



Airbus Tianjin A320 family assembly line stays stalled

Output from Airbus's Chinese narrowbody assembly line in Tianjin remains suspended amid the coronavirus outbreak as the manufacturer evaluates the situation and potential effect on other production sites.

Speaking at the Singapore air show, senior vice-president for marketing Francois Caudron said Airbus froze production in Tianjin over the Chinese New Year period when it was already scheduled to be closed, and it has not re-opened since.

"We are constantly assessing the situation," says Airbus.

Caudron emphasises that the suspension is driven by staffing rather than delivery deferrals from local airline customers.

"It's not related to the fact that we don't need to produce aircraft, it's the fact that you cannot get the workers to come. And you observe that across the industry, it's not just aviation," he says.

Beyond the single-aisle final assembly line, Airbus also has an A330 completion centre in Tianjin and relies on Chinese suppliers for its global production system across its lines in Europe and the USA. Its Chinese joint venture in Harbin supplies composite components for the A320 and A350 families.

Airbus declines to be specific on the status of Chinese supply, saying: "We are still evaluating the situation."

The production plant in Tianjin began operations in 2008 and was the first final assembly line Airbus opened outside of its European facilities in Toulouse and Hamburg. It has subsequently opened a further line in Mobile, Alabama, which is now producing A320s and A220s.



Airframer's chief executive Stefano Bortoli (left) celebrates deal with Abbott

SETTING OUT ITS STOL

ATR buoyed by PNG order for short take-off variant

With customer announcements otherwise thin on the ground on a subdued first day at the show, turboprop manufacturer ATR scored a vital launch order yesterday for the short take-off and landing (STOL) variant of the ATR 42-600.

From 2022, PNG Air of Papua New Guinea is to take three examples of the ATR 42-600S to replace part of its De Havilland Canada Dash 8-100 turboprop fleet.

Fewer than 30 of the 500 airstrips across the island nation are paved or sufficiently long to per-

By **FIRDAUS HASHIM**, CIRIUM

mit a standard ATR 42-600, short-field performance will help the carrier serve new destinations, says chief executive Paul Abbott.

He cites commonality with its existing fleet of seven ATR 72-600s and operating efficiency for the selection. "We are also looking forward to introducing passengers travelling to and from our destinations with short runways to the comfort of the modern ATR -600-series cabin."

PNG operates eight Dash 8-100s, with an aver-

age age of 33 years, according to Cirium fleets data.

ATR formally launched the STOL version in October, and has secured 20 commitments for the variant. Besides the three for PNG Air, turboprop-leasing specialist Elix Aviation has committed to take 10, and Air Tahiti to two. The customers for the remainder have not been identified.

The aircraft can operate 200nm (370km) missions with 40 passengers from 800m (2,620ft) paved runways in standard meteorological conditions, as opposed to the 1,050m lower limit for the non-STOL variant.



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AeroVironment Switchblade cut out for exports

AeroVironment hopes to clinch its first export order for the Switchblade loitering munition in 2020 following a change in attitude from the US authorities.

Gerard Robottom, senior director for unmanned air systems international business development at AeroVironment, says the first international sale of the weapon – which it is displaying at the Singapore air show – should come in the next six to nine months.

The US military has used the Switchblade for years, but the process of getting the weapon approved for international sales has been slow. AeroVironment has to abide by strict restrictions when marketing the loitering munition and prospective customers are directed to the US government if they want to learn anything more than the weapon's basic capabilities, says Robottom.

However, the US government appears to have become more receptive to selling the Switchblade to certain countries within the past 12 months.

"They had some barriers that they had to go through, and it's our understanding that US government is beyond those barriers for a small subset of their NATO customers," he says. "They are allowing the small subset to move forward."

Robottom declines name prospective NATO customers, but notes that close allies of the USA in the Asia-Pacific could be future clients.

Switchblade carries a grenade-sized warhead, is launched out of a tube and is powered by an electric motor.



Dassault's Marie-France Rozenfeld embraces the cabin's space

As Dassault pushes ahead with its Falcon 6X programme, the airframer has given a Singapore air show visitors a peek inside the long-range twin's spacious interior, bringing a cabin mock-up to the show.

Alongside the 6X – which is due to make its maiden sortie next year – the French airframer is also showing current models in its range, with the 8X and 2000LX in the static park.

As a result of cancellations that have been made on the back of the coronavirus outbreak, Dassault is one of a small number of business jet exhibitors at the show.

By GREG WALDRON

Jean Michel Jacob, president of Dassault Aviation Asia Pacific, says that although the company has pared back its presence, its regional team remains on hand to meet customers.

Jacob regards the show as the effective launch of the 6X in the region. The developmental type has attracted strong interest in Europe and North America, but has yet secure orders in Asia.

He expects ground tests to start in 2020, followed by a first flight in 2021 and deliveries commencing in 2022.

Dassault claims that the 6X offers "the tallest

and widest passenger cabin in business aviation."

The aircraft will be powered by a pair of Pratt & Whitney Canada PW812Ds. The 6X is a replacement for the 5X, a programme cancelled in late 2017 owing to problems with Safran's Silvercrest engine.

"We lost a few years but this is a better aircraft," says Jacob.

The 6X, capable of carrying 12 passengers, has an advertised range of 5,500nm (10,100km), allowing flights from Europe to the US west coast. From Singapore, the aircraft will be able to reach cities such as Auckland, Johannesburg, Ankara and St. Petersburg.

Investment flying into Singapore



Glory Wee of JTC (front) with industry representatives

Singapore's aerospace industry will see inward investment of S\$500 million (\$360 million) over the next five years as global firms strengthen their presence in the city state.

Companies including GE Aviation, Rolls-Royce and Safran Aircraft Engines have signed agreements with Singapore government agency JTC for new or expanded facilities.

JTC is the land developer that manages the Seletar Aerospace Park in northeast Singapore, among other industrial sites.

Seletar Aerospace Park will be expanded to include nine ready-built standard factories for aerospace manufacturing and MRO activity.

"These new standard factories will incorporate the industry's requirements for higher technical specifications to cater for Industry 4.0 technologies and the use of heavier and larger equipment," says JTC.

Work to further expand the park's capacity will begin this year. Current residents of Seletar Aerospace Park are also growing their existing facilities. Bombardier is in the process of quadrupling the size of its Singapore service centre, taking the site to 930sq m (10,000sq ft) – the airframer's largest in the region.

Component manufacturer RLC Group (Singapore) is also looking to lease an additional facility at the aerospace park. New entrants to Seletar include aerospace parts distributor

Proponent, as well as paints and coatings firm PPG. Both companies will open their respective facilities this year, says JTC.

Aerospace and defence supply chain provider Pattonair is looking to secure new premises at the park, while Ametek MRO is in discussion with JTC for future facility requirements.

Elsewhere, JTC also inked a series of deals with aerospace companies for new facilities.

Engine overhaul joint venture GE Aviation, Overhaul Services – a partnership between Singapore Airlines Engineering (SIAEC) and GE Aviation – will build its plant at JTC's Loyang estate in the east.

SIAEC has also identified JTC's Changi North estate as a potential site for engine maintenance services on Leap engines produced by CFM International, which is jointly owned by GE and Safran Aircraft Engines.

Lastly, SIAEC and R-R's joint venture, Singapore Aero Engine Services, is exploring expanding its operations at JTC's Loyang estate. JTC chief executive Ng Lang says: "The series of new facility openings and expansions is a vote of confidence for JTC estates and Seletar Aerospace Park. Our estates will continue to support the success of businesses, and grow the ecosystem."

Singapore's aerospace industry output surpassed S\$11 billion in 2018, and has seen a compound annual growth rate of 10% since 2015.

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Lufthansa Technik



Cutaway gets under skin of A220

FlightGlobal presented a framed edition of its latest cutaway drawing, the Airbus A220 series, to the Toulouse-based airframer's engineering chief during the show. The detailed drawing of the Pratt & Whitney PW1500G-powered twinjet, which was published in *Flight International* this month, was presented to Jean-Brice Dumont (left), Airbus executive vice-president for engineering, by Martin Weber, chief executive of DVV Media, the parent of FlightGlobal.

ST unit excels at nacelles

ST Engineering's aerospace unit has signed a five-year nacelle maintenance deal with Qantas covering the carrier's 75 Boeing 737-800s and 28 Airbus A330s.

Separately, ST Engineering announced that its Middle River Aerostructure Systems facility in the USA will, from this year, have nacelle component maintenance service capabilities.

"Through such new capability set-up, customers will get to enjoy integrated solutions in both manufacturing and aftermarket care across a range of nacelle systems under one roof," the company says.

Skeldar rides wave of V-200 naval potential

UMS Skeldar is in discussions with Asia-Pacific navies to sell its V-200 vertical take-off and landing (VTOL) unmanned air vehicle – but the market is still developing, and integrating such a system onto a warship remains complicated.

David Willems, vice-president of business development, says that navies see the value of an integrated UAV capability, as it can greatly extend a warship's situational awareness.

But finding the room on a warship to accommodate a UAV remains a challenge, in terms of both its operation and storage. Aside from the aircraft itself – which may have to compete for space with a manned helicopter – spares and

the UAV's ground control station must also be housed, as well as antennas, which can create electromagnetic interference. Finally, a significant amount of cabling needs to be installed.

For a system like Skeldar, a ship would require three airframes to ensure persistent surveillance, as well as six to eight operatives.

However, VTOL UAVs offer significant advantages over fixed-wing assets, because launch catapults and recovery systems are not required.

Willems spoke with *Flight Daily News* at Saab's Singapore air show stand. UMS Skeldar is a joint venture between Sweden's Saab and UMS of Switzerland.



David Willems is discussing sales to Asia-Pacific navies

MAVERIC IS OUT ON A WING

By GARRETT REIM

Airbus is studying blended-wing airliner designs as a means to cut CO₂ emissions by more than 20%, and has already test flown a sub-scale model as part of its research efforts.

An initial sortie of that test article took place in central France in June 2019, with Airbus using the effort to improve its knowledge of the advanced fly-by-wire technology that is required to control such aircraft.

Airbus will continue the flight-test campaign with the remote-controlled model until mid-2020. The sub-scale test article is 2m (6.6ft) long and 3.2m wide, with a surface area of about 2.25sq m (24sq ft).

Airbus calls the development programme Model Aircraft for Validation and Experimentation of Robust Innovative Controls – or MAVERIC for short.

Blended-wing technology is of interest to the airframer because it is more efficient than standard tube-and-wing designs. The company is increasingly convinced that flying-wings are feasible because of the improvements in fly-by-wire and lightweight structural technology.

"We do believe it's time now to push this technology further, to study what it can bring to us," says Jean-Brice Dumont, executive vice-president of engineering at Airbus. "It is achievable. It's a challenge, obviously... but I think we are up to it."

By 2050, Airbus aims to reduce CO₂ emissions from its products by 50% against 2005 levels – and thinks a blended-wing aircraft, combined with other technologies, might be one of the best paths to reaching that goal.

The model development started in 2017, and was initiated because Airbus believed it did not have enough first-hand knowledge of flight controls for such designs.

"Our models for flying-wings are rather inaccurate," says Dumont. "We have already learned a lot because it helped us understand the flight behaviours, which is the core of what we need to study."



Airbus has been testing model of flying-wing design

Airbus believes flying physical models and demonstration aircraft will increasingly be part of its research and development efforts. "We more and more believe in demonstrators to accelerate technology development," says Dumont.

The airframer also says it is leaning on fly-by-wire know-how, developed for combat aircraft, to control the intrinsically unstable flying-wing design.

MAVERIC has two ducted fans mounted within its twin vertical stabilisers, a stand-in for turbofans – but Airbus says it is considering other propulsion systems. The company believes it could eventually merge distributed hybrid propulsion technology being developed on its EcoPulse demonstrator with its MAVERIC research.

"We are always mixing the propulsion system and the aerodynamic formula," says Dumont. "What's the best fit for a blended-wing body?"

Airbus declines to say what class of commercial airliner would most likely be replaced by a flying-wing, or what the seat count could potentially be.

"It's more likely to be the successor of smaller aircraft than a very big one," says Dumont. "For the equivalent seat count of [a tube-and-wing] aircraft the footprint of such [flying wing] aircraft is much smaller."

In addition to continuing with flight tests through the early part of 2020, Airbus is planning to further study safety, manufacturing, maintenance and airport integration issues related to operating flying-wing airliners.



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UPCYCLING A320S

By MAX KINGSLEY-JONES

European flight simulation specialist Euramec will take delivery of its first recycled Airbus A320 cockpit imminently which it will re-engineer into a flight-training device (FTD).

Bert Buyle, chief executive of the Belgian company, says Euramec has signed an exclusive agreement with Ostend-based recycling specialist AeroCircular to take entire A320 cockpits from retired aircraft. "We have an agreement to take the complete cockpits with everything inside," he says.

