380	7,667nm (14,200km)	March 2016
5. Singapore- Los Angeles				
Singapore Airlines	SQ37	Airbus A350-900ULR	7,621nm (14,114km)	November 2018
6. Houston-Sydney				
United Airlines	UA101	Boeing 787-9	7,470nm (13,834km)	January 2018
7. Sydney- Dallas/Fort Worth				
Qantas	QF7	Airbus A380	7,454nm (13,804km)	September 2014
8. New York JFK-Manila				
Philippines Airlines	PR127	Airbus A350-900	7,404nm (13,712km)	October 2018
9. San Francisco-Singapore				
United Airlines	UA1/29	Boeing 787-9	7,340nm (13,593km)	June 2016
Singapore Airlines (SIA)	SQ31/33	Airbus A350-900ULR	7,340nm (13,593km)	October 2016
10. Atlanta-Johannesburg				
Delta Air Lines*	DL201	Boeing 777-200LR	7,333nm (13,581km)	June 2009

*Owing to Delta retiring the 777-200LR this route's future is uncertain.



Data in the detail

Flying nonstop to far-flung destinations means up to 19 hours' flight time. On its November 2019 Project Sunrise research flights to Sydney from London/Heathrow and New York/JFK, Qantas gathered new data about passenger and crew health and well-being in flight.

Sydney University's Charles Perkins Centre and Monash University scientists and medical experts monitored sleep patterns, food and drink consumption and physical movement of the passengers aboard (mainly Qantas employees), inflight entertainment usage and lighting to assess the impact of such a long flight. Crew melatonin levels were monitored before, during and after the legs, with pilots wearing an electroencephalogram to track brain waves and monitor alertness. The findings (part of the postponed Project Sunrise) have yet to be made public.

Qantas previously conducted research on passenger sleep strategies on its direct Perth-Heathrow service.

connection and QF8 from Sydney to Dallas/Fort Worth, another link in the top ten longest routes.

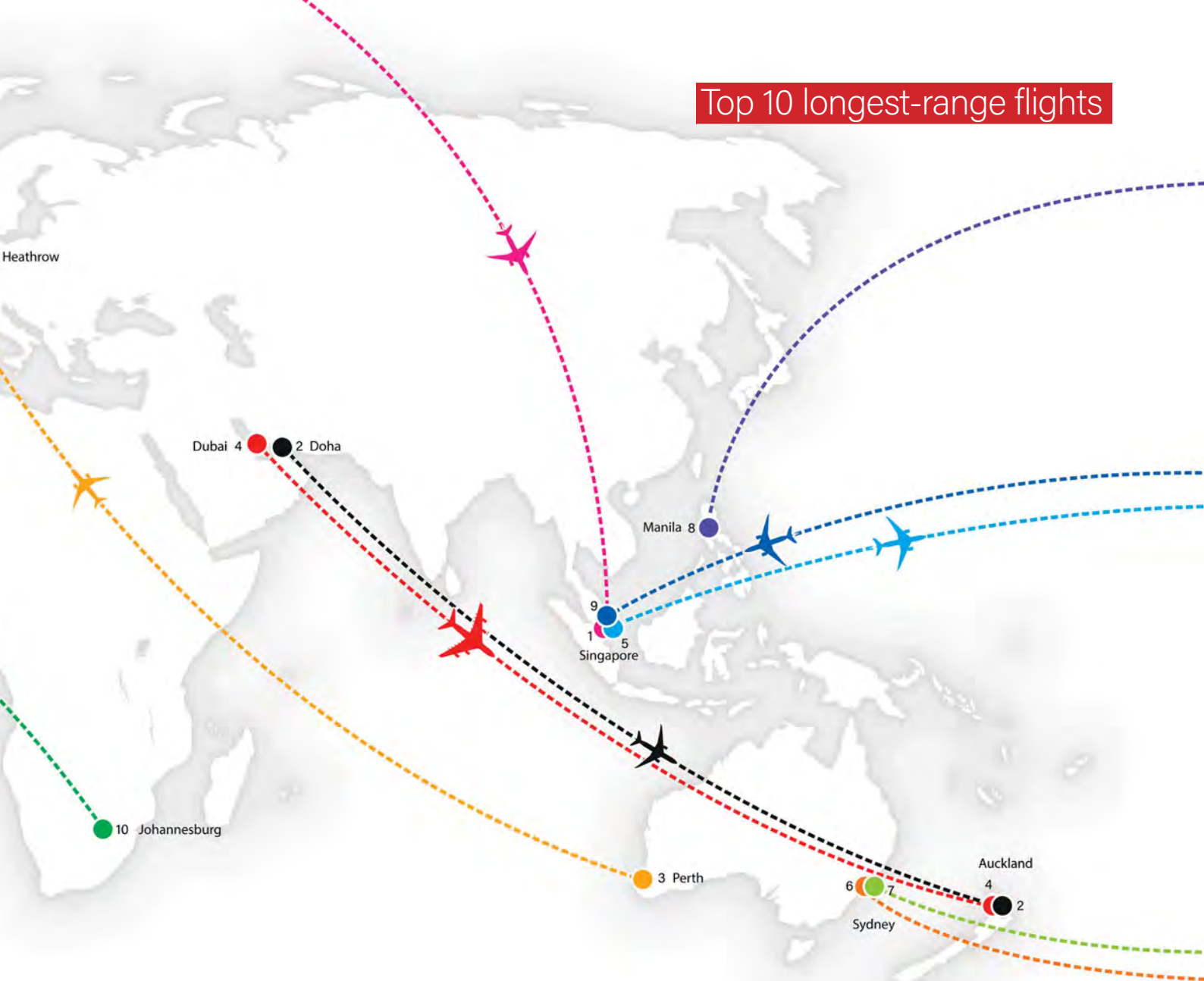
Inevitably, the carrier has also postponed Project Sunrise. Qantas CEO Alan Joyce has always insisted the business case will dictate whether those flights will launch, although in June 2020 he said: "We still have big ambitions for long-haul international flights, which will have even more potential on the other side of this [COVID-19 pandemic]."