The first cockpit – one of an initial batch of three it is taking from AeroCircular – will be delivered to Euramec imminently. "We will then replace the original display units with devices made by us. We also re-

wire the panels to interface with our systems."

The agreement will be extended to other narrow-body types like the Boeing 737 when aircraft become available. Euramec will sell the "upcycled" cockpits from €380,000 (\$414,000), depending whether they are certificated to FTD 1 or FTD 2 level, which determines what type of training they can be used for.

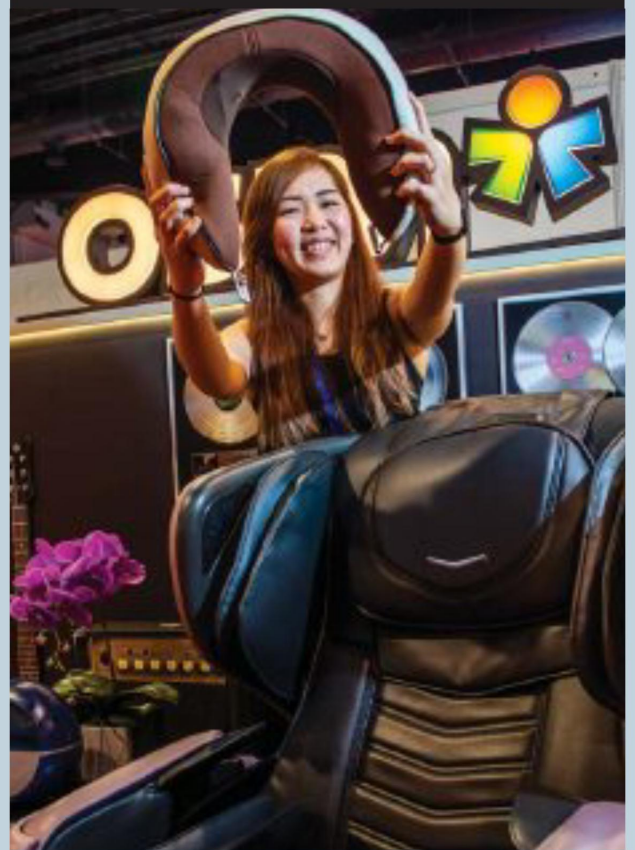
Buyle says Euramec aims to sell up to five devices a year. "We are currently negotiating with our first customers – targets include flight schools and airlines."

In parallel, Euramec is developing its "Flyright" concept where it packages the devices with its training processes to instruct pilots, engineers, air traffic controllers and cabin crew. It is working on a proof of concept using its existing 737 fixed-based trainer and will offer the packages as franchises globally.

RELAX... IT'S OSIM

Make yourself comfortable. The company that supplies massage chairs to Singapore's Changi airport is showing off its range of relaxation products at the show. Singapore-based Osim's customers include the local offices of Facebook and Google, which provide the chairs to enhance employee wellbeing. The 40-year-old company's range includes hand-held massagers and air humidifiers, and it sells directly to retail customers as well as to corporate clients.

Pictured is corporate business executive Veronica Lim.



Neo Aeronautics gets its urban mover off to great start-up

Neo Aeronautics is a Singapore start-up founded by four engineering graduates of Glasgow University in Scotland, who are exhibiting the Crimson S8-SR "personal aerial vehicle" in the What's Next innovation zone.

The platform is making its debut at the show, and the team, who came together in August 2018, plans to flight test it in Utah this year. Neo Aeronautics hopes to pitch the aircraft to an emerging urban mobility market in Californian cities such as Los Angeles, San Francisco and Palo Alto. The Crimson S8 is equipped with an autopilot and light detection and ranging sensors to detect obstacles, but would not be fully autonomous.

Fluid and structural analyst Samuel Gan is shown with the product.





HYDRAULICS IS ALL-GROUNDER

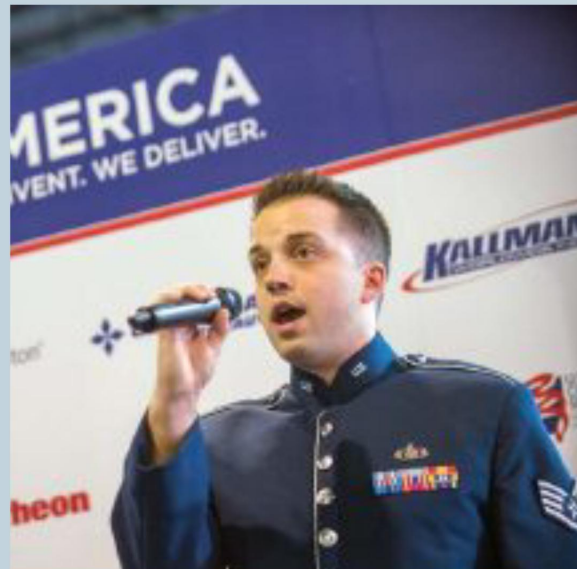
By MURDO MORRISON

From ammunition loaders to wash carts, Hydraulics International prides itself on supplying operators of military aircraft with “everything they need on the ground”, says sales manager Reza Grami. “We don’t do stuff that flies, but if an aircraft needs support on the ground, we do it.”

As well as being a supplier to the US armed forces,

the 40-year-old Chatsworth, California company has a strong presence in the region, with the militaries of Australia, Indonesia, the Philippines, Singapore, South Korea, and Vietnam among its customers.

Its products include the multi-action ground power unit or MAGPU for helicopters, which combines seven units in one. All its lines come as an electric- or diesel-powered version, says Grami. Some are platform-specific, others universal.



American exhibitors on song

Following a rousing rendition of Star-Spangled banner by Staff Sgt Derek Wilson, the USA Partnership Pavilion, the largest single country representation, was opened yesterday by Tom Kallman, president and chief executive of pavilion organiser Kallman Worldwide.

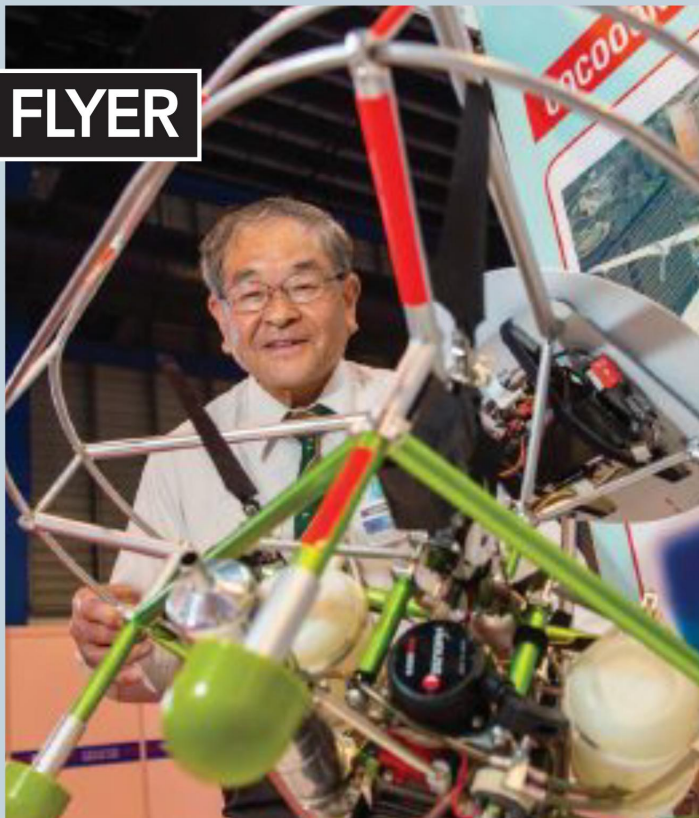
Rafik Mansour, charge d'affaires at the US Embassy in Singapore, said the presence of 87 US firms was a “strong indication of how important the Indo-Pacific region is to our government and our industry”.

FOREST FLYER

This gasoline-driven, four-propeller drone from specialist Japanese technology organisation Industry Network is able to see the wood from the trees. The 5.9kg (13lb) device is used by a research centre of a Tokyo University to fly through forests equipped with a 3kg sensor that can assess the health of individual trees, and help with forest maintenance.

Industry Network’s other products include robots for mowing the grass verges of highways and a climbing robot used to inspect large structures such as bridges.

Pictured with the forest drone is engineering adviser Katsuhiko Chino.



NIGHT EYES

Point Trading, a specialist manufacturer of night-vision equipment, is highlighting its technology on the Australian stand. The supplier of more than 30,000 kits to infantry units of the Australian and New Zealand armed forces now wants to increase its presence in aviation, and the lucrative US market, says business development manager Paul Prince. The company’s other customers include the Australian fire authorities, who use its products to fight blazes during the hours of darkness, and the offshore helicopter sector.



Singapore defence minister Dr Ng Eng Hen (left) and Khaw Boon Wan, co-ordinating minister for infrastructure and minister for transport, prepare to cut the ribbon yesterday to officially open the Singapore Airshow.

L3HARRIS SCORES CHINESE SIM SALE

L3Harris Technologies has committed to supply two full-flight simulators to Chinese flight-training provider Guangdong Meihua Aviation Technology.

The simulators comprise one Airbus A320 and one Boeing 737NG, with Meihua holding options to buy further 737NG and 737 Max full flight simulators by year-end.

L3Harris states that the simulators are equipped with a fully-electric motion system, which reduces maintenance costs and power consumption, while improving reliability.

The simulators will be sited at Meihua's new training facility in Guangzhou, which L3Harris notes will support demand for new pilots in the region.

BLACKSHAPE RISES

By DOMINIC PERRY

Italy's Blackshape may be small but it is already making waves with its Gabriel and ISP light aircraft, which are making their Singapore air show debuts on the static display.

Gabriel – designated the BK-160 – is a two-seat trainer with a maximum take-off weight (MTOW) of 850kg (1,870lb), designed for the “stick and rudder” elements of instruction, says Blackshape founder and chief executive Luciano Belviso.

Gabriel was designed to fill a gap in the market created by a lack of purpose-built training aircraft: “The majority of aircraft were not designed as trainers – they became trainers because of availability,” he says. “The Gabriel is the first plane designed for training for several decades.”

Powered by a single 160hp (120kW) Lycoming piston engine,

the Gabriel is equipped with data-recording systems which turn the aircraft into “something like a flying laboratory”, says Belviso, and allow better analysis of a trainee's performance.

European certification was obtained in 2017, and an MTOW increase was approved in 2019. Service entry also came last year, says Belviso, with both undisclosed civil and military customers.

The BK-100 ISP – or Intelligence and Surveillance Platform – is a lighter aircraft with a 600kg MTOW, powered by a 100-115hp Rotax engine. It can carry a variety of electro-optical sensor payloads.

Both types are made of carbonfibre and feature glass cockpits and retractable landing gear.

Founded in 2010, Blackshape is based in Grottaglie in southern Italy and is owned by conglomerate Angel Group. It is sharing a stand at Singapore with its local distributor Asia Security Technology (AST).



AST's Shalom and Carole Shaphyr, with Blackshape CEO Luciano Belviso (centre)

Farnborough airline event will be Summit special

The Farnborough International Air Show and FlightGlobal are teaming up for the 2020 edition of the biennial event to host the Airlines Leaders Summit, which will take place on the morning of 20 July, the opening day of the show.

This exclusive, invitation-only event will feature a panel of airline and industry leaders debating issues such as sustainability, diversity, the OEM outlook and the disruptive forces that are already battering airlines this year.

“The Summit is an important demonstration of how Farnborough is adding value to the show experience for senior leaders,” says Joe Muir, aerospace sales director for Farnborough International.

The Summit will build on the success of the first forum, held at the

2018 show, which saw figures such as Calin Rovinescu, CEO of Air Canada and Air Lease Corporation founder Steve Udvar-Hazy taking part. The 2020 line-up of leaders will be announced shortly.

Moderated by FlightGlobal's executive director content Max Kingsley-Jones, the Summit is also supported by Farnborough International News Network.

The Summit is just one of the special events Farnborough is promoting this year. It is seeking to give greater emphasis to the final day of the show with “Farnborough Friday”, says Muir.

“Farnborough Friday is being developed to enable global industry to engage with the next generation of innovators and pioneers,” he says.



Joe Muir (right) with Mark Pilling, FlightGlobal vice-president publishing and events

SIAEC KEEPS PROFITS ON ASCENT

Singapore's SIA Engineering (SIAEC) posted a steady operating profit for the three months ended 31 December, with marginal declines on both costs and revenues.

Revenue was down by 1.5% to S\$252.1 million (\$181.5 million), largely as a result of a decrease in airframe and line maintenance revenue. Expenditure meanwhile declined 1.7% to S\$236 million, with a key reason being a fall in material costs.

As a result, operating profit inched up by 1.3% to S\$16.1 million.

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MAXIMUM THIRST

By MURDO MORRISON

May launch happy feelings at supersonic speeds." That's the promise from Brewerkz, which is behind Afterburner, the specially brewed, official exclusive beer of the Singapore Airshow. The 23-year-old Singapore brewery is at the

show for the second time, offering food and beverages from its stall by the static display, and bulk deliveries of the aerospace-themed Pacific pale ale to exhibitors. Brewerkz marketing manager Jowynne Leong says the recipe for Afterburner was agreed using feedback from a 15-strong focus group of exhibitors. Stand manager Ken Wong is pictured with two of the cans.

GMF brings Melbourne site on line

GMF AeroAsia has conducted its first overseas line maintenance work, at its newly-established location in Melbourne, reports Cirium.

The company says the work was carried out on an Airbus A330-300 operated by parent Garuda Indonesia. The jet was used on 1 February to fly a service from Jakarta to Melbourne via Denpasar.

Having secured permission to undertake work on A330s in Australia, GMF foresees boosting its range of capabilities there to include A320s,

A330neos, and Boeing 737-800s and 777s. Subsequently, GMF intends to establish locations in Sydney and Perth.

GMF's expansion into Australia builds on its January 2018 strategic partnership with local services company Korr Group to jointly provide line maintenance at Melbourne, Perth and Sydney airports.

Korr already provides MRO services to Air New Zealand, Qantas Group and Virgin Australia.

WIZZ GETS BUSY WITH AVIATAR

Central European budget carrier Wizz Air has implemented a digital planning tool from Lufthansa Technik to improve its line maintenance operations. The tool is used to plan maintenance activities for each aircraft at multiple line stations across the airline's network. Unlike previous systems, it automatically takes into account, in real time, changes in the airline's flight schedule and aircraft maintenance requirements.

"Scheduling maintenance events is a complex task. Adapting maintenance plans instantaneously in daily operations is more complex, when short-term changes in flight operations occur," says Valerie Hermann, part of the team at Lufthansa Technik that developed the system.

Lufthansa Technik asserts the new tool – an application on the MRO provider's Aviator digital




Tool helps schedule maintenance activities

services platform – will improve productivity, increase aircraft availability and reduce manual planning. The system automatically highlights schedule conflicts and enables planners to manually intervene and focus on issues where [their] know-how is required, the company says.

Wizz Air maintenance planning manager Ljubomir Jesic says: "The tool helps us to reduce our human workload. It is very important to establish efficient processes that can be scaled easily."

The budget carrier has been an Aviator user since Lufthansa Technik launched the platform in 2017, and is the first customer for the line maintenance planning tool.



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Pattonair gives agility to UMW parts provision

UK company Pattonair has deployed its Zero-Lead-Time agile vending solution with Malaysian engine component manufacturer UMW Aerospace.

The Malaysian firm builds fan cases for the Rolls-Royce Trent 1000 engine, and Pattonair and UMW Aerospace are currently working under a five-year agreement for supply chain services that was signed in 2016.

"The introduction of agile vending is part of a key service development focussing on innovation and technology for site-based inventory," Pattonair states. "The UMW system is connected via an intelligent inventory management system, and this provides real time inventory allocation and replenishment."

UMW Aerospace's president of maintenance and engineering division Abdul Rashid Musa says the solution will allow the assembly line to access the materials it requires faster and with greater accuracy.

"It also provides clear traceability to control the usage of each part number," he adds. "With the vending machine linked to the supplier's portal, the replenishment of the parts will happen before any stock run out."

PACIFIC MOTION

By GARRETT REIM

Caught between a growing US government fiscal deficit and an increasing military threat from China, the US Pacific Air Forces command is looking for inexpensive ways to pre-position war materiel on islands across the Pacific Ocean.

In particular, US Air Force General Charles Brown, commander of the Pacific Air Forces, says he would like to pre-position more fuel, ammunition and maintenance equipment across air bases in the region. The supplies would facilitate the service's agile combat strategy – a plan that aims to move fighters quickly around the battlefield, in part by re-arming and refuelling combat aircraft at austere air bases.

Pre-positioning large amounts of materiel – as was done in Europe during the Cold War – is expensive, however. As the USAF is working in the next five years to move \$30 billion away from maintaining old aircraft and weapons in order to reinvest those funds into developing new technologies, Brown says it is important the service find cheaper ways of forward deploying supplies.

"It doesn't necessarily have to be big packages, but small packages that we can put in different

locations, to speed up our ability to respond to any type of crisis," he says.

To allow the USAF's fighter squadrons to survive off smaller caches of materiel, the service needs to use data to "forecast better so we're not bringing everything just in case", says Brown.

The USAF also needs to find ways to incorporate pre-positioned materiel into regular operations, not just hold the supplies for war emergencies, he says.

For example, Pacific Air Forces has recently placed additional maintenance equipment at Hickam AFB in Hawaii, so that when complex fighter aircraft – such as the Lockheed Martin F-22 based in the mainland USA or Kadena AFB in Okinawa, Japan – break down while transiting through the island, they do not become stranded for weeks.

Brown says he is also looking to pre-position equipment around the region to better respond to humanitarian-assistance and disaster-relief missions – work which is good practice for agile combat operations.

"If you look at this region it's full of typhoons, volcanoes, earthquakes, and we respond to a lot of those," he says. "That to me is a way to start the process."



Pre-positioning F-22 equipment supports availability

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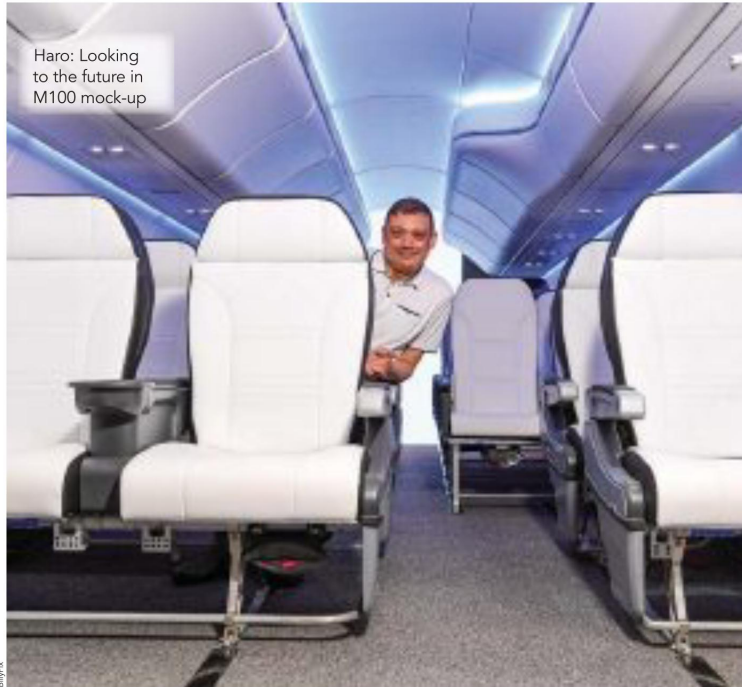


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MITSUBISHI MULLS M200



Haro: Looking to the future in M100 mock-up

By JON HEMMERDINGER

Mitsubishi Aircraft arrives at Singapore unfazed by fresh delays to the development of the SpaceJet, with an M100 cabin mock-up taking centre stage at its stand and interest in developing a larger aircraft called the M200.

The M200 would carry about 100 passengers and arrive approximately two years after first delivery of the 65-88-seat M100, now scheduled for 2024. Meanwhile, Mitsubishi Aircraft continues working toward certification of the 90-seat M90.

The M100 mock-up includes first-class seats in a two-by-one configuration and two-by-two economy seats in various pitches. The SpaceJet's circular fuselage – which differs from the “double-bubble” structure of competitor Embraer's E-Jet – allows for a wider cabin at shoulder level, says Mitsubishi Aircraft head of global marketing and strategy Steve Haro. SpaceJet's economy seats are 47cm (18.5in) wide, offering more space than competing products, he adds.

Designed jointly by Safran and parent company Mitsubishi Heavy Industries (MHI), the cabin has sufficient overhead bin space to accommodate roller-bags for every passenger, says Haro.

Mitsubishi Aircraft launched the M100 at the 2019 Paris air show, pitching it as a clean-sheet competitor to Embraer's E175. Both models meet take-off weight limits for 76-seat aircraft as stipulated by major US airlines' pilot contracts.

In launching the M100, Mitsubishi Aircraft

cancelled the 69-seat MRJ70, which was shorter. To keep the M100 under US airlines' 39,000kg (86,000lb) maximum take-off weight cap, it added lightweight aluminium-lithium fuselage skins to the M100 and carbonfibre tail components, redesigned the engine pylons and gave the M100 vertical wing-tips – rather than the MRJ70's outward-canted tips. Vertical tips sacrifice some efficiency but require less structural support in the wing, meaning weight savings, says Haro.

The M100 also has a smaller cargo compartment (in the aft cabin), but overhead bin capacity compensates for lost hold space, Haro says.

Mitsubishi Aircraft anticipates M100 deliveries will start in 2024, followed by deliveries of the M200 two years later. The M100 will have a range of about 1,250nm (2,320km), says Haro. The manufacturer continues working towards an authority to offer the M100, he adds.

At that milestone, airframers begin negotiating firm sales arrangements. “To get to that point you have to have a lot more analyses – to show how this aircraft can drive efficiency in network,” Haro says.

On a 500nm flight, the Pratt & Whitney PW1200G-powered M100s will have a double-digit cost advantage over competing aircraft such as the E175, he adds. But Mitsubishi Aircraft must still get the first SpaceJet variant – the 90-seat M90 – certified and delivered. Shortly before the show, MHI announced a fresh delay, with M90 deliveries now expected between April 2021 and March 2022, or later.

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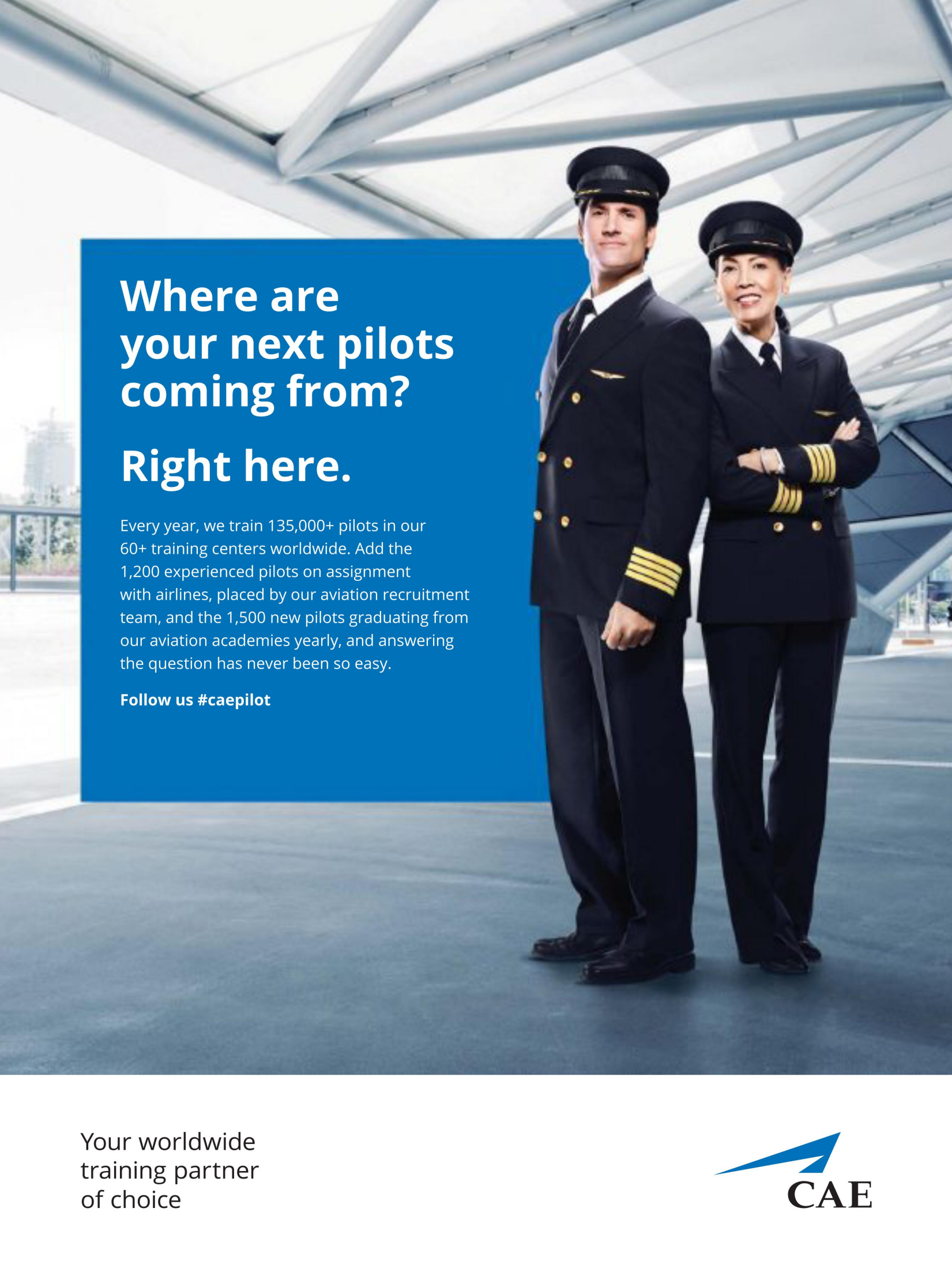
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MAINTENANCE LINE GETS INTO GEAR FOR P&W

A year after it began operations, Pratt & Whitney's PW1000G-series overhaul line in Singapore is looking to ramp up its throughput. Eagle Services Asia (ESA), a joint venture between P&W and Singapore Airlines' engineering arm, has recently had a \$85 million refurbishment, which saw the addition of PW1000G-series engines into its range of capabilities – also including the PW4000 family and the Engine Alliance GP7200.