For now, such bold plans are on ice – and not just at Qantas.

Travel restrictions mean three EI A1 787-9 flights planned for spring 2020 on a 7,417nm Tel Aviv-Melbourne route to assess its commercial and operational feasibility did not happen, although one jet ended up flying the link in April to repatriate 280 Israeli citizens stranded in Australia by COVID-19 lockdowns.

Other planned routes to be paused are American Airlines AA201, Seattle-Bangalore 7,019nm, which had been due to start on October 25 and Air New Zealand NZ1,

Top 10 longest-range flights



Routes are represented diagrammatically and may not be to an exact scale

Auckland-New York/Newark 7,656nm from October 29. Vietnam Airlines was planning a 7,098nm Ho Chi Minh City-Los Angeles service with A350-900s and Thai Airways a 6,894nm Bangkok-San Francisco service.

Commercial viability

A February 2020 Royal Aeronautical Society lecture by Linus Benjamin Bauer, addressed some of the long-distance aviation challenges. The PROLOGIS senior consultant and visiting lecturer in Air Transport Management at City, University of London, said operators flying ultra long-haul, "are exposed to a variety of risks influencing the commercial viability and profitability of such services".

Issues include security requirements, airport and route charges, and the cost of having more crew on board – for example, Qantas' Sunrise test flights used six pilots. John Strickland, director of JLS Consulting, told *AIR International*: "You're committing a [jet] for 36 hours or more in which time you can probably do two shorter long-haul round trips. You need premium yields to



justify the opportunity cost."

Yield is the revenue earned per passenger per kilometre. Higher operating costs mean ultra long-haul flights are positioned squarely at travellers prepared to pay a premium for the time and connectivity savings such routes provide.

So, aircraft serving these routes carry fewer seats than other widebodies to

maximise onboard comfort – and thereby lure the right demographics to provide sufficient yield and make operating the services worthwhile. For instance, SIA's A350-900ULRs have just 170 seats (67 business class, 94 premium economy) compared with 250-300 in the airline's other -900s.