The facility inducted its first geared turbofan (GTF) engine in January 2019.

"Following the induction of the first PW1100G variant overhaul... ESA is on track to more than double the number of GTF engines processed this year following its modernisation," the engine maker states.

P&W adds that more than 60% of the global PW1000G-series engines are in the Asia-Pacific. "It is therefore a strategic business investment for ESA to support the aftermarket needs of our customers for next generation engines and mature models alike," says Brendon McWilliam, P&W's executive director for aftermarket operations in the region.

The Singapore facility is one of the three PW1000G-series engine MRO centres in the Asia-Pacific. Globally, its network spans three continents: Asia, Europe and North America.

Meanwhile, Taiwanese low-cost carrier Tigerair Taiwan has selected PW1100G engines to power the 15 new Airbus A320neos it has on order. The narrowbodies are a combination of new orders from Airbus and leased aircraft. P&W says it will provide Tigerair Taiwan with maintenance through its EngineWise Comprehensive service agreement. The deal follows parent company China Airlines' selection of GTF engines for its order of up to 30 A321neos.

Cirium fleets data indicates Tigerair Taiwan currently operates a fleet of 11 A320ceos.



Boeing and the RAAF are working together to develop Airpower Teaming System

STAYING LOYAL

By GARRETT REIM

Boeing Australia has completed the major fuselage structure for the first Airpower Teaming System unmanned air vehicle (UAV), ahead of a first flight later this year.

A total of three prototypes are planned, in partnership with the Royal Australian Air Force (RAAF), as a part of their joint Loyal Wingman Advanced Development programme.

"This is an exciting milestone for the development programme, and the Australian aerospace industry, as we progress with production of the first military aircraft to be developed in Australia in more than 50 years," says Shane

Arnott, programme director of the Boeing Airpower Teaming System.

The 11.7m (38ft)-long aircraft was designed using advanced digital engineering tools and built with composite materials, says Boeing. That approach has helped keep the aircraft on budget, the company says.

The Airpower Teaming System is designed to fly itself using artificial intelligence, offering "fighter-like performance" and a 2,000nm (3,700km) range. It could be teamed with manned combat aircraft, such as the RAAF's Boeing F/A-18F Super Hornets.

Boeing is working on upgrades to the F/A-18E/F Super Hornet, as well as the derivative EA-18G Growler, to enable those aircraft to control and fight alongside loyal wingman UAVs.

As part of its partnership with Canberra, Boeing has contracted work on the Airpower Teaming System to 16 Australian firms.

BAE Systems Australia is providing flight control computers and navigation equipment; RUAG Australia is supplying the landing gear; Ferra Engineering is handling machined components and sub-assemblies; and AME Systems is providing wiring looms.

Other loyal wingman UAVs, such as the Kratos Defense XQ-58A Valkyrie, have been developed initially for the US Department of Defense, with international customers as a secondary consideration. However, Boeing says it is developing the Airpower Teaming System for the global market.

Elbit makes MUSIC with Asia-Pacific militaries

Elbit Systems has landed \$136 million-worth of contracts for direct infrared countermeasures (DIRCM) systems on Airbus and Boeing aircraft in use by militaries in the Asia-Pacific.

The contracts will be implemented over a four-year period, the company says.

Elbit's DIRCM system is designed to defend large aircraft against threats such as infrared guided missiles.

"Under the contracts, Elbit Systems will equip fleets of Airbus and Boeing aircraft with DIRCM systems from the MUSIC family, including the company's infrared missile warning systems," says the Israeli firm.

It adds that it recently won work to install DIRCM systems aboard Airbus A400Ms operated by Germany, and NATO's A330 Multi-Role Tanker Transports (MRTTs).

"I believe that the recent string of contract awards, by a range of customers, to provide our mature DIRCM systems is a strong testament to the leading position we hold in this area," says Elbit executive vice-president Elad Aharonson.

The company did not specify the buyers, but Singapore and South Korea are both new operators of the A330 MRTT. Both countries make extensive use of Israeli equipment.



System defends aircraft against guided missiles

SHORE TO SHIP UAV DELIVERS ON TIME

ST Engineering and maritime logistics provider Wilhelmshen Ships Service are teaming up to develop and trial shore-to-ship parcel deliveries in Singapore, using unmanned air vehicles on beyond visual line of sight (BVLOS) missions.

Flight testing and technology development services for system integration and prototyping will be provided by ST Engineering.

"Key enabling technologies to be developed include precision landing on-board a ship vessel's metallic platform, non line-of-sight datalink and parcel delivery authentication and release system," the company states.

Meanwhile, Wilhelmshen will support the commercialisation and operational aspects of the system.

The collaboration will receive funding from the Civil Aviation Authority of Singapore and Singapore's transport ministry. ST Engineering's DroNet system was granted the city state's first BVLOS operating permit.

Lim Serh Ghee, ST Engineering's aerospace unit president, says: "Our latest collaboration with [Wilhelmshen] is an exciting development for us as we explore the various use cases for our DroNet solution to solve real-world problems and help organisations enhance their operational efficiency."

Wilhelmshen has previously collaborated with Airbus's Skyways unit, in March 2019 trialling a shore-to-ship drone delivery service.

FLIGHT DAILYNEWS

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HOW TO CONTACT US:

We are located at stand P103

Editor Murdoch Morrison

News editor Dominic Perry

dominic.perry@flightglobal.com

Executive director content

Max Kingsley-Jones

Online content manager

Amber Elias

Content team

Alfred Chua, Jon Hemmerdinger

Garrett Reim, Greg Waldron

Production Clare Goldie

Copy editor Tim Norman

Designer Tim Noonan

Picture editor Ian Billingshurst

Photography

Tom Gordon, Jim Robbins

Distribution

Laura Gardner, Dawn Hartwell

Publisher

Stuart Burgess

Technical support

Mike Blakeman

Printers

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FAMILY AFFAIR



Just 18 months after Toulouse acquired the twinjet from Bombardier, production of the A220 is ramping up steadily – even if rumours of a larger variant appear to be premature

By DAVID KAMINSKI-MORROW
CUTAWAY by TIM HALL

When Air France-KLM chief Ben Smith showed off the group's fleet development plan in early November last year, one of his slides mischievously referred to the "A220-500", a hypothetical stretch of the Airbus A220 beyond its two-member family.

"If Airbus builds a series -500, a larger model, a -400, whatever it calls it," said Smith, "we'd be very interested."

Given that Air France was finalising one of the largest orders for the A220 since Airbus took over the former CSeries programme from Bombardier in mid-2018, Smith's remarks stirred murmurs as to whether the airline – the flag-carrier of Airbus's home nation – was privy to undisclosed aspects of future A220 development.

Bombardier sparked conjecture more than 10 years ago that it would further develop the then-CS100 and CS300 by trademarking a "CS500" designation – purely a protective measure, claimed

the airframer at the time, and the trademark lapsed in 2014.

The French have an expression – "minute, papillon" – which loosely translates as "hold your horses", and this appears to sum up A220 programme chief Florent Massou's view on ambitions to stretch the aircraft into the hallowed 150-seat realm dominated for more than three decades by the A320 and Boeing 737.

"It's good that customers are showing interest in the capability of the platform," says Massou. "But concentrating on the A220-100 and -300 is what we're doing day to day. There is no plan today for a stretch."

If Air France's reference to the A220-500 is premature, the airline's order for up to 120 A220-300s has nevertheless cemented the aircraft as a serious contender in the cut-throat single-aisle sector – justifying Bombardier's faith, maintained for 20 years, that demand existed for an all-new twinjet, optimised for the 100- to 130-seat category.

Airbus has spent its first 18 months of programme ownership examining the A220 airframe to extract near-term improvements and enhance the aircraft's appeal.

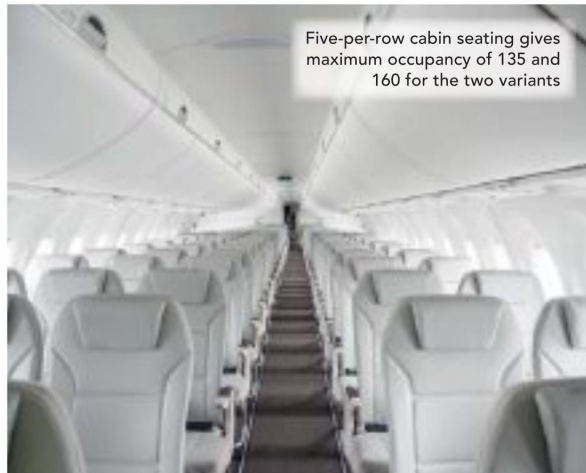
CERTIFICATION

Within six months of the programme acquisition, the European Union Aviation Safety Agency (EASA) certificated the A220 to Category IIIa and IIIb low-visibility autoland capability, enabling it to carry out approaches in more restrictive weather conditions – including zero decision height – compared with the type's previous Category II approval. The A220 also has required navigation performance, approval required capability for area navigation.

Airbus is planning to certificate the A220-300 in the second half of this year with a higher maximum take-off weight (MTOW), lifting it by 2.27t to a figure of nearly 69.9t. This will provide a 450nm (833km) hike in range to 3,350nm. Airbus will also apply the same weight

Once a competitor for the A320neo range, the A220 is now operated alongside other Airbus narrowbodies

Five-per-row cabin seating gives maximum occupancy of 135 and 160 for the two variants



increase to the -100 variant – giving it a 3,400nm range – from the second half of 2021. The change will increase the -100's MTOW to just over 63t.

"Only minor software and hardware change is anticipated," says Airbus, adding that it will achieve the range improvement by taking advantage of existing structural and systems margins as well as current fuel capacity.

Certification is being proposed on "analysis and usage of existing flight-test data", it states.

Minor software and hardware retrofit, as well as paper changes, will enable the new weight capabilities to be introduced to A220s already in service.

Delta Air Lines – which has ordered 95 A220s, split between the -100 and -300 – has already emerged as a customer for the higher MTOW version and will take the enhancement for its entire fleet.

Airbus is also planning additional performance improvements through weight tweaks to the jet. It is to increase, by just over 1.8t, both the maximum zero-fuel weight and maximum landing weight, in order to offer additional payload capability.

Massou says this will be offered as an option to airlines to provide "operational flexibility" and will be available for both variants in 2022, subject to regulatory approval.

The current maximum zero-fuel weights for the -300 and -100 are respectively 55.8t and 50.4t, while the maximum landing weights stand at

"We are very pleased. The A220 is now part of the family, a very dynamic one. It's a very positive message"

FLORENT MASSOU
A220 programme chief, Airbus

58.7t and 52.4t.

Unencumbered by legacy production processes and cockpit designs, the A220 took advantage of sidesticks, fly-by-wire technology and advanced construction, including a resin transfer infusion process to develop the composite torque box for the wing.

The A220's radical Pratt & Whitney PW1500G geared turbofan (GTF) engines – featuring a 1.85m (73in) fan and 12:1 bypass ratio – appear to have escaped the problems that dogged early production of the sister PW1100G for the A320neo.

Early operator Swiss, however, has experienced several low-pressure compressor rotor fracture problems, which are suspected to be linked with high thrust settings during high-altitude climb, and have resulted in temporary operational restrictions on the type. These limit engine power to 94% of N1 while above 29,000ft.

Analysis of the problem indicates a possible link to electronic engine-control software. Massou says the limitations are a "precautionary measure", adding that he is "confident" P&W will succeed with root-cause analysis and resolution.

Massou says the A220 is meeting fuel-burn targets and there are no immediate plans for either a thrust enhancement or specific performance tweaks. "The current performance of the engines is OK, and it is where it needs to be," he states.

FADEC plays a key role for Swiss by providing the A220's steep-approach capability, necessary for London City airport operations, adjusting the idle thrust while the fly-by-wire differentially deflects spoilers.

Transport Canada certificated the

A220 with 180min extended twin-engine operations approval, and at least one future operator – start-up Odyssey Airlines – views the aircraft as having transatlantic potential.

Airbus has ironically helped nurse the A220 to remarkable health, considering that it had originally declared the Bombardier jet to be dead on arrival.

As the 110-seat Bombardier BRJ-X concept somewhat stumbingly, evolved into a 110- to 130-seat family, the Canadian airframer – after false starts – boldly launched the two-member CSeries family in 2008, with little more than a tentative agreement for up to 60 jets from Lufthansa Group.

DIFFICULT BIRTH

Airbus had confidently dismissed the potential threat, insisting that its strategy of developing the re-engined A320neo using the CSeries' GTF powerplants would close off the market to Canada's young pretender. Its A319neo – the direct competitor – would leave the CSeries with "virtually no business case", the airframer's outspoken then-sales chief John Leahy declared.

The market has decided otherwise, although convincing potential operators has been a slow process.

While Lufthansa, which ordered the jets for Swiss, gave the CSeries an early lift, Bombardier doggedly had to persist in building a customer base, picking up piecemeal agreements, often from fringe carriers, as it sought an elusive blue-chip deal.

It had accumulated orders for fewer than 250 aircraft in the seven years following launch, when a financial crisis engulfed the programme in 2015.

Bombardier overhauled its top management and sales strategy, and sought investment for the CSeries, offering a stake in the programme to Airbus – which declined – before the Quebec government stepped in with a \$1 billion bail-out.

The shake-up appeared to revitalise the programme and brought crucial large-scale network carrier orders from Delta and Air Canada, and Bombardier delivered the first aircraft, to Swiss and Air Baltic, in the second half of 2016.

But having done the hard work, seen the CSeries to completion, and notched up just over 400 orders, a weakened Bombardier surrendered the programme to Airbus – whose own A319neo was selling poorly – the following year, beginning a landmark break-up of Bombardier's entire commercial air transport business.

While Airbus still relies on Bombardier for some services, says Massou, the integration has reached a point where "all the [A220] functions in Airbus are just working like any other programme". Procurement, supply-chain agreements, sales and marketing have all been transferred and the support network is being finalised.

"We are very pleased," says Massou. "The A220 is now part of the family, and a very dynamic one. It's a very positive message."

Airbus's influence has been demonstrated by the sales record. Massou says some 300 orders and commitments have been added just in the first 18 months under the airframer. At the close of 2019, firm orders stood at precisely 600.

"There are endorsements by big lessors," Massou points out. "I think it gives confidence to the future of the programme. Without Airbus that >>>



PW1500G geared turbofan engines escaped the problems that hit early production



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» would have been difficult.” Overall production of the A220 has reached triple figures, the 100th aircraft having been delivered to Air Baltic – which was one of the strongest early supporters of the jet.

SECOND OVER-WING EXIT

The A220 features a characteristic five-abreast interior. Transport Canada and EASA originally listed a maximum of 127 passengers for the -100 and 145 for the -300, but Bombardier has since offered a high-density version with 160 seats, requiring the addition of a second over-wing exit.

Air Canada became the latest operator of the type in January, its A220-300 having been configured with 137 seats in two classes, with in-flight entertainment systems.

It was the first to receive a dual aft lavatory option, with a moveable wall to convert to a facility for mobility-impaired users.

Massou says the airframer has also developed a new higher-capacity cabin, providing airlines with the option of up to 149 seats with a single over-wing exit. Czech Airlines has disclosed that it will take A220-300s with a 149-seat layout.

Airbus has been working to bring up the dispatch reliability, which it says is currently running at about 99%, and has also commenced data studies that are intended to maximise aircraft availability by increasing maintenance interval times.

This effort would extend the light-maintenance interval from 850h to 1,000h and similarly expand that for base maintenance from 8,500h to 10,000h. Heavy structural checks would take place at 12 years.

Massou says Airbus is working to improve the A220’s maturity, claiming that intense efforts have reduced by four-fold the number of parts that are late in production, reducing disruption to the industrial system.

He adds that the airframer is focused on ramp-up, rather than any ambitious development of further variants, capitalising on Bombardier’s withdrawal from the commercial aviation market to

restructure and increase the efficiency of A220 production at its Montreal Mirabel site.

Bombardier has chosen to divest the CRJ regional jet programme to Mitsubishi Heavy Industries, and Massou says that, with the CRJ exit from the end of this year, Airbus has been working on a programme it calls a “pre-final assembly line” in order to support the planned A220 ramp-up.

“It’s something we have developed to cope with much higher rates,” he says. “It required something a bit different.”

He says Airbus will “take advantage of the CRJ jigs on site” and plans to change the way the airframer completes the A220 mid-fuselage before it undergoes fuselage join on the final assembly line.

This would apply to aircraft destined for final assembly at both Mirabel and the new US line in Mobile, Alabama. Massou says the pre-final assembly line facility, located in a building adjacent to the Mirabel final assembly line, will be ready in the second half of 2021.

TARGET EXCEEDED

Airbus handed over 48 A220s last year, exceeding its target of 45 and taking the total number of delivered aircraft to 105. Two-thirds of overall deliveries have taken place in the 18 months under Airbus.

Massou says there are no plans for a further final assembly line. Fourteen aircraft per month – 10 from Mirabel, four from Mobile – is Airbus’s production target.

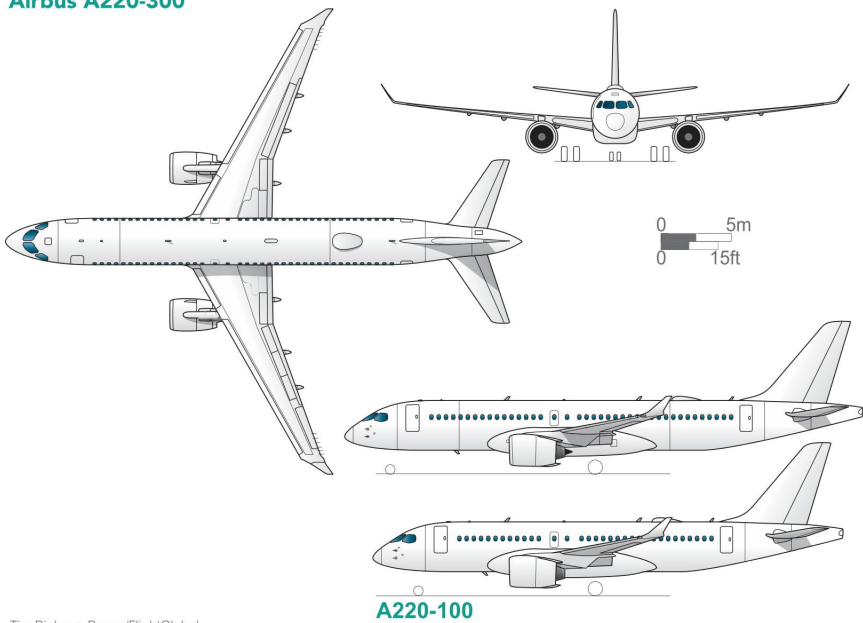
Five aircraft were in production at Mobile at the end of 2019. Initial deliveries from the plant, with a starting rate of one per month, are scheduled to take place this year.

Massou says he is satisfied with the progress Airbus has achieved with A220 production, both in terms of the smooth manufacturing flow and the output.

“We had no problems before Christmas, we delivered everything we had to deliver,” he says. “I went on vacation, for the first time, very happily.” ■

See Cutaways P24/P25

Airbus A220-300



Tim Bicheno-Brown/FlightGlobal

Airbus A220 family specifications

	A220-100	A220-300
Length (m)	35.0	38.7
Span (m)	35.1	35.1
Height (m)	11.8	11.8
Wing area (sq m)	1,209	1,209
Maximum take-off weight (t)*	63.1	69.9
Maximum landing weight (t)	52.4	58.7
Maximum zero-fuel weight (t)	50.4	55.8
Fuel capacity (l)	21,805	21,508
Powerplant options	P&W PW1519G/PW1521G/PW1524G/PW1525G	P&W PW1521G/PW1524G/PW1525G
Thrust options (lb)	18,900/21,000/23,300**	21,000/23,300**
Maximum seating	135	160
Typical two-class seating	100-120	120-150
Max cabin width (m)	3.3	3.3
Max fuselage diameter (m)	3.5	3.5
Design range (nm)*	3,400	3,350
Max cruise speed (Mach)	0.82	0.82
Normal cruise speed (Mach)	0.78	0.78

*From mid-2021 **PW1524G/PW1525G (latter has 5% additional thrust for non-static conditions)
Source: FlightGlobal/Airbus



Design took advantage of sidesticks, fly-by-wire technology and advanced construction

A220 operators

Operator	Variant	In service*	On order
Air Austral	300	0	3
Air Canada	300	1	44
Air France	300	0	60
Air Tanzania	300	2	2
Air Vanuatu	100/300	0/0	2/2
AirBaltic	300	22	28
Czech Airlines	300	0	4
Delta Air Lines	100/300	29/0	16/50
Egyptair Express	300	8	4
Falcon Aviation Services	300	0	2
GTLK - State Transport Leasing	300	6	0
Gulf Air	100	0	10
Ilyushin Finance Company	300	0	14
Iraqi Airways	300	0	5
JetBlue Airways	300	0	70
Korean Air	300	10	0
Lease Corporation Int'l	100/300	0/0	3/17
Macquarie AirFinance	300	0	40
Moxy Airways	300	0	60
Nordic Aviation Capital	100/300	0/0	6/14
Odyssey Airlines	100	0	10
SaudiGulf	300	0	16
Swiss Int'l Air Lines	100/300	9/20	0/1
Undisclosed	100	0	10
Total		107	493

* Includes aircraft in storage
Source: Cirium fleets data (January 2020)

The Way Forward for Special Missions

The special mission aircraft market has been undergoing a profound change in recent years. Traditionally, such platforms relied on large sensors such as stand-off radars, electronic surveillance and signals intelligence. These strategic platforms required specially modified commercial or military aircraft, designed specifically for each mission.

With sensors and electronics becoming ever more compact and versatile and aircraft platforms becoming more diversified, users tend to replace commercial aircraft traditionally used for strategic special missions with business jets, and delegating some of the tactical missions to UAS. Israel Aerospace Industries (IAI), one of the world's pioneers in special mission aircraft and UAS, has been leading this trend by offering compact special mission aircraft since the early 2000s, when ELTA Systems, a subsidiary of IAI, began utilizing business jets for strategic special mission aircraft.

Modern business jets provide all the attributes of large aircraft in an agile and efficient package. Different business jets are available of various applications. The most common are the medium and large aircraft from Gulfstream, Bombardier and Embraer.

The main characteristics of making business jets suitable for special missions are:

Size: Medium and large size business jets offer a combination of spacious cabin size, generous payload volume and weight and ample onboard power & cooling to support the entire suite of systems required for the mission. These attributes are not yet available with unmanned platforms.

Agility: Business jets are smaller, lighter, and have a higher thrust to weight ratio, thus offer better performance compared to commercial jets. They can climb faster to a higher operating ceiling, able to deploy from small airfields, and are capable of extended flight ranges and longer mission endurance.



Efficiency: While commercial and cargo aircraft are designed to carry loads at the lowest cost per seat, business jets are designed to best adapt to customer's requirements and deliver maximum performance per mission at an optimal life cycle cost.

IAI offers different special mission aircraft solutions based on Gulfstream 550 and Bombardier Global 6000 platforms. The most familiar applications are airborne early warning (AEW), Multi Mission Aircraft (MMA), Maritime Patrol Aircraft (MPA), and Special Electronic Mission Aircraft (SEMA). The Global 6500, Bombardier's latest and most advanced business jet, will soon be added to IAI's family of special mission platforms. These are well adapted for strategic missions, able to fly faster, higher and farther than the jets or turboprops previously designed for such missions.

Aircraft configured for special missions are equipped with sensor suites, operating workstations, communications and self-protection systems. Today's modern radars cover large airspace and surface area over land and sea, offering superior performance over the large and heavy mechanically rotating radars of the past. The modern and advanced radars developed by ELTA are based on state of the art Active Electronically Scanned Arrays (AESA) mostly based on the latest Gallium Nitride technology. They employ advanced processing and target detection and classification algorithms enabling more efficient operation by smaller crews. These crews can also be assisted by additional operations on the ground.