However, with reduced demand in



every market segment due to COVID-19, there is little assurance about revenues from even the premium end of the market.

Dr Robert Mayer, senior lecturer in Air Transport Management at Cranfield University, advised *AIR International*: "Corporate travellers will likely only slowly return to regular travel patterns. This limits the demand for these services."

He added: "Many travellers will be hesitant to commit to long-haul routes as repatriation is more complex in case of further lockdowns. Pricing will be an issue and as ultra long-haul flights are premium products, this market segment might be too small to keep load factors sufficiently high in the coming years."

Strickland has a similarly cautious view about current demand for these connections: "We're likely to see a substantial melting away of premium traffic, with businesses being forced to cut back and many companies realising the ease of using online conferencing. I'm not

saying [premium traffic] will go away, but it is more challenging. It's going to take some time to come back."

Given COVID-19-related travel concerns, there is a wider question about whether people are prepared to spend as long as 19 hours – the length of the UK-Australia flights – on an aircraft. This issue could conceivably further restrict demand.

On the other hand, there is a case for direct long-haul becoming more interesting rather than switching flights. Strickland observed: "What with the challenge of social distancing and the need to space out queues going through transfer points, it does have appeal. If people can avoid processes, complexity and uncertainty regarding confidence, then that's a plus."

Will routes resume?

History shows ultra long-haul routes fall by the wayside when demand drops and costs rise.

Ultra long-haul route economics are

highly susceptible to fuel prices. Singapore Airlines initially flew 8,000nm-plus routes to New York and Los Angeles between 2004-2013, operated by the four-engined A340-500 rather than the newer (and less expensive to run) twin-jets.

Strickland recalled: "When the financial crisis hit and fuel prices went up, they [Singapore Airlines] had to scrub it because they had the double whammy of rising costs and lower revenues."

The recent expansion in ultra long-haul flying occurring at a time of lower fuel prices is no coincidence. The International Air Transport Association's Jet Fuel Price Monitor shows fuel was priced at around US\$55-75 per barrel from 2015/16 compared with US\$100/barrel in the 2010s.

Bauer's research noted the fine margins in ultra long-haul operations. It claimed Qantas' Perth-Heathrow route generated US\$68.8m revenue against US\$67.4m costs in its first six months of operation in 2018, and that the fuel costs were up to 30% greater than flights stopping in Qantas' previous transfer hub in Dubai.

Dr Mayer reflected: "There is quite a lot of risk involved and I'm not sure many airlines have an appetite for risk in the current climate. I think in the next one to three years these projects will be parked or at least scaled back."

Bauer put it simply: "Ultra long-haul flights will remain a niche."

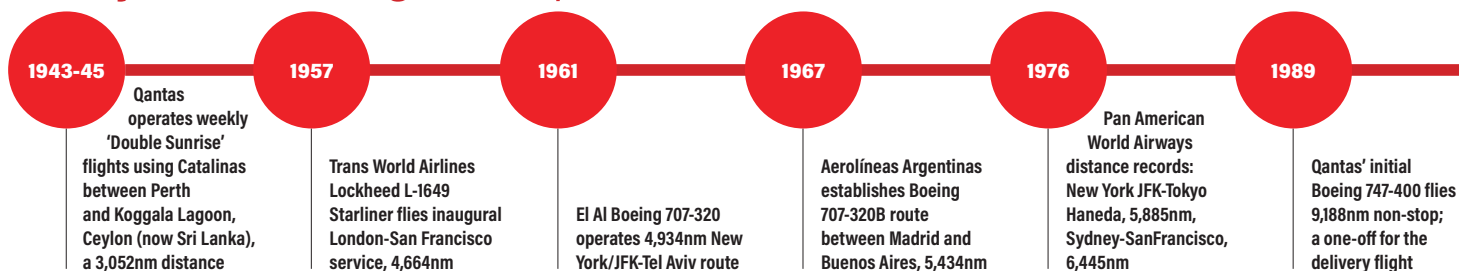


Top ten longest-range flights

There are obviously fixed straight-line ground distances between any pair of airports, but exact flight paths between origin and destination points move around.