Signals Intelligence is another key sensor for special mission aircraft. ELTA SIGINT systems are integrated into many of special mission aircraft on platforms delivered by IAI or other OEMs. This includes integrating radars, SIGINT and communications systems into unified system suites.

Special mission aircraft based on turboprop aircraft are still relevant where users benefit from commonality across their fleet. IAI ELTA, in association with Airbus, developed an AEW radar for the Airbus C295 aircraft for air forces using the C295 as a tactical transport.

With the addition of smaller types in the business jet category, special mission bizjets are not limited to strategic missions. Offering more efficient operation and quick response, business jets are becoming well adept to maritime surveillance and patrol missions previously performed by turboprops that are able to fly at low speeds and altitude. These aircraft can also provide Anti-Submarine Warfare and Anti Surface Warfare (ASW & ASuW) capability.

Witnessing a strong demand for business jet based special mission aircraft for at least 20 years, IAI has expanded the solutions range it offers. Apart from the Gulfstream 550 and Global 6000/6500, the company now offers smaller business jets, such as the Challenger 650 and Embraer Praetor 600, for missions that demand more affordable solutions, while maintaining the advantage of high-performance platform with advanced payload capability.

For IAI, business jets are the way forward for special missions.

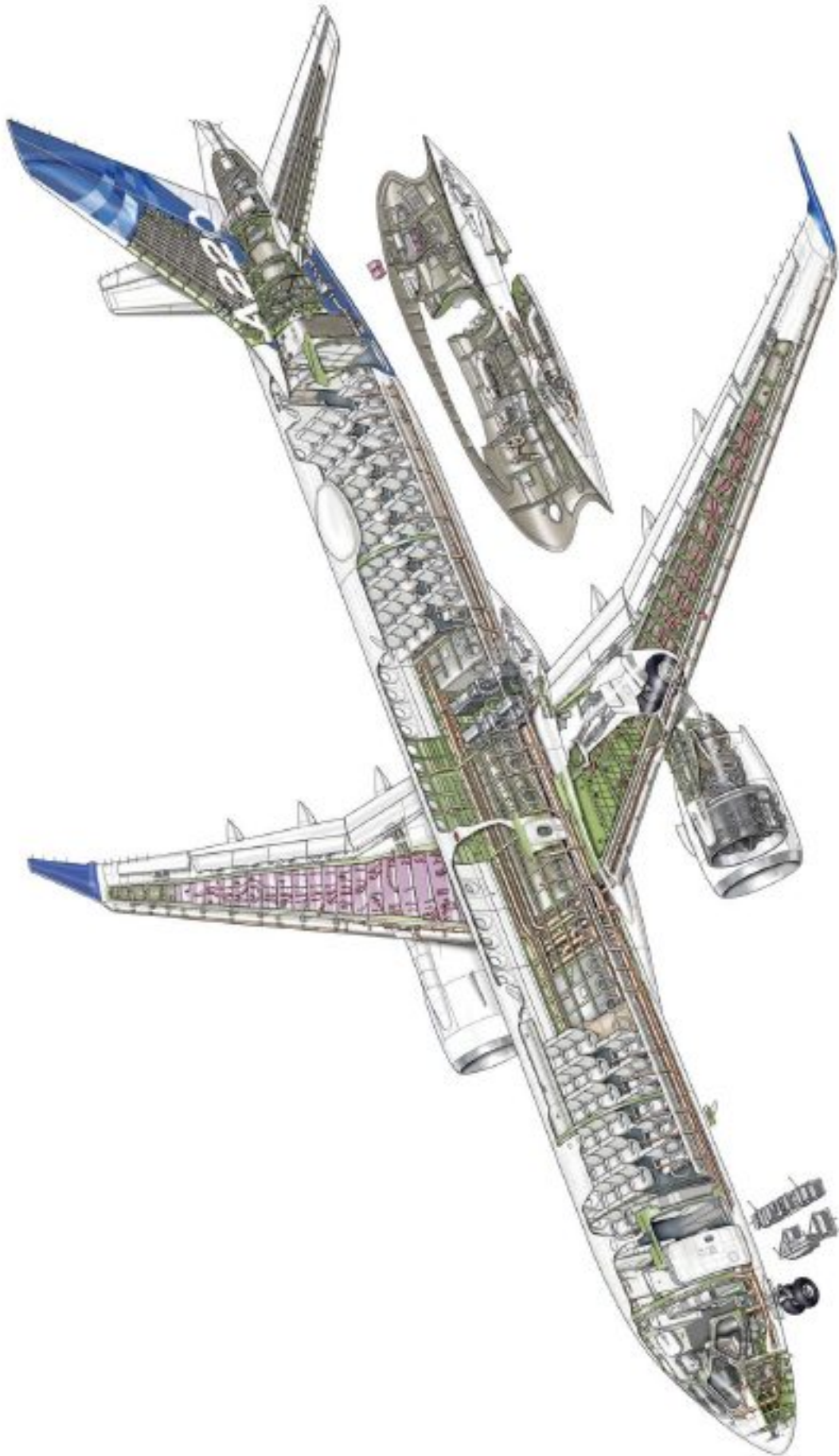


A220-100





A220-300



SINGAPORE'S SUPERJUMBO



By MAX KINGSLEY-JONES

Singapore Airlines (SIA) and Airbus's A380 superjumbo have been inextricably linked for the past two decades. The airline has been at the forefront of each major development of the ultra-large airliner, from cradle to grave.

And while it would be an exaggeration to say that SIA and the A380 is a love story that turned sour, it is certainly true that the aircraft never quite achieved the high expectations Airbus had when the airline signed up its original commitment for what was then the A3XX project 20 years ago.

SIA was one of a number of major Boeing 747 operators that were key to the development of Airbus's own super-large aircraft. It was part of the original airline advisory group with many other prospective future customers.

As the Airbus superjumbo studies crystallised around the double-deck design that would effectively become today's A380, Toulouse needed to secure formal backing from the market. So in 1999 and 2000 the manufacturer's senior management – led by Airbus chief executive Noel Forgeard –

Other than Emirates, SIA has been the airline most associated with the world's largest airliner. We chart the history of the relationship between the carrier and the A380 from the giant type's conception to the programme's ignominious cancellation

set about securing "letters of interest" from prospective customers to support a decision to launch the programme.

In May 2000, SIA became the second carrier to sign a letter of interest, signalling its intention to order up to 10 A3XXs once the programme was launched. Emirates had led the way, with an earlier agreement for five aircraft – this modest deal gave little hint of the huge role the Dubai carrier would subsequently play in the A380's fortunes.

Despite SIA's statement of support, firming up its A3XX "interest" was ap-

parently no slam-dunk for Airbus, as the airline continued to evaluate the 747X stretch proposal from Boeing as an alternative. At the time, SIA was a major operator of the original jumbo jet, with 36 passenger 747-400s in service and a further eight -400 Freighters.

However, Airbus eventually won the day, with SIA moving its agreement on to a firmer footing in September 2000 when it signed a commitment – valued at the time at \$8.6 billion – for up to 25 A3XXs, including 15 options. The A380 would

eventually succeed the 747 as SIA's fleet flagship.

Significantly, Airbus had been pushed by SIA during contract negotiations to refine the A3XX's noise performance to ensure its compliance with more stringent requirements being introduced at London Heathrow, referred to as "QC2".

To achieve this, the two A3XX engine suppliers – Engine Alliance and Rolls-Royce – confirmed they would develop larger fan versions of their engines to ensure noise compliance. Shortly after signing its A3XX commit-

ment, SIA confirmed it had selected R-R to supply the engines, which gave the UK pole position on the programme as its new customer was to be launch operator.

By the end of 2000 Airbus had secured sufficient backing from customers to move ahead with a programme launch. The 555-seater, now named A380, was given the go-ahead on 19 December 2000 with a tally of 50 firm orders. Alongside SIA, customers included Air France, Emirates, US lessor ILFC, Qantas and Virgin Atlantic.

At the time of launch, the first flight of the A380 was for 2004, with deliveries due to begin to first operator SIA in early 2006. This schedule subsequently turned out to be ambitious: the programme experienced several delays during development – both before and after its first flight.

FIRM CONTRACT

But all that was in the future when SIA completed contract negotiations and signed a firm contract for the A380 on 16 July 2001. The deal mirrored the original commitment, comprising 10 firm orders for the A380-800, worth \$2.5 billion, along with options on a further 15. It was due to receive all



SIA has placed two A380 re-orders, but partly to replace older aircraft



In the evacuation test, 873 people got out of the aircraft in 78s

frame was delayed by the wiring glitch and the aircraft eventually rolled off the line for a first flight on 7 May 2006. To be registered 9V-SKA, MSN003 headed from Toulouse to Hamburg for its interior installation and customisation.

As the certification programme progressed, a key milestone was passed in March 2006 with the emergency evacuation demonstration. The full-scale trial was undertaken in Hamburg on 26 March 2006: 853 passengers, 18 cabin crew members and two pilots left the aircraft within 78s.

Despite the delays, SIA reaffirmed its commitment to the Airbus giant during 2006 by firming up orders for

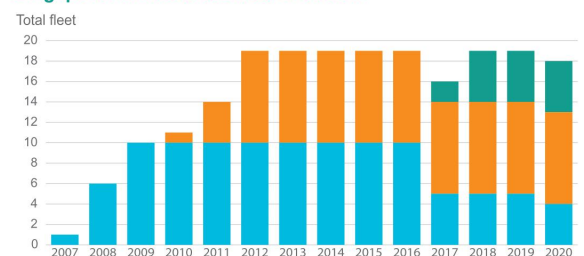
nine more A380s, taking its total orderbook to 19 aircraft. It was an important statement of support for Airbus as it worked to launch series production of the aircraft.

CONSERVATIVE APPROACH

European and US A380 type certification was awarded on 12 December 2006. However, the industrial delays had forced Airbus to take a conservative approach to bringing the ultra-large aircraft into service as it battled to get on top of the issues.

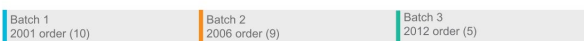
As a result, another 10 months would pass before the first A380 was formally handed over to launch operator SIA. The momentous event for

Singapore Airlines A380 fleet evolution



Note: Year-end in-service fleet (2020 projection)

Source: Cirium fleets data



10 firmly ordered aircraft by the end of 2007.

By 2002, as development progressed, the first flight schedule for the A380 had slipped in to 2005. The first aircraft, MSN001, was finally rolled out at a glitzy ceremony held at the new purpose-built production facility in Toulouse on 18 January 2005. Three months later, on 27 April, MSN001 lifted off to initiate its flight-test and certification programme.

While the first flight had gone smoothly, the same could not be said for the industrialisation of the A380 programme. It quickly became apparent that, owing to production management issues, the plan to deliver the first aircraft in 2006 was unrealistic. Eventually the delivery schedule was reorganised around a fourth-quarter 2007 target, as Airbus worked hard to resolve the infamous "wiring issues" that plagued production of the early aircraft – caused by incompatibility of design software used by French and German divisions.

Meanwhile, production was under way on MSN003, the first customer A380 for SIA, the sub-assemblies for which entered the final assembly line during 2005. Completion of the air-

The 555-seater was given the go-ahead on 19 December 2000 with 50 orders. Customers included Air France, Emirates, US lessor ILFC, Qantas, SIA and Virgin Atlantic



Portugal's Hi Fly now operates one A380 formerly owned by SIA – and it has plans to take more secondhand examples



SIA currently operates 19 of the Airbus superjumbos

Airbus took place at its shiny new delivery centre in Toulouse on 15 October 2007 – around 18 months later than the original schedule at launch.

The 471-seater was accepted by SIA's then chief executive, Chew Choon Seng, who said: "Although it has taken more time than first anticipated, the A380 is well worth the wait. From today there's a new 'queen of the skies' for air travel."

Airbus's then chief executive, Tom Enders, recognised the "landmark day" for everyone involved in the programme.

SIA wasted no time in introducing its new flagship, operating the first passenger service 10 days after delivery, on 25 October. The inaugural flight (SQ380) from Changi to Sydney on 28 October and the aircraft subsequently served London Heathrow and Tokyo Narita as part of its early network.

NEW ORDER

By 2012 SIA had taken delivery of its original batch of 19 A380s and placed a top up order for an additional five aircraft, taking its total commitment to 24

"The A380 is well worth the wait. From today there's a new 'queen of the skies' for air travel"

CHEW CHOON SENG
SIA chief executive (2006)



SIA boss Chew Choon Seng accepted the first aircraft from Airbus in 2007



SIA's latest A380 suite includes a full lie-flat bed and a leather seat

– just one short of the number it had originally signed for in 2000.

However, before these new aircraft had arrived, in 2016 SIA dropped a bombshell for the A380 programme when it confirmed that it would not be extending leases on its early batch of aircraft.

This meant that as the new batch arrived from 2017, featuring updated cabin layouts, withdrawal of the oldest A380s began. The airline's fleet of superjumbos ultimately peaked that year at 20 aircraft, according to Cirium

fleets data. By early 2020 SIA had withdrawn its first five aircraft and is operating a fleet of 18, with the 14 remaining from the original batch being included in the \$850 million cabin refurbishment.

November 2017 marked the beginning of the end for SIA's original A380, when MSN003 was ferried with its SIA livery removed from Singapore to Tarbes, in southern France. The aircraft had been returned off lease to its German owner, Dr Peters Group, in June that year and was taken into the care of Tarbes-based aircraft recycling specialist Tarmac Aerosave.

MSN003 is one of two ex-SIA A380s parted out for spares by Tarmac, which says it has managed to recycle more than 90% of the aircraft's overall mass and is now offering the spares on the secondhand market.

Two other ex-SIA A380s remain in storage and a third is operating with Portuguese wet-lease specialist Hi Fly, which says it plans to take more of the second-hand superjumbos.

Speaking in September 2019, chief executive Paulo Mirpuri said that operations of Hi Fly's single A380 had been going well: "It cannot go anywhere, to any airport, so the A380 is a niche market aircraft, but there is good demand [for it]."

SIA's youngest A380s arrived as recently as 2018. So while the retirement of its early aircraft after just a decade was a setback, the type is set to remain in the airline's fleet for many years to come.

Tarmac Aerosave began recycling SIA's first two A380s last year



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STRUCTURED FOR SUCCESS

MARC DUVALL leads Collins Aerospace's aerostructures business, based in Chula Vista, California. He explains to *Flight Daily News* where the unit fits into the wider Collins empire and the way in which it serves the global industry

Q Collins Aerospace's aerostructures business has been through a number of identities over the past 20 years or so, with legacy brands including Rohr, Goodrich and UTAS. Give us an idea of that evolution, and where the business sits now within the company.

A Rohr Aircraft was founded in 1940 by Fred Rohr. Today, the main product lines include nacelles and related aircraft components such as pylons, doors and flight-control surfaces, along with naval structures.

In 1997, Rohr merged with Goodrich Corporation and continued to focus on aerostructures. Goodrich was then acquired by UTC in 2012 and was merged with Hamilton Sundstrand to create UTC Aerospace Systems.

Finally, UTC Aerospace Systems and Rockwell Collins joined forces in late 2018 to form Collins Aerospace. Aerostructures is one of six strategic business units within Collins and remains headquartered at the original Rohr Aircraft site in Chula Vista, California. August 2020 will mark the business' 80th anniversary.

Although the brand has changed, the core focus of the business has continued to be highly engineered aerostructures with a strong lean manufacturing culture.

A key enabler of this is the development of novel materials and product/manufacturing technologies. We have always focused on innovation, and will continue to do so for future platforms, as well as integrating them into current products, which typically remain in service for 20 years or more.

Q What are the main products of the business unit, and what platforms do you support? How are your activities split roughly between original equipment and aftermarket, between landing gear and nacelles, and between the wide-body and single-aisle segments?

A Our aerostructures business is the industry trusted partner for design, manufacture and support of aerostructures in commercial, business, and military markets. Our focus is on aircraft nacelles, doors, pylons, and wing and tail components, along with naval structures.

These products are enabled by our expertise in advanced materials and manufacturing and advanced noise-reduction technologies built on a legacy of innovation, and a continuous-improvement culture.

Recently, we have developed and certified 17 aircraft programmes in the past 15 years. These new programmes include the Boeing 787, Airbus A350, A320neo, A220, Embraer E2 family and KC-390, among others.

Going forward, we are focused on innovation to improve the cost, performance and sustainability we offer our customers. Examples of these focused efforts include thermoplastics, high-temperature materials and advanced acoustic attenuation technologies.

We continue to invest heavily in associated advanced industrial capabilities, including automation, out-of-autoclave and additive manufacturing, to develop industry-leading products for our customers.

Customer service is at the centre of what we do for our original equipment (OE) and aftermarket services. For our



OE customers, we co-locate engine/nacelle integration services at the customers' final assembly lines.

For our aftermarket customers, we offer eight MRO sites located strategi-

cally around the world with more than 1.2 million sq ft (111,000 sq m) of shop floor. We offer a suite of MRO service programmes that are customised to the unique needs of the customers.

We also distribute rotables and spares, supporting more than 50,000 part numbers from global distribution centres – 96% of which are delivered within two days. We also provide 24/7 worldwide technical services as required by the airline operators.

Q Some of your main commercial platforms, such as the Airbus A350 and Boeing 787, continue to be growth programmes. What are the other areas of potential expansion for Collins Aerospace? How promising, for example, is the business jet sector?

A In aviation, the business jet nacelle market is a strategic initiative for us. We re-entered that market with the Dassault Falcon 6X, and on a second, yet to be announced programme.

We're talking with business jet manufacturers about additional opportunities as well. With our track record of success in commercial aviation, we plan to bring that spirit and expertise to business aviation.

Another area of potential expansion

is reinvigorating our position in other structural components such as doors, flight control surfaces (FCSs) and pylons.

For example, we have more than 20 years of experience and more than 18,000 FCSs shipped. From our industry-leading metallic Gridlock technology to our integrated composites that reduce weight and cost, we continue to develop and evolve the next generation of components and technologies that will redefine aerospace.

Q Looking to the aftermarket, how is Collins Aerospace using the potential of big data analytics to provide the predictive maintenance support that will help operators cut maintenance costs?

A In Collins' aerostructures business, as an industry leader for 65 years we've accumulated significant performance data and maintenance-cost data on our structural products.

Typically our structural products are maintained on an "on-condition" basis. Our extensive database is used to enable us to optimise work scopes and recommended overhaul periods. From our customers' perspectives, this optimises their aircraft uptime and minimises their cost of ownership. ■



Aircraft nacelles are one focus for Collins, with 17 programmes certified in the past 15 years, including one for the Airbus A350



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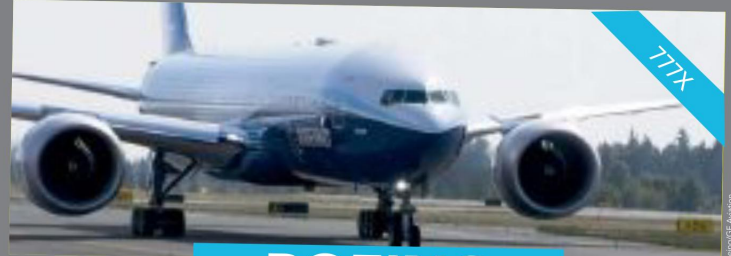
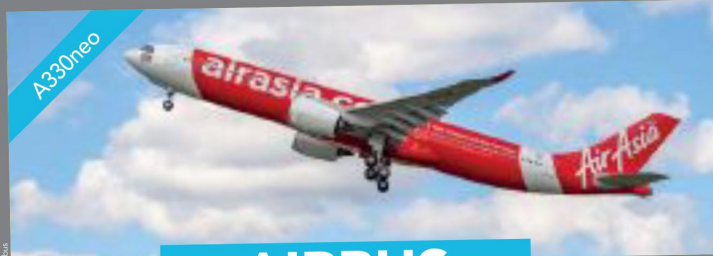
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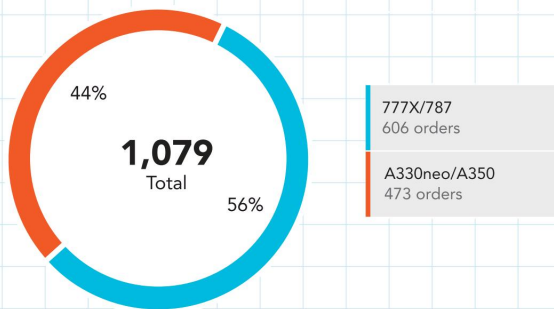


TWIN RIVALRY


AIRBUS
BOEING

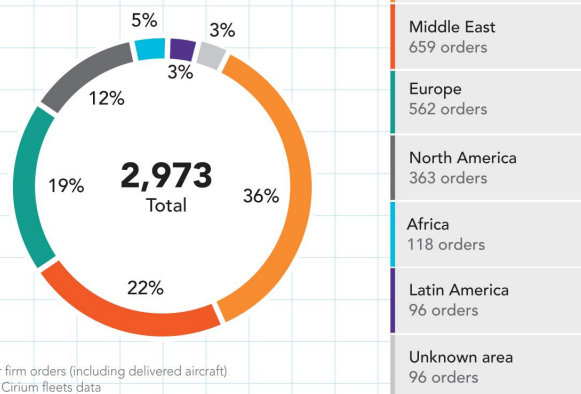
Boeing upped the stakes in the big twin market last month with the first flight of the 777X as it takes on Airbus for supremacy in the widebody sector

Asia-Pacific A330neo/A350 vs 777X/787 order share



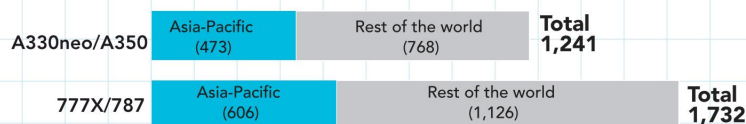
Firm orders (including delivered aircraft) from Asia-Pacific customers
Source: Cirium fleets data

A330neo/A350 and 777X/787 global order share by region



Data for firm orders (including delivered aircraft)
Source: Cirium fleets data

A330neo/A350 vs 777X/787 global order share

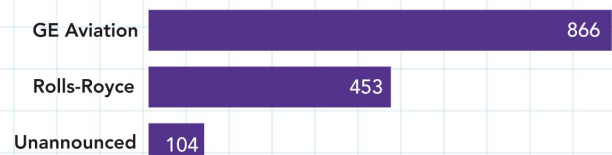


Data for firm orders (including delivered aircraft)
Source: Cirium fleets data

36%

Asia-Pacific is the largest market for big twins, with more than a third of all orders

787 orders by engine manufacturer



Total orders 1,423

Data for firm orders (including delivered aircraft).
A330neo and A350 only offered with R-R engines, 777X with GE engines
Source: Cirium fleets data

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T: +44 (0)20 911 1490
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Carlos Casal

Sponsorship Manager
T: +44 2039946411
M: +44 7415653857
carlos.casal@flightglobal.com

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Lifting prospects
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CHARGED WITH KEEPING SINGAPORE'S SKIES SAFE

KEVIN SHUM, director-general of the Civil Aviation Authority of Singapore (CAAS), has a key leadership role in the country's regulatory regime, as well as the future of Singapore as an aviation hub. He explains the broad range of opportunities and challenges facing Singapore's airborne future

Q What are the key highlights in Singapore civil aviation since the last show?

A Since the last show, we have been focused on improving our value to the users of our Air Hub, passengers and airlines. We need to do this while bearing in mind our constraints, such as land and human capital. With the acceleration in aviation growth, demands on the system, and on our workers, are growing in magnitude and complexity. Our workers are facing more pressure, operating in a more globalised, digital and fast-changing environment.

We have been working in close collaboration with the aviation community and our partners along three key thrusts. The first is innovation and speed. These are particularly significant for terminal operations. To cope with growth, faster terminal processes are required. At the same time, we have to delight passengers. We want more speed, but less haste. With innovation, we can accomplish this.

The second is technology and productivity. We are tapping into the opportunities that new and cutting-edge technologies offer to improve our capabilities and enhance our productivity. CAAS continues to make significant investments to enhance our air traffic management (ATM) capabilities and prepare for future growth.

Digitalisation will be an essential enabler towards being future-ready. This is why we embarked on our smart tower project in 2017. The smart tower project will digitalise tower operations, use data to optimise aircraft ground movements, enhance productivity, and increase capacity. We are currently running shadow operations for our Smart Digital Tower prototype. This is essential in helping us evaluate the feasibility of Smart Digital Tower operations for Changi airport.

Finally, it's about being future-ready. Our aviation industry is characterised by long lead times. It takes years to put in new infrastructure, and for aircraft orders to be delivered. So, to realise our vision for tomorrow, we have to prepare for the future today.

To meet the rising demands of air travel, we are upgrading existing infrastructure and scaling up our capacity. Upgrading works at Changi airport Terminals 1 and 2 will increase the airport's passenger-handling capacity and improve passenger experience. Multi-dimensional tourist destination Jewel Changi also opened its doors in 2019. We are making good progress with our Changi East project.

While driving these industry transformation initiatives, we remain steadfast in maintaining the highest levels of safety. For example, the Changi Aviation Medicine Centre was also established last year to better cater to the unique medical needs of pilots, air traffic controllers and other aviation professionals.