Airlines' flight planners and pilots always choose the most efficient airways between two cities based on the changing position of jet streams (to best use tailwinds and reduce flight times). For example, airliners on the 'tracks' between Europe and North

Key dates in long-haul ops



CLOCKWISE FROM LEFT: Singapore Airlines has seven Airbus A350-900ULRs Airbus

United, which currently has 57 Boeing 787s, used the -9 variant on links to Singapore and Sydney United

Delta has retired the Boeing 777-200LRs used for very long-haul routes to destinations including Australia Boeing

Emirates – the world's largest A380 operator – used the type on its Auckland, New Zealand rotation Emirates

Premium travel demand is essential to support ultra long-haul Qatar Airways



Material differences

The Airbus A350 and Boeing 787, with their new-generation Rolls-Royce Trent XWB, Trent 1000 and General Electric GEnx engines, and advanced materials including carbon fibre, helped make ultra long-haul operations more attractive. The manufacturers say these models are 20-25% more fuel efficient than older widebodies.

The Ultra Long Range (ULR) model of the A350-900 was developed to provide a further option for airlines wanting to fly to particularly far-flung destinations. Singapore Airlines was the launch customer with its order for seven in 2018.

The Airbus Aircraft Characteristics for Airport and Maintenance Planning document shows the -900ULR has a higher maximum take-off weight, 280,000kg, compared with the standard jet's 275,000kg. It also has a modified fuel management system to create extra capacity inside the existing tanks: 165,000 litres versus the baseline 141,000 litres.

These features, slightly reshaped winglets to reduce drag, and airframe weight savings, together give the -900ULR 9,700nm range. Operators can reconfigure -900ULRs to the standard long-haul A350 specification should they require it.

Meanwhile, Boeing integrated the Dreamliner's fuel and operating cost efficiencies of the baseline 787-8 to create the 787-9, which has 280 seats and 7,635nm range. The latest 787-10 variant cannot fly quite as far (6,430nm), as it is configured, primarily as a high-capacity aircraft, however it is still capable of flying many long-haul connections.



America sometimes route over Canada and the Arctic Circle and on other days move further south. Airspace closures due to geopolitical reasons or conflict are also taken into account.

Great Circle navigation, the centuries-old practice of following the most

geometrically optimal routing between two points, is the standard measure of route length and is used for the information here.

This data also refers to regular scheduled flights only. In March 2020, an Air Tahiti Nui 787-9 completed the furthest ever nonstop scheduled passenger (and

technically domestic) service, covering 8,486nm in Great Circle distance from Faa'a International in Papeete, Tahiti to Paris/Charles de Gaulle. However, this was a one-off: it usually stops in Los Angeles for fuel, but COVID-19 restrictions meant the jet was not permitted to land in the US. **AI**



Airbus flew this A340-200, F-WWBA (c/n 004), from Paris to Auckland in 1993 Airbus



1993

Airbus A340-200 dubbed *World Ranger* operates the first ever Europe-New Zealand flight from Paris to Auckland, 10,409nm

1997

A Malaysia Airlines Boeing 777-200ER flies Seattle-Kuala Lumpur 10,823nm on delivery, securing the 'Great Circle Distance Without Landing' Guinness World Records title

2004

Singapore Airlines (SIA) starts SQ21 to New York/Newark, 8,285nm; service discontinued in 2013

2005

A Boeing 777-200LR test aircraft sets a new distance record: Hong Kong-Heathrow eastbound, at 11,664nm

2018

SIA resumes Flight SQ21 using new A350-900ULR, and Qantas introduces Perth-Heathrow 7,829nm

2019

Qantas uses 787-9s to fly non-stop from Europe and North America to Sydney in Project Sunrise flights, from Heathrow, 9,584nm, and New York JFK, 8,747nm



Next month

(*UK scheduled on sale date. Please note that overseas deliveries are likely to be after this.)

November's issue... on sale October 22* includes...

ABOVE: The main deck of an Airbus A321P2F freighter EFW

BELOW: The Royal Netherlands Air Force operates 13 Pilatus PC-7s
Sven van Roij

Black Beauty

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