We have also enhanced our unmanned aircraft regulatory regime, while facilitating innovative use of this fast changing technology.

We are now at an exciting point for aviation in Singapore. We look forward to creating more partnerships with industry and delivering meaningful value to all our community.

Q Singapore will require all drones to be licensed. Can you explain the rationale?

A Mandatory registration of drones above 250g is an important part of our enhanced regulatory framework to ensure that drones can be used in Singapore safely. Its purpose is to help create greater accountability and traceability among drone users. Many countries around the world such as the US, UK, China and Australia have also done the same.

Q Given changes in drone technology and urban air mobility, regulators tread a fine line between over-regulating, which stifles innovation, and under-regulating, which could present safety issues. From a regulator's perspective, how is



this dilemma resolved?

A I believe that it is best managed through having a keen appreciation of the technology, its potential and its limitations, while being always ready to experiment, learn and improve our regulations so that they are fit for purpose. To

achieve this, we need to work closely with industry, even as the technology and applications develops and evolves. For example, we are collaborating with four consortiums to co-develop the solutions they submitted for the unmanned air systems (UAS) call for proposal we issued in 2017. These include

solutions for UAS traffic management (UTM) and UAS-based package delivery in urban environments, and the development of UAS for maritime service deliveries.

Q Singapore is seriously considering a remote tower system for managing aircraft movements at Changi. Can you describe the potential benefits Singapore hopes to derive from this initiative?

A Through the Smart Digital Tower prototype, we aim to prove the feasibility of enhancing operational efficiency, improving visibility including line of sight, and enhancing safety and situational awareness for air traffic control officers at the airport. The digitalisation of the operating environment would also create a platform for technology such as artificial intelligence and machine learning to be introduced. Digitalisation would also allow a recording of activities and allow analysis of events ex-post.

Q The 737 Max grounding has called into question the traditional system of certification, whereby national agencies largely trusted overseas counterparts on issues pertaining to certification. How do you feel the handling of the issue has changed the traditional way of doing things?

A Our industry has always been characterised by constant striving to do better, to make aviation safer. The international system of aircraft certification is no different, and I believe that I and my international colleagues will take to heart the lessons from the 737 Max accidents and grounding to continue working towards improving aviation safety. I hope we take on the need for even greater honesty, transparency, and collaboration between regulators and industry. At the same time, we need to review our policies and practices to guard against this proximity leading to regulatory capture. Safety must never be compromised for cost and efficiency.

Q Finally, do you see the role of regulators such as the CAAS changing in the 2020s? If so, how?

A With global passenger numbers forecasted to soar to 8.2 billion in 2037, air traffic will become more complex. There will be more pressures from new business models, disruptive technologies, as well as human factors. These pressures will demand a more collaborative, agile and flexible regulatory regime. At the same time, we must ensure that aviation safety is not compromised. In this regard, CAAS will remain committed to building a robust and progressive regulatory framework to support industry developments and needs, while upholding high standards of safety. ■



CAAS smart tower project is aimed at creating a remote system for managing aircraft movements at Changi



LIFTING PROSPECTS

Q What are Boeing's key defence focus areas at this year's Singapore air show?

A The Singapore air show provides us with an ideal opportunity to engage with defence and government customers from the Asia-Pacific and around the globe.

At this year's show we'll focus on talking with customers about our vertical lift and commercial derivative aircraft portfolios and the best-in-class capabilities they offer across a range of humanitarian and self-defence missions.

We'll also introduce our new Boeing T-7 to the region through our exhibit, customer meetings and a press event. Finally, we'll highlight the wide range of services and sustainment programmes we can offer as stand-alone procurements or fully integrated with platform sales.

Q Can you discuss the status of Indonesia's potential purchase of CH-47 Chinooks?

A The Indonesian air force has expressed interest in adding heavy-lift helicopter capability to its force structure and we have responded with information on our CH-47F Chinook in partnership with the US government. The Chinook is the most proven and capable heavy-lift helicopter in the world, as evidenced by its use in more than 20 countries – six of which are in the Indo-Asia-Pacific region. The CH-47F is ideally suited for disaster assistance, humanitarian relief and cargo missions in this region, and we stand ready to support continued dialogue between Indonesia and the USA on this potential procurement.

Q Can you provide an update on the T-7A Red Hawk programme?

A We continue to prove out the flight-performance capabilities of the T-7A through a rigorous developmental test programme, often flying our two existing aircraft multiple times daily. We have also successfully performed numerous supplier critical design reviews (CDR) and conducted a successful air vehicle CDR. In total, we are rapidly approaching 150 test flights on the programme to date.

Q Before last year's Paris air show, you said that the company has road-mapped 2,600 opportunities for the T-7 trainer and potential derivatives. Half a year on, has that number gone up or down?

A Following engagements at the Paris, RIAT and Dubai shows last year, and with the unveiling of the official T-7A Red Hawk name by the US Air Force, we only see increasing excitement and interest in the T-7 programme around the globe. We stand by our projection that a 2,600-aircraft global addressable market exists for the platform, including trainer, aggressor and light-fighter derivatives, combined with lifecycle services and sustainment opportunities.

JEFF SHOCKEY is vice-president global sales and marketing for Boeing's defence, space and security and global services divisions. He leads a team representing the airframer's defence, space and government services offerings around the world



Q Boeing sells defence products both through the foreign military sales process and through direct commercial sales. Can you describe Boeing's role in each type of transaction?

A Direct commercial sales (DCS) are business-to-government transactions that occur directly between companies like Boeing and global defence and government customers. Foreign military sales (FMS) are government-to-government transactions between the US government and its international counterparts. In both scenarios, Boeing works closely with customers to understand their capability, cost and schedule requirements in order to develop solutions tai-

lored to their needs. The two paths diverge most significantly in the formal offer and contracting phase of the process, where the government steps in to lead on FMS and the Boeing team handles DCS deals.

Q Boeing and its competitors have made much of Indian requirements for new air force and navy fighters. Have you seen any traction in these competitions?

A The Indian navy and Indian air force have clearly stated needs for medium multi-role fighters and we're working with them through their procurement processes. We responded to the Indian navy's RFI for 57 aircraft and the Indian air force's

RFI for 110 aircraft, and have engaged in numerous follow-on briefings and discussions. We are confident that Boeing can provide India with the best capability fit, unrivalled growth potential, and superior economics in platform and lifecycle costs. We have also committed to partner with India to help build its aerospace ecosystem through supply chain, engineering workforce, innovation and technology investments.

In addition, multiple conversations have taken place between the Indian and US governments on the F/A-18. The opportunities for collaboration between the US and Indian navies on a joint naval aviation ecosystem including carrier integration, training and technology is very compelling, and the

F/A-18 would serve as a lynchpin of that co-operation.

Q Can you describe progress in Australia with the Airpower Teaming System?

A The Boeing Australia team is making great progress with our customer on the first prototype aircraft for the Loyal Wingman – Advanced Development Programme, which is informing our global Boeing Airpower Teaming System (ATS) offering. The first aircraft is currently in production, with support from Australian and other global suppliers. We're looking forward to a first flight of this unmanned aircraft later this year. We're also seeing significant global demand for this type of teaming capability.

Boeing is part of the UK's lightweight affordable novel combat aircraft (LANCA) programme, and our teams are exploring various opportunities in the USA and around the world where ATS-like capability would be a critical force multiplier for future operations.

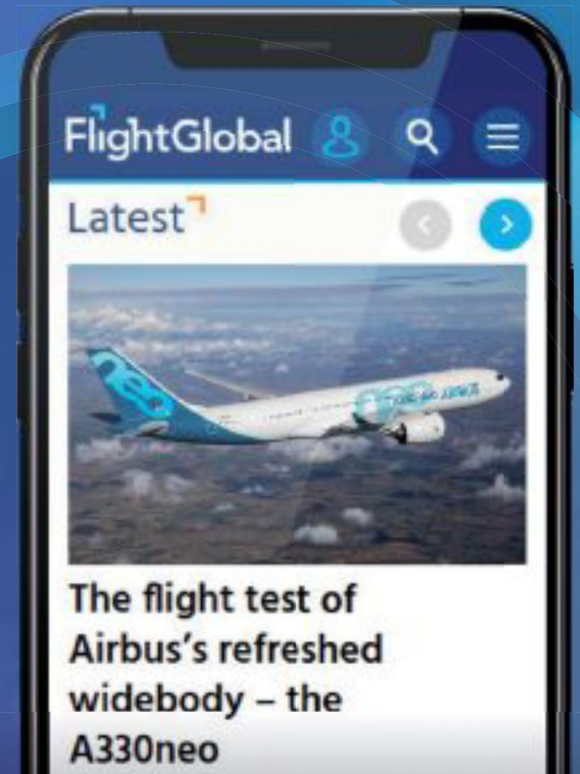
Q Also in June, you said there were up to 10 E-7 airborne early warning and control opportunities globally. How are these campaigns going?

A Following last year's E-7 sale to the UK, we remain optimistic about additional, double-digit global sales opportunities for the aircraft. Preliminary discussions are ongoing with a number of global operators who are interested in the air battle management capabilities offered by the world's only proven, off-the-shelf solution for airborne surveillance, command and control. ■



Indonesian air force has expressed interest in purchasing CH-47F Chinooks to boost its heavy-lift capabilities

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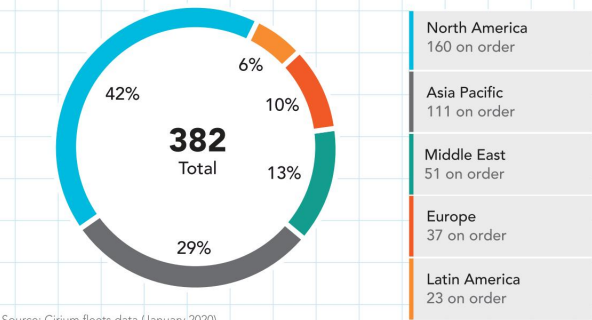
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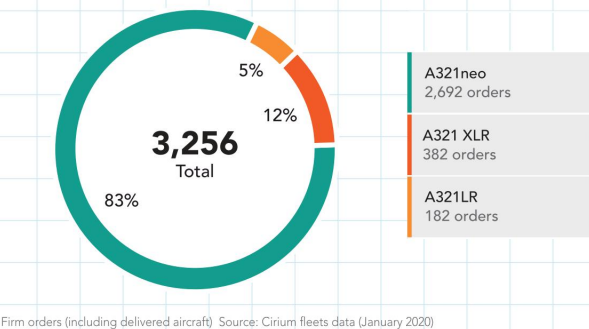
AIRBUS A321XLR

Launched at the Paris air show in June 2019, the extra-long-range variant of the A321neo became an instant best-seller, with service entry expected in 2023

A321XLR total orders by region

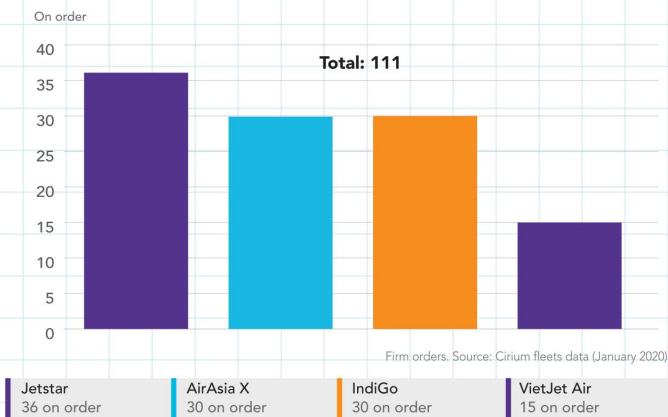


A321neo family orders by variant

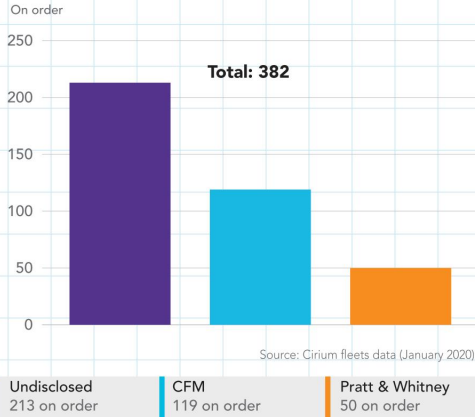


29%
More than a quarter of all A321XLR firm orders are from Asia-Pacific carriers

A321XLR Asia-Pacific customers



A321XLR orders by engine manufacturer



A321XLR top 10 customers

Operator	Orders
American Airlines	50
United Airlines	50
Frontier Airlines	36
Jetstar	36
AirAsia X	30
IndiGo	30
Air Arabia	20
Wizz Air	20
Saudia	15
VietJet Air	15

Firm orders. Source: Cirium fleets data (January 2020)

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